# DEVELOPMENTAL, MODAL, AND PATHOLOGICAL VARIATION — LINGUISTIC AND COGNITIVE PROFILES FOR SPEAKERS OF LINGUISTICALLY PROXIMAL LANGUAGES AND VARIETIES

EDITED BY: Kleanthes K. Grohmann, Maria Kambanaros and Evelina Leivada

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One significant area of research in the multifaceted field of bilingualism over the past two decades has been the demonstration, validation, and account of the so-called 'bilingual advantage'. This refers to the hypothesis that bilingual speakers have advanced abilities in executive functions and other domains of human cognition. Such cognitive benefits of bilingualism have an impact on the processing mechanisms active during language acquisition in a way that results in language variation. Within bilingual populations, the notion of language proximity (or linguistic distance) is also of key importance for deriving variation. In addition, sociolinguistic factors can invest the process of language development and its outcome with an additional layer of complexity, such as schooling, language, dominance, competing motivations, or the emergence of mesolectal varieties, which blur the boundaries of grammatical variants. This is particularly relevant for diglossic speech communities—bilectal, bidialectal, or bivarietal speakers. The defined goal of the present Research Topic is to address whether the bilingual advantage extends to such speakers as well. Thus, 'Linguistic and Cognitive Profiles for Speakers of Linguistically Proximal Languages and Varieties' become an important matter within 'Developmental, Modal, and Pathological Variation'.

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**Editorial on the Research Topic**

**Developmental, Modal, and Pathological Variation—Linguistic and Cognitive Profiles for Speakers of Linguistically Proximal Languages and Varieties**

One significant area of research in the multifaceted field of bilingualism over the past two decades, spanning among many others from Green (1998) to Chung-Fat-Yim et al. (2016), has been the demonstration, validation, and account of the so-called "bilingual advantage." This refers to the hypothesis that bilingual speakers have advanced abilities in executive functions (EF) and other domains of human cognition. Such cognitive benefits of bilingualism have an impact on the processing mechanisms active during language acquisition in a way that results in language variation. Within bilingual populations, the notion of language proximity (or linguistic distance) is also of key importance for deriving variation. In addition, sociolinguistic factors can invest the process of language development and its outcome with an additional layer of complexity, such as schooling, language, dominance, competing motivations, or the emergence of mesolectal varieties, which blur the boundaries of grammatical variants. This is particular relevant for diglossic speech communities-bilectal, bidialectal, or bivarietal speakers.

The defined goal of the present Research Topic is to address whether the bilingual advantage extends to such speakers as well. Thus, "Linguistic and Cognitive Profiles for Speakers of Linguistically Proximal Languages and Varieties" become an important matter within "Developmental, Modal, and Pathological Variation." The larger issue of cognitive-linguistic representations in bilingual speakers is expressed in Putnam et al.'s model for determining language proximity. Building on Hsin's (2014) Integration Hypothesis, the authors sketch a framework in which "bilingual grammars are neither isolated, nor (completely) conjoined with one another in the bilingual mind, but rather exist as integrated source grammars that are further mitigated by a common, combined grammar." Once linguistic distance between the languages of bilingual speakers is measured in computational cognitive architectures, any effects of a bilingual advantage in terms of cognition and memory can be assessed empirically. One such empirical assessment is presented by Bosma et al. who investigate whether degree of bilingualism in Frisian-Dutch children influences EF—and if so, whether this effect is sustained over time. To this effect, they analyzed longitudinal data from Frisian-Dutch bilingual children. The results confirm that "cognitive effects of bilingualism are moderated by degree of bilingualism," where the amount of exposure in

the minority language (i.e., m the home variety) indirectly affects bilingual children's cognitive development. However, as the authors stress, "the findings also demonstrate that the effect of bilingualism on EF is limited and unstable"—a take-home message that is in line with what recent reviews have suggested in relation to the bilingual advantage (Paap et al., 2014; Lehtonen et al., 2018).

A set of three papers further investigates the purported bilingual advantage in combination with sociolinguistic and socio-economic considerations. Blom et al. tested whether the sociolinguistic context of language use affects the bilingual advantage. And indeed, bilingual children outperformed their monolingual peers on selective attention, presumably because they focused on different aspects of the task. Garraffa et al. explore "the effects of bilingualism in Sardinian as a regional minority language on the linguistic competence in Italian as the dominant language and on non-linguistic cognitive abilities" with adults living in Sardinia. No evidence for a "bilingual advantage" emerged through the task that tapped into the cognitive control of attention, but bilinguals did perform better than monolinguals on working memory tasks. In addition, "[b]ilinguals with lower formal education were found to be faster at comprehension of one type of complex sentence," while "bilinguals and monolinguals with higher education showed comparable slower processing of complex sentences." Meir and Armon-Lotem explore the influence of socioeconomic status (SES) and bilingualism on the linguistic skills and verbal short-term memory of Hebrew-Russian bilingual preschoolers, half from low SES backgrounds. The authors propose that bilingualism is associated with decreased vocabulary size and lower performance on verbal short-term memory tasks, while SES also impacts verbal short-term memory with lowest linguistic load. They also argue that "an unprivileged background has a negative impact on children's cognitive development."

Effects of language or linguistic proximity, bi-/multilectal acquisition, and their relevance for the socio-syntax of language development are of particular interest to this Research Topic—that is, apparent sociolinguistic aspects such as formal schooling that may have an effect on the grammatical language development of a child growing up in a bi- or multilectal society. Considering the case of Brazilian (L1) and European (L2) Portuguese bidialectal adults that had moved to Portugal as adults, Castro et al. explore possible differences in the interpretation of null and overt object pronouns. They "test the extent to which [. . .] speakers display cross-linguistic influence in either direction." The high degree of typological proximity between the speakers' linguistic varieties is argued to contribute to L1 attrition and hinder target-like L2 performance at the same time.

There are also four contributions that focus on the differences between the two varieties of Greek spoken in Cyprus. When asked to make acceptability judgments, the performance of speakers of non-standard varieties may actually be subject to interference from factors such as prescriptive notions of grammatical correctness and sociolinguistic values typically attached to "dialects." Recognizing the importance of working with corpora of spontaneous speech, Leivada et al. investigate

variation in the spontaneous productions of adult speakers of the non-standard variety Cypriot Greek. In their corpus, they observed intraspeaker realizations of different values of the same variant within the same syntactic environment; a result that is incompatible with the mainstream "triggering-a-single-value" approach of parametric models. Since the analysis of these conflicting values is ultimately a way of investigating Universal Grammar primitives, the authors further conclude that claims about the alleged unfalsifiability of Universal Grammar are empirically unfounded. Tsiplakou explores the concept of gradient bilectalism by capitalizing on insights from recent developments in second language acquisition, particularly the suggestion that aspects of the syntax-discourse interface that are not easily accessible to the learner may lead to fossilization, even at end state. Based on quantitative data from a questionnaire survey, she suggests that imperfect acquisition of some structural aspects of the standard language may affect bilectals' performance in a way that involves a transfer of features from the dialect to the standard. Themistocleous investigates the effects of two linguistically proximal Modern Greek dialects, Athenian Greek and Cypriot Greek on the temporal, spectral, and co-articulatory properties of fricatives with the aim to determine the acoustic properties that convey information about these two dialects. The results revealed that Athenian Greek and Cypriot Greek fricatives differ in all spectral properties across all places of articulation. The co-articulatory effects of fricatives on following vowel were different across the two varieties, something that suggests that dialectal information is encoded in the acoustic structure of fricatives. The contribution by Ayiomamitou and Yiakoumetti deals with regional linguistic variation and its implications for education by focusing on the Greek Cypriot educational context. The aim of the study was to understand Greek Cypriot primary school pupils' sociolinguistic awareness via examination of their written production in their home variety. The students were advised to produce texts that reflected their everyday way of talking with family and friends (beyond school boundaries and the formal register this environment may induce). The authors found students' texts to include many mesolectal features but also "a significant and unexpected number of basilectal features and instances of hyperdialectism," which rendered their texts register-inappropriate.

Merging sociolinguistic and neurocognitive insights about language variation, three papers seek to uncover which factors derive variation in the course of language development, that is, how variation in cases of pathological development affects different parts of language and whether the affected markers are manifested in a comparable way. For starters, it is common to find that "minority" languages enjoy fewer (if any) diagnostic tools than "majority" languages. This has repercussions for the detection and proper assessment of children with Specific Language Impairment (SLI) brought up in these languages. With a view to remedy this situation for Catalan, Gavarró developed a sentence repetition task to assess grammatical maturity in school-age children. The findings display clear differences with typically developing children providing identical repetition at twice the rate of children with SLI. Moreover, the children with SLI had more deviant productions, both ungrammatical

ones and grammatical yet different repetitions. Saiegh-Haddad and Ghawi-Dakwar tested phonological and lexical distance between a dialect of Palestinian Arabic spoken in the north of Israel and Modern Standard Arabic on word and non-word repetition in children with SLI and age-matched controls. The authors find that children with SLI underperform on all tasks and point to a "general phonological memory deficit." They also argue that the results "reflect the role of linguistic distance in phonological memory for novel linguistic units in Arabic SLI," which in turn would "support a specific Linguistic Distance Hypothesis of SLI in a diglossic setting." Previous work on linguistic abilities of individuals with Down syndrome (DS) suggests severe impairment of complex syntactic structures in a number of languages. Given difficulties reported with comprehension and production of relative clauses and object clitics in typically developing Greek Cypriot bilectal children, one could hypothesize that the bilectal environment in which children with DS grow up may cause an added difficulty in the acquisition of other complex syntactic structures, such that of the understudied syntactically complex subjunctives. Christodoulou and Grohmann examine whether Greek Cypriot bilectal children and adolescents with DS evidence an impairment with the comprehension of subjunctive clauses, corroborating arguments for an overall syntactic impairment from past research on DS. Full analysis of the comprehension data evidenced high means of accuracy, with parallel performance across the two groups. The linguistic differences between Cypriot and Standard Modern Greek do not appear to affect the acquisition of subjunctives.

As its title suggests, the Research Topic "Developmental, Modal, and Pathological Variation—Linguistic and Cognitive Profiles for Speakers of Linguistically Proximal Languages and Varieties" aimed to approach the topic of language variation from different perspectives. To this end, we brought together studies on typologically different languages (both standard and non-standard), ranging from infancy into adulthood, for speakers with different cognitive phenotypes as well as different language backgrounds (e.g., heritage languages in diaspora). The contributions to this research topic are informative with respect to certain key aspects within current linguistic research such as the bilingual advantage, the passive knowledge of the standard in bi(dia)lectal speakers, aspects of transfer, and the key role of SES in cognitive and linguistic development. As Noam Chomsky has repeatedly argued, in order to understand the human capacity to acquire and use language, we need to know *what options it permits* (Chomsky, 2015) through studying language variation, and this Research Topic aims to take a multidisciplinary step into this direction.

## AUTHOR CONTRIBUTIONS

KG wrote a first draft of this editorial, which EL completed and MK edited further. All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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# Integrated, Not Isolated: Defining Typological Proximity in an Integrated Multilingual Architecture

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On the surface, bi- and multilingualism would seem to be an ideal context for exploring questions of typological proximity. The obvious intuition is that the more closely related two languages are, the easier it should be to implement the two languages in one mind. This is the starting point adopted here, but we immediately run into the difficulty that the overwhelming majority of cognitive, computational, and linguistic research on bi- and multilingualism exhibits a monolingual bias (i.e., where monolingual grammars are used as the standard of comparison for outputs from bilingual grammars). The primary questions so far have focused on how bilinguals balance and switch between their two languages, but our perspective on typology leads us to consider the nature of bi- and multi-lingual systems as a whole. Following an initial proposal from Hsin (2014), we conjecture that bilingual grammars are neither isolated, nor (completely) conjoined with one another in the bilingual mind, but rather exist as integrated source grammars that are further mitigated by a common, combined grammar (Cook, 2016; Goldrick et al., 2016a,b; Putnam and Klosinski, 2017). Here we conceive such a combined grammar in a parallel, distributed, and gradient architecture implemented in a shared vector-space model that employs compression through routinization and dimensionality reduction. We discuss the emergence of such representations and their function in the minds of bilinguals. This architecture aims to be consistent with empirical results on bilingual cognition and memory representations in computational cognitive architectures.

Keywords: typological proximity, bilingualism, computational modeling, parallel architectures, vector space models

## INTRODUCTION

The concept of typological proximity/distance has long been a useful one in language science, but despite its intuitiveness on many levels, it remains maddeningly difficult to measure in any large-scale sense. Part of the problem, we argue, is that its development and consequences at the diachronic vs. the synchronic levels have not yet been sufficiently articulated. Diachronically, a great deal of attention has long been paid to the evolution of grammars, from sound change to morphosyntax (Fedzechkina et al., 2012), and historical linguistics has made enormous contributions to our understanding of language, and provides (among other things) ways of understanding typological distance as instantiated in language phylogeny. However, in most cases, our only evidence of phylogenetic relationships are the synchronic correspondences among putatively related languages, meaning that diachronic measures of typological distance are generally

based on synchronic correspondences between languages. Frequently, lexical overlap forms the basis for these classifications, but where this fails, as in Papuan and Oceanic languages, researchers have attempted to make classifications on the basis of shared grammatical features (Dunn et al., 2005). The fundamental problem here is that the researcher must decide what grammatical features are to be used.

Moreover, typological relatedness in the synchronic sense plays an important role in understanding phenomena associated with bilingualism, including second language acquisition, language transfer, attrition, and code-switching, and in this domain, both genetic relationships among languages and also proximity due to convergent evolution are important. What is needed, therefore, is a general concept of typological proximity that can serve as a foundation for a metric that is independent of the source of that proximity, and one that is not based on arbitrary decisions made by the researcher (see e.g., also similar criticisms directed at the generative notion of "parameter" by Newmeyer, 2004, 2005). Specifically, to the extent that any human language can be situated within a common space of possible languages implies that typological distance is measurable synchronically as well, regardless of its source.

This more synchronic conceptualization of typological proximity has played a larger role in second language acquisition research and related sub-disciplines, both explicitly (in various instantiations of the idea of contrastive analysis, going back at least to Lado, 1957), and implicitly (Recchia et al., 2010). This research, too, has tended to focus on specific shared features or families of features, with the general intuition that second language learning proceeds more easily where there is overlap, and that contrast presents more challenges (though partial overlap may present the greatest challenges, e.g., Flege, 2007). The impact of correspondence and contrast between two grammars in second language acquisition is, however, just a specific instantiation of much more general questions about how two or more grammars are instantiated in the multilingual mind, questions that have garnered increasing attention in recent years (Grosjean, 1989; Cook, 1992, 1995; Kecskes, 1998; Roeper, 1999; Kecskes and Papp, 2000; Hall et al., 2006; Braunmüller, 2009; Amaral and Roeper, 2014; Grohmann, 2014; Cook and Wei, 2016, and references therein).

The major intuition in this research is that grammars are not instantiated side-by-side in the multilingual mind, but they are integrated into a single, compound system. What we argue here is that this integration provides a useful way of conceptualizing, and even measuring, the typological proximity of language pairs. It can thus fill the gap in understanding the direct, synchronic relatedness of two grammars, independent of the diachronic histories that brought them to that point. Moreover, via a second important intuition, that language change grows out of synchronic variation, and that the representation of variation can be thought of as a form of multilingualism, this synchronic view of typological proximity can be integrated with the diachronic one, leading to a more comprehensive view of how this proximity arises, and how it shapes the competence and usage of individual language users. Of course, the idea that multilingualism contributes to language change (thus contributing to linguistic

relatedness) has long been acknowledged, particularly in the subdiscipline of contact linguistics (Thomason and Kaufman, 1992 is but one substantial example). But the original focus there was on whether and how specific structures at various levels of linguistic description can pass from one language into another, whereas our proposal is much more comprehensive: that by conceptualizing the language knowledge of a multilingual (or a monolingual, counting variation) as a single grammatical system, and comparing the result to a coordinate system, where both languages are represented side by side, but independently, we can gain vital insight into the notion of typological distance.

Here we introduce the core aspects of an algorithm which can measure typological proximity/distance between languages. Importantly, our primary focus here is on modeling typological proximity in the bilingual mind, which requires the inclusion of a common, combined grammar that we will discuss below. The key to all of this, of course, is to approach a well-developed understanding of what it means for two languages to be "integrated" in one mind. Here we discuss the fundamental ontology of an integrated grammar and how typological similarities and differences can be accounted for in a clear and systematic way.

## A HOLISTIC VIEW - INTEGRATED GRAMMARS

Research in cognitive neuroscience over the past three decades has provided a cascade of evidence that both languages are, to various degrees, simultaneously active in the mind of bilinguals (e.g., Hartsuiker et al., 2004; Deuchar, 2005; Pickering and Ferreira, 2008; Coppock, 2010; Hsin et al., 2013; Kroll and Gollan, 2014; Melinger et al., 2014; Starreveld et al., 2014; de Groot, 2016). Such research has gathered steam since initial proposals from pioneers such as Grosjean (1989) who advanced a holistic view of language, language development, and language use in bilinguals. The impact of this body of research issues significant challenges to research on modeling techniques that seek to better understand the emergence of grammar in individuals, and to an extent, our species. These findings have a profound impact on the (generative) models that we impose on the grammatical competence of multilinguals, as suggested by de Bot (2004), Hall et al. (2006), and Roeper (1999). Cook (2016, section 1.4) lists three primary premises regarding the role of the multi-competent native speaker:

> **Premise 1:** Multi-competence concerns the total system for all languages (L1, L2, Ln) in a single mind and their inter-relationships.
> **Premise 2:** Multi-competence does not depend on monolingual native speakers.
> **Premise 3:** Multi-competence affects the whole mind, i.e., all language and cognitive systems, rather than language alone.

In the remainder of this article, we will focus primarily on the first two of Cook's premises, while acknowledging that we agree with the third and final premise, but will not address it directly due to space constraints (see e.g., Jarvis and Pavlenko, 2008). The initial

charge to treat bilingual grammars on par with monolingual grammars, i.e., as natural/authentic grammars, led to proposals such as the *Null Hypothesis* (Mahootian, 1993), which banned the postulation of constraints and representations that were strictly unique to bilingual grammars. In spite of these advances, work on bilingualism—especially research on the language of late bilinguals—tends to be "deficit"-oriented (Ortega, 2014), i.e., with the focus on differences between target outputs being the result of some sort of competence or production deficit of one of the source grammars.

This perspective can challenge the validity of treating both grammars in the mind of an individual as "natural languages." In our integrated perspective, we adopt Ortega's (2016, pp. 50–51) proposal—following initial proposals by Cook (2012, 2016)—that "linguistic competencies and indeed language itself are dynamic and they change at multiple time scales, including over the lifespan, as the function of actual use (Beckner et al., 2009; de Bot et al., 2013)." Of equal importance, the influence of one source grammar upon another need not be unidirectional; much research (e.g., Kecskes and Papp, 2000; Cook, 2003; Flege, 2007; and others) provides evidence that such influence is bidirectional. Finally, again as pointed out by Ortega (2016, p. 51), "language is part of cognition and, as such, cognition and language influence and affect each other (Langacker, 2008; Pulvermüller, 2013; Bylund and Athanasopoulos, 2014)." Here we sketch out the key underpinnings of an integrated cognitive architecture, while remaining true to Mahootian's (1993) *Null Hypothesis* that bans the inclusion of features, operations, and constraints that are unique to bilingual grammars.

In the remainder of this article we take a bold step forward in attempting to unite these observations about the nature of multi-competence with current cognitive models and linguistic theorizing. Building upon an initial proposal by Hsin (2014), which we will explicate in more detail in the next section, we call for an integrated view of grammatical competence in the bilingual mind. To be clear, our adoption of an integrated grammar should not be confused with previous attempts in the generative tradition to come to terms with the simultaneous acquisition of grammar in bilingual children. In this literature, there are two dominant positions; the FUSED or UNIFIED DEVELOPMENT HYPOTHESIS (Volterra and Taeschner, 1978; Taeschner, 1983) and the ISOLATION HYPOTHESIS (Meisel, 1990). According to the former, the initial state would consist of a unified, or "common" grammar, which, over time, bilingual children would begin to gradually differentiate into (largely) separate source grammars. Hybrid representations found in code-mixing served as the initial empirical support for this hypothesis[1]. In contrast, the latter hypothesis also draws on code-mixing data, but builds upon the observation that although there exists a high degree of lexical items from both source

grammars in such hybrid representations, the amount of cross-linguistic influence from both syntactic systems is relatively scarce. Meisel's (1990) proposal that simultaneously developing grammars remain (mostly) isolated from one another thus contrasts with the former proposal. Hsin (2014, pp. 6–7) introduces a third option, which she calls the INTEGRATION HYPOTHESIS which "embodies an account in which bilingual children indeed begin with the same basic endowments [...] as monolingual children, and [...] where the two languages diverge with respect to a particular syntactic rule, the grammar responds by duplicating, or splitting, the constraint that is not satisfied for both languages." We demonstrate below that these degrees of freedom are necessary in coming closer to an accurate, working model of multilingual competence.

Remaining consistent with the general theme of this Frontiers volume, we then explore how a model that adopts some version of the INTEGRATION HYPOTHESIS can accurately model the typological proximity (and, conversely, distance) between entire linguistic systems. As we discuss below, what is needed is a model that extends beyond the traditional notion of (innate) parameters (a concept that Cook, 1991, already began to adjust in his initial proposal of multicompetence), as suggested in the ongoing research carried out in the Principles and Parameters model (P&P, Chomsky, 1982) and beyond. Recent theorizing has sought to eliminate the reliance on such parameters for a number of reasons, opting instead for "realization options" (Boeckx, 2016, p. 90; also see Roeper, 2016 for similar ideas)[2]. To briefly clarify this point, operations in the Narrow Faculty of Language (Hauser et al., 2002) are reduced significantly to notions of Merge, (possibly) recursion, and another subset of locally-defined operations (such as Agree and c-command) (see e.g., Chomsky et al., 2017 for a detailed overview of the current state of this research program). The generative component of this model is relatively unrestricted and unconstrained when compared with previous instantiations of the P&P-framework, where elements that were previously interpreted as catalysts for syntactic operations (e.g., Case, wh-movement, etc.), now become realization options external to the computational systems (i.e., at the hands of "external" interfaces). Under such assumptions, traditional "parameters" exist outside of the Narrow Faculty of Language (Hauser et al., 2002) and cross-linguistic variation is thus relegated to "third factor" considerations (Chomsky, 2005). We welcome this development for a number of reasons, most notably, because it presents a platform to unite theorizing traditionally thought to be unique to generative inquiry to a larger body of cognitive science. In the third section of this report, we discuss how these recent developments can be integrated into an emergent model of

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[1] As a point of clarification, our definition of hybrid representations is a cover term for linguistic outputs that contain elements from multiple source grammars (e.g., lexical items, morphological units, syntactic elements, etc.). This is not to be confused with more narrow definitions of hybridity provided by scholars such as Aboh (2015), which applies directly to creoles and mixed languages. Although we do not directly discuss how these grammars would fit into our model due to space considerations, it does appear that this would not pose significant difficulties.

[2] As pointed out by a Frontiers reviewer, there is also ongoing work to refine the notion of parameter in generative theorizing (e.g., Baker, 2001, 2009; Fábregas et al., 2015; Eguren et al., 2016; Biberauer and Roberts, 2017). Two particular recalcitrant issues concerning the notion of parameter that are of relevance to our model are: (1) the grain-size of parameters (e.g., Westergaard, 2013), and (2) the vertical and horizontal interaction of different sets of parameters (e.g., Biberauer and Roberts, 2017; Putnam, 2017). Here we adopt an agnostic approach to the notion of parameter, recognizing that in a multi-dimensional grammar space capturing the interaction and competition of these units is of primary importance.

language acquisition, such as that proposed and developed by MacWhinney (2005, 2008).

In the sections that follow, we flesh out our proposal of the general cognitive architecture that underlies a multi-competence language faculty. The fourth section of our report lays out the conceptual motivation and foundation for our model, while the fifth and final section advances a novel sketch of the core desiderata that would be deployed in such a system.

## DYNAMIC INTEGRATION

If we are to move beyond the monolingual biases discussed by Cook (2012, 2016) and Ortega (2016) in an attempt to develop a cognitive architecture, we need to approach such an endeavor with our own set of axioms:

> **Axiom 1:** Mental representations and their sub-components are lossy and gradient by nature. The reliability and stability of representations can be affected by myriad factors such as proficiency, working memory constraints, and activation/usage[3].
> **Axiom 2:** These mental representations only exhibit temporary "resting periods" or, *attractor states*, although these states may often be extremely stable and long-lasting.
> **Axiom 3:** Parametric variation is no longer (primarily) tied to parameters licensed in a narrow computational faculty (i.e., the narrow syntax), and are now external from this core architecture.

Our first axiom shares many similarities with Cook's Premise 1 to the extent that both assume the competence of bi/multilinguals to be an amalgamation of all contributing source grammars. The very existence of mental representations is of paramount importance in understanding and modeling cognition, as explained by Kühn and Cruse (2005, pp. 344–345):

> *By means of these representations, the behavior can be uncoupled from direct environmental control. This enables the organism, for example, to respond to features of the world that are not directly present, to use past experiences, to shape present behavior, to plan ahead, to manipulate the content, etc. (Cruse, 2003). All of these instances characterize a special feature of language called 'displacement' (Hockett, 1960). Therefore we conclude that these mental representations form an essential prerequisite to explaining how organisms can behavior in a cognitive way.*

Importantly, in becoming a unified linguistic system[4], this amalgamation must cope with varying degrees and

concentrations of correspondence between the source systems. This is what leads us to Axiom 1, where features that distinguish similar patterns across two source systems may play a lesser or greater role in representation and processing, depending on the usefulness of the commonalities.

The second Axiom grows out of an important fact about bilingualism, which is that usage patterns change over time. People may become bilingual at different times as well as to different degrees, and the balance of usage may shift toward or away from any given (source) language. Bilingualism thus demands a notion of grammar and mental representation that is generally stable, but underlyingly dynamic, much more clearly than monolingualism, where the underlying dynamism is much less apparent.

Lastly, concerning Axiom 3, the responsibility of the grammar is to generate environments where this unified grammar network can establish instances of congruency. This occurs in monolingual grammars, e.g., in the piecemeal acquisition of structures whose generality is not grasped by the child until later (Yang, 2002). Extending this reasoning to bilingual systems, the relatedness of structures in each language must be reflected in the representational resources at the core of the multilingual system (i.e., bilinguals' knowledge of overlap in their systems does not merely stem from metalinguistic reflection). This in turn implies a novel view of typological relatedness as the degree to which congruency can be established across languages in a combined system.

We view the establishing of congruency and the architecture that it takes place in to be dynamic and emergent, but importantly, this does not eliminate the need for formal theorizing. On the contrary, as we argue here, this view of the cognitive architecture underlying the language faculty strongly supports the integration of competing linguistic information from multiple source grammars at designated points in the grammatical structure. In summary, the consequence of these axioms, and the integrated view we take here, for typological distance is that the kinds, amount, and degree of overlap or correspondence between source grammars is expected to strongly shape the way that the integration plays out, and that a global understanding of typological relatedness falls out from the way bilinguals use that overlap to build an integrated, multicompetent language system.

At this juncture, it will be useful to visit some of the data that motivates this view, and certain research topics where this kind of reasoning is developing, which in turn will provide guidance for where to seek further evidence and test the predictions that will grow out of a more formalized approach to the notions of overlap and equivalence in these aforementioned ways. As examples, we discuss evidence from the literature on code-switching, cross-linguistic structural priming, typological/genetic relationships, bilingual speech, and L2 acquisition.

An obvious domain where these notions of overlap and equivalence take center stage is in code-switching. Although code-switched utterances are frequently analyzable as relying on one source grammar, leading to a strong role in code-switching research for the idea that one grammar is in play at a time (e.g., Myers-Scotton, 2001), this is not always the case, and it has proven difficult—if not impossible—to derive absolute rules and

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[3]Although the concept of lossy representations is commonly associated with constructionist and usage-based approaches (e.g., Goldberg, Forthcoming; Lau et al., 2016), it has also played a role in shaping generative approaches (e.g., Featherston, 2005, 2007; Pater, 2009; Goldrick et al., 2016a,b; Putnam and Klosinski, 2017).

[4]An interesting point about two languages in the mind of bilinguals is that they may merge into a unified system at different time scales. It may occur in the mind of an individual who is becoming bilingual (whether simultaneous or not), but it also occurs at the level of a bi- or multilingual speech community. Something like this reasoning already appears in research on pidgins and creoles, but what we discuss here is broader than that, and could apply to any situation where there is language contact.

strict constraints to account for these data. To address this point, Goldrick et al. (2016a,b) employ a probabilistic grammar model known as Gradient Symbolic Computation (GSC; Smolensky et al., 2014) that shares many affinities with other earlier versions of Harmonic Grammar (HG; Legendre et al., 1990; Smolensky and Legendre, 2006). To account for the fact that both grammars are active to various degrees in the mind of a bilingual, Goldrick et al. propose a calculation that determines the strength of each contributing source grammar as well as a "common" grammar (which is consistent with Cook's Premise 1 discussed above). These values then interact with higher-level cognitive symbols (i.e., violable constraints), which evaluate input-output candidate representations to determine a Harmony profile for each pair. Importantly, the yielded Harmony value of each input-output pair contributes to the probability of occurrence of each representation relative to one another. In other words, every representation that has a non-zero probability of occurrence is essential for computing the probability of a particular form in relation to all possible forms. Hybrid representations containing various lexical and grammatical elements may differ to the extent that they include elements from source grammars (although it is a ubiquitous assumption that one of the source grammars functions as the matrix/dominant language in switches). Putnam and Klosinski (2017) extend the initial work of Goldrick et al. by investigating two different types of code-switches that vary with respect to the degree that both grammars contribute to hybrid representation. They make the distinction between MIXES and BLENDS (see also Chan, 2008, 2009), illustrated below in (1) and (2):

(1)  Mix: Welsh-English Determiner Phrase (Parafita Couto and Gullberg, 2016, p. 855):

     y      Belgian  loaf
     det[W] Belgian[E] loaf[E]
     'the Belgian loaf'

(2)  Blend: Verb + Adverb English-Japanese (Nishimura, 1986, p. 139)

     We bought about two pound  gurai kattekita no.
     we  bought about two pounds about bought  TAG
     'We bought about two pounds.'

Mixes are hybrid representations that consist of lexical items from both/multiple source grammars but appear to only follow one particular source grammar for structural purposes. In the mix-example in (1) above, the determiner phrase (DP) contains a mixture of lexical elements from both source grammars, but, crucially, only the English order of Det(erminer)-Adj(ective)-N(oun) appears (Welsh: Det-N-Adj). In contrast, blends are representations where elements of both source grammars appear in the representation [i.e., the Verb + Adverb – Adverb + Verb orderings in the English-Japanese blend in (2)][5]. The

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[5]Technically speaking, in the model we propose here, there is no distinction between blends and mixes as suggested by Putnam and Klosinski (2017). From the perspective of a multi-dimensional architecture, the difference between the two examples above reduces to the number of levels where the two source grammars do (not) overlap.

work of Goldrick et al. (2016a,b) and Putnam and Klosinski (2017) provide a working metric to determine the activation and gradient nature of bi/multilingual representations. Importantly, this approach is consistent with an integrationist approach to the bilingual cognitive architecture as well as the Null Hypothesis (Mahootian, 1993) and Cook's (2016) Premise 1 (listed above) for the following reasons: First, at no point do they assume that both grammars are truly either fused/united or isolated from one another. The activation and strength of representation (which could also be construed to be an analog for proficiency) of each grammar contributes to determine the value of a shared "common" grammar at a given point in time. It is crucial to reiterate that the value of this "common" grammar can be altered at a given time and over the course of a longer period of time due to a variety of mitigating factors; e.g., priming effects, lack of activation/usage, etc. Second, at no point does this model require features, constraints, or axioms that are solely unique to bi/multilingual cognition and its representations.

Additional evidence that forces us to revisit and better define the notions of overlap and equivalence comes from psycholinguistic data on syntactic priming effects (e.g., Bock, 1986; Branigan and Pickering, 1998; Bernolet et al., 2007; Schoonbaert et al., 2007). This work can provide valuable constraints pertaining to the nature of grammatical representations: how categorical they are, what is their granularity, and what are the mechanisms for general implicit (non-declarative) and procedural memories shared with those storing lexico-syntactic information. A model formulating syntactic storage within a hybrid symbolic/sub-symbolic cognitive architecture (Reitter et al., 2011) has seen several empirical predictions borne out (e.g., Kaschak et al., 2011; Segaert et al., 2016), including that such priming is modulated by the long-term activation (frequency) of syntactic information in the same way in L1 and in L2 speakers (Kaan and Chun, 2017). This lends credence to joint representational mechanisms (i.e., hybrid symbolic/subsymbolic representations), regardless of age of acquisition. As a case in point, Jacob et al. (2016) conducted two cross-linguistic priming experiments with L1 German-L2 English speakers where they investigated both the role of constituent order and level of embedding in cross-linguistic structural priming. The results of these experiments showed significant priming effects in connection with two factors: (i) whenever both languages shared the same constituent order, and (ii) when both languages were identical with regard to level of embedding.

This kind of cross-linguistic effect also extends to morphosyntactic features, such as gender. In a visual world study conducted by Morales et al. (2016), Italian-Spanish bilinguals and Spanish monolinguals listened to sentences in Spanish while viewing an array of pictures, one of which was the target in the sentence. The objects in the experiment depicted elements that either shared the same gender in both languages, or were mismatched with respect to gender assignment. Bilinguals looked less at the target object when its Italian gender mismatched its Spanish gender, suggesting that, to some degree, both gender features were active as the sentence was interpreted, even though the experiment was exclusively

in Spanish. Additional studies by Paolieri et al. (2010a,b) offer further evidence of morphosyntactic interactions in bilingual grammars, and research by Malt et al. (2015) demonstrates similar phenomena in the domain of semantics.

In the realm of bilingual speech, the mapping of phonetic space to speech sounds has long been an active area of inquiry (e.g., Flege, 2003; Best and Tyler, 2007; Gonzalez and Lotto, 2013), but recent evidence suggests integration of phonological systems at more abstract levels. Carlson et al. (2016) tested fluent, early Spanish-English bilinguals on a perceptual illusion related to Spanish phonotactics. Specifically, word-initial /s/-consonant clusters are prohibited in Spanish, and are obligatorily repaired by prepending an [e]. Presented with acoustic stimuli beginning with the illicit clusters, Spanish speakers tend to perceive an illusory [e], but this effect was lessened in Spanish-English bilinguals, and more so if they were dominant in English. Thus, properties of a second language can lead to more veridical perception of certain sound sequences. Similarly, properties of a speaker's L1 can confer an advantage in L2 speech perception, compared to native speakers, as seen in a study by Chang and Mishler (2012) on Korean-English bilinguals' perception of word-final unreleased stops in English. Word-final stops are obligatorily unreleased in Korean, but optionally so in English, which Chang and Mishler linked to a measurable advantage in perceiving the place of articulation in the absence of a stop release.

Considering these empirical issues together, an ideal architecture must account for the gradient nature of knowledge in the form of mental representations, which is sensitive to the possible overlap of grammatical information from two or more (competing) source grammars. These mental representations consist of multiple levels of linguistic information, which leads to the potential of both vertical and horizontal overlap and conflict. In addition to establishing and declaring the (typological) (dis)similarities of both source grammars, this architecture must also establish equivalence amongst categories and constraints in the conjoined "common grammar." In summary, and agreeing with Cook (2016, p. 18) once again, "the mental representation of language is a complex system with all sorts of internal and external relationships; it may be quite arbitrary to divide a bilingual system into separate areas, modules, and subsystems, that can be called languages in the plural."

The variable, dynamic nature of these mental representations is the result of an architecture that embraces the fact that competition amongst these factors is the norm rather than the exception. The final mental representations are thus conditioned and shaped by both internal and external factors that operate perhaps on different time frames and exhibit unique developmental histories. Such is the nature of a dynamic system, whose core attributes are listed by de Bot (2016, pp. 126–30):

- Sensitive dependence on initial conditions
- Complete interconnectedness
- Non-linearity in development
- Change and development through internal reorganization and interaction with the environment
- Systems are constantly changing

- Dependence on internal and external resources
- Systems may show chaotic variation over time
- Development is conceived of as an iterative process

According to the integrationist perspective taken here, in addition to the gradient nature of knowledge in the form of mental representations we also adopt these conditions. Importantly, as explained by MacWhinney (2005, p. 191), "What binds all of these systems together is the fact that they must all mesh in the current moment. One simple view of the process of meshing is that cues combine in an additive manner (Massaro, 1987) and that systems are partially decomposable (Simon, 1969)." An attractive outcome of viewing the language development, maintenance, and activation/usage of bilinguals as a dynamic system is that it stands to bring generative models more in line with emergent (Kirby, 1999) and Bayesian (Culbertson, 2010) approaches to the development of grammar systems.

The shift toward a dynamic system with gradient representations raises questions concerning the compatibility that such a model might share with currently existing frameworks. Again, here we seek to outline how much these current frameworks can handle these important architectural adjustments. In our view, representations that are "partially decomposable" (Simon, 1969) are best interpreted as distributed knowledge that combines to deliver complex representations. There are multiple ways to postulate how these complex representations come into existence, from the use of declarative and violable constraints (van Oostendorp et al., 2016; Putnam, 2017) to those that employ an architecture of grammar with an invariant computational syntax (Kandybowicz, 2009; Lohndal, 2013; Boeckx, 2014, 2016; Grimstad et al., 2014; Alexiadou et al., 2015; Riksem, 2017). Questions regarding the difficulty in arriving at the proper definitive set of universal parameters and the inability to determine if and how these constraints could combine to deliver complex representations had emerged in the work of Newmeyer (2004, 2005) and has led to a reappraisal of the role of the traditional notion of parameters (see e.g., Fábregas et al., 2015; Eguren et al., 2016). What the majority of these recent proposals have in common is the move from parameters to features and cues that are either distributed across multiple levels or realized as associations that are united with a particular combination of derivational units (as is the case in Distributed Morphology, DM). The result from this exploration is that these mental representations consist of multiple levels and simultaneously display complex and atomic natures (cf. Quine, 1940). Under such assumptions, both lexical items (= lexicon) as well as more complex units (= syntaticon) (a la Emonds, 2000) are generated in similar fashion. Gallego (2016, p. 157) suggests that such an approach, i.e., one where items in a lexicon and syntaticon (i.e., the storage of fused units—chunks—typically larger than a lexical item) exhibit a dual atom-complex nature, must address the following questions:

Q1 : What is the set of morphosyntactic features {F} that UG provides?

Q2 : How do these features bundle to form LIs (= lexical items)?

Q3 : Why is LI-internal structure opaque to computation?

Gallego (2016, pp. 157–158) advances a system,

> where syntax recycles complex sound-meaning pairings as brand new units of computation, creating a loop between syntax and the lexicon (roughly as in Starke 2010). A way to conceive of this relation would be the warp the standard "Y Model" into what we would call a "U-Turn Model" collapsing the pre-syntactic lexicon and the post-syntactic interpretive components into a unique interface that would communicate with other cognitive modules (the C-I and S-M systems).

The proposal of such a U-Turn Model enables communication between coexistent systems that is "highly reminiscent of the syntagmatic-paradigmatic distinction" (Gallego, 2016, p. 158). Furthermore, such an architecture is similar in scope and design to other proposals in the literature such as those put forward by Uriagereka (2008) and Stroik and Putnam (2013). As pointed out by Stroik and Putnam, such an architecture supposes that the Faculty of Human Language is situated *within* the performance system, which resonates with connectionist models of cognitive processes and their neurobiological implementation. Neural networks consist of interwoven neural links that "criss-cross in a three-dimensional curved grid structure" and "this grid structure contains highly ordered neural overlaps" (Stroik and Putnam, 2013, pp. 14–15; see also Ramachandran, 2011; Weeden et al., 2012). We maintain that in this overlapped architecture, the common grammar shares a unified semantic representation, which connected with other levels of linguistic information (i.e., phonology, morphology, and syntax). Two additional points are in order here as well: First, appeal to a U-turn-type architecture does not implicate that (strictly) modular models are preferred over parallel ones. On the contrary, as discussed by van Oostendorp et al. (2016), a parallel architecture with limited degrees of overlap among the sub-domains of grammatical knowledge is fully capable of deriving modularity. Second, O'Donnell (2015) shows that not only is the overlap (to some degree) expected between domains of grammatical knowledge, but also that the notions of storage and computation should not be viewed as completely separate entities. In fact, the notion of *fragmented grammars* that he advances in his treatment of probabilistic parsing shares significant overlap with the integrated approach we develop here. We can translate this idea to other representations of grammar as well: a system involving some ranked "soft" constraints that are violable can explain empirical data showing when and why judgments of acceptability are graded (Keller, 2000; Haegeman et al., 2014)[6].

This brings us once again to the notion of cross-linguistic proximity and the challenge of capturing and measuring this heuristic without the aid of traditional parameters. The move

away from traditional parameters toward e(xternal)-parameters raises interesting challenges for the ontology of a model (see e.g., Putnam, 2017; Putnam et al., 2017 for an overview). The challenge for finding proximity and congruence between two source grammars requires a multi-dimensional search. This situation is once again a bit more complex in the bilingual mind, where the separation of individual source grammars is essentially not possible. The notion of proximal and distal has been a cornerstone in research on cross-linguistic influence (CLI) in sequential L2 acquisition. For example, Kellerman (1995, p. 125) states:

> At its simplest, the L1 can be seen as a direct cause of erroneous performance, especially where such performance is shown to vary systematically among learners with different L1 backgrounds…

The concept of "error" is difficult to define in the context of L2 (and in bilingual language production *a priori*), given that other factors such as language mode, cognitive load, and other extraneous factors can impact linguistic output. Once again, one of the primary culprits in this line of thinking is "monolingual bias," that (i) "there are separate language systems that have an impact on each other," and (ii) "languages exist as stable entities in our brain" (de Bot, 2016, p. 133). The very existence of joint representations (i.e., of competence) also address this problem, which reduces notions of language contact since Weinreich (1953) to (non-)facilitative "transfer" as a fluid continuum of bidirectional influence (e.g., Schmid and Köpke, 2007; Seton and Schmid, 2016).

What is more, it is unclear at present how much of an aid or a hindrance similar linguistic information can be. McManus (2015) shows that the high degree of overlap between the aspectual and tense systems in English and French can pose a challenge for the acquisition of French an L2, and the notion that substantial but incomplete overlap presents greater challenges to learners than more distant correspondences has long been current in the literature on bilingual phonetics (Flege, 2003; Best and Tyler, 2007). With respect to research on code-switching, establishing congruence across categories appears to be essential in hybrid outputs (Deuchar, 2005). To date, it is unclear what role typological proximity may play in L1 attrition, although current research hopes to provide some insight into this matter (Schwarz, in progress). In the next section, we take on the task of providing a detailed overview of the fundamental components of our model.

## MODEL: CORE COMPONENTS

We put forward a dynamic model of linguistic representations that shares representations between languages that change over time in response to experience. We note that the encoding strategy in our model is not specific to language. Rather, it is an instantiation of general cognitive mechanisms that encode either declarative knowledge or procedural programs. As a consequence, proximity between languages is determined by how frequently shared representations are used in processing each language. We contrast the concept of this inherent proximity

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[6]A Frontiers reviewer raises the question as to whether or not there are fundamental differences between the "soft" constraints that we mention here versus those found in Optimality Theory. Although they share the trait that they are violable in nature, the constraints we refer to above can combine with one another, resulting in additive gang-up effects as argued for in Harmonic Grammar (Pater, 2009).

from such proximity that is the result of a cultural-evolutionary process, which, of course, has resulted in more or less co-representation between any two given languages.

Typological distance is a result of divergence in a vector space that is spanned by the representations that define syntactic operations in each language. *Compression* describes how shared representations form between those grammar representations associated with each language. In cognitive psychology, *chunking* is an example of such a compression operation. Similar to chunking, we assume that these grammatical representations are built up empirically; yet, they are probabilistic (symbolic and subsymbolic), and they dynamically change as language is used. Compression facilitates the efficient encoding of constructions in each language, with a construction being represented by a vector in space. The *cosine* metric is a common method to characterize the distance (angle) between two vectors in representational space. Then, the mean distance between constructions situated in this shared vector space describes typological similarity. In other words, if languages are represented in similar areas of this space, they are deemed similar, and facilitate and interfere with each other. If languages end up in more distinct clusters, they are typologically more distant, and may interact to a lesser degree.

With this model, we embed linguistic representations in a more general program of distributed (semantic) representations that have been empirically successful in describing human memory, in a psychological sense (Landauer and Dumais, 1997; Jones and Mewhort, 2007) but also language, in an engineering context (Mikolov et al., 2013). All of these approaches define some way to compress representations—often, from an initial vector space with several hundred thousand dimensions into a vector space with, e.g., 300 dimensions. This compression, also called *dimensionality reduction,* achieves generalization of the acquired representations while preserving much of their distinctiveness.

In the following, we discuss four candidate algorithms for compression that can form part of the model. Not all of them make different predictions, but they represent different cognitive mechanisms that have different neuropsychological correlates. All of them share the idea of *compression*, in that they make storage of representations more efficient over space, and/or over access time, and all four could result in a loss of information (i.e., all are *lossy*).

## Chunking

In light of limited memory resources, humans apply an effective technique to recognize commonly used combinations or sequences of signals, storing them as a single, declarative memory item. For example, the sequence **BBCPHDCIA** might be stored not as nine letters (exceeding most people's working memory capacity), but as three well-known acronyms, becoming an easily storable three-item sequence. Chunking has been found at many levels, from perceptual/sensory information to high-level reasoning. Efficient memory encoding, using chunking strategies, has been shown to be a hallmark of expertise (a classic of cognitive psychology: Chase and Simon, 1973). Chunks may capture lexicalized sequences of words, or they may bind related ideas. It bears repeating, that an appeal to chunking does not

necessarily come at the exclusion of a minimalist model of syntax/computation. As pointed out by Adger (2013, p.c.), the idea that the initial stages of language acquisition begin with a limited, yet invariant narrow syntax and then eventually move toward a system of chunked representations is not inconsistent with some versions of minimalist theorizing. Whether this assertion can be upheld is beyond the central claim of this paper; however, we would like to point out that the decomposition of these complex units (i.e., chunks) in order to determine the degree of typological similarity requires a compression-unpacking algorithm discussed here (see e.g., Christiansen and Chater, 2016).

## Routinization

Chunking has its equivalent in learning procedures and sequences. A repeatedly successful sequence of cognitive operations may be combined into a larger one (Anderson, 2013). This principle may apply to goal-oriented actions in the same manner as to linguistic phrases, so that syntax can be represented as a system of routines (Jackendoff, 2002). Within a parallel architecture of grammar, distributed units of information (call them *features*) can become routinized within particular levels of grammars as well as in combination with others (with the aid of functional mapping). As particular combinations of language (on multiple levels) are more frequently used/activated, the units as a whole become easier to generate and comprehend, thus facilitating efficiency as well as reducing entropy in the prediction of immediately preceding units. These units become highly routinized. One interesting consequence of this interpretation of the generation and routinization of linguistic chunks is that it blurs the clear distinction between elements that are exclusively regarded as stored elements of declarative knowledge vs. those that are generated as the result of computational operations (cf. O'Donnell's (2015) notion of *fragmented grammars*).

## Distributed Representations and Declarative Memory

In a distributed model meaning is represented as a composition of weighted references to other meanings, to episodic experiences, or in arbitrary feature space. The *distributional hypothesis* states that words that appear in the same context share (some) meaning. So, we begin with a feature space that is composed of as many dimensions as there are contexts (practically, documents or paragraphs in text). Then, each word is represented as a vector of binary values that describes which contexts the word occurs in, defining the meaning of a word in terms of its usage. Consequently, similar meanings are then represented in nearby locations, or *embeddings*, in this vector space.

The semantic space is optimized in order to maintain a unique representation of meanings while simultaneously ensuring computational efficiency. Throughout language use, it can also be gradually optimized to improve understanding or producing language in context by using predictions about related meanings. Earlier forms of vector space models, such as *Latent Semantic Analysis* (Deerwester et al., 1990), apply a

mathematical operation that reduces the dimensionality of such spaces systematically.

Modern architectures (e.g., Mikolov et al., 2013) are optimized to actually predict a word given its context, i.e., its left and right neighbors. Thus, while these representations can capture some local syntactic regularities, they are not designed to represent syntax more generally. However, it is easy to see that the algorithm that reduces dimensionality and thus determines the encoding is a form of compression: It allows for a more efficient representation of meaning. The representational principles associated with distributed semantic encoding are not limited to the domain of semantics. Syntactic knowledge has rich stochastic ties to semantic representations, and can be seen as configural constraints that display a mix of regularities and exceptions. Distributed representations may well be a neurologically and psychologically plausible framework for syntactic knowledge, and it is a technically realistic candidate (Kelly et al., 2013, 2017). At lexical, syntactic, and morphological levels, the overlap in semantic space and joint compressibility of lexicons associated with two languages determine their mutual facilitation. As we discuss below in the section Testing Our Model, we suggest that these levels exist in parallel with their semantic counterparts occupying another layer of parallel structure (i.e., there exists only one shared semantic/conceptual structure).

We provide an example of joint representation in compressed vector spaces in **Figure 1**. Here, a 1-million-word corpus of parallel Romanian and English newspaper texts was used (Mihalcea and Pedersen, 2003). A semantic space was obtained from a term-document matrix (sample of 1,500 words, 1,050 documents per language), which associates each term with the documents (or paragraphs) it occurs in, and their frequencies. This space, thus, characterizes word meanings in terms of their co-occurrences. A recent, high-performing dimensionality reduction technique that has a neural implementation was used (t-Distributed Stochastic Neighbor Embedding, van der Maaten and Hinton, 2008) to produce a two-dimensional vector space shared by the two languages. **Figure 1** shows the words and their locations in space. Note that a plausible model of such
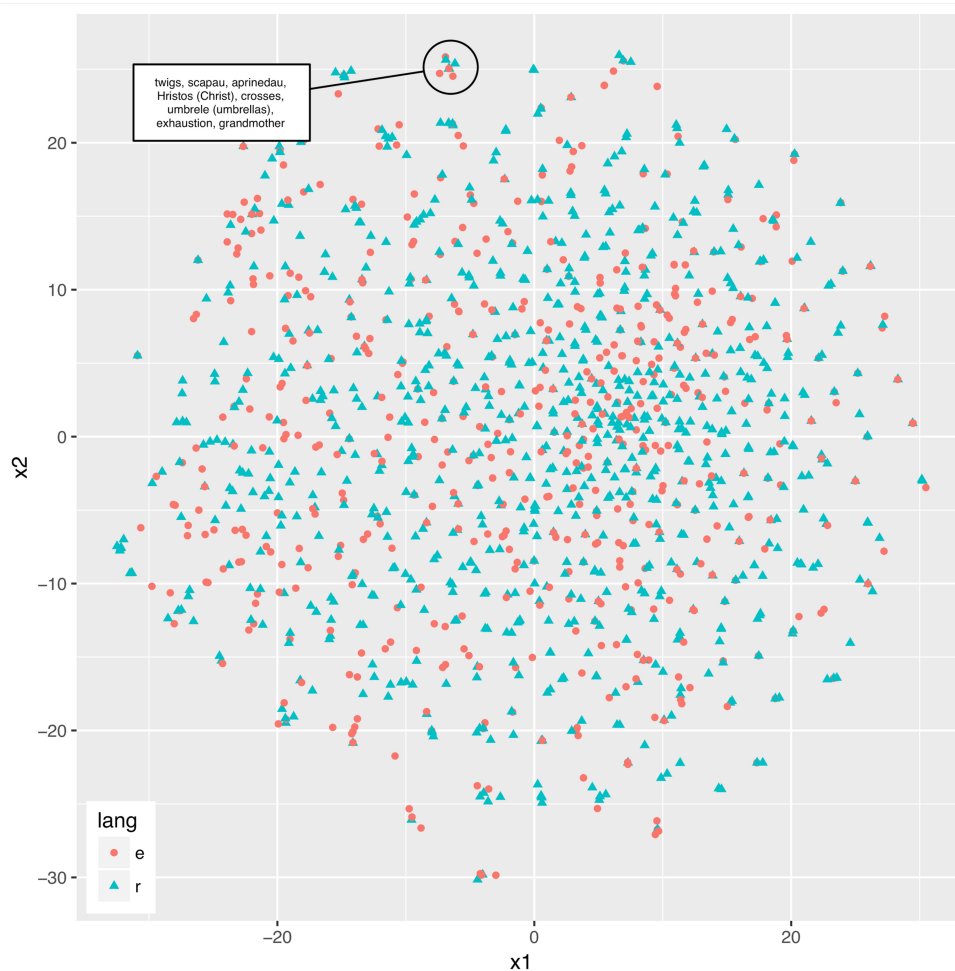


**FIGURE 1 |** Two languages sharing the same lexical-semantic space. Distributed semantic representations for 1,500 word samples were acquired from a parallel Romanian ("r") and English ("e") newspaper corpus and reduced to a two-dimensional vector space using T-SNE for demonstration purposes.

representations will use on the order of 300 dimensions rather than two, and it will result in regions of shared and regions of language-separate semantic-syntactic representations. Such a model would resemble models such as Kantola and van Gompel (2011) and de Bot (1992), in which related representations are connected (such that they can influence each other in processing), and unrelated representations are not, but in our model, the connected representations would be shared, as in Hartsuiker et al. (2016). However, the multi-dimensionality of the representational space would permit sharedness to be gradient. Although for the immediate purposes of illustration **Figure 1** only provides a two-dimensional representation, there is clear room for expansion of vector space that could include other level of grammatical information (e.g., morphology and syntax).

## Compression Algorithms from Computer Science

Compression has its equivalent in computer science. In lossless compression, arbitrary but not random sequences can be represented by replacing frequent subsequences with references to an *ad hoc* table (Ziv and Lempel, 1978). A commonly used example of this principle (in an improved version) would be the popular *Zip* program. Lossy compression allows for differences between the target and the representation retrieved from memory, which is typically used where psychophysics or cognitive phenomena will prevent humans from perceiving the differences, such as in sound (e.g., *MP3*) or vision (e.g., *JPEG*). In terms of grammatical representations, our proposed model posits that compression of sequences of linguistic representations or of grammatical knowledge is a representation of encoding of grammar, including that shared between languages.

Grammatical representations start with declarative representations, which are routinized as a result of their use (see, e.g., Reitter et al., 2011 for such model, and Anderson, 2013 for a cognitive architecture that describes this routinization process). Repeated use of a sequence of memory retrievals leads to their compilation into fast routines that do not require memory retrievals. This process combines short subsequences first, and throughout repeated use, the resulting new chunks are combined again. This mirrors commonly used compression algorithms (Ziv and Lempel, 1978).

Grammatical encoding in the model depends on distributed representations to account for semantics, and it is possible that distributed (neural) representations can account for (some) syntactic knowledge as well. We propose an account of compression that combines this symbol-level compression and the notion of compression of representational spaces. At first sight, compression through routinization (psychology) or lookup tables (computer science) would be applicable to representations of syntactic procedures, while compression of semantic spaces would apply to distributed semantic representations. We propose that semantic and syntactic spaces are represented jointly. Compression at the symbolic level, akin to chunking, is lossless, while compression of representational spaces is lossy.

The architecture we discuss is compatible with accounts of "Shared Syntax," and with empirical data that shows cross-linguistic priming (e.g., English-Spanish, Hartsuiker et al., 2004), as noted in the previous section. An instantiation of the architecture will need to explicate how syntax is represented and how it is compressed; this would yield predictions for the facilitatory and inhibitory effects of an L2 on an L1 in language performance, a point which we turn to in the following section.

## TESTING OUR MODEL

Admittedly, the programmatic model put forward here does not yet constitute a fully implemented model. The principles on which our proposal is founded nonetheless make testable predictions. For example, there is debate over whether structural priming effects are best accounted for through models in which bilinguals' syntactic representations are shared vs. separate (Bernolet et al., 2007; Kantola and van Gompel, 2011; Hartsuiker et al., 2016). At first blush, our model shares a salient affinity with Hartsuiker et al.'s shared syntax model, but by integrating two grammars through lossy compression, we actually bring together both the separateness and sharedness of syntactic representations. We thereby aim to reconcile apparently conflicting findings by predicting when results will support a shared vs. separate (but interacting) syntax model.

As a second example, representational similarity as predicted by the account of distributed representations (and possibly more symbolic chunking) leads to observable behavior, such as facilitation of jointly represented constructions through syntactic priming and the difficulties encountered when attempting to rapidly compress grammatical information where typologically-contrastive information is present. As a point of illustration, consider the following hybrid representation reported by Karabag (1995) (cited by Treffers-Daller, 2017; German appears in regular font, Turkish in *italics*, doubled elements are underlined):

(3)   Deutschland <u>muß</u> mit dies-<u>en</u> Hippie-*ler-le*     *ba?-a*
      Germany     must mit this-dat Hippie-pl-instr. head-dat

*çik-ma-si <u>gerek</u>-iyor*.
leave-nom-3sg must-Pr.Prog-Ø
'Germany must cope with these hippies.'

In the example above (3), there are two instances of doubling, one involving the doubling of modal verbs (G: *muß*/T: *gerek*) and two adposition elements (G: *mit*/T: *le*). Congruence is established in the common grammar with respect to dative/instrumental case. Although German does not license independent morphosyntactic forms of instrumental case, it is subsumed as a sub-function of dative case in this language. In this structure, the lexical item *Hippie* is double-marked with dative/instrumental case, which we predict is likely due to the difficulty encountered in the common grammar to rapidly compress structural information (i.e., syntax) when one of the source grammars is a fusion-language (German) and the other an agglutinating-one (Turkish). To further illustrate this point, we provide a sketch of a formal analysis of this structure in (4) below making use of the Simpler Syntax framework (Culicover and Jackendoff, 2005).

(4)    Phonology:    /mit dies-en Hippie-*ler-le* ba?-a çik-ma-si
                     gerek-iyor /
       Morphology:   [G: Dative/intrumental_*dies-en* / T: N-*le*]
       Syntax:       [VP1 V(modal) [Det-N(plural) V(leave)]
                     V(modal) VP2]
       Semantics:    [Progressive(COPE([INSTRUMENTAL/
                     DATIVE(with) [Hippies; DEF]]]))

Working from the bottom up, we see unified semantic content; i.e., "X must cope with these hippies" in this representation. With respect to the syntax, we propose two separate verb phrases (VP1 and VP2, respectively) that overlap where the modal verbs from each respective language appear at the edge of each VP based on the preference associated between the source grammar home of the verb and the VO- vs. OV-preference[7]. The lexical verb *gerek* "to leave" serves as the anchor of these overlapping VPs (see e.g., Chan, 2008, 2009, 2015; Goldrick et al., 2016a for similar arguments). We propose that there is an additional level of structural (i.e., syntactic) overlap with respect to the determiner/noun phrase (D/NP), with the noun *Hippie* serving as the anchor. Morphological marking indicating the dative/instrumental case on this noun appears both on an independent determiner (G: *dies-en* "these") and as an agglutinating morpheme (T: *-le*). Crucially, the appearance of such hybrid units are dependent on some degree of congruence (i.e., the semantic representation and the recognition that dative case in German and Turkish instrumental case are approximate equivalents) as well as some degree of typological divergence (i.e., the fact that German is typologically classified as a fusion-language, whereas Turkish is agglutinating) in the source grammars contributing to the integrated, common grammar. Admittedly, models based on separate representations for each language could also account for data such as these, but we argue that an integrated model does so more naturally and, more importantly, it can do so in a way consistent with how bilinguals produce and process such structures in real time.

A third and final example of the role of typological relatedness in determining the possibility of doubled elements in the outputs of bilinguals comes from Austin's (2015, 2017) research on the acquisition of Differential Object Marking (DOM) and pre-verbal complementizers in the speech of young, bilingual Basque-speaking children in contact with Spanish. These two particular languages contrast in significant ways, with Euskara, the Basque language, marking DOM-effects with a dative verbal suffix ***zu-***, and Spanish realizing DOM-effects by means of a preverbal marking ***a*** [compare (5a) and (5b) below; both from Austin, 2015]:

(5a)    Basque DOM[8]

        *Nik    zuri    entzun di-    **zu-**    t*
        Erg1sg Dat2sg hear    Abs3sg- Dat2sg- Erg1sg
        'I have heard you-Dat.'

(5b)    Spanish DOM
        *He       visto *(**a**)  mi hija.*
        Have-1sg seem DOM my daughter
        'I have seen my daughter.'

A second structural trait that distinguishes Basque and Spanish concerns the order of constituents in a clause; i.e., Basque is head-final language, whereas Spanish adheres to a head-initial ordering of constituents [compare (6a) and (6b); both from Austin, 2015]:

(6a)    Basque (head-final)
        *Guk     liburu asko irakurri dugu*
        We-Erg book  a lot read    Aux-Abs3sg-Erg1sg
        'We have read a lot of books.'

(6b)    Spanish (head-initial)
        *Nosotros   hemos         leído muchos libros*
        We-Nom have-Nom1sg read   many   books
        'We have read many books.'

One of Austin's key research questions focused on the appearance (or lack thereof) of preverbal complementizers in the speech of monolingual and bilingual Basque-speaking (and –acquiring) adults and children. To broadly summarize her findings, Austin's study revealed the somewhat unexpected result that monolingual children produce more instances of DOM than bilingual children. With respect to the use of preverbal complementizers, Austin (2015, p. 10) provides the following rationale for her findings:

> *The use of pre-verbal complementizers presents a very different developmental pattern. These forms are used exclusively by four bilingual children[9] between the ages of 2;08 and 3;02, and were never produced by monolingual children or adults. Five bilingual children in this age range never used them at all, and their production does not seem to be correlated with their MLU in Basque. […] I understand these utterances as a temporary relief strategy which may be used by some bilingual children when they are confronted with a construction that they have not yet acquired, following proposals by Gawlitzek-Maiwald and Rosemary (1996) and Bernardini and Schlyter (2004).*

Example (7) below (from Austin, 2015) illustrates this non-target structure, where a non-target preverbal complementizer appears:

(7)    *zergatik   badoa       eskuelara*
       why-Comp go-Abs.3sg school-to
       'Because s/he goes to school.'

Interpreting Austin's findings through the lens of the integrated model of bilingual language and cognition that we adopt here, this relief strategy may likely be the result of elements from both source grammars simultaneously competing for a finite space of representation in syntactic structure. Under such conditions of typological contrast, the elements from

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[7]We thank Ray Jackendoff (p.c.) for engaging in discussion with us about this analysis.

[8]Austin (2015) notes that the Basque DOM effect in (5a) where the dative suffix appears is common in the dialect of Basque spoken in the Spanish Basque country but is not in the Basque spoken in France.

[9]Out of a total of 20 bilingual children who participated in the study.

both grammars with occasionally appear together, resulting in hybrid code-mixing. Of particular interest, these structures are only found in developing bilingual grammars, and crucially not in the speech of adults or monolingual children[10]. In summary, Austin's findings and suggested explanations are largely consistent with both ours and Muysken's (2013), where the linguistic output of bilinguals is the result of a (complex) optimization process.

As we have discussed throughout this article, grammatical knowledge—especially in the case of the bilingual mind—is best understood as a multi-dimensional, multi-vector space. In order to combat the need to produce and comprehend grammatical information with a high degree of efficiency, compression is applied whenever possible. One potential strategy to avoid the loss of (important) information, due in no small part to the lossy information within symbolic chunks, is to represent structural information twice. Although hybrid representations are commonly found in both typologically similar and dissimilar languages (see e.g., Braunmüller, 2009 and his work on code-switching among Danish-German and Danish-Faroese bilinguals), we suggest the presence of doubled elements in both developmental grammars and in simultaneous code-switching data represent solid evidence in favor of the dual activation of elements from both source grammars. Here we make the prediction that the difficulty to compress linguistic information into a common bilingual grammar consisting of source grammars that differ on at least one level of linguistic information, will lead to a higher degree of doubled structures. A preliminary survey of the nascent literature on doubled-elements in code-switches supports our hypothesis (see e.g., Chan, 2009, 2015; Goldrick et al., 2016a, and references therein). In contrast, we anticipate that doubled elements in hybrid representations will be far less likely in outputs when the source grammars exhibit higher degrees of (near) typological overlap. For example, we predict that it would be less probable to find doubled adpositions where both source grammars license prepositions [i.e., English-German *mit with der Seife (with-G with-E the-dat soap)][11]. What is yet to be determined is how much overlap across which particular levels of grammatical information represents important thresholds for any particular increase in the appearance of such forms; however, such hypotheses are indeed testable through the analysis of

existing corpus data as well as experimental research with code-switching populations.

Finally, by implementing the compression algorithm in cognitively plausible ways (Anderson, 2013), our model aims to explain the various phenomena associated with bilingualism, as well as second language learning as grounded in the ways that general cognitive mechanisms interact with linguistic experience. With regard to second language acquisition in particular, a compression algorithm makes specific predictions about how learners perform the integration of new and existing linguistic knowledge, including differences based on specific language pairs or individual differences between learners.

## CONCLUSION

Although sufficient evidence exists supporting the importance of typological similarity and distance in the acquisition, spontaneous speech, and attrition of bilingual grammars across the lifespan, deriving a working definition of this concept with predictive power has been a challenge in both generative and cognitive models of language. Here we make the case for a multi-dimensional, multi-vector network and a hybrid symbolic/sub-symbolic cognitive framework, which we deem to be necessary to model linguistic representations. In our view, this approach leads to a more accurate view of typological relatedness in both stored/routinized elements (i.e., lexical items and larger chunks) and their interaction with one another. Modeling bilingual grammar through the lens of this architecture, as we propose here, enables us to establish a depiction of the reality of dueling grammars and the routinization, chunking, and compression operations that take place in establishing congruence among elements of these grammars. There are many diagnostic tools that allow us to evaluate such a model, including code-switching phenomena, typological relatedness as evidenced by facilitation of L2 acquisition, or resistance to attrition. The model put forward here can be extended and adapted into various models, such as, but certainly not limited to, exo-skeletal frameworks of grammar where traditional parameters have been externalized from any sort of universal, or narrow computational system.

## AUTHOR CONTRIBUTIONS

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[10]It is important to recognize here that although typological dissimilarity apparently plays a critical role here, at this point we cannot claim with any degree of certainty which linguistic and cognitive factors may be at play here. One possible candidate would be inhibitory control; if this were a dominant factor, it would indicate that these bilingual grammars have representations that are retrievable to varying degrees, but the lack of inhibitory control leads to doubled structures. Potential evidence in favor of this hypothesis come from work by Lipski (2009, 2014) on code-mixing in dysfluent (or low-proficiency) bilinguals. We leave this for future research and thank Nuria Sugarra (p.c.) for an insightful discussion with us on these matters.

[11]Upon closer inspection, Babel and Pfänder's (2014) hypothesis that typology does not play a dominant role in "copying" phenomena does not pose a serious challenge for our model. Their argument that "speakers' perceptions of differences or similarities between languages are crucial to their development and change" (p. 254) is an appeal to the importance of congruence between simultaneously active grammars. Furthermore, in their proposal they do not addressed representations that contained doubled elements.

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# The Minimal and Short-Lived Effects of Minority Language Exposure on the Executive Functions of Frisian-Dutch Bilingual Children

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Various studies have shown that bilingual children need a certain degree of proficiency in both languages before their bilingual experiences enhance their executive functioning (EF). In the current study, we investigated if degree of bilingualism in Frisian-Dutch children influenced EF and if this effect was sustained over a 3-year period. To this end, longitudinal data were analyzed from 120 Frisian-Dutch bilingual children who were 5- or 6-years-old at the first time of testing. EF was measured with two attention and two working memory tasks. Degree of bilingualism was defined as language balance based on receptive vocabulary and expressive morphology scores in both languages. In a context with a minority and a majority language, such as the Frisian-Dutch context, chances for becoming proficient in both languages are best for children who speak the minority language at home. Therefore, in a subsequent analysis, we examined whether minority language exposure predicted language balance and whether there was a relationship between minority language exposure and EF, mediated by language balance. The results showed that intensity of exposure to Frisian at home, mediated by language balance, had an impact on one of the attention tasks only. It predicted performance on this task at time 1, but not at time 2 and 3. This partially confirms previous evidence that the cognitive effects of bilingualism are moderated by degree of bilingualism and furthermore reveals that substantial minority language exposure at home indirectly affects bilingual children's cognitive development, namely through mediation with degree of bilingualism. However, the findings also demonstrate that the effect of bilingualism on EF is limited and unstable.

Keywords: bilingualism, bilingual advantage, minority language, verbal working memory, exposure

## INTRODUCTION

The benefits of being proficient in two languages extend beyond the domain of language itself. Various studies have shown that bilingualism improves executive functioning (EF) (Adesope et al., 2010), a term which covers a broad range of cognitive functions that are used to control and regulate actions and thought (Miyake et al., 2000). Previous findings show that the cognitive effects of

bilingualism are not found in all bilinguals, but require a sufficient degree of bilingualism (e.g., Bialystok and Barac, 2012).

In a bilingual context with two majority languages, more or less equal exposure to both languages at home provides the best basis for becoming a proficient bilingual. For example, in Quebec, children who had been exposed equally to French and English scored similarly to monolingual children on receptive vocabulary tests in each language (Thordardottir, 2011). However, in a bilingual context with a minority and a majority language the situation is different. A minority language is a language that is different from the language used by the majority of the inhabitants of a given country and that is spoken by a non-dominant group, who wish to maintain their own linguistic, and usually also cultural, identity (Hogan-Brun and Wolff, 2003). In such a context, a larger amount of home input in the minority language improves the chances for a high degree of bilingualism. For example, in Wales, all children become proficient speakers of English, regardless of their home language situation. Proficiency in Welsh, in contrast, depends on the amount of input in Welsh at home and at school (Gathercole and Thomas, 2009). In the United States, Spanish-English bilingual children's development of Spanish receptive vocabulary is influenced by the amount of input at home, whereas this is not the case for the development of English receptive vocabulary (Hammer et al., 2009).

In the current study, we first investigated whether there is an effect of degree of bilingualism on EF in a group of Frisian-Dutch bilingual children, and whether this effect is maintained over time. Second, we examined whether there is an effect of Frisian exposure on EF that is mediated by degree of bilingualism. In what follows, we will first introduce the debate on bilingualism and EF. Subsequently, we will provide more information about the Frisian-Dutch bilingual context.

## Cognitive Effects of Bilingualism

Several studies have shown that bilingual children outperform monolingual children on EF (Adesope et al., 2010). Two EF components that have been found to be enhanced in bilinguals are attention (Martin-Rhee and Bialystok, 2008; Engel de Abreu et al., 2012) and working memory (Morales et al., 2013; Blom et al., 2014). Attention is the ability to focus on category-relevant aspects of the stimuli while ignoring category-irrelevant ones (Gazzaley and Nobre, 2012). Working memory refers to the capacity to store and manipulate information (Baddeley, 2007). The mechanism that is argued to lead to enhancement of EF in bilinguals is the monitoring of two co-activated languages in the brain. According to some researchers, the central process of this mechanism is inhibition of interference from the non-target language (Green, 1998), whereas others suggest that it is attention to the target language (Costa et al., 2006; Chung-Fat-Yim et al., 2016). In any case, it is argued that this linguistic practice of inhibition/attention generalizes to other, non-linguistic, domains, resulting in the bilingual EF advantage (Green, 1998; Bialystok et al., 2004; Costa et al., 2009; Chung-Fat-Yim et al., 2016). Previous studies have also found cognitive effects of bilingualism in majority-minority language settings with closely related languages, such as Italian and Sardinian

(Lauchlan et al., 2013; Garraffa et al., 2015) and Cypriot Greek and Standard Modern Greek (Antoniou et al., 2016).

Although many studies have reported cognitive effects of bilingualism, these effects are not consistently replicated (e.g., Antón et al., 2014; Duñabeitia et al., 2014; Gathercole et al., 2014), thus calling into question the robustness of the bilingual advantage (Hilchey and Klein, 2011; Paap et al., 2015; Valian, 2015; Ross and Melinger, 2016). The inconsistencies in the literature have led some researchers to argue that the cognitive effects of bilingualism either do not exist or are restricted to very specific circumstances that pair the right set of bilingual experiences (Paap et al., 2015).

Most research on this topic has taken a cross-sectional approach, comparing monolinguals to bilinguals at one single point in time. However, group comparisons can never completely exclude the possibility of confounds (Woumans and Duyck, 2015). For example, as monolinguals and bilinguals often come from different cultural backgrounds, it can be difficult to disentangle effects of culture (Sabbagh et al., 2006; Oh and Lewis, 2008) from effects of bilingualism (but see Antón et al., 2014; Duñabeitia et al., 2014; Gathercole et al., 2014). As confounds can lead to misinterpretations, this is a potential reason for inconsistencies in the literature.

One way to overcome the problem of confounds is to avoid group comparisons and to treat bilingualism as a continuous, rather than as a binary variable. After all, bilingualism is not a matter of all or none, but comes in different degrees (Luk and Bialystok, 2013). Treating bilingualism as a gradient furthermore allows investigating if the effect of bilingualism on EF is moderated by degree of bilingualism. As the bilingual cognitive advantage is argued to arise from maintaining attention to the appropriate language system, the extent of this advantage should depend on how much effort is needed to monitor the two language systems. Since bilinguals with equal proficiency in both languages have to deal with a more active second language than bilinguals with unequal proficiency, it is thought that bilinguals with equal proficiency need more effort to maintain attention to the appropriate language system (Yow and Li, 2015).

## Defining Degree of Bilingualism

Various studies with children found support for the effect of degree of bilingualism on EF (Bialystok and Barac, 2012; Poarch and Van Hell, 2012; Videsott et al., 2012; Blom et al., 2014; Tse and Altarriba, 2014; Crivello et al., 2016; Prior et al., 2016; Thomas-Sunesson et al., 2016; Bosma et al., 2017). While some of these studies defined degree of bilingualism in terms of language balance (Prior et al., 2016; Thomas-Sunesson et al., 2016; Bosma et al., 2017), other studies defined it in terms of bilingual proficiency (Videsott et al., 2012; Blom et al., 2014; Tse and Altarriba, 2014; Crivello et al., 2016). Bilingual proficiency refers to the absolute and relative level of proficiency in both languages, while language balance only concerns the relative proficiency. These two constructs are related, because a high degree of bilingual proficiency implies a high degree of balance. However, they are not the same, because the reverse is not true. A high degree of balance does not necessarily imply a high degree

of bilingual proficiency, since a child can be balanced with poor proficiency in both languages.

Following Yow and Li's (2015) argument, balanced bilingual children with low proficiency in both languages are also thought to benefit from their bilingualism. This is one reason to define degree of bilingualism in terms of language balance rather than bilingual proficiency. Another reason is that previous research has shown that language proficiency in monolingual children also predicts EF (Hughes and Ensor, 2007; Fuhs and Day, 2011; Bohlmann et al., 2015; Kuhn et al., 2016), an observation that has so far not been taken into account in studies on the cognitive effects of bilingualism (but see Bohlmann et al., 2015). However, it implies that defining degree of bilingualism in terms of bilingual proficiency could create the risk that an observed effect of bilingual proficiency on EF is not an effect of bilingualism, but (partially) an effect of language proficiency that is independent of bilingualism. Therefore, it may be better to define degree of bilingualism in terms of language balance, because this measure does not include language proficiency.

In a recent study based on a subsample of the Frisian-Dutch bilingual children in the current study, we found that a group of 5- and 6-year-old balanced bilingual children outperformed a group of Dutch-dominant bilingual peers on a selective attention and a verbal working memory task, but not on an interference suppression and a visual working memory task (Bosma et al., 2017). In this previous study, children from the same classroom were assigned to either a balanced or a Dutch-dominant group. These two groups were matched on age, socioeconomic status (SES), non-verbal IQ scores and Dutch language abilities. By selecting matched groups we could exclude confounding variables, but also reduced the sample size and lost the precision of graduality. Therefore, in the present study, the full sample was included and degree of bilingualism was defined as a continuous variable. In doing so, we followed other studies in which children's degree of bilingualism was defined in one of the following ways: as L2 proficiency (Tse and Altarriba, 2014), as the length of time in an immersion program (Bialystok and Barac, 2012), as a formula for language balance based on children's receptive vocabulary scores in both languages (Thomas-Sunesson et al., 2016), as a formula for bilingual proficiency based on children's receptive vocabulary scores in both languages (Blom et al., 2014), or as growth in the number of non-cognate translation equivalents between two measurements (Crivello et al., 2016). All these studies showed that degree of bilingualism predicts performance on EF tasks.

The present study extended previous research by investigating if the effect of degree of bilingualism was maintained over time. Since children's linguistic and cognitive skills are still developing, it is possible, or even likely, that the cognitive effects of bilingualism are not stable. For example, Blom et al. (2014) found bilingual proficiency to predict verbal working memory at age 6, but not at age 5. As the children became more proficient in both languages between the ages of 5 and 6, this suggests that enhanced EF emerged as the children became more bilingually proficient. In contrast to Blom et al. (2014) we did not define degree of bilingualism in terms of bilingual proficiency, but in terms of language balance. As we have argued above, this is a

slightly different measure. The children who participated in the present study were followed over a period of 3 years, starting with 5- and 6-year-olds. Previous findings of enhanced EF in bilinguals cover the whole age range of our study, from 5- and 6-year-olds (Blom et al., 2014; Gathercole et al., 2014; Tse and Altarriba, 2014; Prior et al., 2016; Bosma et al., 2017) to 7- and 8-year-olds (Bialystok and Barac, 2012; Engel de Abreu et al., 2012; Gathercole et al., 2014; Thomas-Sunesson et al., 2016), but the present study is, to our knowledge, the first that uses a 3-year longitudinal design to investigate the development of the effect of bilingualism on EF.

## Frisian-Dutch Bilingual Context

Frisian is a regional minority language that is spoken in the Dutch province of Fryslân, where it has official status next to the national majority language Dutch. Outside of the Netherlands, Frisian is known as West Frisian, to avoid confusion with the Frisian languages that are spoken in Germany. In this study, Frisian refers to West Frisian.

In 1998, the European Charter for Regional and Minority Languages (ECRML) went into force. With a recognition of the Frisian language under part III of this charter the Dutch government is obliged to take concrete actions to promote Frisian in domains like education, administration, and the media. For example, primary schools in Fryslân are required to teach Frisian as a subject for at least 1 h per week and in many schools Frisian is used as one of the languages of instruction. In 2005, the Dutch government recognized the Frisians as the only national minority group under the Framework Convention on the Protection of National Minorities (FCNM). Finally, in 2014, Frisian was recognized as official language of the province of Fryslân, next to Dutch, when the *Wet Gebruik Friese Taal* ('Law on the use of the Frisian language') went into force in the Netherlands.

The province of Fryslân has approximately 650.000 inhabitants (Centraal Bureau voor de Statistiek, 2017). Although Frisian is predominantly spoken in informal domains and more in rural than in urban areas (Breuker, 2001), it still has quite a strong position in the province as a whole. In a recent survey, a little more than half of the population reported to speak Frisian as a mother tongue (55.3%) and a little less than half of the population reported to speak Frisian with their partner (45.6%) and children (47.5%). Furthermore, the survey shows that Frisian is used more as an oral than as a written language: while the majority of the population reported to speak Frisian well (66.6%), only a small minority reported to write it well (14.5%) (Provinsje Fryslân, 2015).

Frisian and Dutch are both West Germanic languages. Historically, Frisian is most closely related to English, but over time English and Frisian have diverged, while Dutch and Frisian have converged (Gooskens and Heeringa, 2004). As a result, the Frisian and Dutch language that are spoken nowadays share a large part of their vocabularies and morphosyntactic structures. However, there are still quite a number of lexical and structural differences which clearly distinguish the two varieties.

Several studies have investigated how children's proficiency in Frisian and Dutch develops before and during primary school and how this is related to home language exposure. Dijkstra

(2013) showed that preschoolers with Frisian at home and preschoolers with Dutch at home (2.5- to 4-year-olds) performed similarly on a number of Dutch language measures, namely receptive vocabulary, mean length of utterance and number of different words. The only Dutch language task for which home language did matter was productive vocabulary. On the Frisian equivalents of all these tasks, the children with Frisian at home outperformed their peers with Dutch at home. Ytsma (1999) tested children's Frisian and Dutch proficiency on a range of language tasks at the beginning and end of the first year of primary school (4- and 5-year-olds). The results showed that the children with Frisian at home progressed more in Dutch than the children with Dutch at home progressed in Frisian. By the end of the first year, the former group of children was more balanced in their two languages than the latter group of children. Van Ruijven (2006) showed that by the fourth year of primary school (7- and 8-year-olds), children with Frisian at home had caught up in Dutch language proficiency relative to their monolingual Dutch peers in the rest of the Netherlands. However, as Ytsma (1995) showed, children with Dutch at home did not catch up in Frisian relative to their peers with Frisian at home. Although most Dutch children did acquire some lexical knowledge of Frisian, they experienced great difficulty with the acquisition of the more structural aspects of the language, such as verb conjugation.

From the studies described above it is clear that in the Frisian-Dutch situation, children with Frisian at home have a good chance to become proficient bilinguals, whereas this is unlikely for children with Dutch at home. However, in these studies, language exposure was defined as a binary variable, either Frisian or Dutch, whereas in practice, most children are exposed to both languages at home, albeit in different relative amounts. Therefore, we investigated to what extent intensity of exposure to Frisian at home, defined as a gradient, predicts language balance. Subsequently, we investigated whether intensity of exposure to Frisian at home also predicts EF and if this effect is mediated by language balance. Exploring these relationships would provide more insight into the child-external factors that influence EF and the mechanism through which this can occur.

## RESEARCH QUESTIONS AND HYPOTHESES

In the current study, we investigated the relationship between EF, exposure and degree of bilingualism in terms of language balance. The research questions are formulated in (1) and (2).

(1) Does degree of bilingualism predict Frisian-Dutch bilingual children's performance on EF tasks that measure attention and working memory, and is this effect maintained over the course of 3 years?

(2) Does intensity of exposure to Frisian at home predict EF and is this relationship mediated by degree of bilingualism?

With respect to the first research question, we expected EF to be influenced by degree of bilingualism (Bialystok and Barac,

2012; Blom et al., 2014; Tse and Altarriba, 2014; Thomas-Sunesson et al., 2016). As cognitive effects of bilingualism have been found across the whole age range covered in our study (Bialystok and Barac, 2012; Engel de Abreu et al., 2012; Blom et al., 2014; Tse and Altarriba, 2014; Prior et al., 2016; Thomas-Sunesson et al., 2016; Bosma et al., 2017), we expected an effect on all three measurements. However, as children's cognitive and linguistic skills were still developing, the effect may not be stable. Furthermore, as the cognitive effects of bilingualism are not consistently replicated (Antón et al., 2014; Duñabeitia et al., 2014; Gathercole et al., 2014), our study may also show mixed results.

With respect to the second research question, we hypothesized that intensity of exposure would predict EF performance and that this relationship would be mediated by degree of bilingualism. In line with previous evidence that only children with Frisian as their home language become proficient in both Frisian and Dutch (Ytsma, 1995, 1999; Van Ruijven, 2006; Dijkstra, 2013), we hypothesized that intensity of exposure to Frisian at home would predict degree of bilingualism to a large extent. As we expected degree of bilingualism to predict EF (research question 1), we hypothesized that intensity of exposure to Frisian at home would also predict EF.

## MATERIALS AND METHODS

### Participants

Primary schools in the countryside of the Dutch province of Fryslân were contacted for the recruitment of participants. The 14 schools that were willing to participate distributed consent forms and information folders among the parents of the children. We only tested children whose parents had signed the consent form. These children were tested annually for three consecutive years. They were 5 or 6 years old at time 1, 6 or 7 years old at time 2, and 7 or 8 years old at time 3. In the first year of the study, a total of 122 children were assessed. After the first wave of data collection, two children dropped out, leaving 120 children for the present study (61 girls, 59 boys).

**Table 1** provides an overview of the participants' age, non-verbal IQ scores, SES and intensity of exposure to Frisian at home. As age (Best et al., 2009), IQ (Arffa, 2007; but see Ardila et al., 2000) and SES (Calvo and Bialystok, 2014) are found

**TABLE 1 |** Descriptive characteristics of the participants.

|  | Mean (SD) | Range | Maximum possible score |
|---|---|---|---|
| Age at time 1 | 70 (7) | 59–83 |  |
| Age at time 2 | 82 (7) | 71–95 |  |
| Age at time 3 | 94 (7) | 83–107 |  |
| IQ | 106 (15) | 73–144 | 144 |
| SES | 6.9 (1.3) | 3.5–9 | 9 |
| % FR home | 63 (29) | 0–100 | 100 |
| % FR friends | 42 (24) | 0–100 | 100 |

*Age, age in months; IQ, intelligence quotient; SES, socioeconomic status; % FR home, intensity of exposure to Frisian at home; % FR friends, intensity of Frisian language use with friends.*

to be correlated with EF, these measures were included as control variables in the current study. Non-verbal IQ was measured with the subsets Matrices and Recognition of the *Wechsler Non-verbal Scale of Ability* (Wechsler and Naglieri, 2006), which was assessed in the first year of the study. Through a questionnaire, based on the *Questionnaire for Parents of Bilingual Children* (Tuller, 2015), parents provided information regarding their own educational level, their children's intensity of exposure to both languages at home and their children's language use with friends. The mean educational level of the father and the mother was used as a proxy of SES. Education was measured on a 9-point scale, ranging from no education (1) to university degree (9). Intensity of exposure to each language was measured as the mean percentage of input that the child received from his father, mother, siblings and other adults. Other adults were only included in this score if they looked after the child at least once per week. For each of these people, we wanted to know how often (s)he spoke each language to the child: 'never' (0%), 'seldom' (25%), 'sometimes' (50%), 'usually' (75%) and 'always' (100%). Language use with friends was measured by asking how often the child spoke each language to other children (s)he regularly played with: 'never' (0%), 'seldom' (25%), 'sometimes' (50%), 'usually' (75%) and 'always' (100%). Intensity of exposure to Dutch was 100% minus intensity of exposure to Frisian. The same applies to Dutch language use with friends.

## Measures

### Degree of Bilingualism

We defined degree of bilingualism as relative proficiency in Frisian and Dutch. As language proficiency not only includes vocabulary, but also grammar (Treffers-Daller, 2015), we took into account both a receptive vocabulary and an expressive morphology task to define language proficiency in each language.

Dutch receptive vocabulary was measured with the Peabody Picture Vocabulary Test-III-NL (PPVT-III-NL; Schlichting, 2005), which is the Dutch version of the PPVT-III (Dunn and Dunn, 1997). Frisian receptive vocabulary was measured with an adaptation of the PPVT-III-NL, which was developed for the purpose of this project (Bosma et al., 2016). In this receptive vocabulary task, children were presented sheets with four pictures from which they had to choose the one that best represented an orally presented word. In total, the PPVT-III-NL contains 17 sets of 12 items, and the sets are ordered by difficulty. For the present study, we only used the first 12 sets, that is, the first 144 items, as these sets suffice to measure the vocabulary knowledge of the children in our age range. To make sure that all children completed all items, we did not use basal and ceiling criteria.

Dutch morphology was assessed with the subtest Word Formation of the *Taaltoets Alle Kinderen* ('Language assessment all children,' Verhoeven and Vermeer, 2002). This expressive task contained 12 items testing noun plural formation and 12 items testing past participle formation. In both Dutch and Frisian, regular nouns are pluralized by adding the suffix *-en* (Dutch/Frisian *boek-boeken* 'book'-'books') or the suffix *-s* (Dutch/Frisian *tafel-tafels* 'table-tables'). Regular participles

in Dutch are formed with the circumfix *ge_t/d* (*dansen-gedanst* 'dance-danced', *rennen-gerend*, 'run-run'), while regular participles in Frisian are formed with the suffix -t/-d (*bakke-bakt* 'bake-baked', *draaie-draaid* 'turn-turned') or with the suffix -e (*dûnsje-dûnse* 'dance-danced'), depending on the infinitival form. In addition to these regular noun plurals and participles, the two languages have different types of irregular forms. Some forms are regular in Dutch, but irregular in Frisian, or vice versa.

To elicit noun plurals, children were presented with pictures of objects and prompt sentences of the following type: *Dat is een X, dat zijn twee...* "This is an X, these are two...". To elicit past participles, children were presented with pictures and prompt sentences like the following: *Rosita is een bal aan het gooien. Gisteren heeft zij ook al een bal...* "Rosita is throwing a ball. Yesterday she has also ... a ball." Both the noun plural and the past participle part of the task contained items with different degrees of regularity. Frisian morphology was tested with a comparable morphology task that was developed for the purpose of this project (Blom and Bosma, 2016).

For both the vocabulary and the morphology tasks, percentage scores were calculated. To create a language proficiency score for each language, the vocabulary and morphology percentage scores were averaged. These Frisian and Dutch proficiency scores were used to calculate children's degree of bilingualism in terms of language balance. This was done by dividing the lowest score (either Frisian or Dutch) by the highest and multiplying by 100, so that 100% indicated perfect language balance and lower scores indicated less balance.

### Attention Measures

One of the attention tasks tested selective attention, which is the ability to filter information and focus on task-relevant cues, while the other tested interference suppression, which is the ability to suppress interference from distracting stimuli pulling for a competing response. Selective attention was measured with the Sky Search task from the *Test of Everyday Attention for Children* (Manly et al., 1998). Instruction was given in Dutch and the children were given a practice sheet before the test began. The task consisted of an A3 sheet with 128 pairs of spaceships, 20 of which were identical. The children had to draw a circle around the identical spaceship pairs as fast as they could, while ignoring the non-identical spaceship pairs. The task was timed with a stop watch. After they had completed this first sheet, the children got a second A3 sheet on which only the 20 target spaceships were displayed. In this motor-control version of the test they had to encircle all pairs of displayed spaceships as fast as they could. The attention score of the Sky Search was calculated by subtracting the mean time per target (one identical pair of spaceships) of the second sheet from the mean time per target of the first sheet. In this way, differences between children could not be the result of differences in circle drawing speed. Note that lower scores in this task indicated better performance. In the first year of the study, there were four children who encircled fewer than 15 spaceships on the motor-control sheet. In line with the manual of the Sky Search task, they were excluded from the analysis.

Interference suppression was measured with the Flanker task from Engel de Abreu et al. (2012), who adapted the task from

Rueda et al. (2004). On a laptop, children were shown a horizontal row of five equally spaced yellow fish. They had to ignore the flanking fish and focus on the fish in the middle. By pressing a left or right response button, they had to indicate the direction of this central fish. Half of the flanking fish swam in the same direction as the target fish (congruent condition), while the other half swam in the other direction (incongruent condition). Each trial started with a fixation cross in the middle of the screen, which was shown for 1000 ms. Then the row of fish was presented for 5000 ms or until a response was given by pressing a left or a right button. Instruction was given in Dutch and the test started with eight practice trials before the real test began. The real test consisted of two blocks of 20 trials in which congruent and incongruent trials were randomly presented. Reaction times (RTs) and accuracy were recorded. The following responses were excluded from the analyses (9.92% of trials at time 1, 5.17% at time 2, 3.50% at time 3): incorrect responses ($n = 425$ at time 1, $n = 178$ at time 2, $n = 102$ at time 3), correct responses with RTs below 200 ms ($n = 4$ at time 1, $n = 3$ at time 2, $n = 0$ at time 3) and correct responses with RTs above three standard deviations of children's individual congruent ($n = 27$ at time 1, $n = 31$ at time 2, $n = 33$ at time 3) and incongruent means ($n = 16$ at time 1, $n = 36$ at time 2, $n = 33$ at time 3). We calculated the difference between the RTs of the incongruent trials and the RTs of the congruent trials, which is also known as the Flanker effect (mean $RT_{INCONGRUENT}$ − mean $RT_{CONGRUENT}$). RTs for incongruent trials are usually slower than RTs for congruent trials, because of interference from the distracting flanking fish. The difference between the congruent and incongruent conditions is thought to measure interference inhibition: the smaller the Flanker effect, the better a child's ability to suppress interference. At time 1, there was one child who only had one correct response in the incongruent condition. This child was excluded from the sample, as his mean RT for the incongruent condition could not be calculated reliably. At time 2 and 3, no children were excluded from the sample.

### Working Memory Measures

Verbal working memory was measured with the Backward Digit Span task and visuospatial working memory with the Backward Dot Matrix task. These measures were based on the *Alloway Working Memory Assessment* (AWMA; Alloway, 2012) and translated to Dutch. In the Backward Digit Span, sequences of digits were auditorily presented and the children had to repeat them in reverse order. Since Dutch is the main language of education and all children had spent at least 1 year in education at the first time of testing, it was assumed that all children were able to count to ten in Dutch. In the Backward Dot Matrix, sequences of blue dots were presented in a $4 \times 4$ matrix on a computer screen. Each dot appeared on the screen for 2 s and when the dots had disappeared children were asked to point out the position of the dots in reverse order. For scoring, the AWMA procedure was applied. Per block, there was a maximum score of 6 points. When the child repeated the first four trials within one block correctly, he or she automatically continued with the next block and received a score of 6. After three incorrect trials within one block the task stopped. Trials were scored as incorrect if the sequence was incorrect, if children recalled one or more

digits/dots incorrectly, or if they omitted one or more digits/dots. The scores could range from 0 to 36 for the Dot Matrix and from 0 to 42 for the Digit Span, so there were 6 and 7 blocks, respectively. In the first year of the study, the Backward Dot Matrix was aborted too early for one child. As this made the score unreliable, this data point was excluded from the analysis.

### Procedure

The tasks in this study were part of a larger test battery that included (language) tasks that were not reported on in the current study. They were administered in the following order, divided over two sessions of about 60 min each: Frisian receptive vocabulary, Frisian morphology, Digit Span, Sky Search and Flanker in the first session; Dutch receptive vocabulary, Dutch morphology and Dot Matrix in the second session. Children were tested in a quiet room at school, except for one child at time 1, four children at time 2 and five children at time 3, who were tested at home. The children were tested by the first author and two research assistants, who all had a native level command of both Dutch and Frisian.

## RESULTS

### Descriptive Statistics

The mean scores and standard deviations of the language measures, degree of bilingualism and the cognitive measures are presented in **Table 2**. The vocabulary and morphology scores represent percentages correct, based on 144 and 24 items, respectively. Correlations between Frisian vocabulary and morphology scores ranged between $r(120) = 0.442$, $p < 0.001$, and $r(120) = 0.514$, $p < 0.001$. Correlations between Dutch vocabulary and morphology scores ranged between $r(120) = 0.260$, $p = 0.004$, and $r(120) = 0.533$, $p < 0.001$. Repeated measures ANOVAs showed that over time, children improved on all language measures, $p < 0.001$. LSD *post hoc* tests showed that the differences between Time 1 and Time 2 and between Time 2 and Time 3 were significant at the $p < 0.001$ level for all language measures. Degree of bilingualism in terms of language balance is based on Dutch and Frisian receptive vocabulary and morphology scores with a score of 100% representing perfect language balance. A repeated measures ANOVA showed that on average, degree of bilingualism did not change over time, $p = 0.267$, $\eta_p^2 = 0.011$. However, as they grew older, more children became dominant in Dutch, 55.8% at time 1, 64.2% at time 2, 75.8% at time 3.

For the Sky Search and the Flanker effect, lower scores indicate better performance, whereas for the Backward Digit Span and the Backward Dot Matrix, higher scores indicate better performance. Repeated measures ANOVAs showed that over time, children significantly improved on all four cognitive measures, $p < 0.001$. LSD *post hoc* tests showed that for the Sky Search, Digit Span and Dot Matrix, the differences between Time 1 and Time 2 and between Time 2 and Time 3 were significant at the $p < 0.001$ level. For the Flanker, the difference between Time 1 and Time 2 was also significant, $p = 0.001$, but the difference between Time 2 and Time 3 was not, $p = 0.087$. Correlations between age in

**TABLE 2 |** Descriptive statistics of the language and cognitive measures.

| | Time 1 *M (SD)* | Time 2 *M (SD)* | Time 3 *M (SD)* | *p* | $\eta^2$ |
|---|---|---|---|---|---|
| **Language measures** | | | | | |
| Dutch receptive vocabulary | 64.38 (5.34) | 69.87 (4.51) | 73.49 (4.94) | <0.001 | 0.689 |
| Dutch morphology | 63.54 (13.28) | 75.07 (12.52) | 85.38 (10.23) | <0.001 | 0.699 |
| Frisian receptive vocabulary | 62.91 (6.33) | 68.03 (5.62) | 71.68 (5.17) | <0.001 | 0.636 |
| Frisian morphology | 54.03 (22.52) | 60.69 (23.35) | 65.63 (23.15) | <0.001 | 0.324 |
| Degree of bilingualism | 82.21 (14.72) | 82.98 (15.27) | 83.39 (14.75) | 0.267 | 0.011 |
| **Cognitive measures** | | | | | |
| Sky Search | 10.39 (7.50) | 5.54 (2.63) | 4.10 (1.61) | <0.001 | 0.414 |
| Flanker effect | 225 (299) | 123 (174) | 93 (172) | <0.001 | 0.097 |
| Backward digit span | 12.81 (2.87) | 14.90 (2.88) | 16.47 (3.57) | <0.001 | 0.391 |
| Backward dot matrix | 13.27 (4.76) | 18.16 (4.55) | 20.69 (4.68) | <0.001 | 0.569 |

months, IQ, SES, intensity of exposure, degree of bilingualism and the cognitive measures at time 1, 2, and 3 are reported in **Tables 3–5**, respectively.

## The Effect of Degree of Bilingualism on EF

The first research question of this study was whether degree of bilingualism predicts EF and whether this effect is stable over the course of 3 years. The correlation matrices in **Tables 3–5** show that degree of bilingualism correlated with one of the four cognitive tasks, namely the Sky Search task. Therefore, follow-up regression analyses were performed for this task only. The correlation matrices also show that the Sky Search task significantly correlated with age and IQ, but not with SES. Therefore, only age and IQ were included as control variables in the regression analyses. As the distribution of the Sky Search task deviated strongly from normality (time 1: skew = 2.33, kurtosis = 7.07; time 2: skew = 2.49, kurtosis = 9.83; time 3: skew = 2.68, kurtosis = 10.43), we applied a log-transformation to improve the distribution (time 1: skew = 0.37, kurtosis = 0.00; time 2: skew = 0.70, kurtosis = 0.89; time 3: skew = 0.93, kurtosis = 1.99). Three sequential hierarchical multiple regression analyses were conducted with the Sky Search task at time 1, time 2 and time 3 as dependent variables. In the first step of the model, age and IQ were included as control variables. In the second step of the model, degree of bilingualism at the time of testing was added as a predictor. The results are shown in **Table 6**. Degree of bilingualism predicted performance on the Sky Search task at time 1, $\beta = -0.191$, $p = 0.026$, but not at time 2, $\beta = -0.163$, $p = 0.058$, and time 3, $\beta = -0.027$, $p = 0.764$.

## The Effect of Minority Language Exposure on EF

The second research question of this study was whether there is a relationship between intensity of exposure to Frisian at home and EF, mediated by degree of bilingualism.

In order to answer this question we first investigated to what extent intensity of exposure to Frisian at home predicted children's degree of bilingualism. Second, we investigated whether intensity of exposure to Frisian at home predicted EF.

The correlation matrices in **Tables 3–5** show that degree of bilingualism and intensity of exposure to Frisian were highly correlated, but that degree of bilingualism did not significantly correlate with age, IQ and SES. Therefore, no control variables were included in the follow-up regression analyses. Three sequential hierarchical multiple regression analyses were conducted with degree of bilingualism at time 1, time 2 and time 3 as dependent variables and intensity of exposure to Frisian at home as predictor. The results (**Table 7**) showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent at time 1, $\beta = 0.682$, $p < 0.001$, time 2, $\beta = 0.784$, $p < 0.001$, and time 3, $\beta = 0.812$, $p < 0.001$.

The correlation matrices in **Tables 3–5** show that intensity of exposure to Frisian at home correlated with the Sky Search task at time 1, $r(116) = -0.220$, $p = 0.018$, and time 2, $r(120) = -0.185$, $p = 0.043$. In order to further investigate this relationship we conducted three hierarchical multiple regression analyses with the Sky Search task at time 1, time 2 and time 3 as dependent variables. Again, we used the log-transformations of the Sky Search task. In the first step of the model, age and IQ were included as control variables. In the second step of the model, intensity of exposure to Frisian at home was added as a predictor. The results are shown in **Table 8**. Intensity of exposure to Frisian at home predicted performance on the Sky Search task in more or less the same way as degree of bilingualism did (research question 1). There was an effect at time 1, $\beta = -0.171$, $p = 0.046$, but not at time 2, $\beta = -0.129$, $p = 0.137$, and time 3, $\beta = -0.015$, $p = 0.867$.

Partial correlations controlling for degree of bilingualism showed no significant relationship between intensity of exposure to Frisian at home and the Sky Search task at time 1, $r(116) = -0.073$, $p = 0.440$, suggesting that the relationship between Frisian exposure and the Sky Search task at time 1 was indeed mediated by degree of bilingualism.

## DISCUSSION

The first aim of the study was to examine whether degree of bilingualism has an effect on Frisian-Dutch bilingual children's EF and whether this effect is maintained as the children grow older. Whereas most previous studies on the cognitive effects of

**TABLE 3 |** Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 1.

|  | IQ | SES | % FR | DegBil | Sky Search | Flanker | BW digit | BW dot |
|---|---|---|---|---|---|---|---|---|
| Age | −0.020 | −0.118 | 0.098 | 0.094 | −0.300*** | 0.025 | 0.264** | 0.271** |
| IQ | − | 0.039 | −0.007 | 0.058 | −0.236* | −0.155 | 0.363*** | 0.285** |
| SES |  | − | −0.244** | −0.095 | 0.057 | −0.045 | −0.003 | 0.101 |
| % FR |  |  | − | 0.682*** | −0.220* | 0.050 | 0.055 | −0.052 |
| DegBil |  |  |  | − | −0.245** | −0.033 | 0.143 | 0.061 |
| Sky Search |  |  |  |  | − | 0.104 | −0.300*** | −0.263** |
| Flanker |  |  |  |  |  | − | −0.244** | −0.191* |
| BW digit |  |  |  |  |  |  | − | 0.438*** |

*% FR, intensity of exposure to Frisian at home; DegBil, degree of bilingualism. $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$.*

**TABLE 4 |** Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 2.

|  | IQ | SES | % FR | DegBil | Sky Search | Flanker | BW digit | BW dot |
|---|---|---|---|---|---|---|---|---|
| Age | −0.026 | −0.115 | 0.100 | 0.036 | −0.352*** | −0.164 | 0.126 | 0.268** |
| IQ | − | 0.039 | −0.007 | 0.048 | −0.159 | −0.015 | 0.265** | 0.322*** |
| SES |  | − | −0.244** | −0.154 | −0.036 | 0.152 | 0.141 | 0.033 |
| % FR |  |  | − | 0.784*** | −0.185* | −0.061 | 0.016 | 0.059 |
| DegBil |  |  |  | − | −0.216* | −0.011 | 0.136 | 0.125 |
| Sky Search |  |  |  |  | − | 0.110 | −0.064 | −0.379*** |
| Flanker |  |  |  |  |  | − | −0.013 | −0.169 |
| BW digit |  |  |  |  |  |  | − | 0.448*** |

*% FR, intensity of exposure to Frisian at home; DegBil, degree of bilingualism. $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$.*

**TABLE 5 |** Correlations between age, IQ, SES, intensity of exposure to Frisian at home, degree of bilingualism and the cognitive measures at time 3.

|  | IQ | SES | % FR | DegBil | Sky Search | Flanker | BW digit | BW dot |
|---|---|---|---|---|---|---|---|---|
| Age | −0.028 | −0.123 | 0.099 | 0.014 | −0.260** | −0.081 | 0.102 | 0.296*** |
| IQ | − | 0.039 | −0.007 | 0.070 | −0.114 | −0.238** | 0.332*** | 0.283** |
| SES |  | − | −0.244** | −0.166 | −0.004 | −0.131 | 0.151 | 0.089 |
| % FR |  |  | − | 0.812*** | −0.045 | 0.046 | −0.001 | 0.084 |
| DegBil |  |  |  | − | −0.057 | 0.141 | −0.003 | 0.074 |
| Sky Search |  |  |  |  | − | 0.365*** | −0.145 | −0.241** |
| Flanker |  |  |  |  |  | − | −0.059 | −0.201* |
| BW digit |  |  |  |  |  |  | − | 0.431*** |

*% FR, intensity of exposure to Frisian at home; DegBil, degree of bilingualism; $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$.*

**TABLE 6 |** Sky Search at time 1, 2 and 3, regressed on degree of bilingualism at the time of testing, controlling for age, IQ and SES.

|  | Sky Search Time 1 ($n = 116$) | | Sky Search Time 2 ($n = 120$) | | Sky Search Time 3 ($n = 120$) | |
|---|---|---|---|---|---|---|
|  | Stage 1 (β) | Stage 2 (β) | Stage 1 (β) | Stage 2 (β) | Stage 1 (β) | Stage 2 (β) |
| Age Tx | −0.371*** | −0.354*** | −0.344*** | −0.338*** | −0.267** | −0.266** |
| IQ | −0.201* | −0.189* | −0.119 | −0.110 | −0.118 | −0.116 |
| Bilingualism Tx |  | −0.191* |  | −0.163 |  | −0.027 |
| $R^2$ | 0.176 | 0.212 | 0.130 | 0.157 | 0.083 | 0.084 |
| $\Delta R^2$ |  | 0.036 |  | 0.027 |  | 0.001 |
| $F$ | 12.091*** | 10.058*** | 8.746*** | 7.180*** | 5.325** | 3.552* |

*Tx = time 1, 2 and 3, respectively; $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$.*

bilingualism compared monolinguals to bilinguals (e.g., Engel de Abreu et al., 2012), the current study adds to the few studies in which children's bilingualism is defined as a gradient (Bialystok and Barac, 2012; Blom et al., 2014; Tse and Altarriba, 2014; Crivello et al., 2016; Thomas-Sunesson et al., 2016), doing justice to the graduality of bilingualism (Luk and Bialystok, 2013). In

**TABLE 7 |** Degree of bilingualism at time 1, 2 and 3, regressed on intensity of exposure to Frisian at home.

|  | Bilingualism Time 1 ($n = 120$) ($\beta$) | Bilingualism Time 2 ($n = 120$) ($\beta$) | Bilingualism Time 3 ($n = 120$) ($\beta$) |
|---|---|---|---|
| Exposure FR | 0.682*** | 0.784*** | 0.812*** |
| $R^2$ | 0.465 | 0.614 | 0.659 |
| $F$ | 102.604*** | 187.722*** | 227.846*** |

*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.

the present study, we defined degree of bilingualism in terms of language balance. Our results partly confirmed previous research showing that bilingualism enhances EF (e.g., Adesope et al., 2010) and that the effects are moderated by language balance (Prior et al., 2016; Thomas-Sunesson et al., 2016; Bosma et al., 2017). However, the effect was limited to selective attention and disappeared over time, thus supporting previous skepticism about the robustness of the bilingual advantage (Hilchey and Klein, 2011; Paap et al., 2015; Valian, 2015; Ross and Melinger, 2016). There was a significant effect of degree of bilingualism on the Sky Search task at time 1 (age 5/6), a close to significant effect at time 2 (age 6/7) and no effect at time 3 (age 7/8). There was no effect on interference suppression, as measured with the Flanker task, and working memory, as measured with the Backward Digit Span and the Backward Dot Matrix.

The absence of an effect on working memory is in contrast with Bosma et al. (2017), who used a subsample of the children in the current study and found that balanced Frisian-Dutch bilingual children outperformed Dutch-dominant bilingual children on verbal working memory and selective attention. The absence of an effect on verbal working memory in the current study suggests that the effect of bilingualism on verbal working memory is less robust than the effect of bilingualism on selective attention. The finding that degree of bilingualism only had an effect on selective attention strengthens the view that selective attention, rather than interference suppression, is the core of the bilingual EF advantage (Chung-Fat-Yim et al., 2016). Chung-Fat-Yim et al. (2016) argue that the ability to selectively attend to visual stimuli and to disengage from the focus of attention when criteria are not met is similar to the kind of challenge that bilinguals face every day, namely to selectively attend to the linguistic structures of the target language and to

disengage attention from structures that do not belong to the target language.

The second aim of the study was to investigate whether exposure to the minority language at home has an effect on EF and whether this effect is mediated by degree of bilingualism. Finding this relationship would provide more insight into the child-external factors that influence EF and the mechanism through which this can occur. Although many studies have investigated the circumstances that support bilingual language acquisition (e.g., Gathercole and Thomas, 2009; Hammer et al., 2009; Dijkstra, 2013), it has only rarely been investigated whether these circumstances indirectly lead to cognitive enhancement (but see Bialystok and Barac, 2012). The results of our study showed that intensity of exposure to Frisian at home predicted degree of bilingualism to a large extent, a finding that is in line with previous evidence that in the province of Fryslân, only children with Frisian as their home language become proficient bilinguals (Ytsma, 1995, 1999; Van Ruijven, 2006; Dijkstra, 2013). Furthermore, intensity of exposure to Frisian at home predicted EF in the same way as degree of bilingualism did, that is, there was an effect on the Sky Search task at time 1, but not at time 2 and 3.

The current study is the first study that examined the effect of language balance on EF in a longitudinal way. The finding that the effect on selective attention fluctuates over time is important, because it may explain some inconsistencies in the literature. Namely, if the current study were cut into three separate cross-sectional studies, these three studies would have contradicted each other, as only one out of three would have found an effect. By following the same group of children for a longer period of time, we were able to show the instability of the cognitive effect of bilingualism. One possibility for the vanishing of the effect is that Dutch is the dominant language in school, which would lead to a reduction in the use of the minority language as the children grow older. This is also supported by the finding that over time, children became more dominant in Dutch. However, as children's overall language balance did not change over time, other explanations may be more likely.

As Valian (2015) pointed out, the cognitive effects of bilingualism may not always be visible, because they are very small and probably compete with many other activities that also enhance EF. Following this line of reasoning, one alternative explanation for the vanishing of the effect is that over time, the

**TABLE 8 |** Sky Search at time 1, 2 and 3, regressed on intensity of exposure to Frisian at home, controlling for age, IQ and SES.

|  | Sky Search Time 1 ($n = 116$) | | Sky Search Time 2 ($n = 120$) | | Sky Search Time 3 ($n = 120$) | |
|---|---|---|---|---|---|---|
|  | Stage 1 ($\beta$) | Stage 2 ($\beta$) | Stage 1 ($\beta$) | Stage 2 ($\beta$) | Stage 1 ($\beta$) | Stage 2 ($\beta$) |
| Age Tx | −0.371*** | −0.352*** | −0.344*** | −0.331*** | −0.267** | −0.265** |
| IQ | −0.201* | −0.202* | −0.119 | −0.119 | −0.118 | −0.118 |
| Exposure FR |  | −0.171* |  | −0.129 |  | −0.015 |
| $R^2$ | 0.176 | 0.205 | 0.130 | 0.147 | 0.083 | 0.084 |
| $\Delta R^2$ |  | 0.029 |  | 0.017 |  | 0.001 |
| $F$ | 12.091*** | 9.631*** | 8.746*** | 6.642*** | 5.325** | 3.530* |

Tx = time 1, 2, and 3, respectively; *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.

effect of bilingualism on visual selective attention got overruled by the effect of literacy. Several studies have shown that literacy enhances visual discrimination abilities (e.g., Ventura et al., 2013; Pegado et al., 2014). Pegado et al. (2014), for example, showed that learning to read has an impact on several stages of visual processing, including repetition suppression. This is the reduction in neural activity in response to a repeated stimulus. Since repetition suppression reflects the brain's capacity to discriminate two items, this suggests that literacy facilitates the identification of identical visual stimuli, a skill that is useful for the Sky Search task. In the first year of our study, most children were in grade 2 and had not started formal literacy education yet. However, by the third year of our study, all children had received between 0.5 and 2.5 years of literacy instruction. It could be that the age at which formal literacy instruction begins influences when the cognitive effects of bilingualism are visible. Therefore, we suggest that future studies investigate the cognitive effects of bilingualism in combination with the cognitive effects of literacy.

Another potential reason why the effect disappears over time is given by Gathercole et al. (2014). They argue that links within a language are usually stronger than links across languages. However, in fluent bilinguals, the between-language links are quite strong and as their linguistic knowledge in both languages is automatized, they may require little cognitive control to monitor their two co-activated languages. On average, the language balance of the children in our study did not improve over time, but their proficiency in Dutch and Frisian did. Following Gathercole et al.'s (2014) line of reasoning, the children in our study with a high degree of language balance may have strengthened the links between their two languages as they grew older, which might have resulted in the leveling off of the cognitive effect. While this explanation seems to be at odds with the suggestion that the effect of bilingualism develops as a result of growing bilingual proficiency (Blom et al., 2014), it is not impossible that once a higher degree of proficiency in both languages has been attained, bilingual monitoring becomes more automatic and bilingual experience does not further enhance EF. What this suggests is a limited window of development in which bilingualism enhances cognitive functioning.

Taken together, the current study only provides minimal support for the claim that minority language exposure, mediated by language balance, influences the cognitive effects of bilingualism. The effect was only visible on one out of four EF tasks and disappeared as the children grew older, thus supporting previous skepticism about the robustness of the bilingual advantage (Hilchey and Klein, 2011; Paap et al., 2015; Valian, 2015; Ross and Melinger, 2016). Although the reasons for this fluctuation over time remain as yet unclear, the instability of the effect may explain why some cross-sectional studies show cognitive enhancement in bilinguals, whereas other studies do not.

## ETHICS STATEMENT

All the parents of the participating children gave their written informed consent, as was stated in the Section "Materials and Methods" of our paper. Unfortunately, the study was not officially evaluated by an ethics committee before the start of the study due to a miscommunication. In hindsight, the ethics committee of the University of Amsterdam evaluated the information folder and the informed consent form that we used and came to the conclusion that the research had been conducted with the wellbeing of the participants in mind.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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# Cognitive Advantages of Bilingual Children in Different Sociolinguistic Contexts

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Many studies have shown that bilingual children outperform monolinguals on tasks testing executive functioning, but other studies have not revealed any effect of bilingualism. In this study we compared three groups of bilingual children in the Netherlands, aged 6–7 years, with a monolingual control group. We were specifically interested in testing whether the bilingual cognitive advantage is modulated by the sociolinguistic context of language use. All three bilingual groups were exposed to a minority language besides the nation's dominant language (Dutch). Two bilingual groups were exposed to a regional language (Frisian, Limburgish), and a third bilingual group was exposed to a migrant language (Polish). All children participated in two working memory tasks (verbal, visuospatial) and two attention tasks (selective attention, interference suppression). Bilingual children outperformed monolinguals on selective attention. The cognitive effect of bilingualism was most clearly present in the Frisian-Dutch group and in a subgroup of migrant children who were relatively proficient in Polish. The effect was less robust in the Limburgish-Dutch sample. Investigation of the response patterns of the flanker test, testing interference suppression, suggested that bilingual children more often show an effect of response competition than the monolingual children, demonstrating that bilingual children attend to different aspects of the task than monolingual children. No bilingualism effects emerged for verbal and visuospatial working memory.

Keywords: bilingual advantage, dialect, bilingualism, regional language, minority language, working memory, attention

## INTRODUCTION

Over the past few years many studies have shown that bilingual children outperform monolinguals on tasks measuring executive functions (for reviews, see Adesope et al., 2010; Barac and Bialystok, 2011; Hilchey and Klein, 2011). The executive functions are part of a domain-general cognitive system that is essential for the flexibility and regulation of cognition and goal-directed behavior (Best and Miller, 2010) and comprises distinguishable yet interrelated components (Miyake et al., 2000). Commonly referred to components are switching (switching flexibly between tasks or mental sets), updating (constant monitoring and rapid addition/deletion of working-memory contents), and inhibition (control of attention and ability to override a strong prepotent response)

(Miyake et al., 2000), although more recent insights suggest that inhibition may not be separable from the other components (Miyake and Friedman, 2012). Bilinguals are thought to develop executive function advantages because they manage multiple languages and continuously monitor the appropriate language for each communicative interaction (Costa et al., 2009). They need to attend to cues that inform the speaker on which language to use, select the right language, and choose appropriate lexicalisation, and while doing this they suppress the interference of other languages. As such, interactions in bilingual contexts may call upon general conflict-monitoring and goal-orienting abilities (Colzato et al., 2008; Costa et al., 2009; Hernández et al., 2013), leading to general executive function advantages (see Bialystok et al., 2012, for an overview).

However, other studies conclude that bilinguals' better executive function outcomes are a mere artifact of experiments (Paap et al., 2015) or that bilingual cognitive advantages are attributable to factors such as differences in socioeconomic status (SES) between monolinguals and bilinguals (Morton and Harper, 2007). Other factors have also been proposed to account for the bilingual-monolingual differences in executive function tasks, such as general intelligence (Craik and Bialystok, 2005; Arffa, 2007; Brydges et al., 2012) or culture (Carlson and Choi, 2008; Carlson, 2009). To prevent confounding effects, within-group comparisons (Wu and Thierry, 2013; Crivello et al., 2016) and between-group comparisons in which the groups are matched on a range of background variables (Hilchey and Klein, 2011) are needed.

One study noteworthy for its careful design has been conducted by Duñabeitia et al. (2015). They compared the inhibitory skills of 252 monolingual Spanish and 252 Basque-Spanish bilingual children using a verbal and a numerical Stroop task in which children had to ignore distracting information. The monolingual children were recruited from provinces where Spanish is the only official language of communication. The bilingual children were recruited from the Basque country where both Basque and Spanish are official languages. Children in the two groups were matched on age, academic skills, attention-related skills, and intelligence. In this study no effects of bilingualism emerged on either of the two Stroop tasks. Furthermore, a large-scale study conducted with Welsh-English bilinguals showed little support for bilingual advantages on non-verbal executive function tasks (card sorting tasks, Simon tasks) and metalinguistic tasks (Gathercole et al., 2014). In both studies a relatively wide age range was included, but breaking down the results by grade or age group did not alter the conclusions.

Gathercole et al. (2014) suggest that it might not be coincidental that the Basque-Spanish and Welsh-English studies showed no effects of bilingualism, as the bilinguals in the two studies grew up in a situation of bilingual immersion in which both the minority language (Basque, Welsh) and the state's official language (Spanish, English) are part of the everyday experience. Assuming a gradual approach to bilingualism, as for instance proposed by Dijkstra (2005) and Lam and Dijkstra (2010), they suggest that fluent bilinguals, such as the Basque-Spanish and Welsh-English bilinguals, have strong between-language links and a large degree of automaticity of the linguistic knowledge in both languages. Consequently, switching between languages may require little cognitive effort and control, and as a result, does not lead to the supposed training effect. Various other studies in which the bilinguals are also immersed in both the minority language and the state's official language do show cognitive effects of bilingualism: balanced Frisian-Dutch children outperform Dutch-dominant children (Bosma et al., 2017), and Spanish-Catalan bilinguals (Costa et al., 2008, 2009; Hernández et al., 2013), Sardinian-Italian bilingual children (Lauchlan et al., 2013; Garraffa et al., 2015) and children who speak Cypriot Greek and Standard Modern Greek (Antoniou et al., 2016) outperform Spanish, Italian, and Greek monolinguals, respectively, on tasks testing executive functioning. It is possible that the participants in these studies are less bilingually fluent than the Basque-Spanish and Welsh-English bilinguals who showed no cognitive effects of bilingualism, because being immersed in the two languages does not necessarily imply fluent bilingualism. The hypothesis seems to be at odds, however, with observations showing that cognitive advantages are limited to bilinguals who are proficient in both languages (Carlson and Meltzoff, 2008; Bialystok and Barac, 2012; Poarch and van Hell, 2012; Videsott et al., 2012; Weber et al., 2016) or emerge as an effect of growing bilingual proficiency (Blom et al., 2014; Antoniou et al., 2016; Crivello et al., 2016).

Unlike the Basque-Spanish and Welsh-English bilinguals, the Frisian-Dutch, Catalan-Spanish, Sardinian-Italian bilinguals, and Cypriot Greek-Standard Modern Greek bidialectals are exposed to two closely related languages or dialects. This may suggest that language distance modulates the cognitive effect and that cognitive advantages are more likely for closely related varieties than for very distinct languages. However, there are also studies on closely related varieties that observe no cognitive effects suggesting that the relevant factor that might affect the emergence of the bilingual cognitive advantage in executive functioning is not language distance. For instance, no effects were observed in bilinguals who speak Italian and a Venetian regional variety (Scaltritti et al., 2015) or English and Dundonian, a regional variety spoken in the north-east of Scotland (Ross and Melinger, 2016). The conclusion that language distance does not modulate the cognitive effect of bilingualism is furthermore supported by research by Bialystok and colleagues who report effects of bilingualism on executive functioning in different language pairs (French-English, Chinese-English) and in heterogeneous bilingual samples (Bialystok, 1999; Bialystok and Martin, 2004; Bialystok et al., 2005). Comparing the Catalan-Spanish (Costa et al., 2008, 2009; Hernández et al., 2013) and Italian-Venetian contexts, Scaltritti et al. (2015) suggest that the frequency of language switching and mixing may explain the differential findings as the sociolinguistic environment of Catalan-Spanish bilinguals is conducive to language switching, whereas language use in the Italian-Venetian context is more compartmentalized. However, according to Green and Abutalebi (2013) separation may be more fundamental than frequency of switching, as functioning in settings in which the two languages are more separated is more likely to be associated with heightened cognitive control than functioning in dense code-switching contexts. The role of language separation appears to be supported by the findings of Antoniou et al. (2016) who observed cognitive

effects in a context of diglossia in which the two language varieties (Cypriot Greek and Standard Modern Greek) are functionally separated and show hardly any overlap between domains of language use.

Despite the many studies that have investigated the cognitive effects of bilingualism, it is still not well-understood which conditions moderate the effect of bilingualism on executive functioning. With the present study, we aimed to shed more light on this issue by comparing three groups of 6- to 7-year-old bilingual children with a monolingual control group in the Netherlands. The four groups are matched on age, non-verbal intelligence, parental education, and gender. They differ in lingual status on two dimensions: besides the bilingual versus monolingual divide, the bilingual groups differ in exposure to a regional versus migrant language. In these two types of bilingualism, exposure to the minority language (i.e., regional, migrant) is not the same because exposure to the migrant language happens predominantly in the home environment, whereas the regional languages are also frequently spoken outside the children's homes in the wider society. Children in the two regional language groups are exposed to either Frisian or Limburgish, apart from the national language (Dutch). Like Dutch, Frisian and Limburgish are West Germanic languages. Frisian and Limburgish share many linguistic properties with Dutch, but they are among the most linguistically distant from standard Dutch (Heeringa and Nerbonne, 2013). The sociolinguistic context is different for Frisian and Limburgish, which will be explained below.

Frisian is spoken in the province of Fryslân, in the north of the Netherlands, where it is an official language besides Dutch. As such, primary schools in the region are obliged to teach Frisian for at least 1 h per week, and in many schools Frisian is used as one of the languages of instruction. As Frisian has a long history of literacy and is present as language of instruction in education, Dutch and Frisian are considered and in general produced by its speakers as two separate varieties, even though code-mixing between Frisian and Dutch does happen regularly (Muysken, 2000). Frisian is recognized under part III of the European Charter for Regional and Minority Languages (ECRML), which went into force in 1998. This obliges the Dutch government to take concrete measures to promote Frisian in domains such as education, administration, and the media. In 2005, Frisian was recognized by the Dutch government as the only national minority language under the Framework Convention on the Protection of National Minorities. In 2014, the *Wet Gebruik Friese Taal* ('Law on the use of the Frisian language') went into force in the Netherlands, which states that Frisian and Dutch are the official languages of the province of Fryslân. Frisian has quite a strong position in the province, although it is more spoken in rural, than in urban areas (Breuker, 2001). In a recent survey of the province, slightly more than half of the population reported to speak Frisian as a mother tongue (55.3%) and slightly less than half of the population reported to speak Frisian with their partner (45.6%) and children (47.5%). Frisian is more used orally than written: most inhabitants of the province of Fryslân reported speaking it well (66.6%), but only few reported writing it well (14.5%) (Provinsje Fryslân, 2015).

Limburgish is spoken in the province of Limburg, in the south of the Netherlands. The dialects of Dutch Limburg were extended minor recognition under the label *Limburgish* in 1997 by the Netherlands, a signatory of the 1992 ECRML. Minor recognition under ECRML compels the Dutch state to formally recognize the status of Limburgish as a separate variety without, however, being obliged to take relevant measures such as financial support. Moreover, Limburgish is not taught in schools and, hence, it does not have the same status as Frisian. Since 1997, public funds have been made available by the Province of Limburg for promoting the use of Limburgish, although most people in Limburg, if not all, use the label dialect instead of Limburgish. Its use in local media is restricted (Cornips et al., 2016), as is its use in writing, public speech, educational contexts, and administration although, in contrast to Frisian, it is spoken as much in rural as in urban area's (with the exception of the former coal mining area in the south-east). Although use of Limburgish is often limited to homely matters of family and community life (Leerssen, 2006) such as in the street, and in shops, it is also commonly spoken in formal domains, for instance by the highest-ranking provincial dignitaries and policy-officers in the provincial government building (Cornips et al., 2016). Therefore, it has a high social prestige in some societal and cultural domains. According to research conducted by the newspaper *De Limburger/Limburgs Dagblad* of a representative sample of 1,078 respondents in spring 2016, 66% indicated to be exposed to Limburgish from birth onward and 9% claimed to be raised partly in Limburgish. Moreover, 59% of the respondents claimed to be highly proficient in speaking the dialect of their birthplace and, in addition, 46 and 69% reported to be highly proficient in speaking and understanding the dialect of the village where they currently live in, respectively. Limburgish is spoken most with one's own partner (64%) or children (62%) at home, with one's parents (66%), and with friends (71%). In contrast, Dutch is the dominant language at the workplace or at school (53%), in civil services (65%), and in the hospital (75%). Although Limburgish and Dutch are perceived as two separate varieties, people frequently code-mix or speak a leveled variety between Dutch and Limburgish dialect in daily contexts (Giesbers, 1986).

The third bilingual group consists of Polish-Dutch immigrant children. Since 2004, when Poland entered the European Union, there has been an increase of Polish labor immigrants in the Netherlands. Recent demographic statistics indicate that there are 137,794 Polish immigrants in the Netherlands. The majority is first generation immigrant (78%) (Centraal Bureau voor de Statistiek [CBS], 2015). In general, Polish immigrants in the Netherlands have a higher educational level than the four largest immigrant groups (that is, migrants from Morocco, Netherlands Antilles and Aruba, Suriname, Turkey), and particularly Polish women are relatively well-educated (Dagevos, 2011). In our sample, the educational level of the Polish group was even higher than expected, which allowed us to match the four groups on SES. Because the influx of immigrants from Poland is relatively recent, limited information is available on language abilities and use in this group. The study by Dagevos (2011) reports that most Polish immigrants have a low level of Dutch and a good command of Polish. Both the low level of Dutch and high level of Polish are

most probably related to recency of migration and are expected to change as a function of length of stay in the Netherlands. A minority of the Polish immigrants reports to always speak Dutch with their partner (20%) or children (10%). The reason why more Dutch is used with partners than children is twofold: relatively many Polish immigrants are in mixed marriages and many do not yet have children who are born in the Netherlands. It may be expected that use of Dutch in the Polish migrant families will increase when more children are born and educated in the Netherlands.

Executive function tasks in this study tested attention and working memory. Working memory refers to the ability to retain information in an accessible state (Engle, 2002). Various studies have shown that performance on working memory tasks is strongly related to attention, specifically to attentional control (Engle and Kane, 2004) and focus (Cowan et al., 2005). Attention and working memory are, however, not isomorphic and are best represented by correlated but distinct factors (Unsworth and Spillers, 2010). Previous research has shown bilingual advantages in attention (Martin-Rhee and Bialystok, 2008; Engel de Abreu et al., 2012), working memory (Morales et al., 2013; Blom et al., 2014) and in a combination of attention and working memory tasks (Antoniou et al., 2016), using similar tasks as those used in the present study. The attention tasks in the present study tested the ability to filter information and focus on task-relevant stimuli (selective attention) and the ability to suppress interference from a specific cue (interference suppression). For working memory, both verbal and visuospatial working memory tasks were used (Alloway et al., 2006).

We expected the bilingual children to outperform the monolingual children on working memory and attention, but because there are also studies reporting no effects, we reckoned with the possibility that no effects would emerge. There could also be reasons why some bilingual groups differ from the monolinguals whereas others do not. Exposure to Polish in a limited number of domains (because of in-home exposure only) may result in a relatively low degree of bilingual proficiency in the Polish group. Given previous observations that a certain level of bilingual proficiency is required for cognitive effects to develop (Carlson and Meltzoff, 2008; Bialystok and Barac, 2012; Poarch and van Hell, 2012; Videsott et al., 2012; Blom et al., 2014; Antoniou et al., 2016; Crivello et al., 2016; Weber et al., 2016), it is possible that the Polish group shows no bilingual benefit, in contrast to the Frisian and Limburgish groups. The Polish group is not as bilingually immersed as the Frisian and Limburgish groups, where both languages are used frequently inside and outside the home environment. Given this difference, children in the Frisian and Limburgish groups may be more fluent bilinguals and experience more overlap in the domains of language use than the Polish children. Fluent bilingualism (Gathercole et al., 2014) and limited language separation (Green and Abutalebi, 2013) may predict that the Frisian and Limburgish groups do not outperform the monolinguals on executive functioning, and contrast with the Polish group in this respect. Between the Frisian and Limburgish contexts, differences exist in use of the regional language in school settings. Teaching Frisian as a subject in school may contribute to language separation, because it raises

awareness that Frisian is a separate language. This would predict that the Frisian children are more likely to show cognitive effects of their bilingualism than the Limburgish children. However, the use of Frisian as a language of instruction, besides Dutch, could have the opposite effect because functional overlap between the two languages in a specific domain, like the educational context, may lead to less separation instead of more.

## MATERIALS AND METHODS

### Participants

In the study 176 children participated, who were assigned to four different groups (monolingual Dutch, Frisian-Dutch, Limburgish-Dutch, Polish-Dutch), with 44 children in each group. All children were either 6 or 7 years old (72–95 months) at time of testing. In addition to age, a number of selection criteria were used. Children with a non-verbal intelligence below 70 were excluded, as were children for whom full datasets were not available. Furthermore, within the bilingual groups, children were only included if at least one of their parents spoke the non-Dutch language with the child, to ensure that all these children could be considered bilingual. Details of the groups are given in **Table 1**.

The four groups did not differ in age [$F(3,172) = 1.13$, $p = 0.34$, $\eta_p^2 = 0.02$]. In addition to age, they were matched on non-verbal intelligence [$F(3,172) = 0.20$, $p = 0.90$, $\eta_p^2 = 0.003$], SES [$H(3) = 3.71$, $p = 0.30$, $\eta_p^2 = 0.004$], and gender [$\chi^2(3) = 0.27$, $p = 0.97$]. Non-verbal intelligence was measured with the short version of the *Wechsler Nonverbal-NL* (Wechsler and Naglieri, 2008), and SES was indexed by the average educational level of both parents of the child, based on the *Questionnaire for Parents of Bilingual Children* (PaBiQ; Tuller, 2015). Educational level represented the highest degree obtained on a nine-point scale ranging from 1 indicating no education to 9 indicating a university degree.

The Frisian-Dutch, Limburgish-Dutch, and monolingual Dutch participants were recruited via regular elementary schools in the north, south, and mid-west of the Netherlands, respectively. All these children were born in the Netherlands. The Polish-Dutch children were recruited via Polish Saturday schools in the western part of the country. In the Polish group, 70% of the children were born in the Netherlands (mean age of arrival = 8.62 months, $SD = 20.38$). All Polish children

TABLE 1 | Mean age, NVIQ, SES, with standard deviations, and gender distribution in the four groups.

|  | N | Age in months | NVIQ | SES | Girls/boys |
|---|---|---|---|---|---|
| Monolingual | 44 | 82 (7) | 107 (15) | 6.56 (1.94) | 20/24 |
| Frisian | 44 | 82 (6) | 107 (15) | 6.73 (1.28) | 20/24 |
| Limburgish | 44 | 84 (6) | 108 (13) | 6.72 (1.93) | 20/24 |
| Polish | 44 | 82 (7) | 108.5 (13) | 7.28 (1.40) | 22/22 |

*N, number; NVIQ, standardized non-verbal intelligence score; SES, socioeconomic status.*

**TABLE 2 | Mean input with standard deviations in different languages before age 4 and current use of languages at home.**

|  | % Dutch input before age 4 | % Non-Dutch input before age 4 | % Other input before age 4 | % Current use Dutch | % Current use non-Dutch | % Current use other |
|---|---|---|---|---|---|---|
| Frisian | 30 (23) | 70 (24) | 1 (3) | 31 (27) | 68 (26) | 0 (2) |
| Limburgish | 40 (20) | 59 (21) | 1 (5.5) | 42 (26.5) | 56 (27) | 1 (6) |
| Polish | 43 (19) | 54 (18) | 3 (8) | 37 (24) | 61 (24) | 1.5 (8) |

*Non-Dutch refers to Frisian, Limburgish and Polish, respectively, whereas 'other' refers to additional other languages that the children are exposed to.*

had lived in the Netherlands for 2 years or more at time of testing. Parental questionnaire data, collected with the PaBiQ (Tuller, 2015), indicated that the bilingual children had received a substantial amount of input in Dutch before the age of 4, measured relative to the total amount of language input that the child received before this age (both inside and outside home context). From the age of 4 onward, all children received regular and frequent exposure to Dutch in kindergarten. There was a difference between the bilingual groups with respect to Dutch input before age 4 [$F(2,129) = 4.83$, $p = 0.009$, $\eta_p^2 = 0.07$]. The Frisian group had received less Dutch exposure than the Polish ($p = 0.01$) children. There was no difference between the Frisian and the Limburgish group ($p = 0.07$) or between the Polish and the Limburgish group ($p = 1.00$). The PaBiQ also provided information on the current use of languages at home, measured relative to the total amount of language input that the child heard from its mother, father, siblings, and other adults that had frequent contact with the child. The groups did not differ on current use of Dutch [$F(2,129) = 2.06$, $p = 0.13$, $\eta_p^2 = 0.03$]. The language input and use patterns at home in the three bilingual groups can be found in **Table 2**.

As expected, the bilingual children were quite proficient in Dutch as confirmed by the outcomes of the Dutch version of the Peabody Picture Vocabulary Test (PPVT; Schlichting, 2005), which is a standardized measure for Dutch receptive vocabulary. The data in **Table 3** show that each group scored, on average, within the normal range of variation for monolingual Dutch children, that is, within 1 standard deviation from the mean of the normative sample ($M = 100$, $SD = 15$). In the Polish sample there were six children who scored 1 standard deviation below the mean and one child who scored over 2 standard deviations below the mean. Most of these children were not born in the Netherlands but arrived at a later age, explaining these

relatively low scores. On average the Polish group also had a lower PPVT score than the other three groups as indicated by a univariate ANOVA [$F(3,172) = 12.42$, $p < 0.001$, $\eta_p^2 = 0.18$] and subsequent Bonferroni *post hoc* comparisons (monolingual: $p < 0.001$, Frisian: $p < 0.001$, Limburgish: $p = 0.01$). Further information about children's skills in Dutch and the non-Dutch language was obtained through the PaBiQ. The Frisian and Polish parents indicated quite similar skills in both languages [Frisian: $t(43) = -0.78$, $p = 0.44$; Polish: $t(43) = -1.55$, $p = 0.13$], whereas the Limburgish parents reported that their children's skills in Dutch were better than in Limburgish [$t(40) = -6.06$, $p < 0.001$].

## Measures

### Receptive Vocabulary

Receptive vocabulary in Dutch was measured with the *Peabody Picture Vocabulary Task* (PPVT-III-NL; Schlichting, 2005, based on the PPVT-III by Dunn and Dunn, 1997). The PPVT is a standardized receptive vocabulary test designed for the age range from 2 years and 3 months to 90 years. It contains 204 items divided over 17 sets. The sets are ordered according to difficulty and each set consists of 12 items. In this task, the child hears a stimulus word and has to choose the correct referent out of four pictures. The PPVT-III-NL was administered and scored according to the official guidelines. Receptive vocabulary in Polish was measured with the standardized *Obrazkowy Test Słownikowy – Rozumienie* (Haman and Fronczyk, 2012). This instrument is very comparable to the PPVT and offers monolingual norms for the age range from 2 to 6 years and 11 months. For Frisian and Limburgish, no standardized receptive vocabulary measures were available.

### Parental Questionnaire

The *Questionnaire for Parents of Bilingual Children* (Tuller, 2015) was administered during a home visit or telephone interview with one of the child's parents. For the bilingual children, the interview was conducted by bilingual assistants, who were proficient in both Dutch and Frisian/Limburgish/Polish and could therefore be carried out in the preferred language of the parent. For the monolinguals, the interview was in Dutch. The questionnaire administered to the parents of the monolingual children was a short version of the PaBiQ in which the items that were only relevant for bilingual children (e.g., amount of input in the different languages, skills in the non-Dutch language) were removed. As described under 'Participants,' the PaBiQ provided information on parental education, on the child's language input before the age of 4, on the current language use at home, and on the child's language skills as evaluated by the parent.

**TABLE 3 | Mean Dutch receptive vocabulary (standardized) score and mean Dutch and non-Dutch language skills as indicated by parental report with standard deviations.**

|  | Dutch receptive vocabulary score | Skills Dutch scale 0-1 | Skills non-Dutch language scale 0-1 |
|---|---|---|---|
| Monolingual | 112 (12) | 0.83 (0.17) | – |
| Frisian | 109 (10) | 0.76 (0.17) | 0.73 (0.21) |
| Limburgish | 106 (8) | 0.91 (0.12) | 0.59 (0.31) |
| Polish | 98 (14) | 0.73 (0.20) | 0.65 (0.25) |

*The receptive vocabulary score is a standardized score with a mean of 100.*

### Working Memory

Verbal and visuospatial working memory were measured with a backward Digit Span task and a backward Dot Matrix task, respectively. These tasks were based on the *Alloway Working Memory Assessment* (AWMA; Alloway, 2012) and translated to Dutch by native to near-native speakers of Dutch and English. In the backward Digit Span task the children had to repeat sequences of auditorily presented digits in reverse order. In the backward Dot Matrix task the children were presented with sequences of blue dots that appeared in a $4 \times 4$ matrix on a computer screen. After the last dot disappeared, the children had to point out the position of the dots in reverse order. The tasks started with a block of six trials with sequences of one digit or dot, after which the difficulty level was gradually increased. The AWMA procedure was applied for scoring. One point was given for each correct trial, so there was a maximum of six points per block. Trials were scored as incorrect if children recalled one or more digits/dots incorrectly, if the sequence was incorrect, or if they omitted one or more digits/dots. Children automatically continued with the next block when they repeated the first four trials within one block correctly, in which case they received a score of 6, or when they repeated four of the first five trials within one block correctly, in which case they received a score of 5. The task stopped automatically when children responded incorrectly to three trials within the same block. There were six blocks in the Dot Matrix task and seven in the Digit Span task, so the scores could range from 0 to 36 for the Dot Matrix and from 0 to 42 for the Digit Span.

### Attention

Selective attention was measured with the visual Sky Search task from the *Test of Everyday Attention for Children* (Manly et al., 1999). In the Sky Search task, children had to look for identical pairs of spaceships on an A3 sheet of paper. The test sheet contained 20 identical pairs and 108 non-identical pairs. The children had to encircle the identical pairs as fast as they could while ignoring the non-identical pairs. They indicated themselves when they were finished. The time per target (i.e., an identical pair of spaceships) was calculated, which was the time it took children to do the task divided by the total number of correctly encircled pairs of spaceships. Selective attention was measured because the children had to focus on the identical pairs in order to perform well on the task. After completion of this sheet the children were given a second A3 sheet, which was the motor-control version of the task. On this sheet only the 20 pairs of identical spaceships were displayed. Again, they had to encircle all the pairs of spaceships as fast as they could; the time per target was calculated for this sheet as well. Children's selective attention score was then calculated by subtracting the time per target of the motor-control sheet (i.e., second sheet) from the time per target of the test sheet (i.e., first sheet). In this way drawing speed was controlled for.

Interference suppression was measured with a flanker test from Engel de Abreu et al. (2012), who adapted the child Attention Network Task from Rueda et al. (2004a,b). The task was administered on a laptop using the experimental software E-Prime 2.0 (Schneider et al., 2002). In the Flanker task a horizontal row of five equally spaced yellow fish was presented to the children. The children were asked to indicate the direction of the central fish by pressing the corresponding left or right response button as quickly as possible. On congruent trials (50%), the flanking fish were pointing in the same direction as the central target fish, and on incongruent trials (50%), the flanking distractors pointed in the opposite direction. Each trial started with a fixation cross in the middle of the screen (1000 ms), followed by the presentation of the five fish. Children had to respond by pressing a left or a right button within 5000 ms. A response after 5000 ms was considered incorrect. All children completed two blocks of 20 trials in which presentation of congruent and incongruent trials was randomized. Eight practice trials preceded the test phase. Accuracy and reaction times (RTs) were documented automatically through E-Prime. As accuracy scores were very high in all groups and in both the congruent and incongruent conditions (>95% correct), we decided to focus on RTs in the analyses. Following Engel de Abreu et al. (2012), mean RTs were calculated excluding incorrect responses, RTs below 200 ms and RTs above 3 standard deviations of children's individual means (<5% of all trials). The flanker effect, reflecting the difference between the average RTs on incongruent and congruent trials (mean $RT_{INCONGRUENT}$ − mean $RT_{CONGRUENT}$), was used as our dependent variable. A small flanker effect was assumed to indicate good ability to suppress interference, whereas a large flanker effect was thought to indicate limited resistance to interference.

## Procedures

This research was screened by the Standing Ethical Assessment Committee of the Faculty of Social and Behavioral Sciences at Utrecht University. Criteria were met and further verification was not deemed necessary. Parents of participants gave informed consent in accordance with the Declaration of Helsinki. All participants were tested individually in a quiet room at their school or their home. The children completed a battery of tests, including several measures that tapped into language, working memory, and attention (not all relevant for the current study). The experimenters who administered the tests all had a native command of Dutch and, in the case of the bilinguals, also of Frisian, Limburgish, or Polish. The language of instruction for all relevant measures was Dutch, except for the Polish receptive vocabulary task, which was administered with Polish instructions.

## RESULTS

## Comparisons between Groups

**Table 4** shows the results of the monolingual and bilingual groups on the working memory and attention tasks.

In the case of the two working memory tasks (backward Digit Span, backward Dot Matrix) a higher score indicates better performance, but in the case of both attention tasks (Sky Search, Flanker) a higher score points to lower performance. The flanker effect showed substantial individual variation as indicated by the large standard deviations. Inspection of the individual scores

**TABLE 4 | Mean working memory and attention scores with standard deviations in the different groups.**

|  | Backward Digit Span | Backward Dot Matrix | Sky Search | Flanker effect (in ms) |
|---|---|---|---|---|
| Monolingual | 15.09 (2.66) | 17.27 (4.83) | 6.07 (2.77) | 91.84 (194.77) |
| Bilingual | 14.61 (2.90) | 17.39 (5.21) | 5.30 (2.20) | 136.38 (207.52) |
| Frisian | 14.80 (3.14) | 17.89 (4.72) | 4.85 (1.46) | 142.81 (185.57) |
| Limburgish | 15.25 (2.91) | 17.20 (6.33) | 5.17 (2.29) | 86.03 (223.28) |
| Polish | 13.80 (2.49) | 17.07 (4.47) | 5.88 (2.60) | 180.30 (205.67) |

revealed that these are caused by *negative* effects, indicating it took children longer to respond to the congruent than to the incongruent items. For reasons of interpretability we removed the negative flanker effects from the analyses below, but return to the issue at the end of the results' section because it concerns removal of a non-neglible amount of data (25%).

To test if the two working memory and the two attention tasks showed an effect of bilingualism, a multiple linear regression analysis was performed on each of the four different dependent variables. The distribution of the Sky Search deviated strongly from normality (skewness = 1.76, kurtosis = 3.74) and for this reason a log-transformation was applied which improved the distribution (skewness = 0.25, kurtosis = 1.78). We included age, non-verbal IQ scores, and parental education as covariates. In order to control for level of Dutch, which was the language of instruction, PPVT scores were included as a covariate as well. A binary variable Group (monolingual versus bilingual) was included to evaluate the effect of bilingualism. The predictors were entered simultaneously. **Table 5** shows correlations between the background measures (age, non-verbal intelligence, SES, and PPVT) and between the dependent variables (backward Digit span, backward Dot matrix, Sky Search, positive flanker effect). The correlations show that the two working memory tasks correlate with each other and with the two attention tasks, whereas the two attention tasks do not correlate with each other. The outcomes of the regression analyses are summarized in **Table 6**.

Age had an effect on all dependent variables in the expected direction: a higher age predicted better performance. Non-verbal intelligence predicted both working memory outcomes, but it did not predict attention. Parental education had no effect on any of the variables, but this could be due to a relatively limited range and lack of variation, as indicated by the means and standard deviations in **Table 1**. Receptive vocabulary had an effect on all measures in interpretable directions: children with larger receptive vocabulary scores in Dutch performed better on the working memory and attention tasks. Group affected performance on the Sky Search, with a better score for bilinguals compared to monolinguals. Normal probability plots of the residuals indicated that the residuals are normally distributed for the backward Dot Matrix and Sky Search tasks. For the backward Digit Span task and flanker effect, the residuals showed a slight right-skew.

To determine which bilingual groups outperformed the monolinguals on the Sky Search, an ANCOVA with age, non-verbal IQ scores, SES, and PPVT as covariates, the four-level

variable Group as the independent variable and the Sky Search as outcome variable was performed. This analysis did not reach statistical significance [$F(3,167) = 2.50$, $p = 0.06$, $\eta_p^2 = 0.04$].

## Exploring the Role of Proficiency in the Non-dutch Language

The data in **Table 4** indicate that all three bilingual groups score, on average, better than the monolinguals on the Sky Search, but the Polish bilinguals show the least indications they may benefit from their bilingualism. The context in which the Polish children develop the non-Dutch language is generally less favorable than the bilingual immersion context of the Frisian and Limburgish children. To explore if a lack of Polish proficiency affected the outcomes, we divided the Polish sample into two equally sized subgroups with, according to parental report, low Polish skills (0–0.67; LPS) and high Polish skills (0.72–1.0; HPS). We then validated the binary split by comparing the Polish receptive vocabulary scores in the two groups. The LPS group scored considerably lower ($M = 57$, $SD = 13.5$; raw scores) on Polish receptive vocabulary than the HPS group ($M = 70$, $SD = 12$; raw scores) [$F(1,42) = 11.60$, $p = 0.001$, $\eta_p^2 = 0.22$]. The LPS group received less Polish input before age 4 compared to the HPS group [$F(1,42) = 4.50$, $p = 0.04$, $\eta_p^2 = 0.10$], and current use of Polish was lower in the LPS group than in the HPS group [$F(1,42) = 6.59$, $p = 0.01$, $\eta_p^2 = 0.14$]. Dutch receptive vocabulary was the same in both groups [$F(1,42) = 0.48$, $p = 0.49$, $\eta_p^2 = 0.01$].

We reran the ANCOVA for the Sky Search, with age, non-verbal IQ scores, SES, and PPVT as covariates and the four-level variable Group as the independent variable. The Polish-Dutch group was limited to the HPS subgroup, which scored on average 5.14 ($SD = 1.62$) on the Sky Search. This time the effect of Group was significant [$F(3,146) = 2.92$, $p = 0.036$, $\eta_p^2 = 0.06$]. Bonferroni pairwise comparisons indicated that the Frisian-Dutch children ($p = 0.01$), Limburgish-Dutch children ($p = 0.03$) and the Polish-Dutch children ($p = 0.03$) outperformed the monolinguals. Visual inspection of the distribution revealed that one child in the Limburgish sample showed an out-of-range value. In order to test if this child did have a disproportional effect on the outcomes, we ran the analysis using bootstrapping. Based on 1,000 bootstrap samples, we found a significant difference between the Frisian-Dutch and the monolingual group, 95% CI [0.05–0.34], and also between the Polish-Dutch group and the monolinguals, 95% CI [0.03–0.42]. The difference between the Limburgish-Dutch group and the monolingual group did not reach significance, 95% CI [−0.02 to 0.35]. Running the ANCOVA for the Sky Search with age, non-verbal IQ scores, SES, and PPVT as covariates and the four-level variable Group as the independent variable, including only the Polish LPS subgroup, we also observed a significant effect of Group [$F(3,146) = 2.93$, $p = 0.036$, $\eta_p^2 = 0.06$]. However, Bonferroni pairwise comparisons indicated that the Frisian-Dutch children ($p = 0.01$) and the Limburgish-Dutch children ($p = 0.04$) outperformed the monolinguals, but the Polish-Dutch children did not ($p = 0.85$). Pairwise comparisons using bootstrapping to reduce the bias caused by the extreme value in the Limburgish sample revealed that the Frisian-Dutch children performed better

**TABLE 5 | Correlations between the background variables age, NVIQ, SES, and receptive vocabulary and the dependent variables backward Digit Span task, backward Dot Matrix task, Sky Search task, and the positive flanker effect.**

|                | Age    | NVIQ   | SES     | PPVT    | Backward Digit Span | Backward Dot Matrix | Sky Search | Positive flanker effect |
|----------------|--------|--------|---------|---------|---------------------|---------------------|------------|-------------------------|
| Age            |        | −0.10  | −0.06   | −0.18*  | 0.30**              | 0.32**              | −0.32**    | −0.24**                 |
| NVIQ           |        |        | 0.12    | 0.24**  | 0.25**              | 0.28**              | −0.11      | −0.16                   |
| SES            |        |        |         | 0.15*   | 0.05                | 0.08                | 0.08       | −0.08                   |
| PPVT           |        |        |         |         | 0.16*               | 0.17*               | −0.10      | −0.22*                  |
| Backward DS    |        |        |         |         |                     | 0.37**              | −0.22**    | −0.26**                 |
| Backward DM    |        |        |         |         |                     |                     | −0.29**    | −0.32**                 |
| Sky Search     |        |        |         |         |                     |                     |            | 0.12                    |

*NVIQ, standardized non-verbal intelligence score; SES, socioeconomic status; PPVT, Peabody Picture Vocabulary Test (Dutch receptive vocabulary, standardized score); \*p < 0.05, \*\*p < 0.01. Note that the correlations for the positive flanker effect are based on a somewhat smaller sample size, because the children with negative flanker effects are excluded.*

**TABLE 6 | Multiple regression models for the backward Digit Span task, backward Dot Matrix task, Sky Search task, and the positive flanker effect.**

|        | Backward Digit Span | | Backward Dot Matrix | | Sky Search | | Positive flanker effect | |
|--------|------|--------|------|--------|------|--------|------|--------|
|        | β    | p      | β    | p      | β    | p      | β    | p      |
| Age    | 0.35 | <0.001 | 0.38 | <0.001 | −0.35 | <0.001 | −0.27 | 0.001 |
| NVIQ   | 0.25 | 0.001  | 0.27 | <0.001 | −0.10 | 0.16   | −0.14 | 0.11   |
| SES    | 0.03 | 0.72   | 0.04 | 0.61   | 0.12 | 0.11   | −0.03 | 0.70   |
| PPVT   | 0.15 | 0.05   | 0.18 | 0.02   | −0.20 | 0.01   | −0.23 | 0.01   |
| Group  | −0.06 | 0.45  | 0.03 | 0.66   | −0.19 | 0.01   | −0.05 | 0.55   |
|        | Adjusted $R^2$ = 0.17*** | | Adjusted $R^2$ = 0.21*** | | Adjusted $R^2$ = 0.15*** | | Adjusted $R^2$ = 0.11*** | |

*NVIQ, standardized non-verbal intelligence score; SES, socioeconomic status; PPVT, Peabody Picture Vocabulary Test (Dutch receptive vocabulary, standardized score); \*\*\*p < 0.001.*

than the monolinguals, 95% CI [0.05–0.34], but the Limburgish-Dutch, 95% CI [−0.01 to 0.34], and the Polish-Dutch groups, 95% CI [−0.19 to 0.22], did not differ significantly from the monolinguals. Note furthermore, that including only the Polish HPS group did not affect the outcomes of the two working memory tasks and the flanker effect, even though the HPS group also scored relatively well on these tasks. Moreover, including only the 50% children who were, according to parental report, the most skilled in Frisian and Limburgish did not result in a larger general effect of bilingualism nor did it lead to a significant effect in the Limburgish sample.

## Negative Flanker Effects

As indicated above, 25% of the flanker data showed a negative flanker effect, instead of the expected positive flanker effect. Because this is a non-negligible amount of data, it is important to investigate if these data are distributed randomly. The children with negative and positive flanker effects turned out to be very similar in many respects. They did not differ in age [$F(1,174) = 0.22$, $p = 0.64$, $\eta_p^2 = 0.001$], non-verbal intelligence [$F(1,174) = 0.11$, $p = 0.74$, $\eta_p^2 = 0.001$], SES ($U = 2988$, $p = 0.77$), and gender [$\chi^2(1) = 0.03$, $p = 0.86$]. Interestingly, relatively more monolinguals than bilinguals showed a negative flanker effect [$\chi^2(1) = 7.92$, $p = 0.008$]. **Table 7** shows the distribution of the negative and positive flanker effects across the different groups.

In the monolingual sample, 41% of the children showed a negative flanker effect (ranging between −13.53 and −257.63).

**TABLE 7 | Negative and positive flanker effect (in ms) distribution in groups.**

|             | Negative flanker effect (n = 44) | | Positive flanker effect (n = 132) | |
|-------------|------|------------------|------|------------------|
|             | n    |                  | n    |                  |
| Monolingual | 18   | −79.37 (70.77)   | 26   | 210.38 (161.64)  |
| Bilingual   | 26   | −120.18 (155.28) | 106  | 199.31 (166.41)  |
| Frisian     | 8    | −38.19 (64.30)   | 36   | 183.03 (180.91)  |
| Limburgish  | 11   | −182.02 (207.95) | 33   | 175.38 (143.33)  |
| Polish      | 7    | −116.70 (99.52)  | 37   | 236.49 (168.75)  |

In the three bilingual samples, this percentage was lower: 18% of the Frisian children (range between −1.95 and −116.63), 25% of the Limburgish children (range between −2.25 and −636.66) and 16% of the Polish children (range between −10.49 and −299.58). The difference with monolinguals was significant for the Frisian [$\chi^2(1) = 5.46$, $p = 0.03$] and the Polish children [$\chi^2(1) = 6.76$, $p = 0.02$], but did not reach significance in the Limburgish group [$\chi^2(1) = 2.52$, $p = 0.17$].

## DISCUSSION AND CONCLUSION

In this study we compared three bilingual groups of 6–7-year-old children with a monolingual control group on two working

memory (verbal, visuospatial) and two attention measures (selective attention, interference suppression). The three bilingual groups differed in sociolinguistic setting: two of the bilingual groups were exposed to a regional language (Frisian, Limburgish) in addition to the nation's dominant language (Dutch), and the third bilingual group consisted of children exposed to a migrant language (Polish) besides Dutch. The inclusion of different bilingual groups is relevant in light of the growing awareness that contextual factors moderate the effect of bilingualism on cognitive development (Green and Abutalebi, 2013; Scaltritti et al., 2015; for an overview see the research topic of Yoshida et al., 2015, and the Bilingualism Forum, 2015 in Cortex). To exclude confounding effects, the four groups were matched on age, non-verbal intelligence, SES, and gender. The regional bilingual language groups and the monolingual group were culturally comparable. Multiple regression analyses, in which all bilinguals were grouped together and compared with the monolinguals, demonstrated that bilinguals outperformed monolinguals on selective attention. Pairwise comparisons of the separate bilingual groups and the monolingual controls suggest that the overall effect of bilingualism on selective attention was carried by the Frisian-Dutch children and the more bilingually proficient Polish-Dutch children. On the Flanker task, which tests the ability to suppress interference, monolingual and bilingual groups differed in the extent to which the incongruent flanking fish led to a slower or a faster response. The working memory tasks showed no effects of bilingualism.

These outcomes support the hypothesis that bilingualism influences the development of attention and confirm that effects of bilingualism on cognition are found across different sociolinguistic settings, that is, children acquiring a regional language (Costa et al., 2008, 2009; Hernández et al., 2013; Lauchlan et al., 2013; Garraffa et al., 2015; Antoniou et al., 2016; Bosma et al., 2017) and children learning a migrant language (Carlson and Meltzoff, 2008; Engel de Abreu et al., 2012; Blom et al., 2014). The data also indicate that the positive effect of bilingualism on the Sky Search is small, elusive, and dependent on sampling and task. For instance, the difference between monolinguals and bilinguals was rather robust in the Frisian sample. In contrast, in the Limburgish sample, the effect did not survive an analysis in which bootstrapping was used. Also, the Polish-Dutch group showed a positive effect of bilingualism, but only if 50% of the children with highest proficiency in Polish were included, confirming that a certain level of bilingual proficiency is required for the cognitive benefits to develop (Carlson and Meltzoff, 2008; Bialystok and Barac, 2012; Poarch and van Hell, 2012; Videsott et al., 2012; Blom et al., 2014; Antoniou et al., 2016; Crivello et al., 2016; Weber et al., 2016). Lastly, the enhancing effect of bilingualism emerged in the Sky Search, which measured selective attention, but not in the Flanker task, which measured attentional control and specifically the ability to suppress interference, and the two working memory tests.

We were not surprised to find that the expected effect of bilingualism emerged in only one task. Much previous research focused on interference suppression, guided by the hypothesis that bilingualism affects inhibitory control because bilinguals continuously need to suppress the interfering language (Green, 1998; Bialystok et al., 2004). However, Paap and Greenberg (2013) as well as Ross and Melinger (2016) showed that the findings on classic inhibition tasks, including Flanker tasks similar to the one we used in our study, are mixed. An increasing number of studies has observed bilingual advantages in tasks testing working memory (Vejnović et al., 2010; Morales et al., 2013; Blom et al., 2014; Kaushanskaya et al., 2014; Delcenserie and Genesee, 2016). However, also with respect to working memory, the outcomes of research are mixed (see Discussion; Calvo et al., 2016). Chung-Fat-Yim et al. (2017, p. 370) suggest that the mixed results on inhibition and working memory tasks in previous research might be "because those components do not define crucial differences between monolingual and bilingual cognition." Instead, they hypothesize that selective attention is primarily influenced by bilingualism, a claim that finds support in our study in a surprisingly consistent way: three bilingual groups scored better than monolinguals on the same selective attention test. In two of the groups (Frisian, proficient Polish) this difference reached statistical significance.

Besides the Sky Search task, a Flanker task was used. In a previous study bilingual Portuguese-Luxembourgish children outperformed Portuguese monolingual children on this task (Engel de Abreu et al., 2012). In our study this finding was not replicated, but a comparison of the positive and negative flanker effects revealed a different effect of bilingualism. Relatively many monolinguals showed a negative flanker effect, indicating that they were faster in the incongruent than in the congruent condition. The difference between monolinguals and bilinguals in the relative frequency of negative flanker effects was significant for the Frisian and Polish children, but, again, did not reach statistical significance in the Limburgish sample. To our knowledge, negative flanker effects have not been reported explicitly in the literature on bilingualism, despite the fact that the "direction of the flanker effect has been a topic of some controversy" (Rouder and King, 2003, p. 288). It is conceivable that the negative flanker effects contribute to the elusiveness of the effects of bilingualism in studies using Flanker tasks (Paap and Greenberg, 2013; Ross and Melinger, 2016).

Rouder and King (2003) ascribe the negative flanker effects to contrast enhancement in lower order perceptual processes early in stimulus processing. Positive flanker effects, in contrast, may reveal response competition in the response selection processes, which takes place later in stimulus processing. Possibly, bilingual children filter out less and attend to more information in their environment, because they are used to attending to many cues for deciding which language to use in their everyday life. The simultaneous processing of contrasting stimuli may, moreover, be common for bilingual children. This happens, for instance, when they interact in one of their languages while a movie is playing in the other language or when they listen to one language while reading the other language as can happen in the case of subtitles. More experience with the simultaneous processing of contrasting information might reduce the effect of contrast enhancement.

The relatively few negative flanker effects in the bilingual sample indicate that the bilingual children in our study more often show response competition which, in turn, demonstrates that they attend to the incongruent flanking fish more than the monolingual children did. However, it was not the case that the bilingual children were more bothered by the incongruent flanking fish, as shown by the absence of a difference when positive flanker effects were compared across monolinguals and bilinguals. Moreover, in the Sky Search task, in which the children were asked to focus on the contrast and compare two adjacent space ships to decide on their similarity, the bilingual children outperformed the monolinguals. This shows that when the children's task is to detect a contrast between stimuli, instead of ignoring interference from contrasting stimuli (as in the Flanker test), bilingual children excel. This supports the hypothesis that bilingual experiences change the way attention is directed to the environment and enhance selective attention (Bialystok, 2015; Chung-Fat-Yim et al., 2017).

In our study two groups of regional language users were tested. In the Frisian sample, the effects of bilingualism were more robust than in the Limburgish sample, both for the Sky Search and for the flanker effect. Parents' ratings of their children's language skills in the two languages indicate that the Limburgish parents rated their children's skills in Limburgish rather low, which may suggest that a lack of bilingual proficiency is related to the less robust effect of bilingualism in the Limburgish sample. However, including only the 50% of the children with, according to parental report, high Limburgish proficiency did not alter the outcomes, suggesting that bilingual proficiency does not play a role. We suggested that teaching Frisian as a subject in school, which is obligatory for at least 1 h per week, may lead to more language separation in the Frisian context. A higher degree of language separation may be linked to cognitive effects of bilingualism (Green and Abutalebi, 2013). However, in many schools Frisian is also used as a language for instruction, like Dutch. Functional overlap between the two languages may have the opposite effect and lead to less separation instead of more, although the direction of the effect may be dependent on specific language use strategies that could vary from school to school and from teacher to teacher (e.g., use of specific days for each language, different classrooms, different subjects, or use of both languages for the same subject, in the same classroom, and at the same day).

Interestingly, recent research comparing *tweets* in Fryslân and Limburg suggests that Limburgish is more often used in tweets than Frisian, but also that Limburgish is more frequently mixed with Dutch (Trieschnigg et al., 2015), which is consistent with the findings by Giesbers (1989) showing frequent mixing between Limburgish and Dutch. Frequent mixing in the Limburgish context is, moreover, supported by the study of Francot et al. (in press) who observed that in a Limburgish word naming task, children used many mixed forms that had characteristics of both Limburgish and Dutch. If these cross-regional differences in language use are representative of the children in our sample, the Limburgish parents may have rated their children's Limburgish relatively low because of frequent mixing with Dutch or because their children's language use is not in accordance

with the parents' normative idea of how a dialect should be spoken. Moreover, frequent mixing may suggest that between-language links are stronger for Limburgish and Dutch than for Frisian and Dutch, explaining why the effect of bilingualism on attention is more robust for the Frisian than for the Limburgish children (Gathercole et al., 2014). If in the Limburgish context frequent mixing is indeed more common than in the Frisian context, the pattern is also in line with Green and Abutalebi (2013) who predict that dense code-mixing behavior is less associated with cognitive control than bilingual behavior in which different languages are used in different environments or both languages are used but with different speakers. The parental questionnaire in our study provided information on language use in the home environment and no information was available on patterns of language use outside of this context. For this reason, we refrained from investigating the influence of language separation and overlap. We do, however, consider this an important venue for future research on the cognitive effects of bilingualism.

This study revealed that cognitive effects of bilingualism are found in children who become bilingual because they are exposed to a regional language, in addition to the national language, and in children who become bilingual because (one of) their parents migrated. Comparisons of different tasks show that bilingual experiences primarily influence how children direct their attention to the environment: it appears that they consider more information to be potentially task-relevant and they are relatively successful at using this information in a task in which they need to focus and attend selectively, i.e., compare two paired stimuli and decide on their similarity. The findings in this study demonstrate that for migrant children, proficiency in the home or migrant language is essential for cognitive advantages to develop and suggest that the cognitive effects for regional language speakers are modulated by differences in sociolinguistic settings.

## AUTHOR CONTRIBUTIONS

All authors were involved in the conception and design of the study. EBl wrote the introduction, results and discussion and carried out the statistical analyses. EE contributed to the literature review and finalizing of the manuscript. TB and EBo drafted the method section and contributed significantly to the collection, processing and analysis of the monolingual and Frisian data respectively. LC enabled the collection of the Limburgish data. TB, EBo, LC, and EE revised the draft for critical content.

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# Linguistic and Cognitive Effects of Bilingualism with Regional Minority Languages: A Study of Sardinian–Italian Adult Speakers

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This study explores the effects of bilingualism in Sardinian as a regional minority language on the linguistic competence in Italian as the dominant language and on non-linguistic cognitive abilities. Sardinian/Italian adult speakers and monolingual Italian speakers living in the same geographical area of Sardinia were compared in two kinds of tasks: (a) verbal and non-verbal cognitive tasks targeting working memory and attentional control and (b) tasks of linguistic abilities in Italian focused on the comprehension of sentences differing in grammatical complexity. Although no difference was found between bilinguals and monolinguals in the cognitive control of attention, bilinguals performed better on working memory tasks. Bilinguals with lower formal education were found to be faster at comprehension of one type of complex sentence (center embedded object relative clauses). In contrast, bilinguals and monolinguals with higher education showed comparable slower processing of complex sentences. These results show that the effects of bilingualism are modulated by type of language experience and education background: positive effects of active bilingualism on the dominant language are visible in bilinguals with lower education, whereas the effects of higher literacy in Italian obliterate those of active bilingualism in bilinguals and monolinguals with higher education.

Keywords: minority languages, sentences processing, working memory, bilingualism, relative clauses, Sardinian

## INTRODUCTION

One of the under-explored topics in current research on bilingualism is the effect of language status and prestige on the linguistic and cognitive characteristics of bilingual competence. The language experience of speakers growing up with more than one language is in fact subject to considerable variation due to different environmental factors, including the contexts of use and the registers adopted for different languages: for example, minority languages are often used in more informal contexts while dominant languages are used in more formal circumstances, including schooling and education. Minority languages therefore provide an ideal ground to explore the influence of these variables. At the same time, minority languages are typically spoken by natives of particular regions: this offers the opportunity to control for socio-economic and cultural differences, which typically characterize other types of bilingual experience, for example bilingualism introduced by migration.

In this paper we focus on the island of Sardinia, where bilingualism with Sardinian – the local minority language – and Italian is the norm, especially in the central areas. We compare bilingual Sardinian–Italian adults with monolingual Italian adults living in the same area, with a twofold aim. First, we address the widespread view that Sardinian undermines competence in Italian, which is often perceived as a negative consequence of bilingualism in these two languages. In testing linguistic competence in Italian in bilingual speakers, the effects of education need to be controlled, since it has been reported in sociolinguistic research that speakers with lower education are more active users of the minority language (Oppo, 2007). Second, we look at some of the general cognitive abilities that have previously been found to be enhanced by the bilingual experience (see section "Cognitive Effects of Bilingualism in Regional Minority Languages"): specifically, we compare bilingual and monolinguals on standard tests of working memory and cognitive control.

Focusing on adult speakers is important for several reasons. Adults who are bilingual with minority languages typically use the majority language in the workplace and in most daily activities, and speak the minority language in a much more restricted range of contexts. This is the age where decisions about intergenerational transmission of the minority language are made, which are increasingly in favor of not speaking it to children due to a perceived lack of usefulness. Adult competence in minority languages – whether native or non-native – has been argued to play a fundamental role in reversing this shift. If native speakers of childbearing age who are fully confident in using the language with their children are decreasing, "new" speakers of minority languages can play a role in re-establishing intergenerational transmission (Fishman, 2001; O'Rourke and Pujolar, 2015).

The incentives for speaking a minority language to children might include the possible benefits of bilingualism gained through this particular bilingual experience, if these are supported by research.

In the next sections we will briefly summarize some recent findings reported in studies of bilingualism with minority languages, with an emphasis on grammatical competence and general cognition. We will then turn to some background information on the status of Sardinian, before motivating our research questions and presenting the results of our study.

## COGNITIVE EFFECTS OF BILINGUALISM IN REGIONAL MINORITY LANGUAGES

A large number of studies in the last 15 years report positive effects of bilingualism on mental flexibility, specifically in terms of enhancement of the cognitive abilities referred to as "executive functions" (Bialystok, 2009; Baum and Titone, 2014; Costa and Sebastian-Galles, 2014 for overviews). More recently, these findings have been questioned by studies reporting no "bilingual advantage" in these cognitive domains (Paap and Greenberg, 2013). The picture emerging from the limited number of studies exploring cognitive abilities in bilingualism with minority

languages is also inconsistent. While no bilingual advantage in executive functions was found in studies of Welsh–English bilinguals (Gathercole et al., 2014) and Basque–Spanish bilinguals (Duñabeitia et al., 2014), other studies show an advantage for bilingual speakers of minority languages such as Scottish Gaelic (Lauchlan et al., 2013), Sardinian [Lauchlan et al. (2013) on adults; Garraffa et al. (2015) on children], and Cypriot Greek (Antoniou et al., 2016). While the evidence based on these studies is too scarce to allow generalizations, it is possible that the type of bilingual experience associated with different minority languages may lead to different (or null) effects on cognitive abilities. For instance, Costa et al. (2009) proposed that speakers with highly separated and predictable domains of use for each language – thus with a low level of switching required – may not show advantages. Similarly, Prior and Gollan (2011) suggest that an advantage in cognitive control may arise only in bilinguals who frequently switch between languages. The typological relatedness of language pairs may also be relevant [Costa et al. (2009); see Grohmann (2014) and Kyriakos et al. (2016) on "language proximity" as an important factor for simultaneous child bilingualism]. Finally, the presence or absence of minority languages in education program and their availability as a medium of instruction may lead to a wider range of uses and enhance possible effects outside the language domain.

## LINGUISTIC ABILITIES AND KNOWLEDGE OF GRAMMAR IN BILINGUALISM

Many studies on bilingual children have reported a bilingual advantage in tasks related to grammatical knowledge, such as grammaticality judgments of sentences and correction of syntactically incorrect sentences (Galambos and Goldin-Meadow, 1990). This bilingual advantage on metalinguistic tasks, especially in the context of detecting semantic anomalies, was replicated across different languages [e.g., Ricciardelli (1992) with Italian–English; Cromdal (1999) with Swedish–English see Barak and Bialystok (2016) for an overview]. As far as bilingual adults, ERPs study by Moreno et al. (2010) recorded markers related to semantic (N400) and syntactic (eLAN, LAN, and P600) analyses during reading and during a sentence judgment task. They found that bilingual experience has an impact on sentence processing and this is more visible in judgment tasks that require selective attention compared to acceptability tasks, based primarily on syntactic knowledge.

Previous research described the role of enhanced as well as impaired short-term memory for comprehension of relative clauses, in particular for comprehension of object relatives such as (2) and (4) (Lauro et al., 2010; Papagno et al., 2012)[1]. Several accounts suggest that comprehension of complex sentences is facilitated by working memory (e.g., Gordon and Olson, 1998).

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[1] In particular in the case of object relatives, the element extracted from the relative clauses (in italics) cross a potential candidate for the same position (in bold), making this structure more complex due to grammatical interference [see Garraffa and Grillo (2008), Grillo (2008) and Rizzi (2013) for a detailed description of interference effects in object relatives].

(1) Subject peripheral: The grandfather pushes *the dog* that <the dog> bites the cat.
(2) Object peripheral: The mother looks at *the dog* that the **boy** chases <the dog>.
(3) Subject center embedded: *The boy* that is watching the cat <the boy> is drinking milk.
(4) Object center embedded: *The boy* that the **cat** is chasing <the boy> is looking at the girl.

In this study we focus on comprehension of complex sentences in Italian and the possible relationship between linguistic and general cognitive factors. Specifically, the aim of the study is to test whether the bilingual experience with Sardinian could affect the processing of complex sentences in the dominant language. The range of sentence types investigated included active and passive sentences, coordinated sentences, and relative clauses varying in complexity. These sentences are part of the *Comprendo* standardized comprehension test (Cecchetto et al., 2012); see the section "Materials and Methods" Sardinian has both similar and different constructions from Italian; the main difference between the two languages is the rare use of the passive form and of center embedded object relatives in Sardinian. All sentence types included in the study and corresponding Sardinian translations are summarized in **Table 1**.

A cognitively based model would predict differences between bilinguals and monolinguals in the processing of complex sentences, such as object relative clauses, due to an enhanced memory capacity in bilinguals (Bialystok, 2007). A linguistically based model would predict bilingual–monolingual differences in processing due to a different grammatical representation in bilinguals, compared to monolingual speakers (Belletti and

Guasti, 2015). Both models predict a different performance for complex sentences in active bilinguals compared to speakers who are not actively using the minority language.

Evidence for a better performance on object relative production in bilingual speakers was reported by Belletti and Guasti (2015) in a group of beginners L2 learners compared to advanced L2 learners and in the previously mentioned study on Sardinian/Italian bilingual children (Garraffa et al., 2015), which found that comprehension of object relative in Italian improved significantly more in bilingual children compared to monolinguals[2].

Another aspect tested in the present study is the impact of education, in particular the combined effect of high competence in the dominant language and reduced use of the minority language (see description of participants below). Dubrowska and Street (2006) in a study on comprehension of passive sentences by native and non-native English speakers reported a better performance of the less-educated non-native group compared to the native group matched for education, although memory and cognitive abilities were not controlled for. The authors suggested that processing more complex sentences, such as passives, depends on metalinguistic skills and this metalinguistic competence could be enhanced in L2 learners. The idea proposed in the study is that although the non-native speakers have less exposure to particular grammar structures, due to both their

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[2]It is possible that the effect on the dominant language of bilingualism in another language is visible both in production and in comprehension due to the necessary involvement of a production step for comprehension of complex sentences, as predicted by working memory-based models [see also Riches and Garraffa (2017) for an overview of grammatical-based effects in children and adults].

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**TABLE 1 |** Sentence structure types tested in the *Comprendo* test of Italian and corresponding Sardinian translations.

| Type | Italian example | Sardinian translation |
|---|---|---|
| Active | Il cane morde il gatto | Su cane mossigat (a) sa gato |
| | *The dog bites the cat* | *The dog bites the cat* |
| Dative | La mamma dà la torta al bambino | Sa mamma li dat su durce a su pitzinneddu |
| | *The mother gives the cake to the boy* | *The mother to-him gives the cake to the boy* |
| Passive | Il bambino viene inseguito dal cane | Su pitzinneddu est pressighidu da esu cane |
| | *The boy is chased by the dog* | *The boy is chased by the dog* |
| | | Su pitzinneddu lu pressighit su cane |
| | | *The boy him chases the dog* |
| Peripheral subject relative | Il nonno spinge il cane che morde il gatto | Su mannoi ispinghet su cane chi mossigat sa gato |
| | *The grandfather pushes the dog that bites the cat* | *The grandfather pushes the dog that bites the cat* |
| Peripheral object relative | La mamma guarda il cane che il bambino insegue | Sa mamma abbaidat su cane chi su pitzinneddu pressighit |
| | *The mother looks at the dog that the boy chases* | *The mother looks at the dog that the boy chases* |
| Center embedded subject relative | Il bambino che sta guardando il gatto beve il latte | Su pitzinneddu chi est pompiande sa gato buffat su latte |
| | *The boy that is watching the cat is drinking milk* | *The boy that is watching the cat is drinking milk* |
| Center-embedded object relative | Il ragazzo che il cane insegue sta guardando la ragazza | Su pitzinneddu chi l'est sighinde su cane est pompiande sa picinna |
| | *The boy that the cat is chasing is looking at the girl* | *The boy that he is chased by the dog is looking at the girl* |
| Object coordination | Il bambino insegue il cane e il gatto | Su pitzinneddu pressighit su cane e sa gato |
| | *The boy chases the dog and the cat* | *The boy chases the dog and the cat* |
| Verb coordination | Il bambino guarda il cane e accarezza il gatto | Su pilosu pompiat su cane e caringiat sa gato |
| | *The boy looks at the dog and strokes the cat* | *The boy looks at the dog and strokes the cat* |
| Sentence coordination | Il bambino guarda il gatto e la mamma accarezza il cane | Su pitzinneddu pompiat sa gato e sa mamma caringiat su cane |
| | *The boy looks at the cat and the mum strokes the dog* | *The boy looks at the cat and the mum strokes the dog* |

being non-native and their low level of education, the type of linguistic experience matters more than the sheer amount: high educated bilingual speakers have the benefit of schooling and thus show convergence to monolingual competence. This account emphasizes the role of language competence, although it does not specify what kind of metalinguistic skills are required for the processing of complex sentences.

A complementary psycholinguistics account is based on the idea of a different competition of alternative structure in bilingual speakers, with less competent speakers experiencing reduced competition between alternative structures due to a weaker knowledge of the grammar (Pickering and Branigan, 1999). This account is compatible to the linguistic account presented above, where possible differences between bilinguals and monolinguals are related to a qualitatively different encoding of the grammar due to the bilingual experience. In specific, according to this approach bilingual learning discard ambiguity and competitions between alternative interpretations, being the opportunities to speak the language confined to specific contexts, often based on a more formal use of the language and few opportunities to speak with a diverse range of speakers.

We now turn to the characteristics of Sardinian as a minority language and of bilingualism in Sardinian and Italian experienced by the participants in our study.

# SARDINIAN–ITALIAN BILINGUALISM

Sardinian is a Romance language spoken in the Sardinian region by approximately 1.2 million people. Since 1996 it is officially recognized, together with Italian, as an official language of the island and protected by Italian laws as a minority language (Italian republic Law 482/1999 and Sardinian regional Law 26). Both laws were introduced to support the use of the minority language in schools and to promote its use in official documents of use in administration. The use of Sardinian in the public administration was supported by the promotion of an official written standard system, the adoption of which has generated a controversial debate.

The term Sardinian language (or *Limba Sarda* in Sardinian) refers to all varieties spoken in the island. Participants involved in this study are proficient in the variety spoken in the Nuoro Province, which is located in the center of the island, as can be seen in the map below.

Most Sardinians regard themselves as bilingual. According to recent extensive surveys on the languages spoken in the island (Ingrassia, 2007; Oppo, 2007), less than 3% of participants reported not to speak Sardinian, or one of its varieties. Around 68% is fluent in both comprehension and production and the remaining 29% are "passive bilinguals" who can understand the language but do not speak it. It is interesting to note for the purpose of the present research that the distribution of Sardinian speakers radically changes according to age, with a marked drop in speaker numbers among the new generations. While Oppo's study reported a large number of bilinguals (around 85%) in the older population, the situation is different for younger adults, with percentages around 59% in the 25–45 years age band.

Education is also correlated with the Sardinian/Italian bilingual status: the near totality of people with lower educational level reporting knowledge of Sardinian (95% for a primary degree and 75% for people with a secondary degree), whereas only 55% of people with a university degree report knowledge of Sardinian. A difference in the use of the language also emerges if one compares small rural towns, where Sardinian is more widely spoken, and larger towns, where Italian is the most common language used.

Oppo's study points to the fact that Sardinian, like many other regional minority languages, is declining due to the lack of intergenerational transmission (see Romaine, 2007; Extra and Gorter, 2008). Fewer and fewer parents speak the minority language to their children because of its perceived lack of "usefulness" or the possibility of a damaging effect on Italian as the dominant language and the only language of schooling. Although Sardinian has a considerable number of speakers compared to other minority languages and it is often described as integral part of the cultural identity of Sardinians, it is not taught a school or included in any medium education program.

## Sardinian Grammar

Sardinian is a Romance language with relatively free word order, with SVO perceived as the unmarked order [see Jones (1993) and Pittau (1991) for more details]. It has a rich inflectional system and a full pronominal system characterized by a consistent use of clitic pronouns. Sardinian, like Italian, is a pro-drop language which allows omission of subject pronouns; the choice between pronoun omission and overt pronoun realization is governed by pragmatic and stylistic factors, whereas objects pronouns are obligatorily realized. Pronouns are inflected for case but case is not used in verbal inflection.

Regarding the structures included in this study and shown in **Table 1** above, passive structures are very rarely attested and they are perceived as due to transfer from Italian. This is also the case of object relative clauses, not attested in spontaneous speech; the preferred structure is a passive object relative instead, as in (5).

(5)  Su pitzineddu chi l'est sighinde su cane est pompiande sa pitzinna.

The boy that he is chased by the dog is looking at the girl.

More common is the use of a resumptive pronoun in relative clauses, which is not an option in standard Italian.

## RESEARCH QUESTION

This study aims to investigate whether Sardinian–Italian bilingual adults have a disadvantage compared with monolingual Italians in their comprehension of Italian due to interference from the minority language, and, if they do, whether the disadvantage is restricted to comprehension of more complex sentences.

Furthermore, the study aimed to explore whether there is a difference between bilingual and monolingual speakers due to level of education, since a higher educational level entails more

extensive use of Italian at the expense of Sardinian, and therefore less active bilingualism.

The following questions were addressed:

(a) Do Sardinian/Italian bilingual adults have a disadvantage in Italian sentence comprehension compared to Italian monolinguals, and in particular in more complex sentences?

(b) Do Sardinian/Italian bilingual adults have an advantage in cognitive abilities related to executive function and working memory, compared to monolinguals?

(c) Are bilinguals with higher levels of education more similar to monolinguals, compared to bilingual with lower education levels, due to a less active and qualitatively different bilingual experience?

## MATERIALS AND METHODS

### Participants

Sixty-three adults (mean age: 39 years; *SD*: 6.5; age range 28–50 years; 36 females) were included in the study. They all lived in the Nuoro Province in Sardinia, where Italian is the dominant language but Sardinian is also widely spoken, especially in small towns. All Sardinian–Italian speakers included in the study ($N = 34$; mean age 39.7 years; *SD*: 6.51) came from villages with no more than 9000 inhabitants; monolinguals ($N = 29$; mean age 38.6 years; *SD*: 6.64) were recruited from Nuoro, Macomer, and Tortoli, towns with more than 9000 inhabitants. This condition mirrors the general distribution of Sardinian speakers in the island, with bilingual Sardinian–Italian speakers living in more rural areas and monolingual Italian speakers living in the larger towns (Oppo, 2007).

Bilingualism was measured using the Bilingual Language Profile (BLP) scale (Birdsong et al., 2012). This questionnaire consists of 19 questions and focuses on different aspects of the participant's language experience in both the dominant and the minority language. An overall score given by the average scores on all four measures of the two languages (Sardinian and Italian), the amount of exposure to each language measured with six questions exploring age of acquisition and years of language learning in different contexts (school, family, work, friends, country), the overall use of each language measured as the percentage of time speaking the language in different contexts (speaking with friends, in the family, at work, with himself, and use for counting), the competence (a ranking self-assessment on production, comprehension, reading, and writing), and the attitude toward the minority language (four ranked questions on the speakers degree of identification as a speaker of the language) were recorded for all participants[3].

Education in Sardinia is only through the medium of Italian; we recorded the level of education for all participants by asking if they stopped after secondary school (SEC: secondary school degree) or if they had a university degree (UNI: graduate participants with a university degree). Four participants with only

[3]For a detailed description of the BLP Questionnaire and all its items, see https://sites.la.utexas.edu/bilingual/. All materials are available online.

primary school education were excluded from the sample, as well as one participant with an outlier performance on one of the test measures (overall *Comprendo* timing greater than 3 SD). See summary in **Table 2** below.

It is interesting to note that exposure, use, competence, and attitude toward Sardinian clearly distinguish between monolinguals and bilinguals: comparisons on all BLP dimensions are highly significant (Sardinian use: $t = 13.0$; Sardinian comprehension: $t = 13.1$; attitude toward Sardinian, $t = 15.4$; all $p < 0.001$). Only exposure to Sardinian shows a difference in education as well, with $t(\text{group}) = 11.5$ and $t(\text{education}) = 3.7$; both $p < 0.001$. For these BLP measures, bilinguals with lower level of education reported higher exposure to Sardinian compared to all other groups.

As for the BLP Italian dominance measures, while the group differences are less marked than in the Sardinian BLP measures, they are nevertheless significant [exposure to Italian, $t(\text{group}) = 4.48$, $p < 0.001$ and $t(\text{education}) = 2.45$, $p = 0.017$; Italian usage $t(\text{group}) = 13.29$, $p < 0.001$; Italian comprehension, $t(\text{group}) = 3.40$, $p = 0.00122$ and $t(\text{education}) = 2.50$, $p = 0.1531$; attitude toward Italian, $t(\text{group}) = 4.96$, $p < 0.001$]. The distribution of Italian competence for the four groups recorded with the BLP is shown in **Figure 2**.

### Test Measures
#### Comprendo

We focused on language comprehension of the dominant language, Italian, by testing the comprehension of sentences with different degrees of grammatical complexity in order to establish whether there were differences in Italian competence due to bilingualism, and whether these differences were less marked in the bilingual group with a higher education level and more use of Italian. We used *Comprendo* (Cecchetto et al., 2012), a comprehensive test battery developed for recording both accuracy and reaction times (RTs) in adults. The battery includes a range of sentences differing in complexity, from simple active sentences to more complex relative clauses, across 10 different sentences types (see **Table 1** in the section "Linguistic Abilities and Knowledge of Grammar in Bilingualism"). There were 10 items per condition, with a total of 100 items per *Comprendo* trial. For each sentence, the participant was asked to select one of four pictures (see example in **Figure 1**). The correct picture matched the sentence meaning: for the sentence "La mamma da la torta al bambino" (*The mum gives the cake to the boy*), the correct picture showed a mother giving a cake to a young boy (D in **Figure 2**). In addition, there were three incorrect "distractor" pictures. The *reversal distractor* depicted the same actors in reversed roles (e.g., a boy giving a cake to his mother). The *verbal distractor* depicted the actors in the same thematic roles, but completing a different action (e.g., the mother caressing the boy). The *nominal distractor* kept the same action (e.g., giving), but replaced all the nouns (both the actors and the object; e.g., *The grandmother gives the keys to the girl*). The task requires mapping the thematic roles (i.e., *Who is doing what to whom?*) in relation to the syntactic form of the sentence.

**TABLE 2 |** Bilingual language profile (BLP) average scores for both languages, namely Sardinian and Italian for the four groups: bilinguals with secondary education, monolinguals with secondary education, bilinguals with university degree, and monolinguals with university degree.

|  | Group; total $N = 63$ | Overall score (means average of four factors) | Exposure | Use | Competence | Attitude |
|---|---|---|---|---|---|---|
| Sardinian | Bilinguals SEC (15) | 164.4 | 91.9 | 30.5 | 17.1 | 22.3 |
|  | Bilinguals UNI (19) | 165.3 | 82.9 | 28.8 | 18.9 | 23.5 |
|  | Monolinguals SEC (18) | 39.9 | 43.6 | 0.1 | 4.6 | 4.3 |
|  | Monolingual UNI (11) | 33.8 | 23.8 | 0.1 | 3.3 | 6.8 |
|  |  | **Overall** | **Exposure** | **BLP use** | **Competence** | **Attitude** |
| Italian | Bilinguals SEC (15) | 145.6 | 91.1 | 19.5 | 21.1 | 15.5 |
|  | Bilinguals UNI (19) | 159.2 | 100.6 | 21.2 | 22.9 | 16.9 |
|  | Monolinguals SEC (18) | 205.5 | 107.2 | 49.9 | 22.5 | 22.6 |
|  | Monolingual UNI (11) | 213.1 | 113.3 | 49.3 | 23.7 | 23.8 |

*BLP: Bilingual Language Profile (Birdsong et al., 2012). SEC: participants with secondary school degree; UNI: participants with university degree. OVERALL SCORE: average score for the four measures (exposure, use, competence, and attitude). EXPOSURE: average score for five questions on age of acquisition and number of years of exposure in different contexts (0–100%). USE: average score for five questions on language use in different contexts (0–100%). COMPETENCE: average score on four questions on language competence. ATTITUDE: average score on attitudes and degree of identification as speaker of the language.*



**FIGURE 1 |** Map of Sardinian Provinces.

Both accuracy and RTs were recorded via E-Prime. Subjects heard a sentence pre-recorded on a laptop and 1000 ms before the end of the recording, a picture, as the one in **Figure 3**, was displayed on the screen for a fixed time of 300 ms. This procedure, adopted from a previous study (Lauro et al., 2010), allowed a uniform onset of the picture across trials even though the length of the recording was variable (due to the different number of words for each sentence). Subjects were asked to select which picture represented the meaning of the sentence by pressing a response key (this measure capture both accuracy and RTs). The task was run in one session, with sentences presented in random order.

## Backward Digit Span

Working memory was therefore assessed using a backward digit span test adapted from Orsini et al. (1987). The experimenter read aloud a string of digits, at the pace of one second per digit, and the participant had to repeat the digits backward. Each sequence was incrementally longer. A sequence was considered correct if the participant repeated the whole sequence in the right backward order. There were two strings of digits per length. A score consisted of the longest sequence repeated correctly.

## BCOS Rule Finding and Concept Switching Test

The rule finding and concept-switching test is a visual task aiming at detecting the ability to switch rule after inferring it. It is a measure of non-verbal intelligence, designed to be used with patients with language impairments and it is part of a larger battery for evaluating cognitive impairment in people with brain injuries (Humphreys et al., 2012). It consists of a set of cards with a grid and colored dots spaced on the grid. The participants have to infer where the black dot will appear in the next card avoiding the interference of the currently active rule. The test measures both correct responses and correct rules inferred in a unique score.

## Stroop Task

We adopted the Italian version of the Stroop test: *Test di Stroop, versione breve* developed by Valgimigli et al. (2010). After a non-timed practice trial on both congruent and incongruent conditions, the participant starts by naming colors in the congruent condition and then in the non-congruent conditions. Participants have 20 s for each condition (congruent and incongruent naming). Each condition has a maximum of 60 items. In both conditions, correctly named items in 20 s
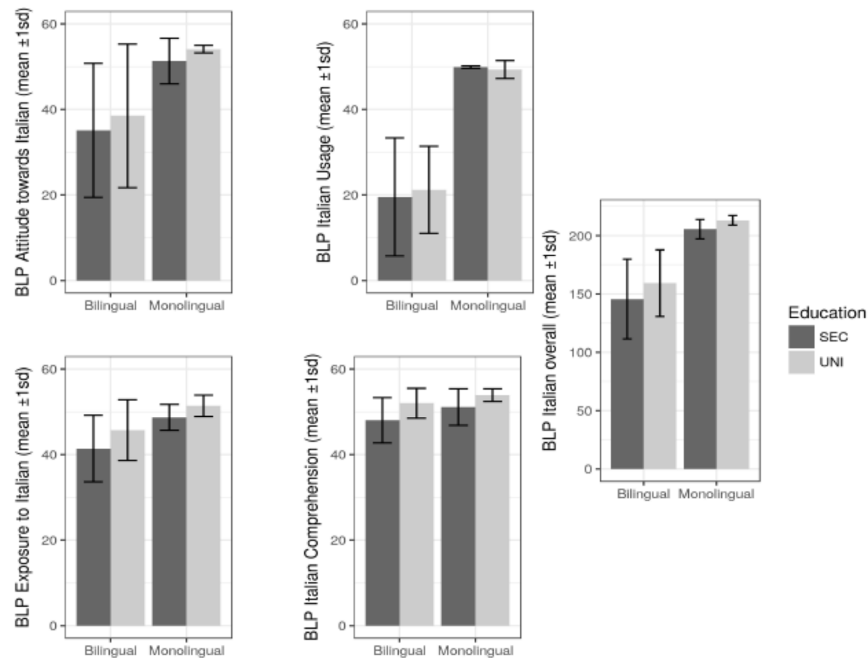
**FIGURE 2 |** BLP results for Italian for all four groups (Bilingual SEC, Bilingual UNI, Monolingual SEC, and Monolingual UNI): Overall, Exposure, Usage, Competence, and Attitude.

are recorded. The Stroop effect is calculated according to the following formula: Interference effect = [(Named colors/Congruent – Named colors/Incongruent)/(Named colors/Congruent + Named colors/Incongruent)] * 100. Low scores are an index of low interference levels.

## Statistical Analysis

Linear regression models were used to test for significant differences across the four groups (monolingual vs. bilingual by two education levels) in the various test measures described above. Additionally, for the Comprendo sentence-to-picture matching tasks, linear mixed effects regression models were run to test for timing differences across the 10 sentence types. This is because the picture choices with different sentence types typically take different amount of time to carry out, and hence times were included in the mixed effect models as random intercepts.

## RESULTS

## Comprendo

The average correct response (out of a maximum 100) across all groups was 90.2 ($SD = 5.24$), in line with what has been reported for standardized assessment scores (Cecchetto et al., 2012). Overall means for RTs were 4375 ms ($SD = 700$). Both the overall bilingual RTs and the overall monolingual RTs matched the overall time ranges reported in the standard assessment for the 40–49 years age range (bilingual mean was 4193, vs. 4242 for the standardized test; monolingual mean was 4589 ms, vs. 4242 for the standardized test).

In terms of accuracy (number of correct responses), there were no significant differences between monolinguals and bilinguals, across the two education levels. Monolinguals adults with a secondary education scored the lowest (AM SEC mean 87.0, $SD$: 6.81), and monolingual adults with a university education scored the highest (AM UNI mean: 93.1, $SD$: 3.08).

As for sentence complexity, adult monolinguals with a lower education level tended to take longer than adult bilinguals with a lower education level in processing center embedded *subject* relative clauses (AB.SEC $m$(sd) = 4613(1129) s, AM.SEC $m$(sd) = 5240(1009) s $t$(31) = −1.68, $p$ = 0.102, two-tailed) and *object* relative clauses (AB.SEC $m$(sd) = 4556(871) s, AM.SEC $m$(sd) = 5293(773) s, $t$(31) = −2.58, $p$ = 0.015, two-tailed). In **Table 3** RTs for all sentences types are reported.

The variation among participants in the time taken for subject relative clauses was relatively large, as can be seen in **Figure 4**.

As shown in **Figure 5** below, adult bilinguals with university education (AB UNI) took less time than their similarly educated monolingual counterparts (AM UNI) in the two conditions with longest sentences measured in term of number of word, namely object coordination and verb coordination. These sentences are longer with no syntactic complexity. However, there was again much variation among participants and the differences only approach significance: for the object coordination clauses, AB.UNI $m$(sd) = 4521(1222) s, AM.UNI $m$(sd) = 5350(1468) s, $t$(28) = −1.66, $p$ = 0.107 two-tailed; for the verb coordination clauses, AB.UNI $m$(sd) = 4685(1101) s, AM.UNI $m$(sd) = 5962(2159) s, $t$(28) = −2.16, $p$ = 0.034 two-tailed.

**FIGURE 3 |** *Comprendo* sample pictures for the dative target sentence "La mamma dà la torta al bambino" (*The mum gives the cake to the child*). Correct picture in the bottom right quadrant.

The distribution of the scores on the backward digit span reveals that four bilinguals (11.8%) had the higher score (span of 6) compared to only one participant (3.5%) in the monolingual group. In particular, the monolingual secondary-educated group (AM SEC) appears to perform worse than the other three groups (mean = 4.11). Likewise, the bilingual university-educated group (AB UNI) is the more proficient of the four groups (mean = 4.58). Additionally, there appears to be an effect related to the bilingual experience: monolingual secondary-educated participants performed worse than the bilingual secondary-educated participants (AB.SEC *m* = 4.40). The performance on the backward digit span will be discussed below in relation to the RTs results from the Comprendo test.

## Stroop Task

The Stroop task showed only a tendency for those with a university education to have smaller interference effects (intercept mean STROOP interference for UNI: 17.5; estimate difference for SEC: 2.88, SE = 1.7, *t* = 1.68, *p* = 0.098) but there were no interactions with language background.

## B-COS Task

None of the three B-COS task measures showed any differences between language groups or education levels. The overall mean (SD) were: N60 = 0.57(0.946); N18 = 12.2(2.73); N3 = 2.27(0.632).

## DISCUSSION

In this study, we compared the performance of a group of adult Sardinian/Italian speakers with low education (secondary school) with a group of monolinguals with the same educational level and living in the same area of Sardinia. To better control for the impact of the educational level, a similar group of bilinguals with a university degree was compared with a group of monolinguals with the same educational level.

All groups performed close to ceiling in all conditions tested, including the tasks that measured cognitive control and working memory. Although performance on the accuracy of sentence comprehension, measured with the *Comprendo* test, did not differentiate between monolinguals and bilinguals, the RTs in this task revealed an interesting difference in the processing of complex sentences, which was slower for monolinguals with lower education compared to bilinguals with a similar education level.

Monolingual Italian speakers with a low level of education (AM SEC in this study) represent the group with the slowest performance in the sentence comprehension task. Bilingual Sardinian/Italian speakers with lower education (AB SEC) were faster than monolinguals, this was significant during comprehension of complex center embedded object relative clauses in Italian. No difference in processing costs was found between the two groups with university education: this is arguably due to the effect of more intensive use of Italian, which levels off any differences due to bilingualism. Bilingual speakers with high education reported low level of use of the minority languages; this is because Italian is the dominant and often only language used in high-educated environments.

The faster processing found for less educated bilingual speakers suggests that the active use of the minority language has a *positive* impact on language competence in the dominant language, which partly compensates the effects of low education levels. Looking back at their language profile (collected with the BLP), bilinguals with secondary education in fact reported higher use of Sardinian compared to monolinguals and consequently less use of Italian. Also interesting is the selective effect on comprehension of object relatives, which shows a faster performance in the bilingual group with lower education compared to monolinguals. It is possible that the use of Italian in the group of bilinguals is associated with a more restricted range of linguistics contexts, which results in less competition among alternative syntactic structures, and consequent faster processing for complex sentences. One option is that bilingual speakers, with low use of Italian and only in formal contexts, have a linguistically different competence in the dominant language and it will be not natural for them to retrieve less costly but alternative grammatical structures. Avoidance strategies based on preference of less costly grammatical structures, as in the case of a preference for passive object relatives instead of object relatives, are often reported in studies on monolinguals (Belletti and Guasti, 2015). It is interesting to note that the passive object relative is the natural option for Sardinian speakers in the context of object relatives (see **Table 1** above). But it is possible that the two languages

**TABLE 3 |** Mean timing (ms) for each *Comprendo* sentence types across the two education levels and the two language groups.

| Sentences | Bilingual SEC | Bilingual UNI | Monolingual SEC | Monolingual UNI |
|---|---|---|---|---|
| Active | 3585 | 3292 | 3657 | 3640 |
| Dative | 4098 | 4027 | 4307 | 4143 |
| Passive | 3741 | 3514 | 3973 | 3656 |
| Relative subject peripheral | 3296 | 3208 | 3589 | 3488 |
| Relative object peripheral | 4435 | 4369 | 4683 | 4460 |
| Relative subject center | 4424 | 4300 | 5107 | 4661 |
| Relative object center | 4556 | 4554 | 5293 | 4616 |
| Object coordination | 5182 | 4521 | 5366 | 5350 |
| Verb Coordination | 5566 | 4685 | 5677 | 5963 |
| Sentence coordination | 4358 | 4247 | 4568 | 4404 |



**FIGURE 4 |** Mean of RTs for comprehension of relative clauses across the four groups.



**FIGURE 5 |** Mean RTs for comprehension of long sentences with simple syntax in the four groups.
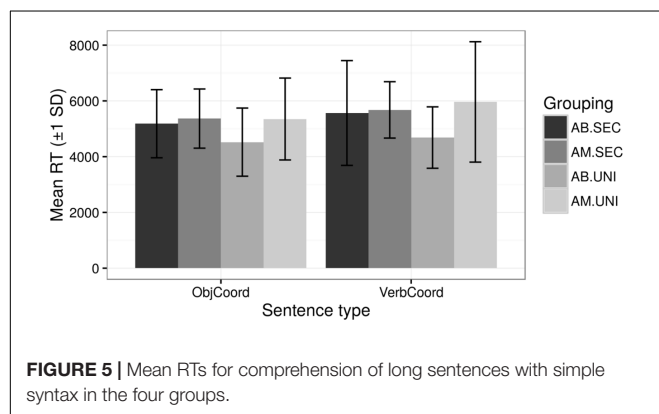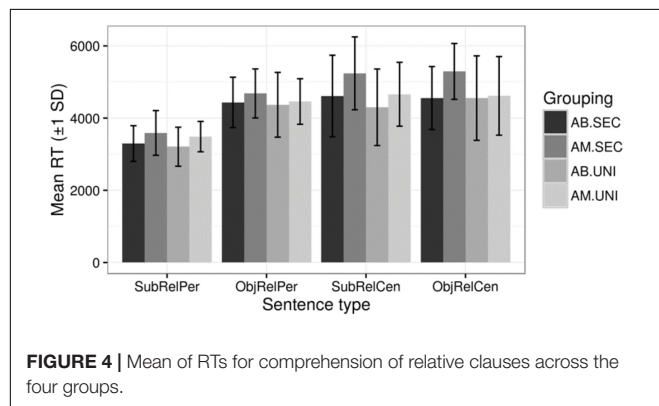
are segregated in their use to two difference registers, richer for Sardinian and more formal for Italian.

A better performance on complex sentences in non-native speakers, similar to our study, was reported in studies on L2 learners; Dubrowska and Street (2006), in a study on comprehension of passive sentences in L2 learners found that less-educated non-native speakers perform better than native speakers English speakers. This converging evidence supports the idea of a linguistically based difference in bilinguals compared to monolinguals with an advantage in the comprehension of more complex sentences in bilinguals due to a different grammatical representation for these sentences.

A second finding of our study is the enhanced performance of adult bilingual speakers on the working memory task. This group showed better results in the Digit Span task compared to monolinguals: 11% of the adult bilinguals obtained the highest score, compared to only 3% of the adult monolingual sample. Considering that both groups are living in a similar setting, it is plausible that the enhancement in working memory may be related to the bilingualism of the Sardinian/Italian group. Interestingly this group does not show any difference in grammatical processing of Italian, where their performance converges with that of monolinguals, but they possibly show the effects of the bilingual experience in their faster processing of long sentences with no greater complexity. This finding supports the cognitively based model, with better working memory skills in bilinguals compared to monolinguals, as reported in other studies on cognition in bilingual speakers (Bialystok, 2007). It is worth pointing out that Sardinian, as many minority languages, is used mainly orally. Many societies do not have an active written system (Montrul, 2008), and this is often the case in regional minority languages, where communications needs are shifted toward an orality. In this study the group of low educated bilinguals showed better working memory scores compared to monolingual speakers with university-level education. This result is not explainable by standard model of WM, where WM is often related to higher levels of education (Murre et al., 2013). Future research it is necessary to address the question of whether the effects of bilingualism are modulated by the modality of language use, for example focusing more on the effects of the exclusive oral use of a language[4].

# CONCLUSION

This study focused on the Sardinian/Italian bilingualism in the Nuoro Province, the area of Sardinia where the minority

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[4] An argument in favor of the impact of oral use on memory was proposed in Plato's Phaedrus in the *Myth of Theuth*, *the God of writing* (Plato, 360 B.C., 274b–279b). Socrates in a well-known passage commented on the invention of writing as follows: "it will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves. The specific which you have discovered is an aid not to memory, but to reminiscence."

language is well used and preserved. A previous study on Sardinian/Italian children living in this area (Garraffa et al., 2015) reported similar comprehension of Italian in bilingual and monolingual children starting primary school in the Nuoro Province, suggesting that the minority language does not interfere negatively with the development of the majority language and that some beneficial cognitive effects emerge gradually over time in bilingual children speaking Sardinian. In extending the investigation of Sardinian/Italian bilingualism to speakers in the adult community, our study again found no differences in comprehension of Italian, and in addition some advantages in memory skills and faster processing of more complex sentences in Sardinian/Italian bilinguals. Both studies supported the idea that minority languages can be beneficial for language competence and some aspects of cognition, although more research is needed to explore the exact source of the differences in processing complex sentences and the mutual effects of cognitive and linguistics capacities in bilingual speakers of minority languages.

## ETHICS STATEMENT

All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the "University of Edinburgh, School of PPLS Ethic committee."

## AUTHOR CONTRIBUTIONS

MG: conception and design of the work; analysis and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part to the work are appropriately investigated and resolved. MO: analysis and interpretation of data for the work; drafting the work and revising it critically for important intellectual content; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. AS: conception and design of the work; interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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# Independent and Combined Effects of Socioeconomic Status (SES) and Bilingualism on Children's Vocabulary and Verbal Short-Term Memory

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The current study explores the influence of socioeconomic status (SES) and bilingualism on the linguistic skills and verbal short-term memory of preschool children. In previous studies comparing children of low and mid-high SES, the terms "a child with low-SES" and "a child speaking a minority language" are often interchangeable, not enabling differentiated evaluation of these two variables. The present study controls for this confluence by testing children born and residing in the same country and attending the same kindergartens, with all bilingual children speaking the same heritage language (HL-Russian). A total of 120 children (88 bilingual children: 44 with low SES; and 32 monolingual children: 16 with low SES) with typical language development, aged 5; 7–6; 7, were tested in the societal language (SL-Hebrew) on expressive vocabulary and three repetition tasks [forward digit span (FWD), nonword repetition (NWR), and sentence repetition (SRep)], which tap into verbal short-term memory. The results indicated that SES and bilingualism impact different child abilities. Bilingualism is associated with decreased vocabulary size and lower performance on verbal short-term memory tasks with higher linguistic load in the SL-Hebrew. The negative effect of bilingualism on verbal short-term memory disappears once vocabulary is accounted for. SES influences not only linguistic performance, but also verbal short-term memory with lowest linguistic load. The negative effect of SES cannot be solely attributed to lower vocabulary scores, suggesting that an unprivileged background has a negative impact on children's cognitive development beyond a linguistic disadvantage. The results have important clinical implications and call for more research exploring the varied impact of language and life experience on children's linguistic and cognitive skills.

Keywords: child bilingualism, verbal short-term memory, socioeconomic factors, Russian–Hebrew, lexicon, sentence repetition

## INTRODUCTION

Socioeconomic status (SES) and bilingualism have been found to impact the development of preschool children, yielding variation in their linguistic and cognitive profiles. Previous studies consistently demonstrate effects of SES on language development (e.g., Locke et al., 2002; Hart and Risley, 2003; Qi et al., 2006). Performance of children from low SES groups is reported to be

three-quarters to one standard deviation below scores for the general population (for an overview see Roy and Chiat, 2013). Similarly, previous research demonstrates that sequential bilingual children with typical language development perform significantly lower than their monolingual peers on standardized language tests, which are normed on monolingual children (e.g., Restrepo, 1998; Bedore and Peña, 2008). Low language performance of children from low SES backgrounds and bilingual children leads to disproportionately high rates of identification of Specific Language Impairment (SLI) among these groups (for more detail see Roy and Chiat, 2013; Armon-Lotem and de Jong, 2015). The results of the current study are expected to deepen our understanding of how environmental factors (SES and bilingualism) affect cognitive and language skills in preschool children and help educators and speech and language pathologists tease apart disorder and variation due to environmental impacts. The current study addresses this problem by exploring the influence of SES and bilingualism on expressive vocabulary and verbal short-term memory of preschool children. In previous studies comparing children of low and mid-high SES, the terms "a child with low-SES" and "a child speaking a minority language" are often used interchangeably, precluding a differentiated evaluation of these two variables.

Moreover, in the few studies that attempted to address the differentiated impact, bilingual children came from widely mixed language, ethnic and cultural groups (Calvo and Bialystok, 2014; Chiat and Polišenská, 2016). In the present study, all bilingual children were born in Israel, attended the same kindergartens as the monolingual children and spoke the same heritage language (HL-Russian). This allowed us to focus on independent and combined effects of SES and bilingualism on expressive vocabulary and three repetition tasks among children who are monolingual and bilingual speakers of Hebrew, the societal language (SL). Repetition tasks [nonword repetition (NWR) and sentence repetition (SRep)] are reliable screening measures for diagnosing SLI among monolingual and bilingual children (e.g., Conti-Ramsden et al., 2001; Armon-Lotem and Meir, 2016). Yet research on effects of SES on repetition tasks is scarce (but see Balladares et al., 2016; Chiat and Polišenská, 2016). Likewise, few studies have evaluated separate and combined effects of SES and bilingualism on repetition tasks (but see Chiat and Polišenská, 2016).

Repetition tasks [including forward digit span (FWD), NWR, and SRep] tap into verbal short-term memory, but also activate long-term memory representations (for an overview see Meir, 2017). Baddeley (2001) suggests that verbal short-term memory storage is facilitated by lexical-semantic and morpho-syntactic knowledge stored in long-term memory. Repetition tasks differ in their linguistic load. For example, FWD carries the lowest linguistic load and is generally viewed as a pure cognitive measure of verbal short-term capacity (Richardson, 2007). This is supported by weaker correlations between FWD and vocabulary, as compared to correlations between NWR and vocabulary size (Baddeley et al., 1998). Contrastingly, SRep draws more on long-term memory representations than on verbal short-term memory, as the task draws on phonological, lexical, morphological, syntactic, and semantic information stored in

long-term memory. Thus, the evaluation of independent and combined effects of SES and bilingualism is expected to deepen our understanding on how environmental factors shape children's language and cognitive skills.

The introduction is structured as follows: an overview of studies evaluating the influence of SES on language development of monolingual children with emphasis on repetition tasks is followed by a brief overview of previous findings on the effects of bilingualism on tasks tapping into verbal short-term memory. The introduction will conclude with a presentation of what is currently known of the combined impact of bilingualism and SES, outlining the research questions addressed in the present study.

## Effects of SES in Monolingual Children

Children from disadvantaged backgrounds exhibit poorer linguistic skills as measured by standardized tests based on developmental norms (e.g., Qi et al., 2006). Due to impoverished language input, children from low SES often perform in the SLI range when assessed on language screening tests: the gap between children from low and high SES is observed on all standardized measures of English (Roy and Chiat, 2013). There is also a strong association between child vocabulary size and SES: children from mid-high SES families have bigger vocabulary sizes than their peers from disadvantaged homes (e.g., Dunn and Dunn, 1981; Hoff, 2003, 2006; Pan et al., 2005). Strikingly, the gap between low and mid-high SES in vocabulary and language processing skills is already evident as early as the age of 18 months, and by age of 24 months this gap presents a 6-month disadvantage (Fernald et al., 2013). Moreover, children from mid-high SES homes develop better morpho-syntactic abilities. In Hebrew, Schiff and Ravid (2012) showed that monolingual Hebrew-speaking children from low SES (as measured by their neighborhood) were consistently less accurate than their peers from high SES families on nominal and adjectival formation across all school grades (Grades 1–5). In a more recent study by Levie et al. (2017), monolingual Hebrew-speaking children with and without SLI from mid-high and low SES aged 6–14 were compared on derivational morphology. The findings showed that typically developing children from the mid-high SES group obtained the highest scores, and the language impaired low SES group always scored lowest. Interestingly, typically developing children from the low SES group often showed similar performance to that of language impaired children from mid-high SES groups. The results indicate that the effects of SES make it difficult to disentangle disadvantaged background and disorder.

Regarding repetition tasks, previous findings are inconsistent. Some studies show a negative effect of low SES on children's performance on repetition tasks, while others show that there is no difference between children from low and mid-high SES. For example, for FWD as a cognitive measure of verbal short-term memory capacity, previous research reported cultural biases for children aged 5–12 (Jensen and Figueroa, 1975). Similarly, for repetition tasks with a larger linguistic load (NWR and SRep), Gardner et al. (2006), studying a group of 668 British English-speaking children, reported effects of geographical location, but not parental occupation. Geographical location and parental occupational status are often used as indices of SES.

Conversely, the negative effect of low SES on verbal short-term memory tasks was not observed in a study by Engel et al. (2008), who investigated the effect of SES on expressive and receptive vocabulary and verbal short-term memory in 40 Brazilian children aged 6–7. The SES index was comprised of three measures (monthly family income, occupational status, and education of a main caregiver). The authors found a negative effect of SES on expressive and receptive vocabulary: children from low SES families scored significantly lower as compared to their peers from high SES families. The authors found neither effect of SES on cognitive measures (e.g., FWD) nor on NWR, a measure of verbal short-term memory more linked to vocabulary. However, the authors suggest that their results should be interpreted with caution. The effect size for NWR was small, suggesting that, indeed, NWR is a measure independent of SES influence. The effect size, however, for FWD was moderate (as measured by Cohen's $d$) indicating that with a larger sample size the effect of SES on FWD might reach significance.

The effect of SES on sentence memory was evaluated by Alloway et al. (2014) in British children aged 4; 3–5; 8. A negative effect of low SES was observed for the SRep task. Similar to other studies conducted in the United Kingdom, SES status was determined by a classification of residential neighborhoods. The authors concluded that long-term memory representations were affected by SES as reflected in lower scores on the SRep task, which taps into syntactic and semantic knowledge. However, the authors showed that repetition tasks of lower linguistic load (e.g., repetition of real words) were not influenced by SES.

The effect of SES on NWR and SRep was further addressed in a large-scale study of British English-speaking children by Roy et al. (2014). A total of 208 children from low SES families and 168 children from mid-high SES families, aged 3; 6–4; 11, were compared on receptive and expressive vocabulary and on NWR and SRep tasks. The children were split into SES groups based on the Index of Multiple Deprivation computed for the geographical area in which they reside. The sample comprised of mainly children for whom English was their only language; however, children with an additional language at home were not excluded from the study. The authors reported that the distribution of children with an additional language at home did not differ across the two SES groups. The results indicated that low SES children scored significantly lower on receptive and expressive vocabulary, demonstrating a negative effect of low SES. Furthermore, the findings indicated significant group differences on NWR and SRep tasks, with children from low SES showing significantly lower scores. The authors showed that proportions of low scorers on the NWR and SRep tasks were eight times greater in the low SES group as compared to the mid-high SES group. Strong associations were observed between children's performance on vocabulary and repetition tasks. The results further indicated that the gap between low and mid-high SES groups narrows with age. The only measure which showed no differences between children from low and mid-high SES was the function-word score on the SRep task: children from low SES backgrounds performed in the expected range for this measure.

A recent study by Balladares et al. (2016) investigated effects of SES on NWR and SRep tasks in 126 typically developing Spanish-monolingual Chilean children, aged 3; 10–6; 3, from low and high SES. The SES status was obtained based on the type of school that children were attending: low-SES participants were recruited from public schools and high SES participants were drawn from private schools. The segregation between public and private schools is reported to also be related to family income. Similar to Roy et al. (2014), there was an effect of SES on SRep; however, as observed in Engel et al. (2008), NWR was found to be free of an SES effect. A negative effect of SES was also observed for receptive vocabulary, and when this was controlled for, the effect of SES on SRep disappeared.

In summary, previous findings consistently indicate that there is an effect of SES on vocabulary: children from low SES score significant lower than their peers from mid-high SES. As for measures of verbal short-term memory with varied linguistic load, previous findings are inconclusive. There are studies showing that verbal short-term memory capacity, as a cognitive measure, is affected by SES (e.g., Jensen and Figueroa, 1975; Gardner et al., 2006), while other findings show no effect of SES for FWD (e.g., Engel et al., 2008). In a similar vein, findings provide inconclusive evidence for NWR. There is evidence that NWR is free of SES influence (e.g., Gardner et al., 2006; Balladares et al., 2016); however, other studies seem to show that NWR is affected by SES (e.g., Roy et al., 2014). The disparity in results has been linked to task differences. For example, some NWR tasks include pseudo-words that resemble the target language morphologically, while other tasks include nonwords that do not contain morphemes of the target language. Results for SRep are more consistent and point at group differences, corroborating the findings for vocabulary: children from low SES score significantly lower than children from mid-high SES (e.g., Gardner et al., 2006; Roy et al., 2014). Some studies demonstrate that the effect of SES on repetition tasks disappears once vocabulary is controlled for (e.g., Balladares et al., 2016), suggesting that the effect of SES is mainly driven by smaller vocabularies. However, there is also some evidence that the effect of SES is not limited to the verbal domain and that it affects children's executive function skills as well (e.g., Klenberg et al., 2001; Ardila et al., 2005). The disparity between low and high SES has been attributed to impoverished linguistic input, genetic factors and numerous environmental factors (e.g., Klenberg et al., 2001; Ardila et al., 2005; Hoff, 2006; Fernald et al., 2013). For example, living in unprivileged environments is associated with decreased levels of safety, higher noise levels, exposure to toxins, inadequate nutrition and medical care and higher levels of stress and instability.

## Effects of Bilingualism

Similar to the effect of SES, previous studies consistently report lower vocabulary scores for bilingual children as compared to monolingual peers when tested in only one of their languages (especially the SL) (for an overview see Haman et al., 2015 and studies cited there). For repetition tasks, previous studies investigating effects of bilingualism report conflicting findings (for a detailed overview see Meir, 2017). Some studies show that

the capacity of verbal short-term memory as measured by FWD is not affected by bilingualism (e.g., Bialystok and Shapero, 2005; Messer et al., 2010; Engel de Abreu, 2011; Blom and Boerma, 2017), while other studies show that bilinguals demonstrate limitation in verbal short-term storage in the SL (e.g., Laloi, 2015). Similar to the findings on FWD, many studies show that bilinguals perform on a par with monolinguals on NWR (e.g., Thordardottir and Brandeker, 2013). However, there are also some studies that demonstrate a negative effect of bilingualism (e.g., Messer et al., 2010; Engel de Abreu et al., 2013; Laloi, 2015). The differences in results across different language groups on NWR have been attributed to the stimulus type used.

Boerma et al. (2015), for example, looked at the effects of bilingualism on two types of Dutch NWR tasks (quasi-universal and language-specific) in children with and without SLI. A negative effect of bilingualism is reported only on the language-specific test, while on the quasi-universal test, which was designed to be minimally influenced by the knowledge of any specific language, there is no effect of bilingualism. A recent study by Chiat and Polišenská (2016) reports no effect of bilingualism for three types of English NWR tasks (quasi-universal with and without the prosody of the English language; language-specific). That is, children are better in repeating word-like nonwords (i.e., nonwords that contain real morphemes of the language, have higher phonotactic probability, and/or fall into dense lexical neighborhoods) (for an overview see Chiat, 2015). This is consistent with the claim that NWR is associated with vocabulary size (Gathercole, 2006) and might explain the gap between monolingual and bilingual children who might have smaller vocabulary in their SL. However, somewhat different findings are reported in the study by Messer et al. (2010), who compared the repetition of nonwords with high and low phonotactic probability in the target language in bilingual Turkish–Dutch and monolingual Dutch children. In Dutch (the SL for the bilingual children), the Turkish–Dutch children had more difficulty in repetition of nonwords with low phonotactic probability as compared to the Dutch monolingual children. The authors suggested that language input provided a possible explanation for the unexpected lower performance of bilingual children on the Dutch stimuli with low phonotactic probability. That is, in the case of monolingual children, a more extensive and longer period of input supported the storage of even relatively infrequent phoneme clusters in Dutch, an advantage that was not available for the Turkish–Dutch children for whom Dutch is the SL.

The findings for SRep, the measure with the highest linguistic load, also provide inconclusive evidence. Two groups of children (Russian–Hebrew and English–Hebrew) reported in Chiat et al. (2013) show performance comparable to monolingual peers, while in the other two groups (Turkish–English and Russian–German), a large portion of children score at risk for SLI. The difference there was associated with the lexical requirements of the SRep tasks used, which were more demanding for the latter groups, as well as the possible difference in SES between the different cohorts as the latter included more children from lower SES. That is, similarly to the results for the effects of SES on repetition tasks, differences between bilingual and monolingual children seem to be driven by vocabulary differences. For example, Engel de Abreu et al. (2013) showed that group differences disappeared once vocabulary size was taken into consideration. In the same vein, Komeili and Marshall (2013) also showed that monolingual-bilingual group differences on SRep disappeared when receptive vocabulary was controlled for.

To summarize, previous research shows that bilingualism is associated with decreased vocabulary size in the SL, whereas the results are inconclusive for repetition tasks with low and high linguistic load. While some studies report no bilingual effect, other studies demonstrate a negative effect of bilingualism. Yet the negative effect of bilingualism on repetition tasks has been linked to decreased vocabulary size and/or limited exposure.

## Independent and Combined Effects of SES and Bilingualism

There are very few studies that address effects of SES in bilingual children. To the best of our knowledge only three studies have attempted to evaluate the effects of SES and bilingualism. Calvo and Bialystok (2014) assessed the separate and combined effects of SES and bilingualism on receptive vocabulary, non-verbal intelligence and executive function tasks. Likewise, Chiat and Polišenská (2016) assessed the independent and combined effect of SES and bilingualism on receptive vocabulary, but also on NWR among English speaking children residing in the United Kingdom. Finally, Gathercole et al. (2016) evaluated the contribution to SES on vocabulary, grammar and cognitive skills in monolingual English, and English–Welsh bilinguals.

Each of these studies used different measures to determine the SES of the bilingual children, who had varied linguistic backgrounds. Calvo and Bialystok (2014) assessed four groups of children aged 6–7 years old residing in Canada: monolingual English speaking from working-class and middle-class families; and bilingual children from working-class and middle-class families. The bilingual children spoke 26 different languages. SES status was determined by mother's years of education. Gathercole et al. (2016) also used parent's educational level (five-point scale: 1 = primary education and five-post-graduate education) as well as parents' occupation (four-point scale: 1 = elementary trades and services; 4 = corporate directors, health and science professionals). Similarly to the other two studies, one of the languages of the children was English, but the other language of the bilinguals was constant, Welsh. Some bilinguals had only English at home, others Welsh and English at home, and another group only Welsh at home. Finally, for Chiat and Polišenská (2016), children's SES status was determined by neighborhood status (mid-high SES: inner-London neighborhood; low SES: outer-London neighborhood), rather than parental education. However, as in the study by Calvo and Bialystok (2014), bilingual children were of mixed ethnic and cultural origins. For example, bilingual children from mid-high SES were Spanish–English, while bilingual children from low SES were predominantly Turkish–English. Moreover, the groups were not matched for age, and age was included as a covariate.

As for cognitive abilities, neither SES, nor bilingualism had an effect on non-verbal intelligence in Calvo and Bialystok (2014). On executive function tasks, there was a negative influence of SES with working class children performing lower than middle-class children, while the effect of bilingualism was positive (bilingual children obtained higher scores than monolingual children). No interaction between SES and bilingualism was observed for any of these cognitive measures. In the same vein, Gathercole et al. (2016) report significant correlations between a composite SES score and cognitive measures. The authors also assess the contribution of the home language and SES for cognitive measures, and found that home language played no role, but SES significantly contributed to performance on cognitive tasks at ages 3 and 5.

Where vocabulary is concerned, the findings are rather systematic. Calvo and Bialystok's (2014) findings revealed an effect of SES and an effect of bilingualism for receptive vocabulary. Children from working class families had smaller vocabularies than children from middle-class families. Similarly, bilingual children were found to have smaller vocabularies than monolingual children. No interaction between SES and bilingualism was found for receptive vocabulary, suggesting that SES affects monolingual and bilingual children's vocabulary similarly. The results for receptive vocabulary in Chiat and Polišenská (2016) were in line with those reported for receptive vocabulary by Calvo and Bialystok (2014): there were significant main effects of SES and bilingualism, with no interaction between SES and bilingualism. The low SES groups showed lower vocabulary scores compared to mid-high SES groups, and bilingual children scored lower than monolingual children. The lack of interaction between SES and bilingualism indicates that SES affected monolingual and bilingual children similarly. Finally, Gathercole et al. (2016) also report significant correlations between a composite SES score and children's performance on language measures (receptive vocabulary in English and Welsh; receptive grammar skills in English and Welsh) with higher influence of SES on language measures as compared to cognitive measures. The effect of home language is reported to be more influential at younger ages, while the influence of SES is observed to be more influential at later ages.

Only Chiat and Polišenská (2016) explored the effects of SES and bilingualism on NWR tasks using three tasks that vary in their use of knowledge stored in long-term verbal memory: cross-linguistic (compatible with different languages and prosody neutral); prosodic specific (the same items as in cross-linguistic but with English real-word-like prosody) and language-specific (containing features specific to the target language, English, e.g., word-like derivational morphemes). All three repetition tasks were found to be free of SES and bilingualism effects. The authors indicated that the effect of SES was approaching significance for a language-specific NWR task. Finally, when vocabulary size was controlled for, these non-significant differences disappeared.

To recap, the three studies assessing independent effects of SES and bilingualism converge in showing that SES affects monolingual and bilingual children similarly. However, the factorial design used in the study by Calvo and Bialystok (2014) pointed out that SES and bilingualism affect different domains.

As for the effect of SES, it was shown to affect both domains (language skills and cognitive skills). Conversely, bilingualism is associated with a lower performance on language tasks only, while it demonstrates an increase on the executive function tasks. Similarly, the factorial design applied to the three NWR tasks in the study by Chiat and Polišenská (2016) also demonstrate that SES is associated with the linguistic load that the tasks carries. A negative effect of SES appears only on the NWR task with greater linguistic load (i.e., on the language specific task). While two of these studies were the first to attempt to evaluate independent and combined effects of SES and bilingualism, the mixed ethnicity and cultural background might have affected the overall results. Previous studies point out the potential effects of cultural and racial difference which were not addressed (e.g., Calvo and Bialystok, 2014; Chiat and Polišenská, 2016). Like Gathercole et al. (2016), the present study controls for this confound by looking at bilingual children who share the same cultural background and share the same home language (here HL-Russian). Following the above studies, the present paper evaluates independent and combined effects of SES and bilingualism on vocabulary, but adds three measures of verbal short-term memory with varying linguistic load (FWD, NWR, and SRep). Secondly, this paper aims to investigate the relation between vocabulary and verbal short-term memory.

## MATERIALS AND METHODS

### Participants

A total of 120[1] monolingual Hebrew-speaking and sequential Russian–Hebrew speaking children with typical language development, aged 5; 7–6; 7, participated in the current study. The children were split into four groups: bilingual children with low SES (bi-LOW: $n = 44$) and mid-high SES (bi-MID-HIGH: $n = 44$); monolingual children with low SES (mo-LOW: $n = 16$) and mid-high SES (mo-MID-HIGH: $n = 16$). See **Table 1** for the information on the participants. Bilingual children and monolingual Hebrew-speaking children were living in the central part of Israel (Tel-Aviv area). Background information was collected from parents on family history as well as aspects of language development and developmental milestones using a short version of the bilingual parental questionnaires (BIPAQs) (Abutbul-Oz et al., 2012). The four groups were matched for age [$F(3,116) = 0.85$, $p = 0.47$] and non-verbal IQ as measured by the *Raven's Colored Progressive Matrices Non-verbal IQ Test* (Raven, 1998) [$F(3,116) = 2.10$, $p = 0.10$].

By definition, the groups differed on the SES parameter, which was operationalized by years of maternal education [$F(3,116) = 80.76$, $p < 0.001$, $\eta_p^2 = 0.68$], and *post hoc* tests using Tamhane's T2 for unequal variances confirmed SES differences: (mo-LOW = bi-LOW) < (mo-MID-HIGH = bi-MID-HIGH). Similarly, there were group differences for father's years of education [$F(3,103) = 19.11$, $p < 0.001$, $\eta_p^2 = 0.36$], and *post*

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[1]Children reported in this study were drawn from a larger pool of 230 participants (see Armon-Lotem and Meir, 2016). In the current study, we included only children with typical language development.

**TABLE 1 |** Background information [Means (SDs) and Ranges] on the participants per group.

| | Bilingual | | Monolingual | |
|---|---|---|---|---|
| | **bi-LOW** $N = 44$ | **bi-MID-HIGH** $N = 44$ | **mo-LOW** $N = 16$ | **mo-MID-HIGH** $N = 16$ |
| Age in months | 73 (3) 67–79 | 73 (2) 68–77 | 72 (2) 68–77 | 73 (1) 71–75 |
| Non-verbal IQ (raw score out of 36) | 20 (4) 12–33 | 22 (4) 13–30 | 19 (2) 16–24 | 20 (4) 13–27 |
| Mother's education (years) | 11 (1) 10–12 | 16 (2) 13–25 | 12 (1) 10–12 | 16 (1) 14–19 |
| Fathers' education (years)[a] | 12 (2) 10–17 | 15 (3) 8–25 | 12 (1) 10–15 | 17 (4) 12–23 |
| AoO (age of onset of bilingualism) in months | 33 (22) 0–60 | 32 (21) 0–60 | n/a | n/a |
| LoE (length of exposure to L2) in months | 39 (21) 13–74 | 41 (21) 13–76 | n/a | n/a |

[a]*Data on father's education were missing for 13 participants (six bi-LOW, four bi-HIGH, two mo-LOW, one bi-HIGH).*
*bi-LOW: bilingual children from low SES; bi-MID-HIGH: bilingual children from mid-high SES; mo-LOW: monolingual children from low SES; mo-MID-HIGH: monolingual children from mid-high SES.*

*hoc* tests using Tamhane's T2 for unequal variances confirmed SES differences: (mo-LOW = bi-LOW) < (mo-MID-HIGH = bi-MID_HIGH). There were significant correlations between father and mother's education ($r = 0.67$, $n = 107$, $p < 0.001$).

The two bilingual groups were matched by the age of Hebrew onset [$F(1,86) = 0.16$, $p = 0.69$] and the length of exposure to Hebrew [$F(1,86) = 0.25$, $p = 0.62$]. We also measured bilingual children's expressive vocabulary in HL-Russian using naming subtests of the *Russian Language Proficiency Test for Multilingual Children* (Gagarina et al., 2010), which includes naming of nouns and verbs. The results using an independent *t*-test indicated that the two bilingual groups (bi-LOW and bi-MID-HIGH) did not differ in their vocabulary size in HL-Russian [$t(86) = -1.86$, $p = 0.32$].

## Tasks

Children were tested with a battery of tasks to explore language proficiency in Hebrew, language proficiency in Russian (for bilingual children only), and three repetition tasks in SL-Hebrew (FWD, NWR, and SRep).

- **Expressive Vocabulary in Hebrew:** The naming subtest of the *Goralnik Screening Test for Hebrew* (Goralnik, 1995) was used as a measure of children's expressive vocabulary in Hebrew.
- **Hebrew Forward Digit Span (FWD):** The Hebrew FWD Task, adapted from Wechsler Intelligence Scale for Children (WISC-R95), was administered to all children.
- **Hebrew Nonword repetition (NWR):** Shortened version of the Hebrew NWR task (Armon-Lotem and Chiat, 2012), which is comprised of 14 items was administered. The nonwords were constructed to include the following variables: item length (2–4 syllabic items); consonant sequences (with or without a consonant sequence); word-likeness (word-like vs. nonword-like). All nonwords were constructed using non-existent roots. Half of the nonwords made use of typical consonant and vowel patterns for Hebrew (word-like nonwords), and half of the words made use of vowelled templates that are atypical of Hebrew.
- **Hebrew Sentence Repetition (SRep):** The Hebrew LITMUS-SRep task (Meir et al., 2016), which includes

56 sentences, was administered. LITMUS-SRep tasks followed the guidelines developed within COST Action IS0804 (Marinis and Armon-Lotem, 2015).

## Procedure and Coding

Informed parental consent was obtained prior to participation for each child. The study was approved by the review board of Bar-Ilan University as well as by the Israeli Ministry of Education. Each participant was tested individually in a quiet room in the preschool or at home. This study is part of a larger study in which bilingual participants were tested in both languages (Russian and Hebrew). The tasks were administered in two sessions: (1) the language proficiency test in Hebrew (which includes a vocabulary subtest), a FWD and the *Raven's Colored Progressive Matrices Non-verbal IQ Test* (Raven, 1998); (2) NWR and SRep tasks. All children in the current study completed all the tasks.

The FWD, NWR, and SRep tasks were pre-recorded for consistency of presentation. The tasks were presented via a power-point presentation, earphones, and a microphone. The child heard each stimulus only once, and was instructed to repeat it verbatim. Children's responses were recorded using Audacity software[2] and were marked as correct/incorrect on-line. Recordings were then transcribed and re-coded off-line.

### Expressive Vocabulary

The children were presented with 15 objects with different levels of familiarity and were asked to name them. The coding system in the current study was different from the original coding schema used in the *Goralnik Screening Test for Hebrew* (Goralnik, 1995). For consistency of presentation of all tasks, raw scores were converted into a ratio out of the15 items presented.

### Forward Digit Span

The children were asked to repeat the digit sequence orally. Test items consisted of two lists of digits administered for each list length, beginning with a length of two digits, and increasing in length by one digit following successful repetition of at least one list of digits at a given length. The test was discontinued when the child failed at two consecutive digit sequences of the same length. The longest list length correctly repeated was noted.

[2]www.audacity.com

## Nonword Repetition

The children's repetitions of the nonwords were scored as correct (a score of 1) if all consonant and vowels were produced correctly. If the response contained any substitution, omission, or insertion, it was scored as incorrect and given a score of 0. Raw scores were converted to a proportion out of the 14 items tested. All children were able to complete the entire task.

## Sentence Repetition

A 0–1 scoring scheme was used for SRep, according to which a score of 1 was allocated if the sentence was repeated entirely verbatim and a score of 0 if there were one or more changes in the child's response. Raw scores were converted to a proportion out of the 56 items targeted. The entire task was presented to all participants.

## Analysis

To evaluate independent effects of SES and bilingualism, two-way ANOVAs with SES (low SES vs. mid-high SES) and language group (monolingual vs. bilingual) as independent factors were applied. Combined effects of SES and language group were determined by interactions between SES and bilingualism. To estimate the magnitude of each factor, effect sizes were determined by partial eta squared (partial $\eta^2$). In order to evaluate the effect of vocabulary on the relationship between SES and repetition tasks, following Komeili and Marshall (2013) and Balladares et al. (2016), we additionally conducted two analyses of variance using expressive vocabulary and FWD as covariates. Finally, outliers (participants performing below −2 SD and above 2 SD) for each group on each measure were identified. Yet excluding these outliers did not affect the statistics reported in Section "Results."

## RESULTS

## The Effect of SES and Bilingualism on Vocabulary in Hebrew

To examine the effect of SES and bilingualism on vocabulary in Hebrew (SL for bilingual children), a two-way ANOVA with SES (low vs. mid-high) and language group (monolingual vs. bilingual) was conducted. **Figure 1** presents children's vocabulary scores. The results indicated a significant effect of SES [$F(1,116) = 5.88$, $p = 0.02$, $\eta_p^2 = 0.05$], a significant effect of language group [$F(1,116) = 48.53$, $p < 0.001$, $\eta_p^2 = 0.29$] and no interaction between SES and language group [$F(1,116) = 1.35$, $p = 0.25$]. The analysis indicated that the effect size of language group for vocabulary size is higher than the effect size of SES (compare $\eta_p^2$ 29 vs. 0.05).

## The Effect of SES and Bilingualism on Tasks Tapping into Verbal STM (FWD, NWR, and SRep) in Hebrew

The effects of SES and bilingualism were further explored for the different repetition tasks that tap into verbal STM but vary in linguistic load. Two-way ANOVAs SES (low vs. mid-high) and
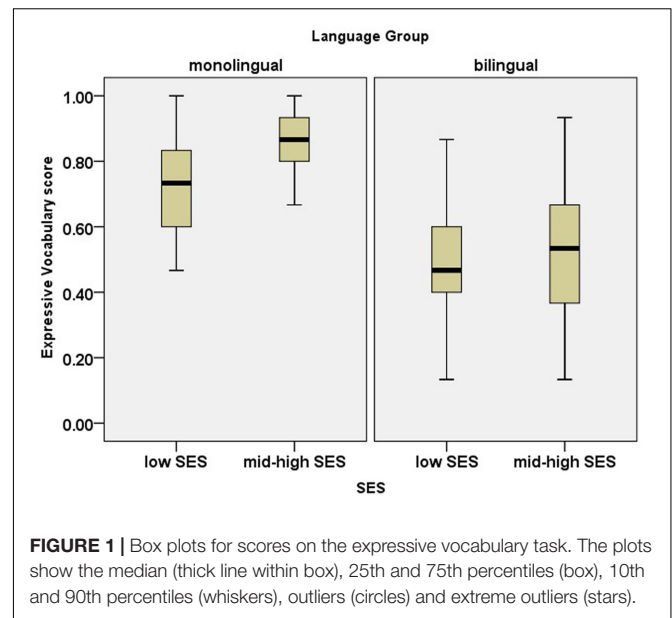


**FIGURE 1 |** Box plots for scores on the expressive vocabulary task. The plots show the median (thick line within box), 25th and 75th percentiles (box), 10th and 90th percentiles (whiskers), outliers (circles) and extreme outliers (stars).

language group (monolingual vs. bilingual) were conducted for the three repetition tasks (FWD, NWR, and SRep) in Hebrew (the SL for the bilingual children).

## Forward Digit Span (FWD) Task

**Figure 2** depicts children's performance on the Hebrew FWD task. A two-way ANOVA with SES (low vs. mid-high) and language group (monolingual vs. bilingual) as independent variables indicated a significant effect of SES [$F(1,116) = 11.17$, $p < 0.001$, $\eta_p^2 = 0.09$], but no effect of language group [$F(1,116) = 0.29$, $p = 0.59$], and no interaction between language group and SES [$F(1,116) = 0.38$, $p = 0.54$].

## Nonword Repetition (NWR) Task

The results for the total score for the Hebrew NWR task failed to show a significant effect of either bilingualism [$F(1,116) = 1.79$, $p = 0.18$]; or SES [$F(1,116) = 0.05$, $p = 0.82$], or interaction between SES and bilingualism [$F(1,116) = 1.79$, $p = 0.18$]. Following previous observation that NWR accuracy depends on the type of stimuli, we conducted a further analysis assessing the nonword type stimuli. **Figure 3** presents the scores on NWR by stimulus type.

A three-way ANOVA with stimulus type (word-like vs. nonword-like) as a within-subject factor and SES (low vs. mid-high) and language group (monolingual vs. bilingual) as between-subject factors revealed that the effect of stimulus type was marginally significant [$F(1,112) = 3.71$, $p = 0.06$, $\eta_p^2 = 0.09$]. There was no significant main effect of SES [$F(1,112) = 2.08$, $p = 0.15$], no significant main effect of language group [$F(1,112) = 2.59$, $p = 0.11$] and no interaction between SES and language group [$F(1,116) = 0.47$, $p = 0.50$]. There was no stimulus type and SES interaction [$F(1,112) = 0.30$, $p = 0.59$]; however, there was a significant stimulus type by language group interaction [$F(1,112) = 7.14$, $p = 0.01$,

**FIGURE 2 |** Box plots for scores on the forward digit span (FWD) task. The plots show the median (thick line within box), 25th and 75th percentiles (box), 10th and 90th percentiles (whiskers), outliers (circles), and extreme outliers (stars).



**FIGURE 4 |** Box plots for scores on the Hebrew Sentence Repetition (SRep) task. The plots show the median (thick line within box), 25th and 75th percentiles (box), 10th and 90th percentiles (whiskers), and outliers (circles), and extreme outliers (stars).



**FIGURE 3 |** Box plots for scores on the nonword repetition (NWR) task (comparison of word-like vs. nonword-like items). (a) The plots show the median (thick line within box), 25th and 75th percentiles (box), 10th and 90th percentiles (whiskers), outliers (circles), and extreme outliers (stars). (b) In the monolingual mid-high SES group, there were 10 participants, whose score was 0.88, and 6 extreme outliers (three participants with the scores of 1.00), represented by a star above the thick line, and three participants with low scores, represented by three stars below the thick line.

$\eta_p^2 = 0.06$]. In order to unpack the interactions, separate one-way ANOVAs were conducted for word-like and nonword-like stimuli with language group (monolingual vs. bilingual) as an independent variable. The results showed no effect of language group for word-like stimuli [$F(1,114) = 0.00$, $p = 0.99$]; however, a negative effect of bilingualism was

observed for nonword-like stimuli [$F(1,114) = 7.39$, $p = 0.01$, $\eta_p^2 = 0.06$].

### Sentence Repetition (SRep) Task

**Figure 4** presents children's scores on the Hebrew SRep Task. The analysis showed a significant effect of SES [$F(1,116) = 8.56$, $p < 0.001$, $\eta_p^2 = 0.07$], and a significant effect of language group [$F(1,116) = 14.55$, $p < 0.001$, $\eta_p^2 = 0.05$] but no interaction between SES and language group [$F(1,116) = 0.16$, $p = 0.69$]. The effect size of SES and the effect of bilingualism were comparable (compare $\eta_p^2$: 0.07 vs. 0.05).

## The Relationship between Vocabulary, SES, and Bilingualism

To assess the role of vocabulary size in the impact of SES and bilingualism on the repetition tasks, we re-analyzed the performance on FWD, NWR and SRep using a two-way ANCOVA with SES (low vs. mid-high) and language group (monolingual vs. bilingual) as independent variables and the expressive vocabulary scores as a covariate.

The analysis of FWD showed that the effect of SES persisted even after the vocabulary size was taken into consideration [$F(1,115) = 7.92$, $p = 0.01$, $\eta_p^2 = 0.06$], while the effect of language group [$F(1,115) = 0.62$, $p = 0.43$] and the SES*language group interaction [$F(1,116) = 0.15$, $p = 0.70$] remained insignificant.

The re-analysis of NWR, using a three-way ANCOVA with stimulus type (word-like vs. nonword-like) as a within-subject factor and SES (low vs. mid-high) and language group (monolingual vs. bilingual) as between-subject factors, with expressive vocabulary scores as a covariate, showed that all the main effects remained non-significant [stimulus type: $F(1,111) = 1.27$, $p = 0.26$; SES: $F(1,111) = 1.12$, $p = 0.29$; language group: $F(1,111) = 0.01$, $p = 0.91$; SES*language

group : $F(1,111) = 2.34$, $p = 0.13$] and the stimulus type* language group interaction became non-significant as well [$F(1,111) = 3.61$, $p = 0.06$]. The effect of bilingualism, which was observed on nonword-like stimuli, was largely driven by vocabulary knowledge, and it disappeared once vocabulary size in Hebrew (the SL for bilinguals) was taken into account.

Likewise, the analysis for the SRep task indicated that the observed effects of language group disappeared once vocabulary size was controlled for [language group: $F(1,110) = 0.19, p = 0.67$; SES*language group : $F(1,110) = 0.59$, $p = 0.45$], while the effect of SES persisted [$F(1,110) = 5.18$, $p = 0.02$, $\eta_p^2 = 0.04$]. Subsequently, we re-analyzed the data for the SRep task, using forward digit scores and vocabulary scores as covariates. The results indicated that once FWD scores were added as a covariate, the effect of SES disappeared [SES: $F(1,108) = 2.40$, $p = 0.12$].

To summarize this subsection, these findings demonstrated independent effects of SES and bilingualism. The negative effect of bilingualism on tasks with higher linguistic load (nonword-like items and SRep) was associated with smaller vocabulary sizes in bilingual children in their SL. Yet the negative effect of SES was not linked to vocabulary size. That is, it did not disappear on the FWD task and the SRep task when vocabulary was controlled for. Moreover, the negative effect of SES on SRep was found to be related to the forward digit task that measures memory and relies the least on long-term verbal memory.

## DISCUSSION

Previous studies consistently demonstrated a negative effect of SES on language development that often leads to variation within the pathological range, but previous research was less consistent for the effects of bilingualism. Few studies explored the interaction between these two variables, looking at independent and combined effects. Moreover, these studies have only enhanced the inconsistency, possibly due to linguistic and cultural heterogeneity among the bilingual children, and wide age-range involved. Furthermore, in most of the previous work, children were tested in English as the SL. The present study controlled for the linguistic background of the children, as all bilinguals had the same HL, Russian, and both bilinguals and monolinguals came from the same neighborhoods and spoke the same SL, Hebrew. Children were matched for age and IQ, and SES was consistently determined by maternal education. All children were tested with the same tools looking at expressive vocabulary and three repetition tasks (FWD, NWR, and SRep) tapping into verbal short-term memory.

Regarding vocabulary size, the results of our meticulous approach were consistent with previous work, showing that both SES and bilingualism have an impact. In line with previous research, monolingual Hebrew speaking children outperformed Russian–Hebrew bilinguals in the SL (Hebrew). Furthermore, children of mid-high SES outperformed those of low SES.

As for the independent effect of SES, the results of the present study indicated that children from lower SES backgrounds score lower on FWD and SRep. FWD measures verbal short-term memory as a cognitive capacity and is less associated with vocabulary, while SRep task is the measure with the highest linguistic load, tapping into long-term linguistic representations. Interestingly, no effect of SES was found for the NWR task, neither for word-like, nor for nonword-like stimuli. The present results are consistent with studies suggesting that NWR is free of SES influence (e.g., Gardner et al., 2006; Balladares et al., 2016; Chiat and Polišenská, 2016). However, the discussion is still open regarding the exact mechanisms involved in NWR. The question is why NWR, which taps into verbal short-term memory capacity, on the one hand, and vocabulary, on the other hand, remains free of SES influence, whereas both verbal short-term memory and vocabulary are negatively affected by low SES. A major difference between NWR and FWD (and to some extent SRep as well) is that NWR does not measure memory span, but rather phonological processing. In NWR, only a single word is held in memory at each point. This might suggest that the difficulty with FWD stems from the need to hold several items in short-term memory rather than the linguistic challenge presented by NWR. This distinction further supports our conclusion that SES interferes with cognitive abilities.

Turning to the independent effect of bilingualism on repetition tasks, previous research brought conflicting evidence. The present study shows that the effect of bilingualism varied on repetition tasks as a function of linguistic load. No effect of bilingualism was detected for verbal short-term capacity as measured by FWD. However, as the linguistic load rises on repetition tasks, so does the effect of bilingualism. This replicates the findings by Calvo and Bialystok (2014), who reported the negative effect of bilingualism only for linguistic tasks. Moreover, a negative effect of bilingualism was observed on the NWR task only for nonword-like items (i.e., items which carry no morpho-lexical information in Hebrew, the SL for bilingual children). These results were surprising, as previous studies showed that bilinguals perform similarly to monolinguals on quasi-universal non-repetition tasks (tasks designed to minimize the influence of knowledge and exposure to any particular language (e.g., Boerma et al., 2015; Chiat and Polišenská, 2016). The discrepancy in results might be attributed to nonword properties. Quasi-universal nonwords are constructed from a limited range of consonants and vowels which are combined into simple CVCV structures. Only those consonants and vowels that are compatible with word phonology in most languages, regardless of the further segmental contrasts and syllable structures particular languages allow, were chosen. In contrast, in the present NWR task, nonword-like items were designed in a different way, using almost the full range of Hebrew consonants and vowels in non-Hebrew-like vowelled templates, and this resulted in differences between monolingual and bilingual children. The results of the present study echo those reported in Messer et al. (2010), who found that in Dutch (the SL for the bilingual children), the Turkish–Dutch children had more difficulty with repetition of nonwords with

low phonotactic probability as compared to their monolingual Dutch peers. One of the explanations for lower performance in bilinguals on nonwords with low phonotactic probability in their SL might be the reduced language input in the SL. More extensive exposure in monolingual children enables the storage of infrequent phoneme clusters, while for bilingual children this advantage was not yet available (Messer et al., 2010). An alternative explanation might relate to bilingual processing, which activates both systems before focusing the attention on the relevant system. In repeating nonwords that are similar to the SL, bilingual children, like monolinguals, are quickly able to identify the SL morpho-lexical information that facilitates their repetition. But once the nonwords are no longer similar to one of the systems, bilinguals might find it more difficult to resolve the competition, thus challenging verbal short-term memory. This option is not available to monolingual children. Neither is it relevant for quasi-universal nonwords as they are compatible with phonotactic rules of both languages, and quasi-universal nonwords gain support from mental lexicons of both languages.

Besides evaluating independent effects of SES and bilingualism, we assessed the combined effects of these two variables on vocabulary and repetition tasks. The results for the combined effects conformed to previous research showing no interaction between SES and bilingualism (e.g., Calvo and Bialystok, 2014; Chiat and Polišenská, 2016). These findings suggest that SES similarly affects bilingual and monolingual children, and that bilingualism affects similarly children from low and mid-high SES. However, similarly to Calvo and Bialystok (2014), our study shows that SES and bilingualism impact different domains. We found that both SES and bilingualism affect vocabulary and repetition tasks with the highest linguistic load (e.g., SRep). However, the capacity of verbal short-term memory (a cognitive measure less associated with vocabulary) is affected by SES, but not by bilingualism.

This was confirmed by exploring the relationship between vocabulary size, SES and bilingualism. The present study shows, as found in previous studies, that the negative influence of bilingualism is largely driven by the smaller vocabulary size of bilingual children in the SL (here Hebrew). Once vocabulary size is accounted for, the negative effect of bilingualism disappeared, pointing to the fact that the bilingual children's lower performance in the SL demonstrates that they are disadvantaged due to lesser experience in that language. Conversely, the negative effect of low SES persisted on the FWD and SRep tasks when vocabulary scores were taken into consideration. The negative effect of SES disappeared when the measure of verbal short-term memory with lowest linguistic load (FWD) was added to the model. Indeed, previous research demonstrated that a negative effect of SES is not limited to the verbal domain. Living in underprivileged backgrounds which provide less adequate social and cognitive stimulation affects children's language and cognitive abilities (e.g., Klenberg et al., 2001; Bradley and Corwyn, 2002; Ardila et al., 2005; Hoff, 2006; Fernald et al., 2013). These differences between low and high SES have been attributed

to genetic factors (see Bradley and Corwyn, 2002; Fernald et al., 2013). However, a study on twins (Turkheimer et al., 2003) showed that in impoverished families 60% of the variance in children's IQ is accounted for by the shared environment, and the contribution of genes is close to zero. These latter findings provide hope that children's lower verbal and cognitive skills can be improved if educational settings accommodate needs of children from low SES for more stimulating environments.

To conclude, the present study is the first to assess independent and combined effects of SES and bilingualism on expressive vocabulary and three repetition tasks (FWD, NWR, and SRep) which tap into verbal short-term memory. It provides new evidence for the distributed impact of SES and bilingualism on the development of preschool children as it has shown that SES and bilingualism impact different abilities of children, yielding variation in their linguistic and cognitive profiles.

Bilingualism is associated with decreased vocabulary size and lower performance on verbal short-term memory tasks with higher linguistic load in the SL. The negative effect of bilingualism on verbal short-term memory evaporates once vocabulary is accounted for. That is, our study shows that bilingualism impacts language development at the lexical level as child vocabulary in the SL is more restricted when compared to that of monolingual. We did not find a cumulative negative bilingual effect on tasks which rely on long and short-term memory, as the difference between bilinguals and monolinguals disappears once lexical abilities in the SL are controlled for. These findings could be interpreted as suggesting that bilinguals' representation of the SL is similar to that of monolinguals, while errors made by bilinguals are related to bilingual processing and gaps in lexical knowledge. Our findings, while not showing a cognitive advantage for bilingual children, do not show a disadvantage either.

Turning to SES the story is very different. SES influences not only linguistic performance, but also verbal short-term memory with lowest linguistic load. The negative effect of SES cannot be attributed solely to lower vocabulary scores, suggesting that an unprivileged background has a negative impact on children's cognitive development beyond a linguistic disadvantage. That is, while bilingualism impacts lexical knowledge only, our findings show a cumulative effect of lexical knowledge and memory-related cognitive skills on the performance of children of low SES. These findings suggest that SES has a negative impact on short and long-term memory. That is, cognitive abilities are tied to socio-genetic factors associated with low SES. The results of the current study have important clinical implication, indicating that caution should be employed when assessing the language and cognitive development of children from diverse communities.

## ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Bar Ilan University review board for studies involving human subjects as well as by the Israeli Ministry of

Education with written informed consent from all parents and the approval of all subjects. All parents gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by Bar Ilan University review board for studies involving human subjects as well as by the Israeli Ministry of Education.

## AUTHOR CONTRIBUTIONS

NM and SA-L both developed, conceptualized the research questions and the design of the study, and wrote the manuscript. NM carried out the data analyses.

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# On the Directionality of Cross-Linguistic Effects in Bidialectal Bilingualism

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This study explores the interpretation of null and overt object pronouns by Brazilian Portuguese (BP) and European Portuguese (EP) bidialectal bilinguals. Object pronouns are a particularly good domain to examine, given that, particularly with respect to null objects, the underlying syntax as well as the semantic and discourse constraints that regulate their distributions in the two varieties are superficially different but inherently similar. We test the extent to which native BP speakers who moved to Portugal in adulthood and have lived there for a considerable time display cross-linguistic influence in either direction. Each subject is tested twice, once in BP mode and once in EP mode, which allows us not only to test if they have acquired the EP target structure but also to test the extent to which acquisition of EP might have consequences for the same domain in BP. Our results show that the high degree of typological proximity between the L1 and the L2 may contribute to L1 attrition and hinder target-like performance (i.e., processing) of L2 properties. We relate the findings to key theoretical questions and debates within the context of the larger field of bilingual studies, particularly with respect to L1 attrition and L2 acquisition.

Keywords: null objects, Portuguese, bilingualism, bidialectalism, attrition

## INTRODUCTION

The present study examines attainment in the second language (L2) and retention of the first language (L1) in the same adult native Brazilian Portuguese (henceforth BP) speakers under naturalistic exposure to L2 European Portuguese (henceforth EP). Thus, this study is one of a few in recent years that examines adult L2 acquisition and its potential consequence for L1 maintenance in bidialectalism (see e.g., Cornips, 2014; Garraffa et al., 2015). Even though BP and EP are largely mutually intelligible, under Smith and Wilson (1979, p. 13) conceptualization for determining language status—"[a] language is definable in terms of a set of rules" constituting a unique grammar—there is no question that BP and EP embody distinct grammatical systems. BP and EP present structural differences at all levels (i.e., syntax, semantics, morphology, phonology, discourse, lexis), making it reasonable to consider them distinct languages on linguistic categorizing grounds (e.g., Galves, 2001; Azevedo, 2005). After all, Galician, an equally mutually intelligible Ibero-Romance language, would never be confused as the same language as BP or EP despite the fact that the degree of difference between Galician and BP or EP is not larger than those that distinguish BP from EP (see Fontenla, 2003; Rodrigues, 2004; de Freitas, 2012 for discussion). Although historical reasons conspire to explain why certain genetically related languages of mutual

intelligibility are taken to be sub-dialects while others are labeled as fully distinct languages, terminological debates of this type are of little consequence for the present purpose. Whether or not one considers BP and EP to be dialects of a single language or extremely closely related, yet distinct languages, no one familiar with BP and EP would deny that each corresponds to different sets of rules in the Smith and Wilson (1979) sense. For this reason, we consider Brazilians living in Portugal who (seemingly) are speakers of both BP and EP to be (bidialectal) bilinguals, and thus we will refer to BP and EP as languages rather than dialects in this paper. Indeed, examining L2 acquisition and L1 retention in such contexts might be especially illuminating precisely because of the typological relatedness of the languages (see Rowe and Grohmann, 2013; Antoniou et al., 2016; Grohmann et al., 2016 for similar studies on bilectal Cypriot and Standard Greek speakers).

The present study compares and contrasts adult L2 learners—BP natives who moved to Portugal in adulthood—to BP and EP monolingual counterparts. Individuals tested in the L2 target group were primed and tested in both BP and EP in order to trigger different language modes (see Grosjean, 1998, 2008). We capitalize on the null object distribution in BP and EP to test the extent to which: (a) the high degree of typological similarity between the two languages plays a role in the target-like acquisition/processing of L2 structures in EP and (b) the BP used by these Brazilians in Portugal remains unaffected or displays influence from the L2 as a consequence of length of exposure to EP.

In this study, we examine the participants' knowledge of how null objects—phonologically unpronounced, but syntactically present given the verbal argument structure—operate differently across the two languages. Under some analyses, the syntactic status of phonetically unrealized objects in BP and EP is quite distinct (Raposo, 1986), whereas in others the underlying syntactic representations are argued to be very similar (Raposo, 2004), at least sharing some partial overlap. Older analyses that argued for distinctions at the level of syntactic representations had assumed that null objects in syntactic islands are only grammatically possible in BP. This misguided assumption is itself the basis of and the best evidence for claiming differences in BP and EP at the level of underlying syntax. The fact that BP allows null objects in islands must mean that an *in situ* small *pro* is licensed in the grammar. If it were true that the EP grammar precluded null objects in islands as robustly as claimed in earlier work, then it would stand to reason that the syntax of EP and BP must be different. EP presumably does not allow for null objects in islands because the underlying syntax is a topic-operator variable construction (Raposo, 1986), which requires covert extraction (movement) that, by definition, would be blocked by the island itself. The problem, however, is that EP does in fact allow for null objects in islands contrary to Raposo (1986) original intuitions and analysis—as acknowledged in Raposo (2004)—and so it is not at all clear that the underlying syntax of the two languages is different at all. What is clear, however, is that null objects distribute differently in the two languages. Semantic and discourse constraints apply differentially in the two languages, one knock-on effect of which surfaces as a

much greater/freer/natural use of null objects in syntactic islands in BP as opposed to EP. Moreover, it had originally been claimed that semantic variables such as animacy only—or most obviously—applied to delimit the distribution (in and outside of islands) of null objects in BP (Schwenter and Silva, 2002). More recent work, however, shows that the very same constraints are also operative—albeit less so—in EP (Duarte and Costa, 2013; Rinke et al., 2016; Castro et al., in revisions). And so, it seems to be the case that null objects can appear in all the same syntactic contexts and are subject to the same semantic and discourse constraints in both BP and EP. However, it is equally clear that in practice null objects are not used in the same ways in the two languages, whereby the constraints that make their use more or less likely have different weightings in BP and EP. We take these differences to be related to processing preferences/strategies as opposed to bonafide grammatical (representation) differences across the languages. Therefore, we will couch the research within this paper as potentially revealing for the interaction interface between bidialectal bilingualism and the application of native target-like processing preferences for the use of null objects. That is, we pursue the idea that crosslinguistic influence, especially in bidialectal bilingualism, can potentially surface as the result of affected processing preferences.

We take advantage of the typological relatedness between BP and EP to test whether the proximity between the L1 and the L2 can contribute to L1 attrition, as has been previously argued (e.g., Altenberg, 1991; Gürel, 2008). Moreover, we make use of these languages' largely shared lexicon to determine whether lexical priming can trigger syntactic co-activation of the L1 (Hartsuiker et al., 2004) or its inhibition, leading to target-like L2 processing (Miller, 2014; Hopp, 2016).

## TYPOLOGICAL PROXIMITY IN THE CONTEXT OF L2 PROCESSING AND L1 ATTRITION

Over the past few decades, first language attrition has been widely discussed in the literature (e.g., Sharwood Smith, 1989; Altenberg, 1991; Köpke, 1999; Cook, 2003; Schmid, 2014). Ecke (2004, p. 322) defines attrition as the "decline of any language (L1 or L2), skill or portion thereof in a healthy individual speaker". In the case of L1 attrition, speakers who have become highly proficient in the L2 can exhibit signs of cross-linguistic transfer into their native language across various linguistic domains (see e.g., Dussias and Sagarra, 2007; Chang, 2012). The extent to which variation is expected in L1 attriters is attributed to factors such as frequency of L1 usage and length of exposure to the L2. In fact, more interference is expected in speakers who more often use the L1 than in speakers whose L1 is dormant, since both languages are constantly active (Köpke, 2007). Typically, initial stages of L1 attrition are most commonly manifested in word retrieval and processing, especially in near-native speakers of the L2 as a result of a shift in dominance patterns between the two languages (Köpke, 2002; Schmid and Kopke, 2008). Core syntactic computations, however, have been argued to remain unaffected in the L1 of late L2 learners despite prolonged

naturalistic exposure to the L2, as L2 interference is commonly found in optionality at the syntax-discourse interface (Tsimpli et al., 2004; Sorace, 2011).

Regarding L1 attrition, Sharwood Smith (1989) has suggested that typological proximity is one of 12 loss-inducing properties (among structural similarity, cross-linguistic support and others). Altenberg (1991), through a case-study of an L1 German couple under naturalistic exposure to L2 English in the United States, also concludes that L1 attrition is more likely to occur when the two languages are typologically similar. Though Altenberg's case-study was based on a small sample size, this conclusion seems to be the consensus among many scholars (see Schmid, 2011, p. 122 for discussion). Gürel (2008) claims that any change in L1 properties can only be triggered by certain L2 forms, as long as they are less complex in the L2 than in the L1, which is generally linked to simplification (see also Seliger, 1989, 1996). On that note, the conclusion is that the integration of the two languages causes L1 and L2 rules to compete, if they are linguistically comparable, which is more likely when the two languages are typologically similar (Köpke, 2007; Paradis, 2007).

Another long-debated issue relates to the facilitative vs. non-facilitative transfer of L1 properties into the L2 (e.g., Flynn and Martohardjono, 1994; Schwartz and Sprouse, 1994, 1996; Lardiere, 1998) and possible L1 interference in L2 processing (e.g., Elston-Güttler et al., 2005; Clahsen and Felser, 2006; Hopp, 2010). With respect to the influence of the lexicon in L2 processing, Hartsuiker et al. (2004) have proposed a shared-syntax model, according to which syntactic co-activation of the L1 can be triggered by its lexical co-activation, as lemma entries appear to be linked to combinatorial nodes of syntactic structures. For instance, when the lemma for the English word *hit* is activated, it consequently activates combinatorial nodes that indicate its grammatical structure—transitive verb, active voice, etc. These combinatorial nodes are then linked to all words in the lexicon, unspecified for language. As a result, L1 syntactic structures could emerge as a result of lexical priming in the L2, provided that they share some syntactic elements, irrespective of typological proximity (see Hartsuiker and Pickering, 2008, for discussion). Naturally, parallel co-activation of the L1 lexicon is more likely to occur when the words are similar in the L2, such as cognate words (Kroll et al., 2013).

It has also been suggested that cognate facilitation can result in greater inhibition of the L1 syntax as a consequence of faster lexical processing in the L2. For example, in a study analyzing cognate vs. non-cognate facilitation for syntactic processing of *wh*-dependencies, Miller (2014) concluded that L1 English-L2 French readers were able to reach target-like syntactic structures more successfully in cases where there was cognate facilitation, and that non-cognate items typically led to errors. Hopp (2016) discusses the results of a study investigating how L2 on-line sentence comprehension can trigger activation of L1 syntax in an L1 German-L2 English population. The results of two eye-tracking tasks indicate that lexical cognate facilitation can help inhibit L1 syntax and thus lead to successful syntactic processing in the L2.

Several studies have been carried out to measure L1 attrition and L1 transfer in late L2 learners, with language pairings

that are typologically distant (e.g., Turkish-English in Yağmur, 1997; Greek-English in Pliatsikas and Marinis, 2013) and typologically similar (e.g., Swedish-German in Håkansson et al., 2002; German-English in Hopp, 2016). A high degree of typological relatedness has thus been described as a factor that can contribute to L1 attrition and influence L2 processing. Håkansson et al. (2002) argued that L1 transfer of syntactic properties does not take place in native Swedish learners of L2 German. Bohnacker (2006), however, used the same language pairing to show that transfer from L1 can also occur, in light with the Full Transfer/Full Access Approach (Schwartz and Sprouse, 1994, 1996). The typological relatedness factor is also seen in third language (L3) acquisition, a context in which it should be relatively easy to detect which of the first two languages transfer comes from and whether it is conditioned by how similar they are to the L3. The Typological Primacy Model (Rothman, 2011, 2015) maintains that L3 learners selectively transfer either the L1 or the L2 grammar into the initial stages of L3 acquisition based on the parser's determination of which is typologically closest to the target L3. In a comparative study, Rothman (2011) tested L3 acquisition of BP by a group of L1 Italian-L2 English learners and a group of L1 English-L2 Spanish learners and concluded that transfer emerges from the closest language, regardless of the order in which it was acquired. In this particular case, transfer was from Italian and Spanish, as they are typologically closer to BP than English.

The aforementioned studies are of special relevance to this study, since we provide a language context of two distinct grammars with a mostly shared lexicon, which allows us to investigate the issues raised in this section. Given the high degree of typological relatedness between BP and EP, we have an ideal scenario to test the extent to which L1 attrition and/or L2 processing can be linked to typological relatedness.

## PHONETICALLY UNREALIZED OBJECTS

It is well-documented that verbal arguments—subjects and accusative objects—in some of the world's languages can be left phonetically unrealized. Generally speaking, Portuguese is a language that exercises the option to drop accusative arguments. In all Portuguese variants, to our knowledge, accusative arguments can be dropped via VP-ellipsis, a topic operator syntax and/or the licensing of an empty category pronoun under certain conditions.

Although EP and BP are both classified as null object languages, the surface distribution—as alluded to in the introduction section—is quite distinct related to the likelihood of choosing an overt or null object depending on different syntactic environments and semantic features related to object, which give rise to default interpretation preferences notwithstanding the same surface string of words. Before going into the specifics of the differences between BP and EP, it is worth pointing out that both languages only allow 3rd person objects to be null and that all null objects are restricted by the Identification Requirement on empty categories (Rizzi, 1982; see Kato, 1993 for application in these constructions). The Identification Requirement highlights

how the syntax for licensing empty categories is a necessary, but not sufficient condition for the production of null arguments, since they must be semantically interpretable. As a result, in order for an argument to be phonetically unrealized it must be in a pragmatic context in which the referent can be recovered by the interlocutor. Apparently, what meets the Identification Requirement in BP and EP is distinct or weighted differently, giving rise to a series of knock-on effects that we recognize as preferences in use and interpretation across the grammars, as described in detail below.

## Brazilian Portuguese

Null objects in BP have been described in the literature as an instantiation of the empty category *pro* (Farrell, 1990; Rothman and Iverson, 2013)[1], since they appear in strong and weak islands alike. Lopes and Santos (2014) point out that both VP-ellipsis and anaphoric null objects can occur in strong islands in BP, as illustrated in (1) and (2), respectively (from Lopes and Santos, 2014, p. 197):

(1)  A: -  O      João  soube    que      você  ia convidar
            the    João  knew     that     you   were inviting
            ele pra festa?
            him to the party?
            'Did John know you were inviting him to the party?'
     B: -  Não,   ele    morreu antes de eu     convidar      Ø.
            no,    he     died    before I     invited      [-]
            'No, he died before I did it.'

(2)  Ela  comprou  o casaco  quando  experimentou Ø.
     she  bought   the coat   when     tried         [-]
     'She bought the coat when she tried (it) on.'

The distribution of null and overt objects is not entirely free, however. In order for objects to be dropped in BP, they must be 3rd person, as 1st, and 2nd person referents must remain overt. In addition, pragmatic felicitousness conditions and semantic feature constraints appear to limit their occurrence. Schwenter and Silva (2002) argue that, in order for the object to be null in BP, the referent must be inanimate or non-specific. If the referent is animate and specific, an overt pronoun or DP appears to be obligatory. The specificity constraint is shown in examples (3–4) (from Lopes and Cyrino, 2005, p. 3) and the animacy constraint is illustrated in examples (5–6) (from Schwenter and Silva, 2002, p. 579):

(3)  [+animate, +specific]
     O policial     insultou o preso antes de torturar
     The policeman insulted.3sg the prisoner before of torture.INF
       *____/ele.
       *____/him
     'The policeman insulted the prisoner before torturing (him).'

(4)  [+animate, −specific]
     O policial     insulta presos antes de torturar
     The policeman insult.3sg prisoners before of torture.INF
     ____/them
     ____/eles.
     'The policeman insults prisoners before torturing (them).'

(5)  [−animate, +specific]
     Sabe a árvore grande que tinha na minha rua? A prefeitura
     know-3sg the tree big that had on+the my street? the city
       derrubou Ø/?ela.
       hall knocked down she
     'You know the big tree that was on my street? City Hall
       knocked (it) down.'

(6)  [+animate, +specific]
     O cachorro da Ana adora ir na rua. Ela sempre
     the dog of+the Ana love.3sg go on+the street. she always
       leva ?*Ø/ele para passear.
       take-3sg he to walk
     'Ana's dog loves to go out in the street. She always takes him
       for walks.'

## European Portuguese

Phonetically unrealized objects in EP are also restricted to 3rd person accusative contexts. Early studies argued that the syntax of null objects in EP must be a topic-operator-variable structure as opposed to *pro,* most convincingly argued on the basis of data suggesting that null objects are patently ungrammatical in island contexts. If accurate, having only a topic-operator structure would indeed mean that null objects are precluded from island contexts because they cannot be bound by the topic operator in the matrix clause when necessarily crossing a strong island boundary (Raposo, 1986; Maia, 1997). Data that lead to this conclusion are exemplified in (7) (from Raposo, 1986, p. 382):

(7)  *O rapaz que  trouxe Ø agora mesmo da      pastelaria
      the boy    who brought Ø now  just from+the bakery
      era o teu afilhado.
      was the your godson
      'The boy who brought (it) right now from the pastry
      shop was your godson.'

In more recent work, however, Raposo (2004) revises his initial stance, and argues that sentences such as (7) are (marginally) acceptable in EP, and therefore, at least some null objects in EP are instances of *pro* as is the case in BP. According to Raposo (2004), while null arguments within strong islands are not completely ruled out, they are not preferred whereas the null object is highly preferred in simple clause contexts.

   It has also been discussed that, unlike what was shown for BP, animacy constraints do not seem to delimit null objects in otherwise possible syntactic environments in EP (Costa and Duarte, 2001; Costa et al., 2009). Since the object referent in (8a) is [−animate, +specific], this sentence is grammatical in both EP and BP; however, (8b) is not possible in BP because it is [+animate] and [+specific], but completely acceptable in EP (from Costa and Duarte, 2001, p. 5):

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[1]There are other proposals suggesting that BP null objects are not instances of *pro*. Kato, for instance, argues that the null object in BP is possibly a case of a null-clitic, because its antecedent has obligatory non-c-commanding status, whereas *pro* can appear both with and without c-commanding antecedents (Kato, 1993). Because the facts of the distribution are best understood by assuming a licensing of *pro*, e.g., subjacency effects, we will follow the *pro* analysis.

(8a)   A: E    este    carro?
       and this    car
       'What about this car?'
       B: O    Zé    quer    saber  quem comprou *ec.*
       the  zé     wants  know  who bought *ec*
       'Zé wants to       know who bought (it).'

(8b)   A: E    a Maria?
        and   the Maria
       'What about Maria?'
       B: O    Zé quer    saber quem  beijou *ec.*
       the zé  wants know       who kissed *ec*
       'Zé wants to know       who kissed (her).'

However, recent work by Duarte and Costa (2013) acknowledges that animacy effects on object drop can also be found in EP in limited contexts. These authors argue that, if the antecedent is within the same sentence, the object can be dropped if inanimate, as shown in (9), but if animate, dropping it is either marginally acceptable or ungrammatical, as illustrated in (10):

(9a)   Se achas que *esse livro* é chato, eu não compro Ø para
       if think$_{2PSG}$ that this book is boring$_{MASC}$ I not buy [−] for
       a Maria.
       the Maria
       'If you think that this book is boring, I will not buy (it) for Maria'.

(9b)   Quando encontro *uma gralha*, corrijo Ø imediatamente.
       when find$_{1PSG}$ a typo correct [−] immediately
       'When I find a typo, I correct (it) immediately.'

(10a)  ??Se achas que *a Maria* é uma chata, eu não convido
       if think$_{2PSG}$ that the Maria is one annoying$_{FEM}$ I not invite
       Ø para a festa.
       [−] to the party
       'If you think that Maria is annoying, I will not invite (her) to the party.'

(10b)  *Quando encontro *o Pedro*, beijo Ø com ternura.
       when meet$_{1PSG}$ the Pedro kiss [−] with tenderness
       'When I meet Pedro, I kiss (him) with tenderness.'

In addition, Duarte and Costa (2013) argue that some EP speakers allow for null objects within island contexts, provided that the referent is inanimate, as shown in (11a), but not with animate referents, as can be seen in (11b):

(11a)  A –  E então, *o carro novo*?
            and so the car new
            'So, what about the new car?'
       B –  A minha mulher está furiosa porque comprei
            the my woman is furious because bought$_{1PSG}$
            Ø sem ela saber.
            [−] without she know$_{INF}$
            'My wife is furious because I bought (it) without her knowing.'

(11b)  A –  E então, *a Maria*?
            and so the Maria
            'So, what about Maria?'

       B –  *A minha mulher ficou furiosa porque eu beijei
            the my woman became furious because I kissed$_{1PSG}$
            Ø na festa.
            [−] at+the party
            'My wife became furious because I kissed (her) at the party.'

## Some Notes about Overt Pronouns in Portuguese

Although this chapter deals with the nature of phonetically unrealized objects in BP and EP, our analysis will focus on how speakers interpret the differences between null and overt object conditions. While it is true that overt objects are the only other default choice—aside from null—, they typically surface differently in the two systems. While EP speakers make use of clitic pronouns in accusative contexts, BP speakers choose strong pronouns, as illustrated in (12) (adapted from Silva, 2015, p. 21):

(12)   a.  Não empurrei a    Diana. (BP/EP)
           not I-pushed the   Diana
           "I did not push Diana."
       b.  Não empurrei ela. (BP/*EP)
           not I-pushed her.
       c.  Não a empurrei. (*BP/EP)
           not her-$_{CL-ACC-3SG}$ I-pushed
           "I did not push her."
       d.  Empurrei-a. (*BP/EP)
           I-pushed-her-$_{CL-ACC-3SG}$
           "I pushed-her."

As a replacement for the overt DP *a Diana* "Diana" in (12a), the strong pronoun *ela* "she" is chosen in BP, as shown in (12b), whereas EP speakers select the clitic *a* "her" instead. These clitics in BP are limited to written formal register and do not surface in colloquial speech (Montrul et al., 2011). EP licenses preverbal clitic placement in certain syntactic environments, as in (12c), but shows a higher preference for postverbal clitics, as in (12d) (see Madeira, 1992; Barrie, 2000 for discussion). These differences may not have a direct impact on the speakers' choice between null and overt pronouns, as this choice is arguably determined by the semantic and syntactic constraints previously discussed. However, they are especially relevant for a better understanding of our experimental design and the discussion of our results.

## Contrastive Summary of BP and EP Null Object Distribution

The relevant comparative facts regarding null object distribution in BP and EP are summarized in **Table 1**:

## HYPOTHESES

Given the similar syntactic nature of the null object in BP and EP, we believe that comparing the performance of the control and target groups in the null conditions exclusively or, alternatively, the overt conditions exclusively would only

**TABLE 1 |** Summary of constraints which determine the distribution of null objects in BP and EP.

|  | Brazilian Portuguese (BP) | European Portuguese (EP) |
|---|---|---|
| Syntactic constraints | Null objects allowed in both strong islands and simple clauses. | Null objects allowed in simple clauses and in some strong islands. |
| Semantic constraints | Null objects allowed with inanimate referents but ruled out with animate referents, unless non-specific. | Null objects allowed with inanimate referents, but marginally acceptable or ungrammatical with animate referents. |

**TABLE 2 |** Participant information.

|  | L2ers (*n* = 32) | BPC–BP controls (*n* = 34) | EPC–EP controls (*n* = 32) |
|---|---|---|---|
| Mean age (at time of testing) | 33.1 | 30.3 | 27.0 |
|  | (range = 22–53) | (range = 20–54) | (range = 18–67) |
| Standard deviation | 7.577 | 7.919 | 9.708 |
| Mean age of L2 onset | 22.9 | – | – |
|  | (range = 13–42) |  |  |
| Standard deviation | 6.700 | – | – |
| Mean length of L2 exposure (years) | 10.2 | – | – |
|  | (range = 6–17) |  |  |
| Standard deviation | 3.005 | – | – |
| Mean frequency of BP usage | 45.31% | 88.97% | 21.09% |
| Mean frequency of EP usage | 54.69% | 11.03% | 78.91% |
| Standard deviation | 15.863 | 12.417 | 11.025 |

be valid if the syntax was truly distinct. Thus, any measurable difference in behavior would be shown in an intra-group comparison between null and overt conditions, which indicates the preferences of each group, followed by an inter-group comparison of these preferences. To the extent that there is a link between typological similarity and L1 attrition as has been suggested, whereby the closer the L1 and the L2 are typologically, the more likely the L1 will show signs of the L2 syntax (e.g., Altenberg, 1991; Gürel, 2008; Schmid, 2011 among others), we propose:

(a) The high degree of typological relatedness between BP and EP will lead to measurable L1 attrition. Hypothesis (a) will be confirmed if naturalistic L2 learners of EP display signs of EP-like behavior in their native BP, as measured by their choice of null vs. overt object pronoun. This would be seen under two scenarios: (i) they make no distinction in performance between BP and EP modes and are only different from the BP monolingual controls, or (ii) they do make a distinction between BP and EP but are comparatively different only from the BP controls in such a way that EP effects are noted, for example, an emergent, yet not absolute effect of islandhood.

Taking into account that the syntactic distribution of null objects in the two languages is underlyingly similar, any instantiation of non-monolingual-like behavior by the L2ers should be attributed to difficulties in processing. With respect to possible effects of typological relatedness on L2 processing, we can derive two possible hypotheses:

(b) In light of Hartsuiker et al. (2004), the (extreme) lexical overlap of the L1 and L2 will lead to L1 syntactic co-activation, and consequently, to non-target-like L2 processing as a result of L1 syntactic influence.

(c) Conversely, in light of Miller (2014) and Hopp (2016), the lexical co-activation of the L1 will inhibit the L1 syntactic structure, and as a result, target-like L2 processing will take place.

If our results indicate that L2 learners of EP show influence from BP when in EP-mode, hypothesis (b) will be supported. If, on the other hand, it is not the case that signs of BP structure emerge in their EP, and they reach target-like performance, we will have supportive evidence in favor of hypothesis (c).

## METHODOLOGICAL APPROACH

### Participants

We have already alluded to the three groups participating in the experiment presented in this study. In **Table 2** we provide details on their make-up and backgrounds.

The control groups (BPC and EPC) were recruited via social media, networks created by the main author, and collaboration of universities in different regions of Brazil and Portugal. Participants filled out a questionnaire, where they reported their age, age of arrival in Portugal (thus length of EP exposure) and various questions related to a self-assessment of frequency of BP/EP usage. As shown in **Table 2**, though the target group reported using EP more often than BP, their L1 usage was still quite high, which means that both languages are frequently activated. This frequency was estimated based on their answers to the following question: 'Taking into account the Portuguese language only, what option best describes your linguistic scenario?'. The options were the following, and the values we attributed to them are shown in parentheses.

(a) I only interact with BP speakers. (BP = 100%, EP = 0%)
(b) Most of the people I interact with are BP speakers. (BP = 75%, EP = 25%)
(c) Half of the people I interact with are BP speakers, and the other half, EP speakers. (BP = 50%, EP = 50%)
(d) Most of the people I interact with are EP speakers. (BP = 25%, EP = 75%)
(e) I only interact with EP speakers. (BP = 0%, EP = 100%)

The target group was tested in and around the city of Lisbon. All participants had normal or corrected vision and normal hearing.

### Experiment

The experiment was designed to test the subjects' interpretation of null vs. overt accusative objects. There are two versions of the experiment—one in EP and one in BP—which differ in their adjustment with respect to lexis, phonology, and morpho-syntax.

The bilingual groups took both versions and the controls took only the version corresponding to their L1. We used an Acceptability Judgment Task (AJT), by which participants judged the acceptability of sentences on a Likert scale of 1–6. Each sentence was preceded by a context to ensure its plausibility.

Experimental items consisted of 80 items—40 items testing the effect of the differences between null and overt object pronouns and 40 fillers which served as target items for another study—and 20 random fillers to ensure equal distribution of acceptable and unacceptable items for both versions of the task. The target items were divided into eight conditions with five items each, as illustrated with examples from each version in (13–20):

(13) null animate in islands (NAI)
 (a) BP version
   "- *O André convidou a Priscila para um jantar. O que foi que aconteceu?*"
   "- André invited Priscila to dinner. What happened?"
   "- **O André pagou a conta quando Ø levou Ø ao restaurante.**"
   "- André paid the bill when Ø took Ø to the restaurant."
 (b) EP version
   "- *O João convidou a Fernanda para um jantar. O que é que aconteceu?*"
   "- João invited Fernanda to dinner. What happened?"
   "- **Ele pagou a conta quando Ø levou Ø ao restaurante.**"
   "- He paid the bill when Ø took Ø to the restaurant."

(14) overt animate in islands (OAI)
 (a) BP version
   "- *O André convidou a Priscila para um jantar. O que foi que aconteceu?*"
   "- André invited Priscila to dinner. What happened?"
   "- **O André pagou a conta quando Ø levou ela ao restaurante.**"
   "- André paid the bill when Ø took her to the restaurant."
 (b) EP version
   "- *O João convidou a Fernanda para um jantar. O que é que aconteceu?*"
   "- João invited Fernanda to dinner. What happened?"
   "- **Ele pagou a conta quando Ø a levou ao restaurante.**"
   "- He paid the bill when Ø took her to the restaurant."

(15) null inanimate in islands (NII)
 (a) BP version
   "- *O Guilherme recebeu uma bicicleta da avó. O que foi que aconteceu?*"
   "- Guilherme got a bike from his grandmother. What happened?"
   "- **O Guilherme ficou feliz quando Ø levou Ø pra casa.**"
   "- Guilherme was happy when Ø took Ø home."
 (b) EP version
   "- *O Tiago recebeu uma bicicleta da avó. O que é que aconteceu?*"
   "- Tiago got a bike from his grandmother. What happened?"
   "- **Ele ficou feliz quando Ø levou Ø para casa.**"

"- He was happy when Ø took Ø home."

(16) overt inanimate in islands (OII)
 (a) BP version
   "- *O Guilherme recebeu uma bicicleta da avó. O que foi que aconteceu?*"
   "- Guilherme got a bike from his grandmother. What happened?"
   "- **O Guilherme ficou feliz quando Ø levou ela pra casa.**"
   "- Guilherme was happy when Ø took it home."
 (b) EP version
   "- *O Tiago recebeu uma bicicleta da avó. O que é que aconteceu?*"
   "- Tiago got a bike from his grandmother. What happened?"
   "- **Ele ficou feliz quando Ø a levou para casa.**"
   "- He was happy when Ø took it home."

(17) null animate in simple clauses (NAS)
 (a) BP version
   "- *O namorado da Tatiane estava entediado. O que foi que ela decidiu fazer?*"
   "- Tatiane's boyfriend was bored. What did she decide to do?"
   "- **Ø levou Ø pra praia.**"
   "- Ø took Ø to the beach."
   EP version
   "- *O namorado da Carolina estava entediado. O que é que ela decidiu fazer?*"
   "- Carolina's boyfriend was bored. What did she decide to do?"
   "- **Ø levou Ø para a praia.**"
   "- Ø took Ø to the beach."

(18) overt animate in simple clauses (OAS)
 (a) BP version
   "- *O namorado da Tatiane estava entediado. O que foi que ela decidiu fazer?*"
   "- Tatiane's boyfriend was bored. What did she decide to do?"
   "- **Ø levou ele pra praia.**"
   "- Ø took him to the beach."
 (b) EP version
   "- *O namorado da Carolina estava entediado. O que é que ela decidiu fazer?*"
   "- Carolina's boyfriend was bored. What did she decide to do?"
   "- **Ø levou-o para a praia.**"
   "- Ø took him to the beach."

(19) null inanimate in simple clauses (NIS)
 (a) BP version
   "- *A professora tinha em casa um livro interessante. O que foi que ela fez?*"
   "- The teacher had at home an interesting book. What did she do?"
   "- **Ø levou Ø pra escola.**"
   "- Ø took Ø to school."

(b) EP version

"- *A professora tinha em casa um livro interessante. O que é que ela fez?"*

"- The teacher had at home an interesting book. What did she do?"

***"- Ø levou Ø para a escola."***

"- Ø took Ø to school."

(20) overt inanimate in simple clauses (OIS)

(a) BP version

"- *A professora tinha em casa um livro interessante. O que foi que ela fez?"*

"- The teacher had at home an interesting book. What did she do?"

***"- Ø levou ele pra escola."***

"- Ø took it to school."

(b) EP version

"- *A professora tinha em casa um livro interessante. O que é que ela fez?"*

"- The teacher had at home an interesting book. What did she do?"

***"- Ø levou-o para a escola."***

"- Ø took it to school."

This division was made to include different variables that can be analyzed simultaneously. Hence, we were able to test both animacy and island effects, which are expected to have an impact on the speakers' choice of null vs. overt pronoun in both languages. As can be seen in the sample test items, each version contained the appropriate choice of pronoun for that system—strong pronouns in the BP version and clitic pronouns in the EP version. This was done to ensure that participants would be judging sentences which are natural in spoken language, as the clitic choice is not the preferred option for Brazilians, and the strong pronoun is never selected by EP speakers. This also allowed us to check whether their overt pronoun preferences have undergone cross-linguistic influence, in both directions.

This task was built on an online platform called SurveyGizmo, which allows the user to create and design experiments with pictures, audio, and other media. Each test item was shown on a computer screen with a simultaneous audio recording of the context and the target sentence, in order to enhance the different modes triggered in each testing session (BP-mode vs. EP-mode). A male and a female voice were used for each version, all native speakers of each respective language. The recordings were counterbalanced such that for half the items, a male voice asked the context question and a female voice answered, and vice-versa for the other half. This was done to ensure that the participants were able to distinguish the context from the test sentence and express their preference considering only the latter.

All items, including fillers, were randomized to avoid priming. After reading and listening to the context and the target sentence, the participants were instructed to judge the sentence based on the scale placed immediately below it. Each point on the scale was distinctly labeled to ensure full understanding of their distribution. The scale used in this task is detailed in **Table 3**.

Once the participants had made their choice, they clicked on the button *Continuar* (Continue) to move on to the next item. All of their choices were automatically registered online after each click. **Figures 1**, **2** illustrate screenshots of a random item from the BP and the EP versions respectively:

The semantic and syntactic constraints in the null object distribution patterns in the two languages give rise to potentially different preferences by the target group as a result of interference due to intense exposure to EP, since the monolingual choices are geared by preference rather than grammaticality. This task helps measure the extent to which cross-linguistic influence takes

**TABLE 3 |** Acceptability scale.

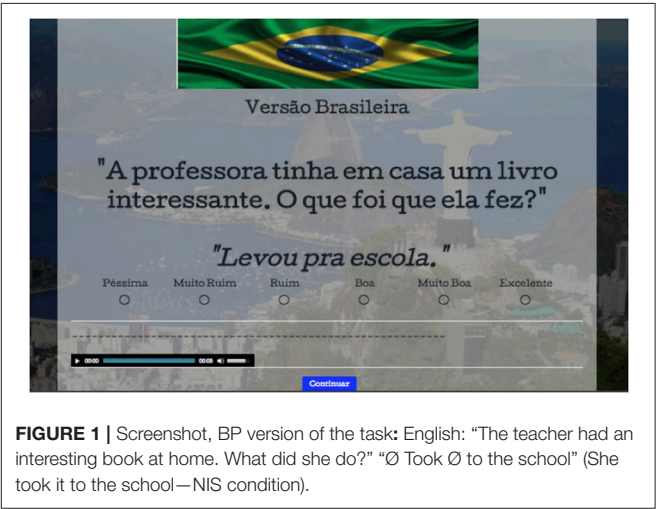|         | 1      | 2        | 3    | 4    | 5         | 6        |
|---------|--------|----------|------|------|-----------|----------|
| BP      | *Péssima* | *Muito Ruim* | *Ruim* | *Boa* | *Muito Boa* | *Excelente* |
| EP      | *Péssima* | *Muito Má*   | *Má*   | *Boa* | *Muito Boa* | *Excelente* |
| English | Poor   | Very Bad | Bad  | Good | Very Good | Excellent |



**FIGURE 1 |** Screenshot, BP version of the task: English: "The teacher had an interesting book at home. What did she do?" "Ø Took Ø to the school" (She took it to the school—NIS condition).
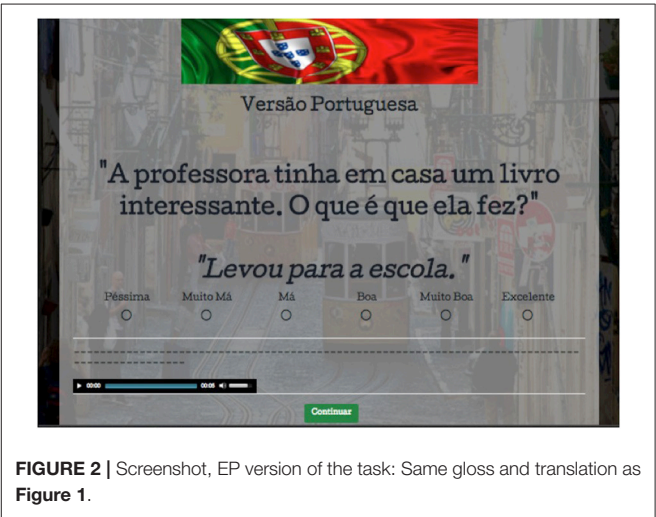


**FIGURE 2 |** Screenshot, EP version of the task: Same gloss and translation as **Figure 1**.

place, and whether it is bidirectional (BP⇔EP), or unidirectional (BP⇒EP or vice-versa).
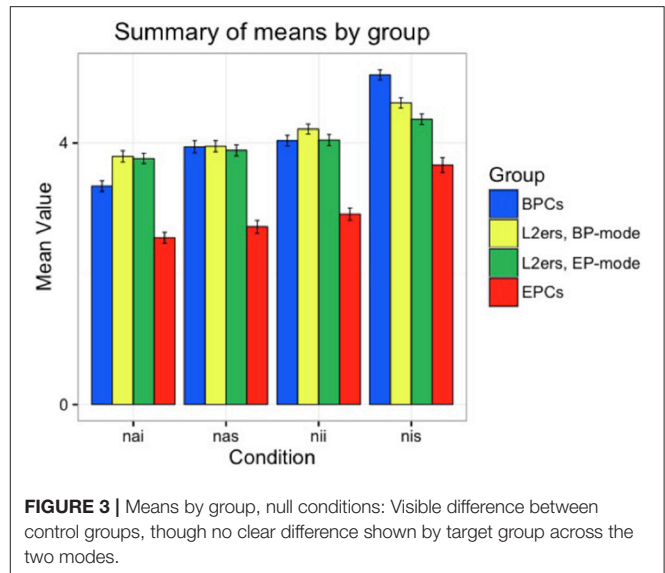
## Bidialectalism: BP Mode vs. EP Mode

The most accurate way to check if these speakers are indeed bidialectal bilinguals is to test them separately in BP and EP. Therefore, the L2ers were tested twice, either first in BP, then EP, or the reverse, by native speakers of each variant. Grosjean (1998) has shown that bilinguals display different language modes in their everyday lives (see Grosjean, 1998, 2008 for discussion). In other words, depending on their interlocutor, speakers tend to switch from one language mode to another, even resorting to language mixing such as code-switching and borrowing (Grosjean, 1998). The two versions of the task were very similar, but adjusted for vocabulary distinctions between the two languages. While it is true that the participants all live in Portugal, it may not necessarily be the case that they interact with speakers of both variants to the same extent. Therefore, we included a mode-trigger rapport at the beginning of both sessions. The native EP speaker who conducted the EP version of the tasks started the sessions with general questions about what they liked most about Portugal, e.g., music, films, food, and so on. When tested in BP, they were asked about what they missed from their home country and what sort of connection they still have with Brazil, such as how often they visit, whether they participate in Brazilian events in the area, and so on. After 5 min of chatting, they were considered to be in the mode in which they were about to be tested.

## RESULTS

First, we offer a descriptive analysis of the performance for each group in the null conditions investigated in the Acceptability Judgment Task (AJT), null animates in simple clauses (NAS), null animates in islands (NAI), null inanimates in simple clauses (NIS), and null inanimates in islands (NII), followed by their overt counterparts. Considering 1–6 as the spread of the Likert scale used in the test, judgments above 3.5 were considered "Good," and below 3.5 "Bad." **Figures 3**, **4** show the overall pattern displayed for the null and overt conditions, respectively, across all groups. **Table 4** presents the mean values attributed to each condition by group.

We see in **Table 4** that BPCs and EPCs differ in their choices, in that null objects are mostly judged as unacceptable by the EP controls and mostly as acceptable by the BP controls. The only exceptions are that EP controls marginally accept them in simple clauses, provided that they have an inanimate referent, and that BP controls marginally judge them below the 3.5 threshold in islands, in contexts where the referent is animate. With respect to the target group, the pattern seen is that the participants do not show differences across the two modes for any of the four null conditions. The results show that L2ers still show BP-like behavior regarding the distribution of null objects, despite over 10 years of exposure to EP.x As for the overt conditions, all groups found the items acceptable (above 3.5), as expected. Note, however, that the L2ers attributed lower values to these sentences than both controls, and showed different behavior across the



**FIGURE 3 |** Means by group, null conditions: Visible difference between control groups, though no clear difference shown by target group across the two modes.

two modes. Our statistical analysis will help understand which variables have an effect on participants' judgments.

## Statistical Analysis

The statistical analysis used for this experiment consisted of mixed-effects models with condition and group as fixed effects. We ran several models in order to consider all variables in our comparisons. First, we look at how the groups interpret the difference between each of the four null conditions and their overt counterparts. We then check for effects of semantic constraints (animates vs. inanimates) and syntactic environment (simple clauses vs. islands). The tables we include in the Appendix (Supplementary Materials) indicate the relevant lines of the models of mixed effects linear regression of all variables analyzed.

BPCs have significantly different values in all four comparisons (see Appendix Table 5 in Supplementary Materials). L2ers do not show a significant distinction between NII and OII in BP-mode ($p = 0.686$), or between NIS and OIS in EP-mode ($p = 0.077$), but all other comparisons show a clear null vs. overt difference for this group in both modes ($p < 0.05$). Like EPCs, BPCs also interpreted all four null conditions to be different from their overt counterparts (and thus assigned different values to them). The spread of the difference between each null and overt context for each of the groups tested is illustrated in **Figure 5**.

Even though BPCs and EPCs are aware that they should assign different values to sentences with null objects and to sentences with overt objects, the spread of this difference in values is significantly different across the two control groups in all four contexts ($p < 0.05$), (see Appendix Table 6 in Supplementary Materials).

We also found that, in contexts with animate referents within strong islands (NAI and OAI), L2ers interpreted the null vs. overt distinction in BP-mode the same way as they did in EP-mode. However, for the other three environments, they showed statistically different behavior across the two modes, especially

**FIGURE 4** | Means by group, overt conditions: No difference between controls, whereas target group shows mode-split.
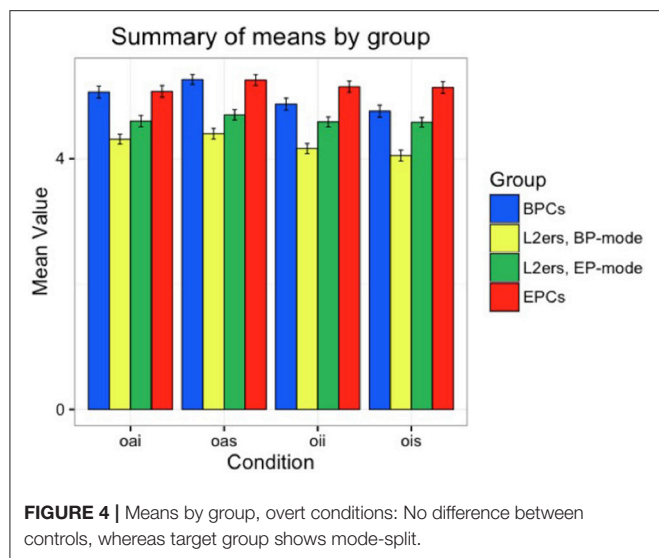
**TABLE 4** | Means by group for each condition, grouped as null conditions (top) and overt conditions (bottom).

| Condition | BPCs | L2ers–BP-mode | L2ers–EP-mode | EPCs |
|-----------|------|---------------|---------------|------|
| NAI | 3.341 | 3.793 | 3.762 | 2.550 |
| NAS | 3.941 | 3.950 | 3.887 | 2.718 |
| NII | 4.035 | 4.212 | 4.043 | 2.912 |
| NIS | 5.041 | 4.612 | 4.362 | 3.662 |
| OAI | 5.064 | 4.312 | 4.600 | 5.075 |
| OAS | 5.264 | 4.400 | 4.700 | 5.256 |
| OII | 4.870 | 4.162 | 4.587 | 5.150 |
| OIS | 4.758 | 4.050 | 4.581 | 5.137 |

with inanimate referents (see Appendix Table 7 in Supplementary Materials). In BP-mode, L2ers only behaved like BP monolinguals regarding the null vs. overt distinction in contexts with inanimate referents in simple clauses (NIS-OIS) ($p = 0.104$). In EP-mode, L2ers patterned with BPCs in contexts with inanimate referents in strong islands (NII-OII) ($p = 0.091$), being significantly different from BP controls in all other comparisons. In both modes, L2ers behaved differently from EPCs with respect to how they interpreted the differences between null and overt in all four environments (see Appendix Table 8 in Supplementary Materials).

Effects of animacy were found for all groups. Participants' assigned values to contexts with null objects are significantly different in items with animate referents than in items with inanimate referents, both in simple clauses and in strong islands (NAI-NII, NAS-NIS), as shown in the Appendix Table 9 in Supplementary Materials. With respect to the syntactic environment, Table 10 in the Supplementary Material illustrates that all groups show a statistical difference between null objects in strong islands and null objects in islands when the referent is inanimate (NIS-NII). BPCs also displayed statistical differences with animate referents (NAS-NAI). This did not seem to be the



**FIGURE 5** | Coefficients of differences between means of null vs. overt conditions across all groups: This illustrates how different the overt conditions are from the null conditions, for each group. The higher the spread, the higher the difference.
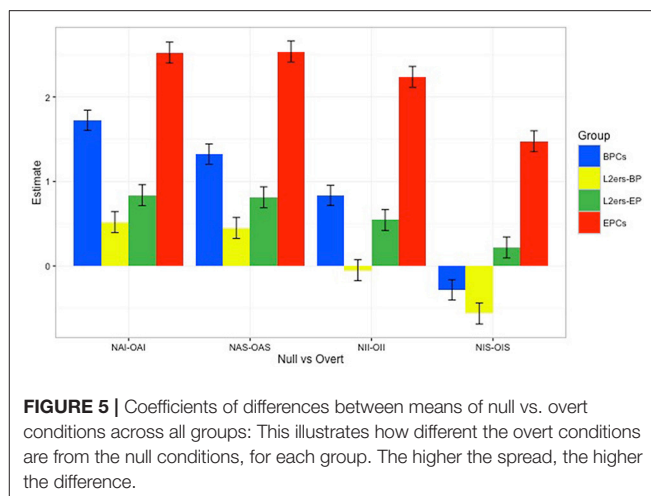
case for L2ers in either mode and EPCs, for whom the syntactic environment does not affect their judgment on null objects with animate referents.

Lastly, we ran a few additional models (see Appendix Table 11 in Supplementary Materials) focusing solely on the overt conditions, in order to determine whether the morphosyntactic status of overt pronouns—strong pronouns vs. clitic—had a significant effect on the L2ers' preferences. Our results show that L2ers gave significantly lower ratings to sentences with overt pronouns than the monolingual counterparts, in each respective mode ($p < 0.01$).

## DISCUSSION

In this section, we first discuss the results of the interactions between the control groups in light of what current literature predicts. We then discuss the performance of the target group and the comparison to the controls, linking the results to the hypotheses/predictions we made in Section Hypotheses.

### Control Groups

The fact that both BPCs and EPCs attributed different values to sentences with null pronouns vs. overt pronouns was not surprising, given that the contexts created took into consideration the variables that arguably determine the null object distribution in each language. The extent to which these two groups interpreted the null vs. overt distinction was not the same, which confirms that the reason why this spread was larger in EP than in BP must be linked to either semantic or syntactic constraints. In light of Schwenter and Silva (2002), we expected BPCs to prefer null objects in contexts with inanimate referents (regardless of syntactic environment). Indeed, we find an effect of animacy for BPCs, as they attributed higher values—though not categorically—to sentences with null objects when the referent was inanimate than to similar sentences with animate referents. EPCs also seemed to show animacy effects, which confirms the arguments made by Duarte and Costa (2013). In fact, when the two control groups are compared to one another, they showed statistically similar behavior with respect to how

they interpreted the animacy differences in the contexts given. We conclude from this that the distribution of null objects in BP and EP is not determined, but rather influenced by the [± animate] status of the referent, since the results indicate a general preference rather than a categorical grammatical vs. ungrammatical distinction.

With respect to how the syntactic environment may influence the participants' choices, we expected BPCs to show no effects, as null objects can freely appear within strong islands—provided that the animacy constraints are not violated—, as shown in Rothman and Iverson (2013), Lopes and Santos (2014) and others. Conversely, EPCs are expected to use the syntactic environment as a determining factor for their choice of null vs. overt, in light of Raposo (1986), but in combination with the animacy status of the referent (Raposo, 2004; Duarte and Costa, 2013). Our data show that BPCs display island effects, contrary to what we expected, as the difference in mean values between the contexts with null pronouns (both animate and inanimate) in simple clauses and the same contexts in islands is statistically significant. This suggests that null objects in BP are more likely to occur in contexts with simple clauses than in contexts with strong islands, especially if their referents are inanimate. Therefore, the syntactic environment seems to also have an effect on whether or not the object is likely to be dropped in this language.

EPCs do not make a distinction between these two syntactic environments when the null pronoun has an animate referent—judging both NAS and NAI as equally unacceptable (below the threshold of 3.5)—, but do show a distinction between them when the referent is inanimate, as they judged NIS acceptable but NII unacceptable, as predicted. In other words, the data confirm that null objects in EP are more likely to occur in simple clauses than in strong island contexts, but for inanimate referents only, as the null-object contexts with animate referents were judged unacceptable despite the syntactic environment. When compared to BPCs, the only environment where EPCs show significant differences regarding the syntactic environment was in contexts with null pronouns and animate referents (NAI-NAS), which suggests that the syntactic environment has a stronger effect in EP than in BP. As we pointed out, while the syntactic and semantic constraints appear to be the same in the two systems, the way in which they surface differs, and these differences across the monolingual groups with respect to the syntactic environment serve as evidence for this.

To summarize the comparison between the control groups, we conclude that, even though both the syntactic environment and animacy status appear to have an effect in both BP and EP, the surface distribution of null vs. overt pronominal objects in the control groups is distinct because of the order in which the constraints apply. Our data show that, in EP, the animacy status applies first, and then the syntactic environment, but in BP this order is not clear.

## Target Groups

Based on the differences between the control groups with respect to the null vs. overt distinction, we have the tools to discuss

the L2ers' performance and the statistical comparisons we made. First of all, L2ers appear to differ significantly from themselves across BP- and EP-modes, except for environments with animate referents in syntactic islands (NAI-OAI). In the other three environments, the null vs. overt distinction for the L2ers was higher in EP-mode than in BP-mode, which reflects the behavior shown by the control groups.

The semantic and syntactic effects also seem to hold for this group. In both modes, L2ers assigned different values to contexts with null objects with animate and with inanimate referents, in both simple clauses and islands. Regarding the syntactic environment, this group also showed significant distinctions in both modes in contexts with null objects and inanimate referents (NII-NIS), but not in similar contexts with animate referents (NAI-NAS). When we consider the null vs. overt distinction, L2ers show significant differences to both control groups in almost all comparisons, except for contexts with inanimate referents in simple clauses (NIS-OIS), where they pattern with BPCs when in BP-mode, and in contexts with inanimate referents in strong islands, where they show BP-like behavior when in EP-mode.

In short, the syntactic environment and animacy status that determine the null object distribution in BP and EP are both at play simultaneously for the target group. Their interpretation of null vs. overt object contexts is highly dependent on these two factors, as it is for monolingual speakers of each language. However, the distinctions between these contexts are mostly interpreted in a way that is different from what was shown by the control groups. Nevertheless, L2ers still behaved BP-like in contexts with inanimate referents in simple clauses (when in BP-mode), and showed signs of the BP distribution when in EP-mode in contexts with inanimate referents in strong islands. No EP-like behavior was detected for these speakers in either mode. Moreover, with respect to overt object pronouns, L2ers gave significant lower ratings than both BPCs and EPCs in each respective mode, which indicates cross-linguistic influence in both directions. Since the clitic option is less preferred in monolingual BP, the lower ratings attributed by L2ers to sentences with overt clitics when in EP-mode can be interpreted as a result of BP=>EP influence. Conversely, sentences with overt strong pronouns were significantly less preferred by the L2ers in BP-mode, which suggests EP=>BP influence. With this in mind, we can link the data to the hypotheses we test in this study.

## Hypothesis (A)–Testing for L1 Attrition

As discussed in Section Typological Proximity in the Context of L2 Processing and L1 Attrition, recall that several researchers have drawn a link between typological proximity and L1 attrition (e.g., Gürel, 2008; Schmid, 2011). Given the high level of proximity between BP and EP and the length of residence in Portugal of the target group, we hypothesized that these naturalistic L2 learners of EP should display some signs of EP influence in their native BP. As we have shown, the way in which L2ers perceived the differences between contexts with null objects and overt objects when in BP-mode was no longer BP-like, with the exception of one of the contexts (inanimate

referents in simple clauses). While not entirely EP-like either, the behavior shown by L2ers in BP-mode indicates that they interpret the null vs. overt distinction differently from monolinguals. As shown in **Figure 5**, L2ers showed much lower coefficients of differences between the null and overt conditions than the monolingual controls. However, BPCs themselves did not distinguish between the two sets of conditions to the same extent that EPCs did, particularly in the NIS condition. In addition, L2ers in BP mode gave lower ratings to sentences with overt pronouns than BPCs. This can be attributed to the fact that strong pronouns, which are the default choice for most BP monolinguals, are significantly less acceptable to the target group. While it is true that they still judged the sentences as acceptable (well above 3.5), the significant difference between their judgments and the BPCs' judgments suggests a possible effect of EP grammar on their BP. We take this as evidence of cross-linguistic influence from EP to BP instead of a general effect of bilingualism.

## Hypotheses (B) and (C)–Testing For L1 Effects in L2 Acquisition

In light of Hartsuiker et al. (2004), we understand that the lexical co-activation of the L1 should lead to its syntactic co-activation, and as a result, we expected the L2ers in EP-mode to display preferences similar to those of BP monolinguals. Miller (2014) and Hopp (2016), however, defend that the lexical co-activation of the L1 might actually inhibit the L1 syntactic structure, and consequently, L2ers are expected to display target-like performance instead, which would have been manifested if their preferences in EP-mode reflected those of EP monolinguals. We take advantage of the high level of typological proximity between BP and EP to test these two possible outcomes.

Our data show that, in EP-mode, L2ers do not quite reach target-like performance with respect to the EP null vs. overt object distribution, as they are statistically different from EP controls. While also different from BP monolinguals in three of the comparisons, they show BP-like behavior in contexts with inanimate referents in strong islands (NII-OII). We interpret this as an indicator that the BP structure is activated in these speakers' minds, despite the fact that they are in EP-mode. This suggests that, as shown by Hartsuiker et al. (2004), L1 syntax is co-activated with the lexical co-activation of the L1, which was expected given that these two languages share most of the lexicon. Unlike what was shown by Miller (2014) and Hopp (2016), L2ers were not able to fully inhibit their L1 syntax and thus did not reach target-like performance in their L2. Their L1 syntax, despite showing signs of attrition, remains active in the brain, enough to cause them to display some BP-like behavior, even when in EP-mode.

## CONCLUSION

The conclusions drawn here aim at shedding light on bidialectal bilingualism from a formal linguistic perspective, especially the roles that input and contact play in the acquisition of closely related varieties. In this study, we tested how Brazilians living in Portugal perceive the distribution of null and overt pronominal objects after prolonged exposure to EP, given the apparently different semantic and syntactic constraints that have an effect on their distribution in each language. As it turns out, we find that the animacy status and the semantic environment do not categorically determine the null object distribution in these languages, but rather influence the speakers' preferences. This is because these two factors apply in both BP and EP, but due to strict rule-ordering in the latter, the way in which BP and EP monolinguals deal with the differences between null and overt pronouns is not quite the same. We encourage scholars to consider this conclusion and further explore how null objects are distributed in these two languages.

In this study, we offer some additional evidence in support of the hypothesis that typological proximity is a factor that contributes to L1 attrition (Altenberg, 1991; Gürel, 2008; Schmid, 2011), as our target group, for the most part, no longer patterns with BP monolinguals with respect to the null vs. overt object distribution, displaying cross-linguistic influence potentially stemming from their L2. In addition, we were able to test whether typological proximity hinders or facilitates L2 processing, as compared to what has been shown in previous studies. We conclude from our data that the high degree of similarity between the L1 and the L2 leads to syntactic co-activation of the L1, which results in non-facilitative influence, as previously shown by Hartsuiker et al. (2004).

We strongly believe that the field of L2 acquisition will benefit from further research investigating cross-linguistic transfer, L1 attrition and L2 processing in typologically similar languages, particularly in closely related varieties. In this paper, we have given our small contribution to the field, in the hope that similar studies come to expand on issues raised here.

## ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Personvernombudet for forskning (ombudsman for research), Norsk samfunnsvitenskapelig datatjeneste AS (Norwegian Social Science Data Services-NSD) with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Norsk samfunnsvitenskapelig datatjeneste AS (Norwegian Social Science Data Services-NSD), project number 35815.

## AUTHOR CONTRIBUTIONS

TC is the main author of this manuscript. He has conducted the experiments in person, completed the data analysis and written the majority of the manuscript. JR has given substantial contribution via means of supervision and guidance, and has written some sections of the manuscript. MW has contributed with general and specific comments.

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# Functionally Equivalent Variants in a Non-standard Variety and Their Implications for Universal Grammar: A Spontaneous Speech Corpus

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Findings from the field of experimental linguistics have shown that a native speaker may judge a variant that is part of her grammar as unacceptable, but still use it productively in spontaneous speech. The process of eliciting acceptability judgments from speakers of non-standard languages is sometimes clouded by factors akin to prescriptive notions of grammatical correctness. It has been argued that standardization enhances the ability to make clear-cut judgments, while non-standardization may result to grammatical hybridity, often manifested in the form of functionally equivalent variants in the repertoire of a single speaker. Recognizing the importance of working with corpora of spontaneous speech, this work investigates patterns of variation in the spontaneous production of five neurotypical, adult speakers of a non-standard variety in terms of three variants, each targeting one level of linguistic analysis: syntax, morphology, and phonology. The results reveal the existence of functionally equivalent variants across speakers and levels of analysis. We first discuss these findings in relation to the notions of competing, mixed, and fused grammars, and then we flesh out the implications that different values of the same variant carry for parametric approaches to Universal Grammar. We observe that intraspeaker realizations of different values of the same variant within the same syntactic environment are incompatible with the 'triggering-a-single-value' approach of parametric models, but we argue that they are compatible with the concept of Universal Grammar itself. Since the analysis of these variants is ultimately a way of investigating the status of Universal Grammar primitives, we conclude that claims about the alleged unfalsifiability of (the contents of) Universal Grammar are unfounded.

Keywords: variation, dialect, bilingualism, Universal Grammar, parameters, falsifiability

## INTRODUCTION

Research in non-standard varieties has reliably shown that the process of eliciting acceptability judgments from native speakers of such varieties —often called (non-standard) dialects— faces various challenges. Among them, one finds (i) the interference from prescriptive notions of correctness, that is, the outcome of speakers' awareness that some of the variants of their native

linguistic repertoire are considered 'incorrect' by speakers of the standard variety, (ii) a greater degree of interspeaker and intraspeaker variation due to non-standardization leading to less clear-cut variants and judgments over variants, and (iii) the unclear dividing lines among the various 'lects' (e.g., acrolect, mesolects, basilect) that exist on the standard-dialect continuum (Cheshire and Stein, 1997; Milroy, 2001; Henry, 2005; Papadopoulou et al., 2014). Such features blur the boundaries of grammatical variants in a way that results in a high degree of grammatical hybridity attested in the form of utterances that may incorporate elements from various lects *without* code-switching being in place (Cornips, 2006; Tsiplakou et al., 2016; Leivada and Grohmann, 2017).[1] In this context, it has been argued that working from corpora of spontaneous speech might be more useful or desirable than using acceptability judgements when the language under investigation is a non-standard/-codified one — as is the case of the variety investigated in this study — because speakers may be influenced by prescriptive notions of correctness (Henry, 2005).

Findings from the field of experimental linguistics stress the necessity for corpora studies. The use of spontaneous speech corpora allows us to obtain reliable insights into speakers' actual production instead of what they think or say they produce, which is possibly subject to more interference by prescriptive rules of language. It has been shown that native speakers may judge a grammatical variant as unacceptable, but still be recorded producing it spontaneously (Labov, 1996; Cornips and Poletto, 2005; Beltrama, 2013).[2] If this is true in cases of monolingual speakers, in cases of bilingual or bilectal development (i.e., two varieties of the same language instead of two different languages) that at times involves non-standard/-codified —and as such, possibly more hybrid— varieties, *more* discrepancy is expected between speakers' introspective judgments about their repertoire and the actual linguistic repertoire itself (Leivada et al., 2017). To explain this further, let's consider Labov's (1975, 1996) *Consensus Principle* in (I):

(I) The Consensus Principle
If there is no reason to think otherwise, assume that the judgments of any native speaker are characteristic of all speakers of the language. (Labov, 1996: 79)

The Consensus Principle presupposes some degree of uniformity in terms of judgments among native speakers of the same language. However, when eliciting introspective judgments, other extra-grammatical factors and variables may interact with the linguistic performance in the phenomena under investigation, especially so when these judgments come from dialect speakers. Considering that (i) standardization leads to more clear-cut judgments and (ii) the possible emergence of

various mesolects in the dialect-standard continuum which may feature different exponents/values for the same linguistic variant, it is possible that speakers of non-standard varieties will *not* be as uniform in terms of their judgments as the idealized picture of linguistic uniformity among the members of a linguistic community suggests (see also Chomsky, 1965). The existence of a dialect-standard continuum where varieties do not always appear with discrete edges invests the process of linguistic development and its outcome with an additional layer of complexity (Papadopoulou et al., 2014). Moreover, although acceptability judgment tasks are a reliable tool in linguistic research (Sprouse and Almeida, 2012; Sprouse et al., 2013), it has been noted that at times discrepancies can be observed between overt linguistic behavior and introspections about decontextualized, constructed examples, and these discrepancies are particularly pronounced when dialectologists or sociolinguists present data from non-standard dialects (Bresnan, 2007, see also Baggio et al., 2012 for a review). The following passage in Devitt (2006) illustrates how formal instruction and standardization may mediate the process of providing intuitive judgments about grammatical variants:

"As a graduate student, I spent a summer in the Pyrenees (Andorra, Perpign[a]n, etc.) doing field research on the phonology of various dialects of Catalan. Many of our native informants were illiterate peasants. I was forcefully struck how difficult it was to elicit linguistic judgments from them regarding their language, which of course they spoke perfectly well. Just getting the plurals of certain nouns was tough. These folks seemed to be very hard of hearing when it came to hearing the voice of competence! Their difficulty, it seemed, was that their native language was largely transparent to them—they had never thought of it as an object for observation and hence were largely unable to form even the most rudimentary judgments about its character. Catalan speakers with only a modicum of grade school education, by contrast, were good informants, presumably because they had learned through their grammar lessons to think of *language as an object with various properties*, even if they had no sophisticated knowledge of what those properties might be, theoretically speaking. (Bob Matthews, in correspondence)." (Devitt, 2006: 497)

Hagoort (2014) has recently made some useful suggestions with respect to the way linguistic work could increase its impact and visibility within cognitive (neuro)science. The first suggestion he offers is to exploit the availability of large corpora, the existence of which "puts linguists in a historically unprecedented position" (Hagoort, 2014). For these and other reasons, spontaneous speech data have been described as the best data that one can obtain for the study of language variation (Cornips, 2015). Recognizing the value of working with corpora in experimental linguistics, this work investigates patterns of grammatical variation and hybridity through analyzing the spontaneous production of five neurotypical, adult speakers of a non-standard variety in terms of three variants, each targeting a different level of linguistic analysis: syntax, morphology, and phonology. The variety under investigation is Cypriot Greek, a largely understudied language in many domains of grammar that

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[1]Code-switching refers to the alternation of two languages within a single sentence, constituent, or discourse intersententially and/or intrasententially (the latter is also known as code-mixing; Poplack, 1980; Auer, 1999).

[2]In noting the possibility of a discrepancy between judgments and spontaneous production, we do not question the reliability of acceptability judgment tasks as tools of research; a reliability that has been repeatedly shown in the literature, mainly for standard/codified languages (see Sprouse and Almeida, 2012; Sprouse et al., 2013).

**FIGURE 1 |** Functionally equivalent variants (Rosenbach, 2002, p. 82).
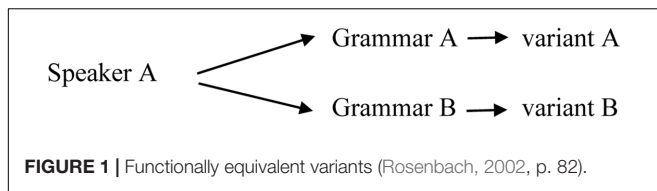
lacks the status of an official language. Instead, Standard Modern Greek is the official, standard variety used in Cyprus, which shows the characteristics expected to find in such context, such as its use in school education, formal speech, and media.

Apart from gaining valuable insights into the grammatical system of an understudied variety, investigating the limits of variation *within* a hybrid 'lect' is directly related to a parametric conception of Universal Grammar (UG) within the Principles & Parameters framework (Chomsky, 1981). The reason is the notion of *functionally equivalent variants* (Kroch, 1994) which, in the case of Cypriot Greek, is the result of (once) competing grammars.[3] These variants are doublets that consist of two equivalent forms or constructions that have the exact same function, but are grammatically incompatible (**Figure 1**). Incompatibility here refers to the fact that the two variants A and B cannot co-exist in a single environment. As correctly pointed out in Embick (2008), the occurrence of functionally equivalent variants in the repertoire of a speaker poses important questions for the models through which language is interpreted.

After presenting the methodological aspects of this research and the obtained results in the next two sections, we discuss the implications that our findings carry for the notions of competing, mixed, and fused grammars as well as for parametric approaches to UG.

## LANGUAGE UNDER INVESTIGATION

Cypriot Greek has often been referred to as a dialect of Greek (Contossopoulos, 2000); a variety that is linguistically proximal to Standard Modern Greek (Grohmann and Kambanaros, 2016; Grohmann et al., 2016), which is the official language in the environment our participants acquire language. Although the official language in education and other formal settings is indeed Standard Modern Greek, research has shown the boundaries between the two varieties, Standard Modern Greek and Cypriot Greek, and their distribution across different registers is not straightforward (Grohmann and Leivada, 2012; Tsiplakou et al., 2016). At times mixing is attested without code-switching being in place, while no official characterization has been provided for any of these terms in this specific context. The question arising in this context is whether the attested variants emerging in mixed speech repertoires are functionally equivalent for an individual speaker.

The two varieties have differences in all levels of linguistic analysis and often monolingual speakers of Standard Modern Greek judge Cypriot Greek as unintelligible. At the same time, Greek Cypriot speakers do not always provide reliable judgments of their own speech since these are often clouded by sociolinguistic attitudes toward using the non-standard variety. Cypriot Greek lacks official codification and its status as a different language/variety is often denied by Greek Cypriots who may downplay the differences between Standard Modern Greek and Cypriot Greek and describe the latter as just an accent (Arvaniti, 2010). As the discussion of the different variants will make clear in the next section, the two varieties have differences across levels of linguistic analysis and these differences vastly exceed the sphere of phonetics or phonology.

All speakers of Cypriot Greek have exposure to Standard Modern Greek through education and other mediums and in this way, they are competent to different degrees in both varieties. We employ the term 'bilectal' (Rowe and Grohmann, 2013, 2014) to refer to the participants of this study, although it is not entirely clear that the varieties they are exposed to are Standard Modern Greek and Cypriot Greek or that they are only two varieties, under the assumption that a continuum is in place. For instance, the term 'Cypriot Standard Greek' (Arvaniti, 2010) has been proposed to refer to an emerging variety that may count as the standard in the context of Cyprus. This would be a sociolinguistically 'high' variety (Ferguson, 1959) that is used in formal settings, although its degree of proximity with Standard Modern Greek is difficult to determine with precision because great fluidity is attested across different settings and geographical areas. At the school environment, for example, one notices the existence of three different varieties: Cypriot Greek, as the home variety that is used when students interact with each other, Standard Modern Greek, as the language of the teaching material, and another standard-like variety that incorporates elements from both varieties, and is present in the repertoire of both the students and the instructors (Sophocleous and Wilks, 2010; Hadjioannou et al., 2011; Leivada et al., 2017).

Observing the existence of different varieties that have boundaries which are unclear as often evidenced between standard and non-standard varieties, the following questions still beg answers: "Is it at all possible to have continuum-external code-switching, if part of Standard Greek is taken to belong to the Cypriot continuum, or if we are dealing with a "fused lect"? How do acquisition factors enter the picture? And, finally, do such data allow us to make a case for competing grammars, and, if so, what is the precise nature of the competition?" (Tsiplakou, 2009).

Importantly, the answers to these questions relate to the study of language variation and posit the question of how the possible existence of functionally equivalent variants fares within a theory of UG that involves parametric values. Functionally equivalent variants in grammar raise the question of constraints, or the lack thereof, on the coexistence of various variants whose distribution is clearly found in different environments when discussed separately. While this is the case for descriptions that focus on the grammar of each variety (Standard and

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[3]The concept of "competing grammars" goes back to Kroch (1989, 1994), who proposed that speakers project multiple grammars to deal with ambiguous input. This concept has been explicitly connected to the relation between Standard and Cypriot Greek (Papadopoulou et al., 2014; Tsiplakou, 2014; Grohmann et al., 2017).

Cypriot Greek) separately, actual use as evidenced through the production of these bilectal speakers reveals a grammar that contains doublets of variants. In certain frameworks, such as the one of Distributed Morphology, the constraints which would explain, for example, the formation of words would focus on the competition of different alternants and the environment in which particular morphemes are inserted in the syntactic component of grammar for spell-out (Embick, 2010, among others). For example, *dur-abil-ity* is a well-formed English word, while **dur-ity* is an ill-formed one, suggesting that for this particular case the suffix *-ity* is conditioned by the presence of the morpheme *-able*, which surfaces here as *-abil*. In the current study, grammatical constraints are absent from the variation observed in the variety under investigation. The use of variant A from a doublet (see **Figure 1**) does not prohibit the use of variant B; they cannot appear simultaneously, but they can appear in the same grammatical environment. Our goal here is to document the existence of variation in spontaneous speech and the implications of its existence for variation theories in Universal Grammar.

## METHODOLOGY

Typical issues that appear in experimental studies of non-standard varieties relate to the attitude of speakers to present their linguistic repertoire by actively choosing to incorporate characteristics of the standard variety in their speech. This creates problems to experimental investigations that use a variety of structured methodologies, ranging from direct investigation of judgments by speakers, to offline questionnaires and other elicitation techniques. Importantly, spontaneous speech is not necessarily biased for any external factors that relate to speakers' attitudes and *can* show the different choices available in speakers' repertoire. In fact, the data presented here that show variation in all the different components of grammar could not be collected in any way other than spontaneous speech: speakers can often choose to use one variant from each doublet, depending on their language attitude toward Cypriot Greek and Standard Modern Greek. Carefully designed experimental studies would probably focus again on the acquisition or use of one part of these pairs and in cases where they consider using both as variables, they can prime and/or guide speakers' response by either making them aware of the presence of these variables in their speech or, by using specific lexical items that can prime the production of one variant instead of another (Papadopoulou et al., 2014).

For these reasons, the current study presents spontaneous speech data that are important both to the study of this specific variety, but more importantly, to the field of language variation. The next section presents the study by providing the linguistic profile of the participants, and the procedure followed for the analysis variants that we will discuss.

### Participants and Corpus

All participants in this study are neurotypical adults, native speakers of Cypriot Greek. In total, five participants and two researchers interact in five different occasions. The researchers

are also adults and native speakers of Cypriot Greek. **Table 1** presents the demographic characteristics of participants' and researchers' and the number of utterances produced during each recording. Participants (PA) and researchers (RE) are presented in chronological order with PA1 being the youngest of the participants and PA5 being the oldest. Only female participants were recruited in order to avoid gender effects: previous research that investigated the linguistic production of speakers of Cypriot Greek has identified gender as one relevant factor that affects linguistic performance. More specifically, it has been observed in the relevant literature that male speakers with a particular level of education and degree of familiarity with the researcher show higher rates of use of the Cypriot rather than the standard-like forms (Tsiplakou et al., 2016).

Given that level of education is also found to play a role in the literature —male speakers that have completed secondary education *only* produced forms that were less close to the standard according to Tsiplakou et al. (2016)— we have included in our sample participants with different levels of education.

## Procedure

The purpose of this work is to identify the nature and limits of hybridity (i.e., understood here as the incorporation in one lect of elements that once belonged to different lects probably due to language-dialect contact; a process that results to the existence of functionally equivalent variants in a single lect) in whatever the home variety corresponds to across different speakers. We aim to show that, even in those lects that are closer to the standard, great variation and grammatical hybridity still exists. All participants had a good degree of familiarity with the researchers in order to ensure that the conversation would flow effortlessly. Aiming to obtain a truly spontaneous production, participants had no training in linguistics and no information as to what the researchers were interested in. Participants were familiar with the REs' profession and they were told that the researchers would like to record a 30-min discussion, without knowing any further details. The recordings took place at participants' houses and other places that were familiar to the participants.

The seven participants presented in **Table 1** produced 4.818 utterances while engaged in a conversation in an informal setting. Every intelligible unit of speech that was separated by pauses was treated as an utterance (see (1) for an example). There were three participants in each session: One participant and two researchers. Each recording lasted for approximately 30 minutes and there was no specific topic of discussion. Participants were free to lead the discussion and talk about whatever they liked. For this reason, the discussions eventually included different topics across sessions, such as the description of a recent trip to China, the possibilities of applying abroad for a post-graduate degree and aspects of the daily 'update' between friends. The overall average utterance production per session was 963,6 utterances (441,6 utterances per participant and 261 utterances per researcher). All conversations were recorded and transcribed by researchers other than RE1 and RE2. Cross-verification of transcription and codification was also done by two other researchers.

**TABLE 1 |** Participants.

| Recording | Participant | Age | Education | Utterances | Total per recording |
|---|---|---|---|---|---|
| 1 | PA1 | 21 | Graduate Degree | 333 | 994 |
| | RE1 | 25 | Post-graduate degree | 365 | |
| | RE2 | 31 | Post-graduate degree | 296 | |
| 2 | PA2 | 21 | Graduate Degree | 528 | 999 |
| | RE1 | 25 | Post-graduate degree | 208 | |
| | RE2 | 31 | Post-graduate degree | 263 | |
| 3 | PA3 | 33 | Post-graduate degree | 385 | 847 |
| | RE1 | 25 | Post-graduate degree | 161 | |
| | RE2 | 31 | Post-graduate degree | 301 | |
| 4 | PA4 | 54 | Secondary Education | 315 | 918 |
| | RE1 | 25 | Post-graduate degree | 222 | |
| | RE2 | 31 | Post-graduate degree | 381 | |
| 5 | PA5 | 57 | Secondary Education | 647 | 1060 |
| | RE1 | 25 | Post-graduate degree | 177 | |
| | RE2 | 31 | Post-graduate degree | 236 | |
| | Mean Age | 34,5 | Total | 4818 | 4818 |

*PA4 and PA5 are 'outliers' in two respects: they are both older and less educated, with the gap in age and education between them and the other participants being rather significant. Since this is an orientative, small-scale study, we opted for including them in our sample.*

## Variants

We analyzed the corpus, focusing on three sets of variants, each of which belongs to a different level of linguistic analysis: (i) syntax is approached through clitic placement which varies in declaratives; it is pre-verbal in Standard Modern Greek and post-verbal in Cypriot Greek, (ii) morphology is examined through the use of the Cypriot Greek diminutive affix *-u* (vs. *-ak* in Standard Modern Greek) and (iii) phonology is examined through the use of the Cypriot-specific post-alveolar affricate /tʃ/ which corresponds to the Standard Modern Greek palatal /c/ in the lexical items we examined.

Syntax was approached by identifying an environment where the two varieties differ, namely, clitic placement in declaratives: Cypriot Greek requires enclisis (1), whereas Standard Modern Greek requires proclisis (2) (Terzi, 1999; Agouraki, 2001; Mavrogiorgos, 2013; Neokleous, 2014; among others). While matrix environments are identified as showing enclisis in Cypriot Greek (1), embedded environments headed by certain complementizers can show either proclisis or enclisis (Pavlou, 2016). Some speakers admittedly have a preference toward proclisis or enclisis in embedded clauses and because of this variation, these clauses were also included in the sample.

(1)  θelo            to.              [Cypriot Greek]
     want.PRES.1SG    it.NEU.ACC
     'I want it.'
(2)  to              θelo.            [Standard Modern Greek]
     it.NEU.ACC       want.PRES.1SG
     'I want it.'

Although certain environments are associated with only one option (i.e., matrix declaratives and enclisis in Cypriot Greek), mixed placement patterns arise to varying degrees in the production of Greek Cypriots even when they converse in the home variety. As Tsiplakou et al. (2016, p. 11) show, one finds in the linguistic repertoire of Greek Cypriots some "pragmatically and conversationally unexpected switch[es]", where standard-like proclisis surfaces with verbs that bear phonological characteristics of Cypriot Greek. In (3), for example, two instances of enclisis are followed by an instance of proclisis where the clitic attaches to a verb whose phonological form includes the palatoalveolar fricative [ʃ] which is specific to the Cypriot Greek repertoire and absent from Standard Greek.

(3) ksero      to        tuto       ksero      to
    know.1SG   it.NEU.ACC this.ACC   know.1SG   it.NEU.ACC
    to         eʃi       maθitis               mu.
    it.NEU.ACC have.PRES.3SG student.NOM.SG     my.GEN.SG
    'I know it, this one, I know it! A student of mine has it.'
    (Tsiplakou et al., 2016, p. 11)

At the morphological level, we calculated the occurrences of the Cypriot Greek diminutive suffix *-u* vs the Standard Modern Greek *-ak*. The two suffixes have the exact same meaning and function, but they have slightly different distribution depending on the noun declension; their only difference is with respect to the variety they belong to. The *-u* variant is not an option in Standard Modern Greek. Morphology is of particular interest in the context of our study because it has been argued that structural mixing in the emerging *koiné* (i.e., a variety that incorporates elements from the standard variety but is different from it, like Cypriot Standard Greek) is mostly achieved through morphological choices, while Cypriot phonology and syntax show less hybridity and remain largely intact (Tsiplakou, 2014). Diminution is an extremely productive process of derivation across both varieties (Giannoulopoulou, 2010), hence we take

the comparison of the two diminutive variants in our corpus to be a reliable indicator of what has been argued to be the most productive domain when it comes to structural mixing.

Another possible pair of alternants is the future marking that is employed in Cypriot Greek with the periphrastic nonpast tense structure *en na* ([lit. 'is to']) and its possible Standard Modern Greek alternant θ*a* 'will'. Even if the two would be found in the same context with a future reading, they could involve a very different structure which is not immediately comparable to each other. Merchant and Pavlou (unpublished) show that the periphrastic structure is different than the future marker 'will' used in Standard Modern Greek. For this reason, we do not analyze cases like these that arguably have a very different underlying structure.

Phonology was tested by counting the occurrences of the Cypriot Greek postalveolar affricate variant /tʃ/, which would be realized as a palatal /c/ in Standard Modern Greek. For example, the realizations of the conjunction 'and' would be *tʃe* in Cypriot Greek and *ce* in Standard Modern Greek. The latter variety lacks the post-alveolar affricate making this one of the most salient differences between the two varieties.

For our analysis, we identified all the indicative clauses that feature a clitic, excluding other syntactic environments where the two varieties do not differ (e.g., imperatives, subjunctives), all the occurrences of the two diminutives regardless of their realization in terms of number and case, and all the realizations of the two phonemes /tʃ/ and /c/ in words that are syntactically, semantically, and phonologically the same across the two varieties apart from their difference in the phoneme in question (e.g., as in the case of the conjunction 'and').

## RESULTS

Our findings highlight the presence of variants that belong to different varieties/lects across levels of linguistic analysis. As **Figure 2** shows, the degree of incorporation of elements from one of the different poles of the continuum varies across levels.

**Figure 2** shows that the linguistic repertoire of the participants of this study features predominantly, but not exclusively variants that belong to Cypriot Greek. Morphology indeed stands out as the most hybrid domain (in agreement with what was argued in Tsiplakou, 2014), however some level of hybridity is attested in phonology and syntax as well. This difference was statistically confirmed for all three domains (phonology and syntax $X^2(2) = 19,91$, $p < 0,0001$, syntax and morphology $X^2(2) = 10,82$, $p < 0,0001$ and morphology and phonology $X^2(2) = 46,75$, $p < 0,0001$. In **Table 2**, the number of calculated items is shown for each variety.

In **Figures 3–5**, the overall performance is broken down for each level of analysis showing the performance of each participant individually. The results reveal the existence of functionally equivalent variants across speakers. In relation to phonology, **Figure 3** shows that all participants, apart from PA2 in recording 2 and RE1 in recording three incorporate both variants to some degree, but prefer the Cypriot /tʃ/.

As **Figure 4** indicates, not all participants used diminutives in their spontaneous productions. When diminutives were used, there was a clear preference for the Cypriot Greek variant *-u* rather than the Standard across all participants except RE2 in some sessions.

Syntax is the second domain where all participants incorporated 'conflicting' values (i.e., different values of the same variant) of the structures in question in their production. **Figure 5** suggests that the presence of functionally equivalent variants in our bilectal population is not a matter of differential position of each participant on the dialectal continuum. Put differently, our findings reveal both *interspeaker* and *intraspeaker* variation with respect to the patterns of clitic placement that are featured in the grammar under investigation, but with preference for the Cypriot Greek placement pattern.

Participants in our study used different values *without* any code-switching being in place. For example, (4)–(5) were



**FIGURE 2 |** Overall production.

| | CG | SMG |
|---|---|---|
| phonology | 79,3 | 20,7 |
| morphology | 70,1 | 29,9 |
| syntax | 85,4 | 14,6 |
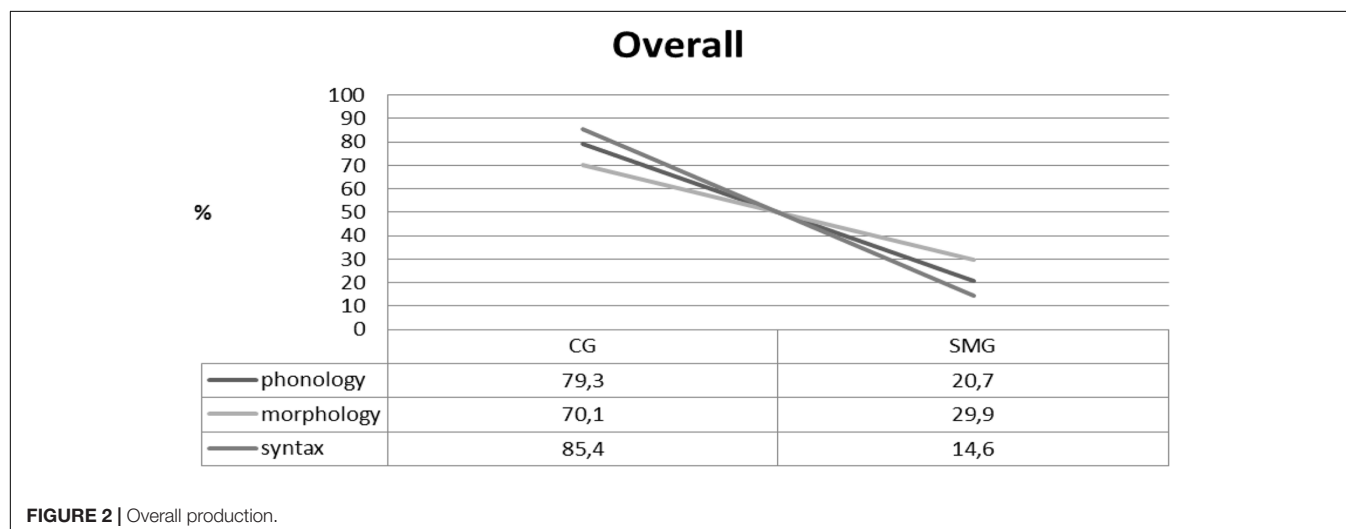
**TABLE 2 |** Calculated items.

| Recording Area | Phonology | | Morphology | | Syntax | | Other utterances (not featuring the variants under examination) |
|---|---|---|---|---|---|---|---|
| | tʃ | c | –u | –ak | Enclisis | Proclisis | |
| 1 | 21 | 15 | 4 | 0 | 39 | 9 | 906 |
| 2 | 52 | 5 | 8 | 2 | 79 | 12 | 841 |
| 3 | 40 | 3 | 8 | 4 | 99 | 13 | 680 |
| 4 | 36 | 7 | 20 | 7 | 88 | 9 | 751 |
| 5 | 35 | 18 | 14 | 10 | 58 | 19 | 906 |
| Total | 184 | 48 | 54 | 23 | 363 | 62 | 4084 |



**FIGURE 3 |** Individual performance for each participant in phonology.



**FIGURE 4 |** Individual performance for each participant in morphology.
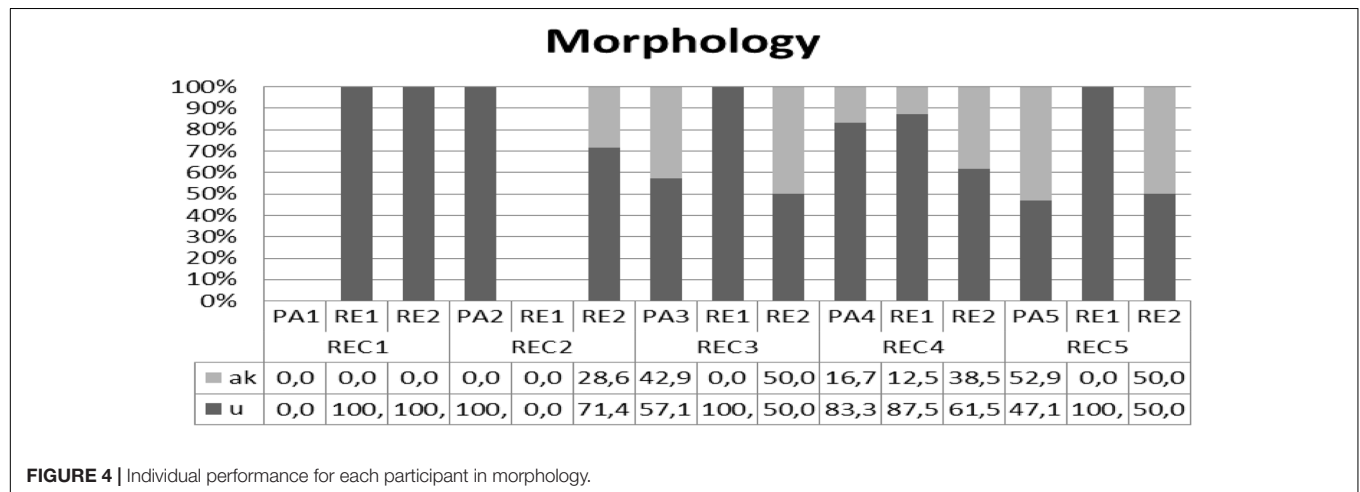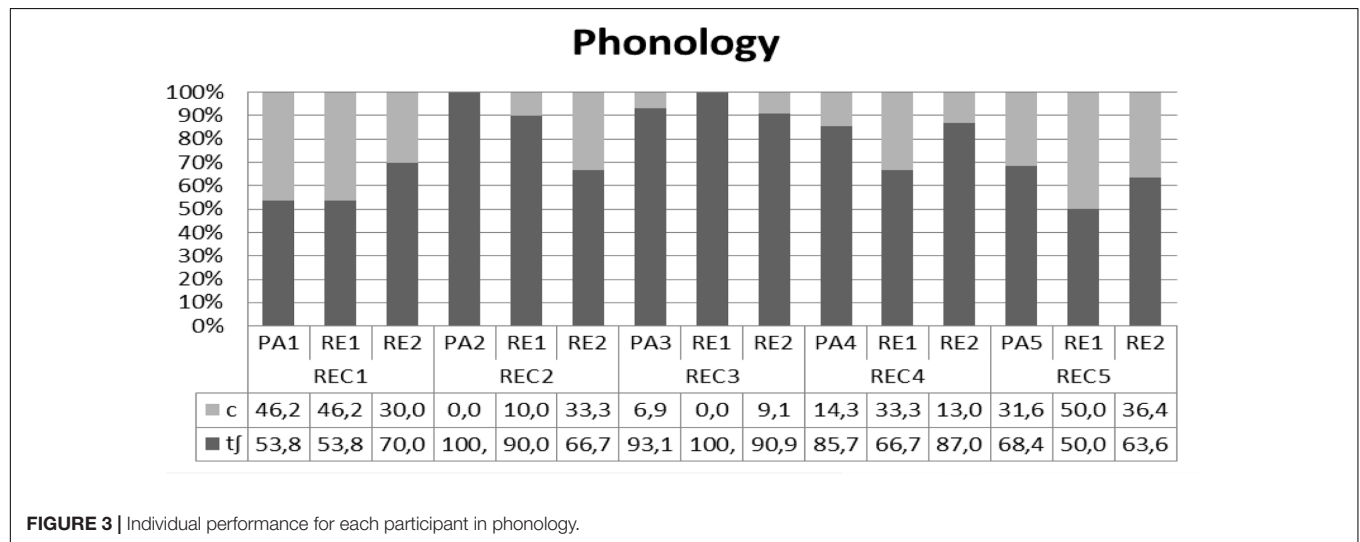
produced by participant PA5 in a succession; consistent enclisis or consistent proclisis could have been used in both cases, but instead she mixed the two throughout her productions and even within the same utterance (5). We thus observe the existence of functionally equivalent variants within her repertoire. Variation is manifested across speakers, as evidenced by the fact that different participants align more with the standard variety than others, but also within speakers, as (4)–(5) suggest.

(4)  apla        ta                  ðiakosmisan.
     simply    them.NEU.ACC    decorate.PAST.3PL
     'They simply decorated them.'

(5)  ta                valan          tʃame        ekaman
     ta                              jali.
     them.NEU.ACC    put.PAST.3PL    there        do.PAST.3PL
     them.NEU.ACC    glass
     'They put them there, they cleaned them.'

**FIGURE 5 |** Individual performance for each participant in syntax.
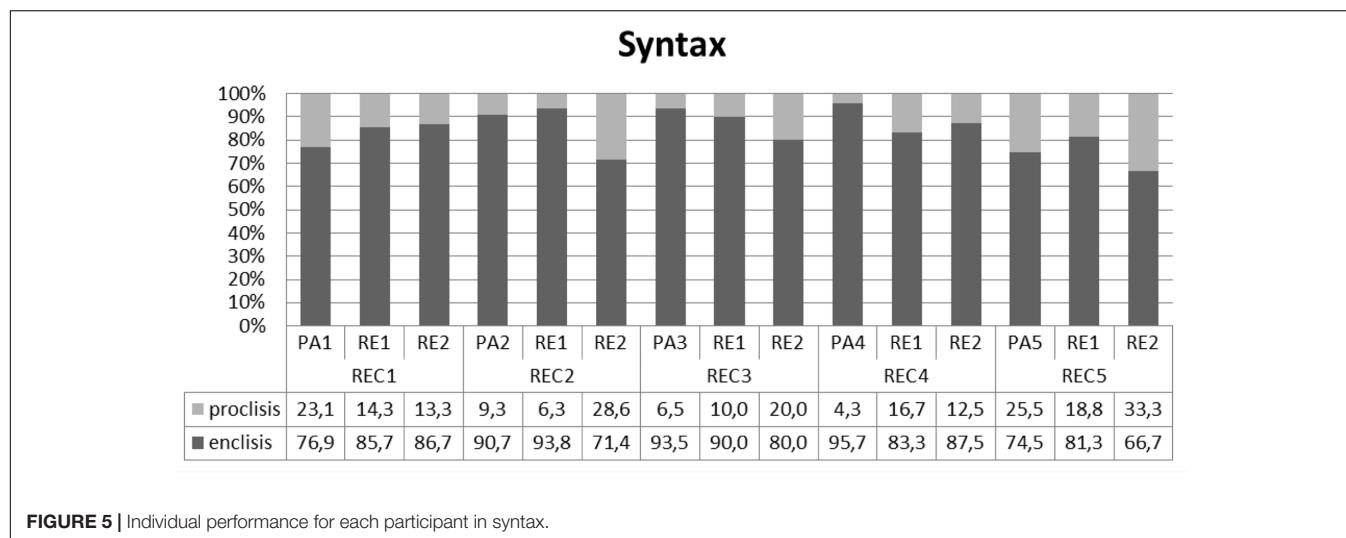
The observed incorporation of patterns from different lects in one grammar goes far beyond the production of the three variants presented above. In some cases, hybridity extends to the production in a single utterance of two or more Cypriot Greek-specific variants — including variants other than the three pairs that are the focus of this study—, in *varying degrees* across utterances (see **Table 3** and examples (6)–(7)).

In (6), we see an utterance produced in Cypriot Greek that involves the Standard Modern Greek diminutives and phonology on the two last nouns *only*. The conjunctive 'and' consistently appears both times with the Cypriot Greek /tʃ/. On the contrary, its realization varies in (7), which is why we claim the incorporation of elements from different lects varies from production to production. These examples cannot be treated as code-switching for a switch would serve no discourse purpose here. Therefore, we conclude that hybridity in the grammar offers a more accurate description of the situation at hand.

(6) Elpizo          na men      fao          apla          tʃe
    monon   ɟati      exo
    *hope.PRES.1SG to not      eat.PRES.1SG   simply        and*
    *only      because    have.PRES.1SG*

iðieteri   aɣapi   pros   ta   ɣataca tʃe   ta   scilaca.
*special   love   to   the   kitties   and   the   doggies*
'I hope to not eat because I have a special love for kitties and doggies.'

(7) tʃe   en:a   kamnun       opos tin ðania       ce   ta   lipa.
    *and FUT   do.PRES.3PL   like   the Denmark   and the rest*
    'And they will act like Denmark etc'.

**Figure 6** breaks down the performance that features the Cypriot variants of the three pairs under investigation in relation to the different levels of education of the participants. It can be observed that interspeaker variation transcends the boundaries set by different levels of education. For instance, PA4 and PA5 have both completed secondary education only, but their performance is quite different in all levels of analysis.

## DISCUSSION

Comparing the occurrences of three different pairs of variants in a corpus of spontaneous speech, we argue that in the case of our bilectal subjects, the competing grammars that are in

**TABLE 3 |** Production of multiple Cypriot Greek-specific variants within the same utterance.

|  | Variant | Plus 1 item[1] | Plus 2 or more items | Other Cypriot Greek-specific items[2] | None |
|---|---|---|---|---|---|
| Phonology | tʃ | 57 | 9 | 102 | 16 |
|  | c | 21 | 3 | 18 | 6 |
| Morphology | –u | 23 | 3 | 24 | 4 |
|  | –ak | 6 | 4 | 10 | 3 |
| Syntax | enclisis | 145 | 22 | 166 | 30 |
|  | proclisis | 17 | 7 | 27 | 11 |

[1]*The variants calculated are tʃ and c for phonology, -u and -ak for morphology, and enclisis and proclisis for syntax.*
[2]*The variants calculated are all other Cypriot Greek-specific variants except the three sets examined so far in this study.*
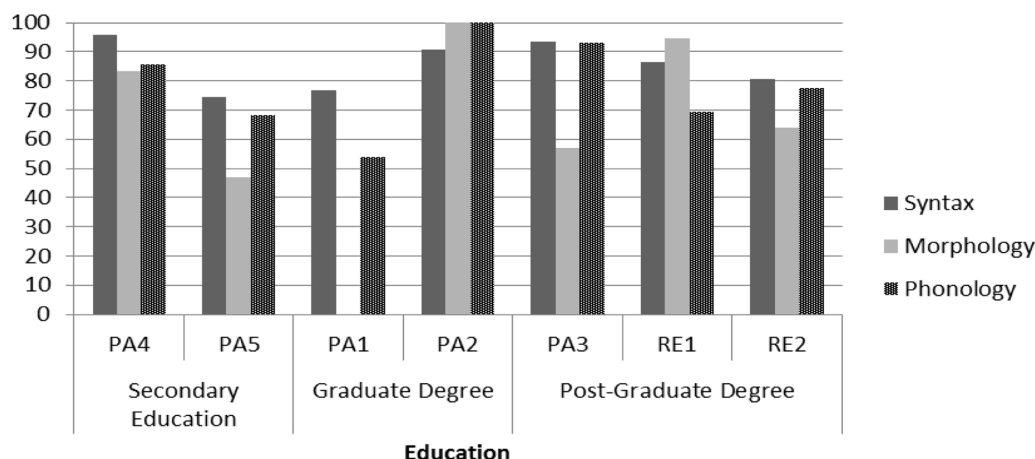
**FIGURE 6 |** The use of Cypriot Greek variants across participants and levels of education.

place in the process of language acquisition —a claim that is frequently explored in the relevant literature (see Tsiplakou, 2009; Grohmann and Leivada, 2012; Papadopoulou et al., 2014)— eventually result in a linguistic repertoire that involves *mixed* grammars. More specifically, we argue that the existence of (i) closely related varieties that form a dialect-standard continuum and (ii) non-standardization may affect the process of linguistic development and its outcome through blurring the boundaries of linguistic variants. The speaker that once had to deal with ambiguous input and project multiple (competing) grammars has now a repertoire that includes elements from these different grammars/lects into a single grammar. More concretely, the linguistic repertoire of our subjects eventually incorporates values from the acrolect (Standard Modern Greek or Arvaniti's 2010 'Cypriot Standard Greek') and the basilect (Cypriot Greek), resulting to intermediate lects that, depending on the context, the purpose of the discourse, and the speaker's attitude toward language, might approximate more 'Cypriot Standard Greek'.

We aim to put forth two sets of claims with respect to the findings presented above: First, in terms of the notion of mixed or fused grammars and the notion of competition, and second in relation to UG. Starting off from the former, let us restate the set of questions that should be addressed when discussing variation in the grammar under investigation: "Is it at all possible to have continuum-external code-switching, if part of Standard Greek is taken to belong to the Cypriot continuum, or if we are dealing with a "fused lect"? How do acquisition factors enter the picture? And, finally, do such data allow us to make a case for competing grammars, and, if so, what is the precise nature of the competition?" (Tsiplakou, 2009).

In order to address the first question, we employ Auer's (1999) criteria in order to first distinguish switching from mixing (**Table 4**).

Our participants do not show preference for one language at a time, there is no meaning in their alternations, and the grammatical hybridity affects units of any size. For these reasons,

**TABLE 4 |** Basic criteria for distinguishing code-switching from code-mixing (Auer, 1999).

| Code-switching | Code-mixing |
|---|---|
| • Preference for one language at a time | • Does not relate to preferences of speakers |
| • Possible to describe how code-switching relates to the two codes | • Difficult to find meaning in alternations |
| • Occurs at major syntactic and prosodic boundaries | • Affects units of any size |

we suggest that code-mixing is in place, and not code-switching. The second step is to decide whether the outcome of this mixing amounts to a fused lect or a mixed lect. Auer (1999) suggests that the use of one variety or the other for certain variants and constituents is obligatory in fused lects. Our findings show the exact opposite pattern (see (4)–(5)): The same variant might be realized with two different values in the spontaneous production of our subjects. In this context, we interpret the variation shown in **Figure 2** as language mixing and not as language fusing, since the observed patterns are not stabilized and intraspeaker variation suggests that speakers do have a choice as to which variant they use.

All in all, our results indicate that the linguistic repertoire of our bilectal speakers incorporates elements from different lects across levels of linguistic analysis, resulting to a mixed lect (see also the results of Pappas, 2014 that show *marginal* preferences of Greek Cypriot speakers in terms of proclisis/enclisis following different complementizers). We thus observe a transition from once competing grammars (i.e., competing during the process of language acquisition) to a mixed grammar in the production of adult, neurotypical speakers. Precisely because this mixed grammar is not standardized, it may differ with respect to the degree of mixing that it features from speaker to speaker, from register to register, and from production to production. Eventually, this mixing gives rise to functionally equivalent

variants that are the result of bringing into one grammatical system two realizations of the same variant that each comes from a different grammar.

# IMPLICATIONS FOR UNIVERSAL GRAMMAR

Showing that a syntactic or a morphological pattern can receive two different values or realizations, under the exact same syntactic conditions, within the production of a single speaker is at conflict with the mainstream conception of our initial state of the faculty of language within a generative approach (i.e., UG). Yang (2004) presents this conflict in the following way: "adult speakers, at the terminal state of language acquisition, *may retain multiple grammars, or more precisely, alternate parameter values*; these facts are fundamentally incompatible with the triggering model of acquisition [...] *It is often suggested that the individual variation is incompatible with the Chomskyan generative program*" (2004: 50-51; emphasis added). This alternation between parameter values is evident in the repertoire of our speakers, but also in earlier forms of Greek such as Later Medieval Greek (Pappas, 2004).

As mentioned already, the second aim of the present work is to flesh out the implications that 'conflicting' values of functionally equivalent variants carry for parametric approaches to UG. More concretely, in light of the obtained results, our aim is to examine whether there is a way to reconcile the attested variation (as this is manifested both within and across speakers) with UG as one of the main pillars of generative linguistics. We suggest that this is possible. This way entails stripping down UG to only *operations* (see also Di Sciullo et al., 2010 for a claim along these lines). A UG that consists of parameters and parametric values would have trouble explaining how the linguistic repertoire of a neurotypical, adult speaker can involve functionally equivalent variants with different values that are alternatively realized in the *same* syntactic environment. Arguing in favor of microvariation that is sensitive to individual lexical items (as in Kayne, 2005, see also the collection of papers in Eguren et al., 2015) instead of different syntactic environments would not solve the problem at hand, as speakers alternate across values for the exact same lexical item when this is realized multiple times in their production.

A non-parametric theory of UG that encompasses only operations would, however, be compatible with the 'conflicting' values of the functionally equivalent variants that are found in the grammar under investigation. Moreover, through showing that the attested patterns of variation in this grammar are not compatible with parametric approaches to UG, we essentially take a step toward removing parameters from the UG inventory. This step would be in the direction of approaching language from below (Chomsky, 2007) through relegating (parametric) variation from UG to the externalization component of language. This idea is increasingly explored in current conceptions of Minimalism (Berwick and Chomsky, 2011; Leivada, 2015; Chomsky et al., unpublished).

The analysis and interpretation of our results shows that there clearly exists a way of investigating some of the contents of UG,

hence there exists a way of 'falsifying' these contents. Falsification should be understood as subjecting these contents to analysis that confirms or disconfirms our current theory about them. The issue of falsification is important because linguists that question UG have often highlighted in their criticisms the 'unfalsifiability' argument (Dabrowska, 2015; Lin, 2017 and references therein). If a theory makes no falsifiable claims, it is an unscientific theory (Popper, 1959), and indeed it would be worrying if a theory of UG involved no falsifiable predictions. We embrace Chomsky's (1980) view that this is not the case for UG.[4]

Parameters have been traditionally conceived as UG primitives that are part of our innate ability to acquire language; our *language-readiness*, to use Lenneberg's (1967) term. This theory makes certain predictions about parameters being set to a single value (Chomsky, 1981 et seq.). We have demonstrated the existence of patterns of variation that show different grammatical options (i.e., parametric values) being operative and alternating after the critical period both across and within speakers. This value-alternation possibility suggests that the 'triggering-a-single-value' approach is not correct. Such a conclusion inevitably presupposes that our theory about primitives of UG is subject to falsification.

All in all, our results lead us to the claim that points of variation (what is referred to as 'parameters' in generative terms) may not be fixed in terms of their values even past the acquisition stage in a neurotypical speaker. Of course, the phonological exponents discussed in the previous section do not bear any relation to parametric variation and cannot support this claim, however, considering the big range of proposals that suggest parametrization of morphosyntax (see Leivada, 2015 for an overview), it is no surprise that clitic placement has been related to parametric variation. One explanation that has been proposed in the literature is that a filled $C^0$ requirement gives rise to enclisis (as in Cypriot Greek), while proclisis arises from the absence of this requirement, as happens in Standard Greek (Agouraki, 2001). Clitic placement has thus been explicitly argued to be the outcome of the interplay between the Proclisis Parameter and verb movement (Duarte et al., 2005). This enables us to make the connection between our results and (parametric) theories of UG.

# CONCLUSION

In collecting and analyzing spontaneous speech data in an understudied variety, we implement two of Hagoort's (2014) suggestions for maximizing the contribution of linguistics within the greater scheme of things in cognitive science: (i) the use of corpora and (ii) the exploitation of language-specific information which is a "unique selling point of linguistics". The first aim of this work was to illustrate that grammatical hybridity, understood here as the incorporation of elements from two different linguistic systems into a third linguistic system, results to the existence of functionally equivalent variants

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[4]One finds in the literature concrete suggestions about sets of primitives that form part of UG (see Mendívil-Giró, unpublished, for a recent review of related long-standing misinterpretations).

across speakers and levels of analysis. We have argued that the once competing grammars that are in place in the process of language acquisition (Grohmann and Leivada, 2012) result in a mixed, hybrid system, that of the adult performance, in which elements from different lects are merged into a single grammar.

The second aim was to show that the patterns of variation attested in this hybrid lect boil down to language mixing, and not fusing or switching. Our results show that indeed mixing takes place, and consequently, the Consensus Principle (Labov, 1996) cannot be straightforwardly assumed as true for speakers of non-standard varieties that acquire language in an environment that involves exposure to a standard-dialect continuum. In view of these findings, we have claimed that only a non-parametric theory of UG is compatible with the 'conflicting' values of the functionally equivalent variants that create the grammar under investigation. Last, the noted incompatibility between value-alternation and the 'triggering-a-single-value' approach of parametric models, has led to the suggestion that theories of UG are indeed based on falsifiable (or 'refutable' to use Chomsky's, 1980 word) hypotheses, and as such claims about the alleged unfalsifiability of UG should be dismissed as unfounded.

# ETHICS STATEMENT

This study has been reviewed by the Cyprus National Bioethics Committee which waived the need for a full screening. The study was conducted in accordance with the declaration of Helsinki and written informed consent was obtained from each participant.

# AUTHOR CONTRIBUTIONS

EP and NP recruited the subjects and participated in the recording sessions. EP supervised the transcription of the material. EL, EP, and NP analyzed the results. EL drafted the manuscript. EP and NP reviewed and revised the manuscript.

# ACKNOWLEDGMENTS

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# Imperfect Acquisition of a Related Variety? Residual Clefting and What It Reveals about (Gradient) Bilectalism

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This article explores the concept of gradient bilectalism by capitalizing on insights from recent developments in second language acquisition, particularly the suggestion that aspects of the syntax–discourse interface that are not easily accessible to the learner may lead to fossilization, even at end state. I explore the implications of this suggestion for bilectal grammars by examining the ways in which speakers of Cypriot Greek do syntactic focusing in Standard Greek. The phenomenon is structurally different in the two varieties of Greek examined: clefting is the Cypriot syntactic focusing strategy *par excellence* while in Standard Greek the relevant strategy is movement of the focused item to an immediately preverbal position. Interestingly, this focusing strategy is largely unattested in the acrolectal or standard-like production of bilectal Greek Cypriot speakers; on the contrary, the preferred strategy for syntactic focusing appears to be clefting, as is indicated by data from spontaneous speech. Quantitative data from a questionnaire survey presented in this article confirm that such "residual clefting" persists even at end state, which in turn suggests imperfect acquisition of the relevant structural aspect of Standard Greek, the second variety of these otherwise bilectal speakers. The data invite an approach couched within the Interface Hypothesis, and the argument is put forward that, being a structure at the interface between syntax and other modules or cognitive domains (semantics, pragmatics, and discourse), focusing in the target variety is vulnerable as regards acquisition.

Keywords: bilectalism, cleft, clitic, Cypriot Greek, diglossia, focus, interface

## INTRODUCTION

The sociolinguistic situation in the Greek Cypriot speech community arguably still meets the criteria for Fergusonian diglossia, despite ongoing processes of leveling of local subvarieties and the emergence of a pancypriot *koine* with numerous standard-like structural features (Tsiplakou et al., 2016). The exploration of structural mixing within the Cypriot Greek *koine* (Tsiplakou, 2014a,b) points to "arrested" convergence to Standard Greek, the H variety in Cyprus's diglossic context. Alternatively put, in terms of acquisition of a second, related variety, it seems that the dialect speaker is not fully bilectal (Grohmann and Leivada, 2012; Rowe and Grohmann, 2013).

The purpose of this article is to explore what this assumption means for bilectal grammar(s) by looking at syntactic focusing, which is structurally different in the two varieties of Greek in question: clefting is the Cypriot syntactic focusing strategy *par excellence*; in *wh-* questions (with the exception of those introduced by *iⁿda* "what") the clefting strategy is optional and arguably conditioned by D-linking (Grohmann et al., 2006; Tsiplakou et al., 2007; Fotiou, 2009; Grohmann, 2009). Interestingly, clefting surfaces consistently in Cypriot speakers' standard-like or acrolectal production, although genuine clefting is unavailable in Standard Greek, with the added wrinkle that in such production the copula inflects for tense and agreement, unlike in the *bona fide* Cypriot cleft, while the Standard Greek syntactic strategy for focusing, focus movement, is largely unattested in the acrolectal production of bilectal speakers (Tsiplakou, 2014a). Such "residual clefting" data arguably invite an approach whereby an aspect of the syntax of the target variety which relates to the syntax–discourse interface has strong effects on syntactic acquisition (Sorace, 2011; Tsiplakou, 2014a).

## BILECTALISM IN CYPRUS: STRUCTURAL AND SOCIOLINGUISTIC FACTORS

Unlike other geographical Greek varieties, which have been leveled out or are undergoing sweeping processes of leveling (Contosopoulos, 1969), and despite the fact that diglossia between Cypriot and Standard Greek is still going strong (Papapavlou, 1998; Arvaniti, 2010; Hadjioannou et al., 2011; Tsiplakou, 2011; Rowe and Grohmann, 2013), Cypriot Greek is a variety that still by-and-large resists full dedialectalization (Tsiplakou, 2011, 2014a,b; Rowe and Grohmann, 2013).[1] As has been argued in previous work, dense contact between Standard and Cypriot Greek as well as a host of historical, socio-political, economic, and demographic factors have spurred on currently ongoing processes of leveling of local varieties and the emergence of a pancypriot *koine* (Terkourafi, 2005; Tsiplakou, 2006, 2009a,b; Tsiplakou et al., 2006, 2016; Tsiplakou and Kontogiorgi, 2016), which now stands in a diglossic relationship to Standard Modern Greek. The *koine* acts as a robust buffer against dedialectalization in virtue of the fact that it is (perceived as) a hybrid system, displaying strong structural influences from Standard Modern Greek; such standard-like structural aspects allow for what Rowe and Grohmann (2013) have aptly termed (co-)overt prestige to accrue to the *koine,* due to is perceived, if not actual, convergence with the standard variety (Tsiplakou, 2011, 2014b).

Such structural quasi-convergence with Standard Greek results in hybrid structural patterns akin to code mixing, which are however pragmatically/discursively difficult to interpret as code mixing since they seem to serve no obvious discourse purpose, suggesting instead that some kind of grammatical convergence is at work.[2]

In previous work I have suggested that such structural hybridity ultimately "does not allow the two systems to merge fully, as convergence *qua* structural mixing is mostly achieved through (surface) morphological, as well as lexical, choices, while Cypriot phonology and syntax remain largely intact" (Tsiplakou, 2014b: 164). The argument was based on the availability in acrolectal/standard-like registers of the *koine* of structures where surface lexical or morphological exponents from Standard Greek are inserted in structures which are otherwise *bona fide* Cypriot (or common to both varieties), giving the data its hybrid, quasi-standard flavor, as in (1), where the accusative plural of the feminine determiner appears in the same utterance in both its Standard Greek and its Cypriot form (*tis* and *tes*, respectively)[3]:

| (1) | na to | eⁿdopísume spot.PERF.1P | tis the ACC.FEM.P | ðinatótites strength.ACC.FEM.P |
| | ce and | tes the.ACC.FEM.P | aðinamíes weakness.ACC.FEM.P | |

"in order to spot the strengths and the weaknesses"

In (1) above, the underlying syntactic structure and the morphosyntactic features of the determiner are identical in both varieties; of much greater interest are cases of hybrid production where the syntactic properties of the two varieties differ. Syntactic focusing is a very interesting case in point, not least because, together with clitic placement, it is one of the two core syntactic areas distinguishing the two varieties in question.

## CLEFTS IN THE CYPRIOT *KOINE* AND IN STANDARD(-LIKE) PRODUCTION

Cypriot Greek has focus clefts (Grohmann et al., 2006; Tsiplakou et al., 2007; Grohmann, 2009) whereas in Standard Greek syntactic focusing involves movement of the focused element to a position in the left periphery (a syntactic Focus Phrase above TP) and verb raising (Tsimpli, 1995, 1998):

| (2) | ti the.ACC.FEM.S | stavrúla Stavroula.ACC. FEM.S | vlépo see.NONPAST.1S |

"STAVROULA I am looking at."

(Standard Greek)

[3]The converse pattern obtains in the innovative periphrastic tenses of Cypriot Greek, where dialectal phonology and syntax (e.g., clitic-second effects) occur in innovative, morphologically and semantically standard-like, periphrastic perfect tense structures (Tsiplakou et al., 2016):

| íxamen had.1P | tʃin that.ACC.MASC.S | ton the ACC.MASC.S | filóloɣon Greek teacher.ACC.MASC.S |
| ton the.MASC.ACC.S | fasísta fascist.MASC.ACC.S | | |
| iʃen had.3S | mas us.CL.GEN | ta them.CL.ACC | priíksi swollen | me with | tin the.ACC. FEM.S | eóka EOKA |

"We had this Greek teacher, a total fascist; he had busted us our balls about EOKA." (Melissaropoulou et al., 2013; Tsiplakou et al., 2016).

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[1]Dedialectalization is defined as full leveling of a variety and its subvarieties and concomitant convergence to a related standard (see, e.g., Trudgill, 1999; Kerswill, 2010). The data presented in this paper provide further evidence against the full dedialectalization of Cypriot Greek.

[2]Hence the argument for the availability for competing grammars (Kroch, 1994; Kroch and Taylor, 2000) put forward in Tsiplakou (2009a,b, 2014a) and taken up in Grohmann et al. (2017).

| (3) | en | tin | stávrin | pu |
|---|---|---|---|---|
|  | be | the.ACC.FEM.S | Stavri.ACC.FEM.S | that |
|  | θoró |  |  |  |
|  | see.NONPAST.1S |  |  |  |
|  | "It's Stavri that I am looking at." |  |  | (Cypriot Greek) |

Cypriot Greek presents an added wrinkle: there is a Cypriot-specific clefting strategy (of the *est-ce que* type) available in *wh-* questions; it is obligatory in *wh-* questions introduced by *íⁿda* "what" when *íⁿda* is an argument and it is optional when *íⁿda* is adverbial. In the case of all other *wh-* expressions, the clefting strategy is optional and arguably associated with a D-linked interpretation for the *wh-* expression that is "doubled" by *en pu* "is that" (the Cypriot equivalent of *est-ce que, m bu* below being its phonetically reduced form; see Grohmann et al., 2006; Tsiplakou et al., 2007; Grohmann, 2009; Kanikli, 2011):

| (4) | a. | íⁿda | m | bu | kámni |
|---|---|---|---|---|---|
|  |  | what.ACC | be | that | do.NONPAST.3S |
|  |  | i |  |  | stávri |
|  |  | the.FEM.NOM.S |  |  | Stavri.FEM.NOM.S |
|  |  | "What is it that Stavri is doing?" |  |  |  |
|  | b. | *íⁿda | kámni | i | stávri? |
|  |  | what.ACC | do.NONPAST.3S | the.FEM.NOM.S | Stavri.FEM.NOM.S |
|  |  | "What is it that Stavri is doing?" |  |  |  |
|  | c. | pcos | {en | pu} | írten? |
|  |  | who.MASC.NOM.S | {be | that} | come.PAST.3S |
|  |  | "Who {is it that} came?" |  |  |  |

By contrast, Standard Greek exhibits only *wh-* movement, the feature [wh] inducing verb raising to C:

| (5) | a. | ti | káni |
|---|---|---|---|
|  |  | what.ACC | do.NONPAST.3S |
|  |  | i | stavrúla |
|  |  | the FEM.NOM.S | Stavroula. FEM.NOM.S |
|  |  | "What is Stavroula doing?" |  |
|  | b. | pços | írθe? |
|  |  | who.MASC.NOM.S | come.PAST.3S |
|  |  | "Who came?" |  |

In previous work (Tsiplakou, 2009a,b, 2014a,b), data from spontaneous speech production in Cypriot Greek were discussed in which Cypriot focus and *wh-* clefts display some rather unexpected surface properties: there are instances of focus clefts with the Standard Greek third person copula *íne*, rather than the Cypriot *en* [a form which looks like the third person singular or plural form of the copula but which in fact lacks tense or agreement features, as has been argued in Grohmann et al. (2006) and Tsiplakou et al. (2007); see Merchant and Pavlou (2017) for further extensive discussion]:

| (6) | íne | fitités | pu | θa | aksioloɟísume |
|---|---|---|---|---|---|
|  | be | student.MASC.ACC.P | that | FUT | evaluate.1P |
|  | "It's students that we will evaluate." |  |  |  |  |

There are also some occurrences of focus clefts cum focus movement to the left of the "copula" (see also Gryllia and Lekakou, 2007; Fotiou, 2009; Papadopoulou et al., 2014):

| (7) | teliká | o | arçiepískopos | íne | pu |
|---|---|---|---|---|---|
|  | ultimately | the.MASC.NOM.S | archbishop.MASC.NOM.S | be | that |
|  | ta | ðiicí | óla |  |  |
|  | CL.NEUT.ACC.P | rule.NONPAST.3S | all.NEUT.ACC.P |  |  |
|  | "Ultimately, it's the Archbishop that rules everything." |  |  |  |  |

| (8) | pcos | énːa | me | kataⁿɟíli? |  |
|---|---|---|---|---|---|
|  | who.MASC.NOM.S | FUT | me.CL.MASC.ACC.S | denounce.3S |  |
|  | stin | cípron | en | pu | ímasten |
|  | in the.FEM.ACC.S | Cyprus.ACC | be | that | be.NONPAST.1P |
|  | "Who is going to denounce me? It's in Cyprus that we are." |  |  |  |  |

The standard-like form of the "copula" may furthermore inflect for tense, although, at least in the data from spontaneous production, there are no instances of the copula inflecting for agreement; the Cypriot-specific *est-ce que* type strategy may also occur in *wh-* questions with the standard form of the copula (also inflecting for tense but arguably not for agreement):

| (9) | ítan | metaksí tus | pu | eðiaskeðázan |
|---|---|---|---|---|
|  | be.PAST | among them | that | have fun.PAST.3P |
|  | "It was among themselves that they were having fun." |  |  |  |

| (10) | pu | ítan | pu | emílisen? |
|---|---|---|---|---|
|  | where | be.PAST | that | speak.PAST.3S |
|  | "Where was it that she spoke?" |  |  |  |

Of particular interest for this discussion is the fact that clefts also show up in written production by Cypriot Greek speakers, in texts otherwise written in Standard Greek, e.g., in the newspaper articles in (11) and (12) below[4]:

| (11) | Εμείς | δεν | είναι | που | θέλουμε |
|---|---|---|---|---|---|
|  | emís | ðen | íne | pu | θélume |
|  | we.NOM.P | NEG | be | that | want.NONPAST.1P |
|  | να | λύσουμε | το | κυπριακό. |  |
|  | na | lísume | to | cipriakó |  |
|  | MOD | solve.1P | the.NEUT.ACC.S | Cypriot.NEUT.ACC.S |  |
|  | "Isn't it us that want to solve the Cyprus problem?" |  |  |  |  |

| (12) | Είναι | εμάς | που | πρέπει |
|---|---|---|---|---|
|  | íne | emás | pu | prépi |
|  | be | us.ACC.P | that | Must |
|  | να | απασχολήσει. |  |  |
|  | na | apasxolísi |  |  |
|  | MOD | concern.3S |  |  |
|  | "It's us that this should concern." |  |  |  |

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[4]Sources: http://politis.com.cy/article/o-nikos-pou-xeperase-ton-tasso and http://www.nomisma.com.cy/υπέρ-της-μεταρρύθμισης-της-δημόσιας-υ/ [retrieved 07/18/2017].

In earlier work, it was suggested that "such cases may be treated as arising as a result of an extension of a grammatical structure of the base variety in an attempt to fit the 'perceived' structural properties of the target variety" as "the structural properties of the target variety may not be fully recoverable" (Tsiplakou, 2014b: 175; cf. Tsiplakou, 2014a), an issue which will be taken up in detail in this article.

## QUANTITATIVE DATA

## Convergence to Standard Greek Does Not Affect Clefting

The data presented above were sampled from spontaneous speech (Tsiplakou, 2014a,b; Tsiplakou et al., 2016). In this section, I will present quantitative data from a questionnaire survey, which indicate that clefting displays resistance to language shift; I will attempt to relate the resilience of focus clefting to acquisition factors, with the hope of shedding some (more) light on the notion of gradient bilectalism.

In Tsiplakou et al. (2016), a sociolinguistic study is presented the aim of which was to gage whether there is consistency and coherence vis-à-vis rates of occurrence of particular variants, either Cypriot or standard(-like). The methodology adopted was the sociolinguistic interview; the two interviewers, both young males, were speakers of Cypriot Greek, who used the *koine* throughout, taking care to speak relatively informally. Participants were asked to relate something exciting or emotionally loaded (typically a previous experience) to ensure spontaneity and naturalness in their linguistic production. A total of 57 participants were interviewed, 29 males and 28 females. Their ages ranged from 26 to 90. The participants' profiles were similar in all respects except age, gender and education. All were city dwellers. The variants analyzed quantitatively were (i) the ratio of [ʃ] over [ç], (ii) the ratio of [t͡ʃ] over [c], (iii) the ratio of Simple Past over the innovative periphrastic tenses and (iv) the ratio of enclisis over (unexpected) proclisis.[5] The finding which is of relevance for the discussion in this article is the fact that in that sample there was not a single instance of the Standard Greek syntactic focusing strategy, focus raising; by contrast, every single instance of syntactic focusing involved clefting. This finding is in stark contrast to the variation exhibited in the phonological data and the data involving periphrastic tenses and clitic placement. In all of these areas, standard-like variants were ubiquitously present in the participants' oral production.[6]

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[5]As regards the correlations among these variants and their correlation with extralinguistic factors, the reader is referred to Tsiplakou et al. (2016) for extensive discussion.

[6]Below are examples of "unexpected" proclisis or exceptional clitic placement, i.e., proclisis without a triggering element in the C field:

| a. kséro | to | túto |
|---|---|---|
| know.NONPAST.1S | it.NEUT.ACC.S | this.NEUT.ACC.S |
| kséro | to | |
| know.NONPAST.1S | it.NEUT.ACC.S | |

Of special interest here is the syntactic variation in the data from the other core syntactic area where Cypriot differs radically from Standard Greek, namely pronominal clitic placement. As is well-known, the generalization is that in Standard Greek proclisis (clitic placement in the immediately preverbal position) depends on the finiteness of the verb form, hence gerunds and imperatives trigger enclisis; Cypriot Greek displays clitic-second/Wackernagel or, alternatively, Tobler–Mussafia effects (Horrocks, 1990; Terzi, 1999; Agouraki, 2001; Condoravdi and Kiparsky, 2002; Pappas, 2004, 2014; Revithiadou, 2006, 2008; Tsiplakou, 2006; Chatzikyriakidis, 2010, 2012; Mavrogiorgos, 2010, 2013; Grohmann, 2011; Neokleous, 2015; Grohmann et al., 2017 among others). As with the other variants, while the Cypriot structure, enclisis, was the preferred option, the standard-like strategy of proclisis without a triggering element in C or below, i.e., exceptional clitic placement, was certainly present in that extensive sample of Cypriot Greek oral production.[7] It would then seem that proclisis is seeping into Cypriot Greek grammar (or that competing grammars are at work). This is, however, clearly not the case with focus raising; by contrast, the Cypriot syntactic focusing strategy appears to be used *in lieu of* focus raising even in production which is (or attempts to be) standard-like [as is also indicated by examples such as (7), (11), and (12) above].

| to | éʃi | maθitís | mu |
|---|---|---|---|
| it. NEUT.ACC.S | have.NONPAST.3S | student.MASC.NOM.S | my.GEN.S |

"I know it, this one, I know it! A student of mine has it."

| b. o | cemális | ítan | télos páⁿdon |
|---|---|---|---|
| the.MASC.NOM.S | Kemal.MASC.NOM.S | was.3S | anyway |
| túlos this. MASC.NOM.S | o túrkos the Turk. MASC.NOM.S | | |
| o the MASC.NOM.S | meθístakas drunkard.MASC. NOM.S | | |
| tʃ and | ercetun come. PAST.3S | tʃe and | mas us.ACC | efoitʃazen scare. PAST.3S |

"Anyway, Kemal was this Turkish drunkard, and he would come and scare us."

| c. eɣó | paʎ:á | ðen | milúsa |
|---|---|---|---|
| I.NOM.S | in the past | NEG | speak.PAST.1S |
| tin the.FEM.ACC.S | cipriací Cypriot.FEM.ACC.S | | ðiálekto dialect.FEM.ACC.S |
| tin CL.FEM.ACC.S | eθeórun consider.PAST.1S | | ðíɣman sign.NEUT.ACC.S |
| amorfoʃás illiteracy.FEM.GEN.S | | | |

"In the past I did not speak the Cypriot dialect; I used to consider it a sign of lack of education."

Such exceptional clitic placement occurred at 19% in the data in Tsiplakou et al., 2016.

[7]Leivada et al. (2017) present comparable data, with exceptional clitic placement reaching 17% in their spontaneous speech corpus (which however contained data from five participants). On the whole, both studies present data that may plausibly be taken to attest to the partial reshuffling of the syntax of cliticization in Cypriot Greek.

## The Study

As the numerical data from the study in Tsiplakou et al. (2016) were too few to make meaningful comparisons, and, crucially, as it is impossible to draw any conclusions based solely on the *absence* of a phenomenon in a particular sample, indicative though that absence may be, for the purposes of this article a questionnaire survey was conducted, the focus of which was to gage whether this absence relates to the observation made in previous work and already discussed above to the effect that Cypriot Greek speakers opt for clefting rather than focus movement even in acrolectal/standard-like production, moreover couching the clefted structure in Standard Greek phonology and morphology. The case can then be made that Cypriot Greek speakers treat clefts as part of the grammar of the standard variety, while Standard Greek focus movement slips under the radar, as it were. If this is the case, the findings can be taken to suggest a transfer effect from Cypriot Greek in the acquisition of the standard variety, which needs to be accounted for (cf. Tsiplakou, 2014a,b).[8]

## The Questionnaire

The questionnaire, which was administered electronically, tested for the acceptability of Cypriot-like focus clefts of the following types: (a) clefted adverbials/PPs (two items), (b) clefted first and second person pronominal subjects (four items), (c) clefted third person subjects, pronominal and non-pronominal (two items), (d) clefted direct objects, pronominal and non-pronominal (six items), (e) clefted indirect object PPs (P + ACC, two items) and (f) clefted indirect objects in genitive (two items). The questionnaire also contained nine fillers. Examples of questionnaire items are provided below:

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[8]The study was carried out in accordance with the general recommendations of the Cyprus National Bioethics Committee and with written, informed consent from the subjects; ethics approval was not required as per the Open University of Cyprus guidelines and national regulations.

| (13) | Μετά | από | πολλές | | καθυστερήσεις, |
| | metá | apó | polés | | kaθisterísis |
| | after | from | many.FEM.ACC.P | | delays.FEM.ACC.P |
| | είναι | μόλις | χτες | που | άρχισαν |
| | íne | mólis | xtes | pu | árçisan |
| | be | just | yesterday | that | start.PAST.3S |
| | πάλι | οι | | συνομιλίες. | |
| | páli | i | | sinomilíes | |
| | again | the.FEM.NOM.P | | talks.FEM.NOM.P | |

| (14) | Πάλι | φασαρίες | | έχουμε | | |
| | páli | fasaríes | | éxume | | |
| | again | troubles. FEM.NOM.P | | have.NONPAST.1P | | |
| | στη | | δουλειά, | | | |
| | sti | | ðuʎá | | | |
| | at the.FEM.ACC.P | | work. FEM.ACC.P | | | |
| | και | είναι | εγώ | που | θα | τα |
| | ce | íne | eɣó | pu | θa | ta |
| | and | be | I.NOM.S | that | FUT | them.CL.ACC.P |
| | τραβήξω | | όλα. | | | |
| | travíkso | | óla | | | |
| | suffer.1S | | all.NEUT.ACC.P | | | |
| | "We have problems at work again, and it's I that'll bear the brunt of if all." | | | | | |

| (15) | Έχω | πολλούς | φίλους, | | |
| | éxo | polús | fílus | | |
| | have.NONPAST.1S | many.MASC.ACC.P | friends.MASC.ACC.P | | |
| | αλλά | είναι | ο | Σπύρος | που |
| | alá | íne | o | spíros | pu |
| | but | be | the.MASC.NOM.S | Spyros.MASC.NOM.S | that |
| | με | | στηρίζει | | |
| | me | | stirízi | | |
| | me.CL.ACC.S | | support.NONPAST.3S | | |
| | στα | | δύσκολα. | | |
| | sta | | ðískola | | |
| | in the.NEUT.ACC.P | | difficulty.NEUT.ACC.P | | |
| | "I have many friends, but it's Spyros who stands by me when the going gets tough." | | | | |

| (16) | Στην | παρούσα | πολιτική |
| | stin | parúsa | politicí |
| | in the.FEM.ACC.S | current.FEM.ACC.S | political.FEM.ACC.S |
| | συγκυρία, | είναι | |

| | | |
|---|---|---|
| siʝiría | íne | |
| situation.FEM.ACC.S | be | |
| τους | εξωκοινοβουλευτικούς | που |
| tus | eksokinovuleftikús | pu |
| the.MASC.ACC.P | extraparliamentary.MASC.ACC.P | that |
| εμπιστεύεται | ο | κόσμος. |
| ebistévete | o | kózmos |
| trust.NONPAST.3S | the.MASC.NOM.S | people.MASC.NOM.S |

"In the current political situation, it's the extraparliamentary forces that people trust."

| (17) | Αν κι | είναι | πολλοί | | |
|---|---|---|---|---|---|
| | an ci | íne | polí.MASC.NOM.P | | |
| | although | be | many.NOM | | |
| | οι | | συνυποψήφιοι, | | |
| | i | | sinipopsífii | | |
| | the.MASC.NOM.P | | candidates.MASC.NOM.P | | |
| | είναι | εσένα | που | θα | επιλέξουν. |
| | íne | eséna | pu | θa | epiléksun |
| | be | you.ACC.S | that | FUT | select.3P |

"Although the candidates are several, it's you that they'll select."

The 12 controls, all highly educated monolingual speakers of Standard Greek, all found the questionnaire items ungrammatical.[9]

Participants were asked to rate the sentences as grammatical or ungrammatical in Standard Greek and were moreover asked to suggest corrections in case they thought the sentences were ungrammatical. Data were discarded in case the corrections were irrelevant to the focus of the study.[10]

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[9]The controls were also asked to correct the sentences; all opted for focus movement, as in

| Εσένα | θα | επιλέξουν. |
|---|---|---|
| eséna | θa | epiléksun |
| you.ACC.S | FUT | select.3P |

A second choice for some of the controls was a structure involving an inflected copula and a relative clause, which has only partial similarity to the Cypriot cleft, e.g.:

| Εσύ | είσαι | αυτός | που | θα | {τον} | επιλέξουν. |
|---|---|---|---|---|---|---|
| esí | íse | aftós | pu | θa | {ton} | epiléksun |
| you.NOM.S | are.2P | he.MASC.NOM.S | that | FUT | {him. CL.ACC.S} | select.3P |

"YOU are the one that they'll select."

This structure, however, differs from the Cypriot cleft in several important respects: first, it involves an inflected copula and number and person agreement between the copula and the focused item, which, crucially, has been changed to a subject; second, the nominative case on the focused element along with the presence of an object pronoun in the relative clause suggests that no extraction of the focused object out of the non-matrix clause has taken place; this is a major difference to true focus clefts such as the Cypriot Greek ones, where the focused element in the cleft retains what case marking corresponds to its position within the lower clause (e.g., accusative for the direct object in the example above) and the use of a resumptive pronoun results in ungrammaticality.

[10]The questionnaire also examined the acceptability of focus clefts cum focus movement to the left of the "copula"; the results for these items will be discussed in future work.

## Participants

A total of 96 subjects participated in the study, 61 females and 35 males. All identified themselves as native speakers of Cypriot Greek. All participants were born and raised in Cyprus, they had Greek Cypriot parents, and there were no bilingual speakers in the sample. Their ages ranged from 18 to 70 (M = 37.1, SD = 11.1). As regards age groups, 64 were younger than 40, while the rest (32) were 40 years old or older. It is worth noting that most participants were quite highly educated (with degrees from tertiary education or higher at 92%), while the rest (8%) had only completed secondary education. The high education level of participants may in fact be advantage, if not a *desideratum*, in this case as highly educated speakers can be reasonably assumed to be highly proficient speakers of Standard Greek, so their judgments reflect accurately the acquisition of the phenomenon in question at end state.

Regarding geographical provenance, 60 participants were of urban origin, while 36 were of rural origin;[11] the expectation was that the urban-rural distinction would be more relevant than precise geographical provenance for the purposes of this discussion.

## RESULTS

Overall, participants accept clefting as a focusing strategy in Standard Greek at 53%. A binomial test indicated that the

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[11]Participant groupings into areas of origin are shown in the following table:

| | M | N |
|---|---|---|
| Lefkosia | 47% | 45 |
| Lemesos | 20% | 19 |
| Larnaka | 13% | 12 |
| Ammochostos | 11% | 11 |
| Pafos | 9% | 9 |

Grouping of subjects according to area of origin.

observed acceptance rate of clefts (53%) was significantly different from the 50% chance level, $p = 0.017$ (two-sided).[12]

A logistic regression was performed to ascertain the effects of gender, age group, education, area of origin and the urban-rural distinction on the likelihood that participants accept cleft structures in otherwise Standard Greek sentences (see **Table 1**). The logistic regression model was statistically significant, $\chi^2(23) = 217.096$, $p < 0.0005$. The model explained 16.4% (Nagelkerke $R^2$) of the variance in cleft acceptability and correctly classified 62.8% of cases.

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[12] I am very grateful to Spyros Armostis for his invaluable help with the analysis.

**TABLE 1** | Logistic regression results.

| | b (SE) | Sign. | Exp b | 95% CI for exp b | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| **Included** | | | | | |
| Gender | 0.913 (0.302) | 0.002 | 2.491 | 1.379 | 4.500 |
| Age group | 2.637 (0.878) | 0.003 | 13.969 | 2.500 | 78.046 |
| Area (Lemesos) | −2.405 (0.498) | <0.0005 | 0.090 | 0.034 | 0.239 |
| Area (Pafos) | −4.408 (1.241) | <0.0005 | 0.012 | 0.001 | 0.139 |

*$R^2 = 0.095$ (Hosmer and Lemeshow), 0.123 (Cox and Snell), 0.164 (Nagelkerke).*
*Model $\chi^2(23) = 217.096$, $p < 0.0005$. Percentage of correct prediction: 62.8%.*

As can be seen from **Figure 1**, males accepted clefts were 2.491 times that of females, $b = 0.913$, Wald $\chi^2(1) = 9.144$, $p = 0.002$. Males (M = 57%) accepted clefts at *higher* rates compared with females (M = 51%).

The odds of older subjects ($\geq 40$) accepting clefts was 13.969 times that of younger subjects ($<40$), $b = 0.913$, W $b = 2.637$, Wald $\chi^2(1) = 9.023$, $p = 0.003$. As can be seen from **Figure 2**, older subjects (M = 56%) accepted clefts at *higher* rates compared with younger subjects (M = 51%).

Quite interestingly, there was no statistically significant difference between subjects of tertiary and secondary education (**Figure 3**).

Also quite interestingly, there was no statistically significant difference between subjects of urban and rural origin (**Figure 4**).[13]

The data were further analyzed on the basis of cleft type. Results were as follows (**Figure 5**):

A binomial test indicated that the observed acceptance rate of *Clefted Adverbials/PPS* (41%) was significantly different from the 50% chance level, $p = 0.014$ (two-sided).

A binomial test indicated that the observed acceptance rate of *Clefted Subjects (third person)* (68%) was significantly different from the 50% chance level, $p < 0.0005$ (two-sided).

_____
[13] As regards precise area of origin, overall this was not a predictive factor, as expected.
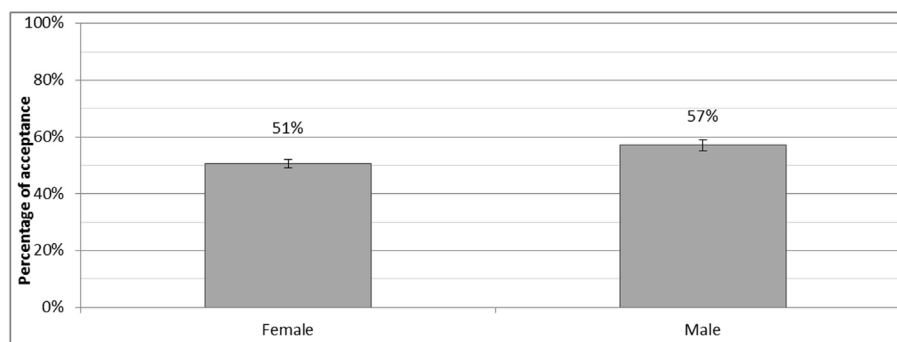


**FIGURE 1** | Rates of cleft acceptance as a function of gender.
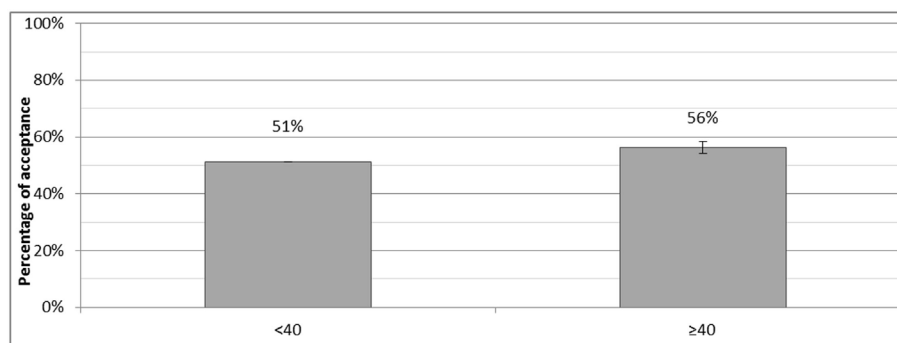


**FIGURE 2** | Rates of cleft acceptance as a function of age group.
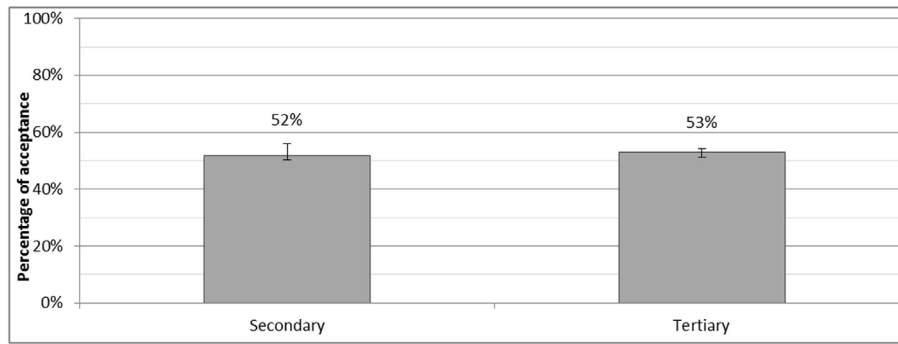
**FIGURE 3** | Rates of cleft acceptance as a function of education.
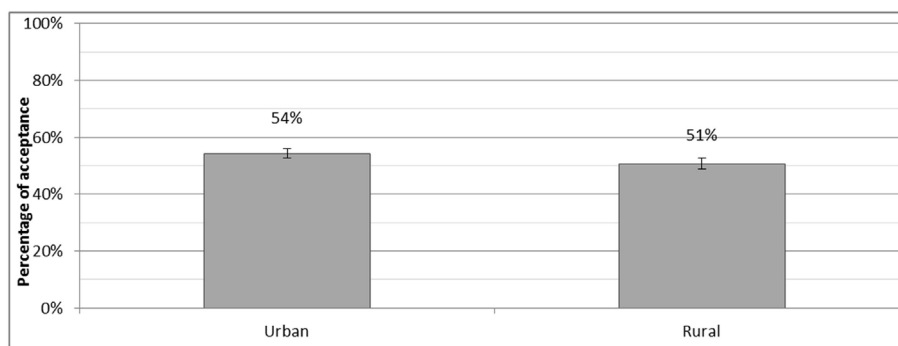


**FIGURE 4** | Rates of cleft acceptance as a function of urban vs rural provenance.
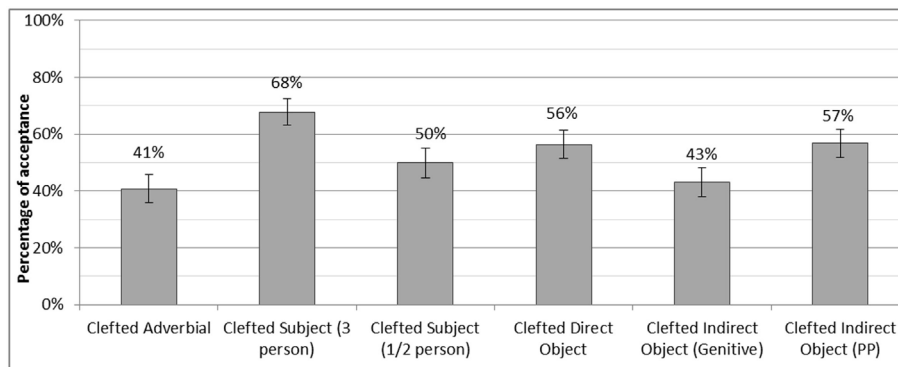


**FIGURE 5** | Percentage of cleft acceptance as a function of cleft type.

A binomial test indicated that the observed acceptance rate of *Clefted Subjects (first or second person)* (50%) was not significantly different from the 50% chance level, $p = 1.000$ (two-sided).

A binomial test indicated that the observed acceptance rate of *Clefted Direct Objects* (56%) was significantly different from the 50% chance level, $p = 0.002$ (two-sided).

A binomial test indicated that the observed acceptance rate of *Clefted Indirect Objects with Genitive* (43%) was not

significantly different from the 50% chance level, $p = 0.071$ (two-sided).

A binomial test indicated that the observed acceptance rate of *Clefted Indirect Objects with PP* (57%) was not significantly different from the 50% chance level, $p = 0.071$ (two-sided).

On the basis of these findings, it appears that the acceptability of focus clefts in Standard Greek, our participants' second variety, an effect which I termed "residual clefting" in the beginning of

this article, is still quite prevalent, as is evidenced by the fact that participants performed significantly above chance.[14]

## DISCUSSION

A closer look at the quantitative data reveals some interesting details as regards the distribution of variation in acquisition: women and the younger age group accept focus clefts in Standard Greek less than do men and the older age group, the differences between groups being statistically significant. In other words, women and younger speakers display higher rates of convergence toward the standard than do men and the older age group.

As regards variation in acquisition depending on the type of cleft, what is rather striking is the difference in acceptability between clefted first and second vs third person subjects (50 and 68%, respectively). A possible explanation may be that participants accept to a lesser extent structures in which there is person mismatch between the "copula," which superficially looks like a morphological third person form, and the subject, which may in turn be taken to suggest some kind of reshuffling in the grammar, in the sense that the preference for third person clefted subjects may indicate that the "copula" is treated as having agreement features (cf. the Standard Greek data in text footnote 9).

On the whole, the imperfect acquisition of the Standard Greek focusing strategy evidenced by the data and the concomitant transfer of Cypriot Greek clefting into the target variety may at first blush appear to be puzzling. In a sense, focus raising is a "simpler" strategy than clefting, which involves a more complex biclausal structure (Grohmann et al., 2006; Tsiplakou et al., 2007). Moreover, it may be reasonably assumed that the acquisition of focus movement is not underdetermined by input, as structures with syntactic focusing are quite run-of-the-mill in the standard variety. The perseverance of clefting in standard-like production is probably less hard to account for: excluding clefting would involve focusing on negative evidence (White, 1987), i.e., somehow deducing the absence of this structure in the target variety.[15] What needs to be accounted for independently is the acquisition deficit as regards the Standard Greek syntactic focusing strategy.

As stated in the introductory section, the problematic acquisition of syntactic focusing, as evidenced by the "residual clefting" data in the target variety, invites an approach in terms of the Interface Hypothesis, according to which adult second language acquisition of phenomena which only pertain to a particular module of grammar, e.g., syntax only, is ultimately fully achieved at end state, whereas acquisition of phenomena which pertain to an interface (e.g., syntax–semantics, syntax–pragmatics/syntax–discourse) is extremely hard to achieve and is almost never perfect. It is tempting to suggest that this is what underpins the imperfect acquisition of syntactic focusing in Standard Greek by Cypriot Greek speakers, as evidenced by the questionnaire data, as it would seem that an aspect of the syntax of the target variety which relates to the syntax–discourse interface has strong effects

on syntactic acquisition (Montrul, 2011; Sorace, 2011; White, 2011; Tsiplakou, 2014a).

Relevant research in SLA has shown that, as regards formal grammatical properties and operations in the narrow syntax, near-native competence can be reached despite the fact that these are often underdetermined by input (Tsimpli et al., 2004; Lozano, 2006, 2008, 2016; Sorace and Filiaci, 2006; Tsimpli and Sorace, 2006; Tsimpli and Dimitrakopoulou, 2007; Tsimpli and Mastropavlou, 2007; Sorace and Serratrice, 2009).[16] By contrast, syntactic focus movement involves operations not only in the narrow syntax but, crucially, at the syntax–discourse interface: in Greek syntactic focus movement involves an (interpretable) [+f] feature associated with an $F^0$ in an FP which is lower than C but higher than I; the syntactic reflexes of [+f] include changes in the word order, raising of the focused constituent to FP and concomitant I-to-F raising, which accounts for the fact that syntactically focused constituents occur in the immediately preverbal position (Tsimpli, 1995, 1998). Crucially, these operations need to be mapped on to the relevant information/discourse structures, which in turn involve notions such as old vs new, presentational vs contrastive focus (Kiss, 1998). A further complication is that in Standard Greek focused constituents *in situ* may be interpreted either as presentational or contrastive foci, while moved focused constituents are interpreted as contrastive foci. The acquisition of the relevant structural configurations thus involves aspects of the syntax–discourse interface and is therefore predicted to be complex, underdetermined by input, and perfect attainment is predicted to be hard to reach (Tsimpli and Sorace, 2006; Sorace, 2011). Standard Greek syntactic focus structures indeed appear to be a problematic case for acquisition, as evidenced by the persistence of transfer of focus clefts in otherwise standard(-like) production by speakers of Cypriot Greek and the level of non-native competence suggested by the data presented in this article.

## CONCLUSION

In previous work it was argued that the grammatical systems of Standard and Cypriot Greek are far from converging, and this despite leveling of local subvarieties and the emergence of a

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[14]On optionality as non-native attainment see Sorace (2000, 2005, 2006).
[15]A confounding factor may be the availability in Standard Greek of structures such as those discussed in text footnote 9.

[16]As was mentioned earlier, exceptional clitic placement appears to present the opposite picture from that of residual clefting for bilectal grammar(s), not only in terms of full acquisition, but also as full acquisition arguably has structural effects on the syntactic system of the first variety. It is worth posing the question whether the full acquisition of Standard Greek clitic placement can be attributed to the fact that this structural phenomenon relates to formal operations in the narrow syntax, with pragmatic or discourse considerations not bearing upon the acquisition of such operations. However, Standard Greek clitic placement relates to finiteness, with proclisis depending on full person agreement on T (Mavrogiorgos, 2010, 2013; cf. Neokleous, 2015) or, alternatively, to verb movement to Mood or above (Agouraki, 1997, 2001; Terzi, 1999; cf. Uriagereka, 1995); in other words, in available analyses the formal operation of clitic placement also seems to involve some aspect of the syntax-semantics interface. It is worth exploring whether the differential acquisition of cliticization and syntactic focusing may be related to the fact that in the former interfacing takes place between modules of the grammar and involves formal semantic features that are arguably internal to the grammar (e.g., Mood) while in the latter interfacing also takes place between grammar and discourse, which makes for more vulnerable acquisition [as is argued, e.g., in Tsimpli and Sorace (2006), Sorace and Serratrice (2009), and Sorace (2011)].

pancypriot *koine* which displays grammatical hybridity; in this article the suggestion was taken up that grammatical hybridity is achieved through standard-like morphological choices while the syntax of the base variety remains intact and this suggestion was explored further by examining syntactic focusing in acrolectal, standard-like production. It was shown that speakers do not achieve native-like attainment as regards Standard Greek focus movement at end state, as evidenced by the prevalence of Cypriot clefts in acrolectal, standard-like production and related acceptability judgments. An attempt was made to show that imperfect acquisition of this core area of Greek syntax may be captured by the Interface Hypothesis and the difficulties for acquisition posed by phenomena at the syntax–discourse interface. Exploring and accounting for different levels of attainment in a second, related variety along such theoretical lines in turn yields a richer understanding of gradient bilectalism.

## ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the "Cyprus National Bioethics Committee" with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

## AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

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# Effects of Two Linguistically Proximal Varieties on the Spectral and Coarticulatory Properties of Fricatives: Evidence from Athenian Greek and Cypriot Greek

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Several studies have explored the acoustic structure of fricatives, yet there has been very little acoustic research on the effects of dialects on the production of fricatives. This article investigates the effects of two linguistically proximal Modern Greek dialects, Athenian Greek and Cypriot Greek on the temporal, spectral, and coarticulatory properties of fricatives and aims to determine the acoustic properties that convey information about these two dialects. Productions of voiced and voiceless labiodental, dental, alveolar, palatal, and velar fricatives were extracted from a speaking task from typically speaking female adult speakers (25 Cypriot Greek and 20 Athenian Greek speakers). Measures were made of spectral properties, using a spectral moments analysis. The formants of the following vowel were measured and second degree polynomials of the formant contours were calculated. The findings showed that Athenian Greek and Cypriot Greek fricatives differ in all spectral properties across all places of articulation. Also, the co-articulatory effects of fricatives on following vowel were different depending on the dialect. Duration, spectral moments, and the starting frequencies of $F1$, $F2$, $F3$, and $F4$ contributed the most to the classification of dialect. These findings provide a solid evidence base for the manifestation of dialectal information in the acoustic structure of fricatives.

Keywords: spectral variation, spectral moments, coarticulation, fricatives, consonants, speech production, Athenian Greek, Cypriot Greek

## 1. INTRODUCTION

During the last few decades, there has been a surge of interest on the acoustic properties of fricative consonants. Fricatives are sounds characterized by complex production patterns that result in different acoustic spectral shapes (Ladefoged and Maddieson, 1996; Iskarous et al., 2011). However, the effects of dialects on fricatives' acoustic productions are poorly understood (see for a discussion Thomas, 2013, p. 116). Earlier research determined how linguistic categories, such as the place of articulation and voicing shape the spectral properties of fricatives (e.g., Hughes and Halle, 1956; Nittrouer et al., 1989; Baum and McNutt, 1990; Ladefoged and Maddieson, 1996; Jongman et al., 2000; Fox and Nissen, 2005; Shadle, 2010; Iskarous et al., 2011; Koenig et al., 2013), yet most of these findings are based on acoustic evidence from a single language variety (e.g., for Korean fricatives see

Cho et al., 2002, for English fricatives see Tabain, 1998; Jongman et al., 2000; Iskarous et al., 2011). Despite the fact that a number of earlier studies showed that social factors, such as gender and age (e.g., see Jongman et al., 2000; Fox and Nissen, 2005; Li et al., 2016), education, social identity, social networks (e.g., Baran, 2014) and the place of origin, urban vs. rural (Dubois and Horvath, 1998; Kochetov, 2006; Stuart-Smith, 2007; Mazzaro, 2011) have significant effects on fricatives, the effects of dialect on fricatives acoustic structure are understudied.

The purpose of this study is to determine the acoustic characteristics of fricative productions in two linguistically proximal varieties: Athenian Greek and Cypriot Greek and establish the sociophonetic effects of these two varieties on fricatives' production. By determining the acoustic patterns of fricatives that differ in the two varieties, the study aims to establish which aspects of fricative spectra convey sociophonetic information about the distinct lingualities of Athenian Greek and Cypriot Greek speakers. The central thesis of this paper is that cross-dialectal studies of fricative's acoustic structure can reveal patterns that designate speakers of different dialectal groups. The findings of this study can be important as they can unveil patterns of language variation and change, which often as Labov (1994, p. 78) suggests, "[a]t the outset, and through most of their development, they are completely below the level of social awareness. No one notices them or talks about them, and even phonetically trained observers may be quite unconscious of them for many years." Notably, such effects can potentially unveil the cognitive processes that bidialectal speakers employ to elicit information about the dialect from fricative spectra.

Earlier studies on Greek point to impressionistic differences in the production of Athenian Greek and Cypriot Greek fricatives (e.g., see Newton, 1972a,b; Vagiakakos, 1973) and to differences in the fricative inventories of Athenian Greek and Cypriot Greek. Namely, unlike Athenian Greek, Cypriot Greek is characterized by quantity distinctions in its fricatives (geminates vs. singletons) (see **Table 1**)[1] and also includes in its phonemic inventory fricatives articulated at the post-alveolar place of articulation (Newton, 1972a,b; Vagiakakos, 1973; Arvaniti, 2000; Tserdanelis and Arvaniti, 2001; Botinis et al., 2004; Payne and Eftychiou, 2006; Armosti, 2009; Christodoulou, 2015)[2].

Notably, only a handful of studies provides acoustic evidence on Athenian Greek and Cypriot Greek fricatives: Nirgianaki (2014) who provided acoustic evidence on the Athenian Greek fricatives, two earlier pilot studies of ours that report acoustic evidence for four fricatives of the Cypriot Greek and Athenian Greek fricatives, i.e., [f, θ, ç, x] (Aristodemou et al., 2015; Themistocleous et al., 2016), and Eftychiou (2008) who

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[1]In Cypriot Greek there is no phonemic contrast between a long /z:/ and short /z/, so in **Table 1** it is unspecified for quantity; however, see for a different approach Arvaniti (1999b) and Armosti (2009) who claim that /z/ is phonemically long, proposing as the default the marked pair of a supposed phonetic contrast.
[2]Cypriot Greek post-alveolar fricatives can be phonemes, especially in loan words or allophones of velar fricatives when the fricative precedes a front vowel. In that case, the post-alveolar fricatives is more marked than the palatal, which is considered more standard (see for example Baltazani et al., 2016, for a current exposition on Modern Greek palatalization).

**TABLE 1 |** Athenian Greek (AG) and Cypriot Greek (CG) fricative consonants.

|  |  | Labiod. | Dental | Alveolar | Postalveolar | Palatal | Velar |
|---|---|---|---|---|---|---|---|
| AG |  | f   v | θ   ð | s   z |  | ç   ʝ | x   ɣ |
| CG | Singl. | f   v | θ   ð | s   z | ʃ   ʒ | ç   ʝ | x   ɣ |
|  | Gemin. | f:   v: | θ:   ð: | s: | ʒ: | ç:   ʝ: | x:   ɣ: |

investigates vowel elision and within this context, she reports acoustic measurements for the Cypriot Greek [s]. So, this study will be the first to provide comparative data from Athenian Greek and Cypriot Greek fricatives and it will show their coarticulatory effects on the following vowels.

To understand the effects of dialects on fricatives, we provide evidence from three distinct studies: (i) an investigation of the spectral and temporal properties of fricatives, using spectral moments analysis and measurements of fricative duration; (ii) an investigation of the co-articulatory effects of fricatives on the following vowel formants, using polynomial models of vowel formants; and (iii) a classification model of the contribution of fricatives' spectral and temporal properties together with the effects of fricative-vowel coarticulation.

## 2. STUDY 1: SPECTRAL PROPERTIES

Study 1 investigates the effects of dialect on the acoustic structure of fricatives. Fricative spectra are characterized by frication noise that can be distinguished from the aperiodic energy in a mid-high frequency range that extends throughout fricatives production. Also, the periodicity that occurs simultaneously with frication distinguishes fricatives into voiced and voiceless. Depending on their spectral properties, fricatives can be grouped into sibilants (e.g., [s, z, ʃ, ʒ]) and non-sibilants [f, v, θ, ð] (e.g., Hughes and Halle, 1956; Jongman et al., 2000; Shadle, 2010). The sibilants are produced when the air jet is forced to pass across the upper teeth. The non-sibilants consist of a more distributed noise, which is produced when the air-jet runs across an inclined obstacle, such as the hard or the soft palate. The labiodental fricatives are produced very close to the mouth opening and can be considered a third category, in terms of their spectra and articulators involved (Shadle, 2010).

A long established technique that attempts to provide an account of the local and global properties of fricative spectra is the spectral moments analysis. An advantage of using spectral moments is that this method can enable the probabilistic analysis of fricative spectra (see also Koenig et al., 2013). In our earlier research, we employed spectral moments to specify the effects of the place of articulation and stress on fricatives (Aristodemou et al., 2015; Themistocleous et al., 2016). In this study, we employ spectral moments to determine the effects of dialect on fricative spectra. In the following, we present the main effects observed from the three different studies employed in this research and then we discuss their main findings.

## 2.1. Methodology

The recordings of this study were conducted between 2011 and 2012 in Athens, which is the capital city of Greece and in Nicosia, which is the capital city of Cyprus, and it is part of larger program that aims to understand the effects of dialects on the acoustic structure of speech sounds (see also Themistocleous, 2016, 2017b).

### 2.1.1. Speakers

Fricative sounds were produced by 20 female speakers of Athenian Greek and 25 female speakers of Cypriot Greek born and raised in Athens and Nicosia, respectively. The reason for selecting female speakers is that in this study we are not interested in exploring the effects of gender on speech production and also in this way we avoid normalization for gender with respect to fricative spectra and vowels. At the time of the recording, i.e., during the years 2011–2012, the speakers were between 19 and 29 years old (years; months; mean = 22;8). Sociolinguistically the speakers represented a young and educated population. Specifically, all speakers were university students, from middle-class families, and bilingual in Greek and English (as a second language). Note that Cypriot Greek speakers were familiar with Athenian Greek from their interactions with Athenian Greek speakers, the media, the formal education etc. By contrast, Athenian Greek speakers have much less familiarity with Cypriot Greek. The speakers had no speech or hearing disorders or previous history of neurological, cognitive, orostructural problems.

### 2.1.2. Speech Material

The speech materials consisted of CVCV words (see **Table 2**). Each word contained a labiodental ([f v]), dental ([θ ð]), alveolar ([s z]), palatal ([ç ʝ]), and velar ([ɣ x]) fricative in both stressed and unstressed position. Note that Cypriot Greek postalveolar consonants ([ʃ ʒ]) have been also recorded but they are not reported in this study, since there are no corresponding Athenian Greek consonants at the post-alveolar place of articulation. To allow for the production of both velar and the palatal fricatives the speech material included two vowel environments after the fricative consonant, namely the vowels /a/ and /i/. The keywords were embedded in a carrier phrase, that varied slightly so as to sound more natural to the speakers of each dialect. Specifically, the carrier phrase for Athenian Greek was /ˈipa *keyword* ˈpali/ (I told *keyword* again) and for the Cypriot Greek experiment the carrier phrase was /ˈipa *keyword* ˈpale/ (I told *keyword* again). Also we added filler words in the speech material to distract speakers from focusing on the keywords of the experiment. Since all contextual effects are kept constant in all cases, other coarticulatory or prosodic effects on fricative productions or on vowels measured are not expected.

Overall, the speech material consisted of 5,760 fricative productions, namely, 1,920 productions for the six fricatives of Athenian Greek (i.e., 20 speakers × 6 fricatives × 2 repetitions × 2 word positions × 2 stress conditions × 2 vowels) and 2,400 productions for the eight fricatives that can precede both vowels in Cypriot Greek (i.e., 25 speakers × 6 fricatives × 2 repetitions × 2 word positions × 2 stress conditions × 2 vowels) and 1,440 productions for the four fricatives that precede either vowel /i/ or /a/ (i.e., 45 speakers × 4 fricatives × 2 repetitions × 2 word positions × 2 stress conditions × 1 vowel).

The Athenian Greek speakers were recorded in a recording studio in Athens and the Cypriot Greek speakers were recorded in a quiet room at the University of Cyprus. To avoid influence from the experimenter's speech variety on participants' productions (like code-switching from one variety to another, as it is often the case with Cypriot Greek speakers), the instructions were given to the Athenian Greek speakers by an Athenian Greek speaking assistant whereas the author, a Cypriot Greek speaker himself, provided the instructions to Cypriot Greek speakers. The instructions did not include information about the purposes of the experiment. The only information we provided included basic instructions about the experimental setting, such the appropriate distance from the microphone. Subjects read the sentences written in Greek orthography in random order. A Zoom H4n audio recorder was used for the recording and the voice was sampled at 44.1 kHz. Praat (Boersma and Weenink, 2016) was used for segmentation and acoustic analysis, spectral moments were calculated in Praat using a modified version of DiCanio (2013)'s script. The onsets and offsets of the frication noise were determined both in the waveform and spectrogram. Also, the offsets and onsets of the $F1$ and $F2$ facilitated the segmentation.

### 2.1.3. Statistics

Fricative spectra are measured at multiple windows and then the probability distribution of these measurements is estimated with moments:

- *Center of gravity* is a measure of the mean energy concentration of fricatives.
- *Standard Deviation* is a measure of the deviation of spectral values from the center of gravity.
- *Skewness* is a measure of the shape of the spectral distribution; a positive skewness indicates a right-tailed distribution and a negative skewness indicates a left-tailed distribution.
- *Kurtosis* is a measure of the shape of the distribution and indicates how heavy the tails of the distribution are. When the distribution is flat, the kurtosis is negative and when the distribution forms a peak, then the kurtosis is positive.

We analyzed the middle 80% of the total duration of the fricative by excluding a 10% from each side. Then the first four spectral moments that correspond to the center of gravity, standard deviation, skewness, and kurtosis were calculated from the fricative spectra. A linear mixed effects analysis was conducted with the center of gravity, standard deviation, skewness, kurtosis, and duration as response variables. The dialect, place of articulation, voicing, and stress were employed in the model as fixed factors. Random intercepts for speakers and keywords were added in the models (for an account on linear mixed-models see Baayen, 2008; Bates et al., 2015). The duration was log-transformed where needed to improve the model—these cases are reported in the Results section.

**TABLE 2 |** Experimental material.

| Stress | [f] | | [v] | | [θ] | | [ð] | |
|---|---|---|---|---|---|---|---|---|
| S | 'fisa | sa'fi | 'visa | sa'vi | 'θisa | sa'θi | 'ðisa | sa'ði |
| U | fi'sa | 'safi | vi'sa | 'savi | θi'sa | 'saθi | ði'sa | 'saði |
| S | 'fasa | 'safa | 'vasa | sa'va | 'θasa | sa'θa | 'ðasa | sa'ða |
| U | fa'sa | sa'fa | va'sa | 'sava | θa'sa | 'saθa | ða'sa | 'saða |

| Stress | [s] | | [z] | | [ç x] | | [ʝ ɣ] | |
|---|---|---|---|---|---|---|---|---|
| S | 'sisa | si'sa | 'zisa | sa'zi | 'çisa | sa'çi | 'ʝisa | sa'ʝi |
| U | si'sa | 'sisa | zi'sa | 'sazi | çi'sa | 'saçi | ʝi'sa | 'saʝi |
| S | 'sasa | sa'sa | 'zasa | sa'za | 'xasa | sa'xa | 'ɣasa | sa'ɣa |
| U | sa'sa | 'sasa | za'sa | 'saza | xa'sa | 'saxa | ɣa'sa | 'saɣa |

## 2.2. Results

Athenian Greek and Cypriot Greek fricatives differed in all spectral properties across all places of articulation. The mean and the standard deviation of spectral moments are reported in **Table 3**. The linear mixed effects models for the center of gravity and standard deviation are shown in **Table 4** and those for skewness and kurtosis are reported in **Table 5**.

*Center of Gravity.* More specifically, *Cypriot Greek alveolar and velar fricatives* had higher center of gravity than the corresponding Athenian Greek fricatives. By contrast, *Athenian Greek dental fricatives* had higher center of gravity than Cypriot Greek fricatives. In the labiodental and palatal places of articulation, *Cypriot Greek voiceless fricatives* are produced with higher center of gravity than Athenian Greek voiceless fricatives whereas the voiced fricatives had higher center of gravity in Athenian Greek. The effects are the following:

1. *Cypriot Greek > Athenian Greek*:

   - [f]. Cypriot Greek: $M = 7,440$, $SD = 3,375$; Athenian Greek: $M = 6,260$, $SD = 1,736$.
   - Alveolar fricatives. Cypriot Greek [s] $M = 10,064$, $SD = 1,271$, [z] $M = 8,249$, $SD = 2,759$; Athenian Greek: [s] $M = 6,968$, $SD = 954$, [z] $M = 5,453$, $SD = 1,670$.
   - [ç]. Cypriot Greek: $M = 6,900$, $SD = 1,871$; Athenian Greek $M = 6,060$, $SD = 767$.
   - Velar fricatives. Cypriot Greek: [x] $M = 2,879$, $SD = 1,053$; [ɣ] $M = 1,461$, $SD = 961$, Athenian Greek: [x] $M = 2,627$, $SD = 756$, [ɣ] $M = 1,162$, $SD = 399$.

2. *Cypriot Greek < Athenian Greek*:

   - [v]. Cypriot Greek: $M = 1,909$, $SD = 2,170$; Athenian Greek: $M = 2,366$, $SD = 1,841$.
   - Dental fricatives. Cypriot Greek [θ]: $M = 6,567$, $SD = 3,646$) and Cypriot Greek [ð]: $M = 1,133$, $SD = 881$; Athenian Greek [θ]: $M = 6,790$, $SD = 1,816$, Athenian Greek [ð]: $M = 1,306$, $SD = 1,067$.
   - [ʝ] Cypriot Greek $M = 2,253$, $SD = 2,170$; Athenian Greek: $M = 2,443$, $SD = 1,696$.

First, the dialect had an overall significant effect on the center of gravity (see also **Figure 1**). The interaction of dialect × place of articulation shows that the dental, alveolar, palatal and velar fricatives differ significantly in the two varieties. Also, the Athenian Greek and Cypriot [θ], [s], and [ç] differ significantly in their center of gravity. In addition to these effects, stress resulted in significantly different effects on the center of gravity of the Athenian Greek and Cypriot Greek *palatal* fricatives.

*Standard Deviation.* Dialect had significant effects on the spectral standard deviation of fricatives. Overall, Cypriot Greek fricatives are characterized by higher standard deviation than Athenian Greek fricatives (see also **Figure 2**). This is true for

- [v] (Cypriot Greek: $M = 2,488$, $SD = 1,811$, Athenian Greek: $M = 2,911$, $SD = 1,447$,
- [ð] (Cypriot Greek: $M = 1,861$, $SD = 1,402$, Athenian Greek: $M = 1,822$, $SD = 1,162$,
- the alveolars [s] (Cypriot Greek: $M = 2,409$, $SD = 640$, Athenian Greek: $M = 1,952$, $SD = 468$) and [z] (Cypriot Greek: $M = 3,382$, $SD = 1,206$, Athenian Greek: $M = 2,666$, $SD = 730$,
- the palatals [ç] (Cypriot Greek: $M = 3,619$, $SD = 697$, Athenian Greek: $M = 2,731$, $SD = 463$), [ʝ] (Cypriot Greek: $M = 2,671$, $SD = 1,362$, Athenian Greek: $M = 2,527$, $SD = 969$) and
- the velars [x] (Cypriot Greek: $M = 2,743$, $SD = 1,062$, Athenian Greek: $M = 2,211$, $SD = 738$) and [ɣ] (Cypriot Greek $= M = 1,965$, $SD = 1,266$, Athenian Greek: $M = 1,189$, $SD = 502$.

The results suggest that Cypriot Greek speakers produced all these fricatives with greater variation with respect to the center of gravity than Athenian Greek speakers. Only the Athenian Greek voiceless labiodental [f] (Cypriot Greek: $M = 4,483$, $SD = 1,253$, Athenian Greek: $M = 4,563$, $SD = 766$) and the dental [θ] (Cypriot Greek: $M = 4,299$, $SD = 1,358$, Athenian Greek: $M = 4,391$, $SD = 756$) had higher standard deviation than the corresponding Cypriot Greek fricative productions. Specifically, the two dialects had an overall effect on the spectral standard deviation, especially in dental, alveolar, palatal, and velar places of articulation. Also, there were significant differences in the

**TABLE 3 |** The mean and SD of duration (in ms), center of gravity (in Hz), standard deviation (in Hz), skewness, and kurtosis of Athenian Greek (AG) and Cypriot Greek (CG) fricatives articulated at Dental, Labiodental, Alveolar, Palatal, and Velar place of articulation.

| | | | | Duration | | CoG | | SD | | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| CG | Labiod. | V | S | 67 | 23 | 2,192 | 2,478 | 2,789 | 1,958 | 8 | 7 | 134 | 219 |
| AG | Labiod. | V | S | 77 | 20 | 2,650 | 1,947 | 3,199 | 1,457 | 4 | 4 | 41 | 103 |
| CG | Dental | V | S | 68 | 17 | 1,205 | 1,040 | 2,066 | 1,541 | 11 | 9 | 252 | 514 |
| AG | Dental | V | S | 79 | 20 | 1,387 | 1,143 | 2,002 | 1,217 | 7 | 5 | 101 | 139 |
| CG | Alveolar | V | S | 106 | 29 | 8,462 | 2,644 | 3,349 | 1,240 | −1 | 2 | 4 | 7 |
| AG | Alveolar | V | S | 86 | 17 | 5,718 | 1,594 | 2,605 | 722 | 0 | 1 | 3 | 6 |
| CG | Palatal | V | S | 92 | 35 | 2,970 | 2,718 | 2,987 | 1,455 | 3 | 3 | 25 | 35 |
| AG | Palatal | V | S | 93 | 20 | 2,176 | 1,342 | 2,512 | 984 | 3 | 3 | 25 | 45 |
| CG | Velar | V | S | 66 | 23 | 1,536 | 1,086 | 2,096 | 1,366 | 8 | 5 | 112 | 128 |
| AG | Velar | V | S | 78 | 22 | 1,219 | 453 | 1,269 | 539 | 7 | 4 | 90 | 146 |
| CG | Labiod. | VL | S | 103 | 24 | 7,422 | 3,637 | 4,484 | 1,279 | 1 | 3 | 9 | 42 |
| AG | Labiod. | VL | S | 100 | 21 | 6,390 | 1,758 | 4,577 | 770 | 1 | 1 | 0 | 3 |
| CG | Dental | VL | S | 107 | 27 | 6,983 | 3,675 | 4,443 | 1,217 | 1 | 2 | 7 | 28 |
| AG | Dental | VL | S | 89 | 19 | 6,818 | 1,956 | 4,360 | 760 | 1 | 1 | 0 | 2 |
| CG | Alveolar | VL | S | 121 | 37 | 10,104 | 1,258 | 2,370 | 630 | −1 | 2 | 5 | 30 |
| AG | Alveolar | VL | S | 111 | 24 | 6,933 | 1,152 | 1,977 | 559 | 1 | 1 | 4 | 4 |
| CG | Palatal | VL | S | 109 | 26 | 6,891 | 2,027 | 3,636 | 730 | 1 | 1 | 2 | 7 |
| AG | Palatal | VL | S | 106 | 21 | 6,094 | 758 | 2,789 | 480 | 1 | 0 | 2 | 2 |
| CG | Velar | VL | S | 103 | 25 | 2,810 | 975 | 2,730 | 1,026 | 4 | 2 | 22 | 30 |
| AG | Velar | VL | S | 96 | 21 | 2,695 | 836 | 2,272 | 759 | 3 | 1 | 13 | 13 |
| CG | Labiod. | V | U | 55 | 16 | 1,559 | 1,656 | 2,114 | 1,535 | 10 | 7 | 178 | 226 |
| AG | Labiod. | V | U | 59 | 14 | 2,087 | 1,692 | 2,628 | 1,386 | 5 | 5 | 70 | 142 |
| CG | Dental | V | U | 55 | 16 | 1,055 | 665 | 1,640 | 1,199 | 12 | 8 | 268 | 387 |
| AG | Dental | V | U | 64 | 14 | 1,224 | 983 | 1,641 | 1,079 | 8 | 5 | 131 | 165 |
| CG | Alveolar | V | U | 87 | 25 | 8,036 | 2,863 | 3,414 | 1,176 | −1 | 2 | 4 | 8 |
| AG | Alveolar | V | U | 72 | 17 | 5,192 | 1,709 | 2,726 | 737 | 0 | 1 | 4 | 14 |
| CG | Palatal | V | U | 73 | 26 | 1,554 | 1,094 | 2,364 | 1,206 | 6 | 5 | 64 | 109 |
| AG | Palatal | V | U | 62 | 28 | 2,727 | 1,976 | 2,542 | 961 | 3 | 2 | 14 | 21 |
| CG | Velar | V | U | 52 | 19 | 1,387 | 824 | 1,833 | 1,162 | 9 | 7 | 186 | 354 |
| AG | Velar | V | U | 70 | 18 | 1,104 | 331 | 1,109 | 453 | 8 | 3 | 112 | 104 |
| CG | Labiod. | VL | U | 98 | 24 | 7,459 | 3,522 | 4,483 | 1,230 | 1 | 2 | 6 | 28 |
| AG | Labiod. | VL | U | 92 | 19 | 6,130 | 1,708 | 4,548 | 765 | 1 | 1 | 1 | 3 |
| CG | Dental | VL | U | 90 | 23 | 6,157 | 3,581 | 4,156 | 1,475 | 2 | 4 | 18 | 79 |
| AG | Dental | VL | U | 85 | 21 | 6,751 | 1,607 | 4,435 | 751 | 1 | 1 | 0 | 1 |
| CG | Alveolar | VL | U | 102 | 26 | 9,990 | 1,295 | 2,481 | 651 | −1 | 1 | 3 | 11 |
| AG | Alveolar | VL | U | 99 | 21 | 7,005 | 688 | 1,926 | 348 | 1 | 1 | 4 | 3 |
| CG | Palatal | VL | U | 108 | 23 | 6,909 | 1,710 | 3,602 | 668 | 1 | 1 | 1 | 5 |
| AG | Palatal | VL | U | 103 | 21 | 6,026 | 781 | 2,671 | 442 | 1 | 1 | 3 | 2 |
| CG | Velar | VL | U | 103 | 21 | 2,950 | 1,131 | 2,757 | 1,107 | 4 | 3 | 30 | 62 |
| AG | Velar | VL | U | 91 | 17 | 2,559 | 665 | 2,150 | 716 | 3 | 1 | 15 | 14 |

standard deviation between the Athenian Greek and Cypriot Greek [s] and [x].

*Skewness.* The effects of skewness are shown in **Figure 3**. The boxplots in the figure represent the quantiles of skewness, namely the minimum value of skewness, the first quantile, the median, the third quantile, and the maximum skewness for each fricative. The upper and lower edge of the whiskers stand for the maximum and minimum value, respectively; the top and bottom of the box represent the third and first quantile and the black solid horizontal line in the middle of the box displays the median of the distribution. It is apparent from this figure that voiced fricatives differ from the voiceless ones in their skewness. Therefore it is not unexpected that voicing resulted in significant effects on skewness: voiced labiodental, palatal, and velar fricatives are characterized by relatively high skewness whereas alveolars

TABLE 4 | Results from the linear mixed effects models for the effects of the effects of dialect [Athenian Greek (AG) and Cypriot Greek (CG)], place of articulation, voicing, and stress on duration, center of gravity, and standard deviation.

| | | Estimate | SE | df | t value | Pr (>|t|) |
|---|---|---|---|---|---|---|
| Duration | Intercept | −2.60 | 0.06 | 88 | −44.21 | 0.001 |
| | Alveolar | 0.33 | 0.10 | 43 | 3.24 | 0.01 |
| | AG | 0.12 | 0.05 | 87 | 2.61 | 0.05 |
| | Voiceless | 0.30 | 0.08 | 50 | 3.69 | 0.01 |
| | Alveolar:AG | −0.30 | 0.03 | 6,589 | −8.95 | 0.001 |
| | Alveolar:Voiceless | −0.45 | 0.14 | 40 | −3.21 | 0.01 |
| | AG:Voiceless | −0.19 | 0.03 | 6,594 | −5.73 | 0.001 |
| | Alveolar:AG:Voiceless | 0.34 | 0.04 | 5,545 | 8.24 | 0.001 |
| | Palatal:AG:Voiceless | 0.13 | 0.06 | 6,566 | 2.15 | 0.05 |
| | Palatal:AG:Unstressed | −0.22 | 0.07 | 6,066 | −3.36 | 0.01 |
| | Velar:AG:Unstressed | 0.14 | 0.07 | 6,074 | 2.06 | 0.05 |
| | Palatal:AG:Voiceless:Unstressed | 0.21 | 0.09 | 6,414 | 2.27 | 0.05 |
| Center of gravity | Intercept | 7.69 | 0.10 | 70 | 78.30 | 0.001 |
| | Dental | −0.80 | 0.17 | 37 | −4.64 | 0.001 |
| | Alveolar | 1.27 | 0.17 | 37 | 7.39 | 0.001 |
| | AG | 0.31 | 0.07 | 287 | 4.60 | 0.001 |
| | Voiceless | 1.00 | 0.14 | 46 | 6.99 | 0.001 |
| | Unstressed | −0.23 | 0.09 | 1,508 | −2.50 | 0.05 |
| | Dental:AG | −0.20 | 0.07 | 6,602 | −2.72 | 0.01 |
| | Alveolar:AG | −0.69 | 0.07 | 6,601 | −9.52 | 0.001 |
| | Palatal:AG | −0.46 | 0.10 | 6,582 | −4.67 | 0.001 |
| | Velar:AG | −0.44 | 0.10 | 6,581 | −4.41 | 0.001 |
| | Dental:Voiceless | 0.69 | 0.23 | 38 | 3.00 | 0.01 |
| | Alveolar:Voiceless | −1.30 | 0.24 | 34 | −5.41 | 0.001 |
| | AG:Voiceless | −0.34 | 0.07 | 6,597 | −4.78 | 0.001 |
| | Voiceless:Unstressed | 0.31 | 0.11 | 2,257 | 2.69 | 0.01 |
| | Dental:AG:Voiceless | 0.39 | 0.10 | 6,592 | 3.95 | 0.001 |
| | Alveolar:AG:Voiceless | 0.37 | 0.09 | 6,604 | 4.13 | 0.001 |
| | Palatal:AG:Voiceless | 0.42 | 0.13 | 6,572 | 3.26 | 0.01 |
| | Velar:AG:Voiceless | 0.44 | 0.13 | 6,573 | 3.33 | 0.01 |
| | Palatal:AG:Unstressed | 0.64 | 0.14 | 6,572 | 4.55 | 0.001 |
| | Palatal:AG:Voiceless:Unstressed | −0.58 | 0.20 | 6,291 | −2.93 | 0.01 |
| SD | Intercept | 7.64 | 0.05 | 99 | 139.38 | 0.001 |
| | Dental | −0.24 | 0.07 | 41 | −3.37 | 0.01 |
| | Alveolar | 0.42 | 0.07 | 41 | 6.03 | 0.001 |
| | Palatal | 0.27 | 0.12 | 35 | 2.30 | 0.05 |
| | AG | 0.17 | 0.06 | 160 | 2.68 | 0.01 |
| | Voiceless | 0.73 | 0.07 | 60 | 11.24 | 0.001 |
| | Unstressed | −0.31 | 0.06 | 140 | −5.00 | 0.001 |
| | Dental:AG | −0.18 | 0.06 | 6,081 | −2.87 | 0.01 |
| | Alveolar:AG | −0.43 | 0.06 | 6,078 | −6.81 | 0.001 |
| | Palatal:AG | −0.38 | 0.09 | 6,526 | −4.42 | 0.001 |
| | Velar:AG | −0.63 | 0.09 | 6,530 | −7.25 | 0.001 |
| | Dental:Voiceless | 0.25 | 0.10 | 49 | 2.58 | 0.05 |
| | Alveolar:Voiceless | −0.95 | 0.09 | 37 | −10.11 | 0.001 |
| | Palatal:Voiceless | −0.44 | 0.14 | 40 | −3.10 | 0.01 |
| | Velar:Voiceless | −0.33 | 0.15 | 42 | −2.26 | 0.05 |
| | AG:Voiceless | −0.15 | 0.06 | 5,473 | −2.51 | 0.05 |

*(Continued)*

**TABLE 4 |** Continued

|  | Estimate | SE | df | t value | Pr (>|t|) |
|---|---|---|---|---|---|
| Alveolar:Unstressed | 0.34 | 0.10 | 51 | 3.45 | 0.01 |
| Voiceless:Unstressed | 0.32 | 0.08 | 225 | 3.86 | 0.001 |
| Alveolar:AG:Voiceless | 0.19 | 0.08 | 6,172 | 2.43 | 0.05 |
| Velar:AG:Voiceless | 0.39 | 0.11 | 6,567 | 3.41 | 0.01 |
| Dental:Voiceless:Unstressed | −0.27 | 0.13 | 99 | −2.19 | 0.05 |
| Alveolar:Voiceless:Unstressed | −0.30 | 0.12 | 81 | −2.58 | 0.05 |
| Dental:AG:Voiceless:Unstressed | 0.28 | 0.13 | 1,856 | 2.09 | 0.05 |

**TABLE 5 |** Results from the linear mixed effects models for the effects of the effects of dialect [Athenian Greek (AG) and Cypriot Greek (CG)], place of articulation, voicing, and stress on skewness, and kutosis.

|  |  | Estimate | SE | df | t value | Pr (>|t|) |
|---|---|---|---|---|---|---|
| Skewness | Intercept | 1.64 | 0.14 | 52 | 11.80 | 0.001 |
|  | Dental | 0.47 | 0.17 | 37 | 2.78 | 0.01 |
|  | Alveolar | −2.62 | 0.21 | 82 | −12.57 | 0.001 |
|  | AG | −0.74 | 0.16 | 156 | −4.57 | 0.001 |
|  | Voiceless | −1.53 | 0.17 | 70 | −8.81 | 0.001 |
|  | Dental:AG | 0.32 | 0.16 | 4,371 | 2.01 | 0.05 |
|  | Alveolar:AG | 1.05 | 0.22 | 4,686 | 4.79 | 0.001 |
|  | Palatal:AG | 0.49 | 0.22 | 4,705 | 2.19 | 0.05 |
|  | Velar:AG | 0.75 | 0.22 | 4,695 | 3.45 | 0.01 |
|  | Alveolar:Voiceless | 1.62 | 0.28 | 89 | 5.79 | 0.001 |
|  | Velar:Voiceless | 0.82 | 0.35 | 40 | 2.31 | 0.05 |
|  | Alveolar:Unstressed | 0.68 | 0.30 | 107 | 2.27 | 0.05 |
|  | Voiceless:Unstressed | −0.56 | 0.23 | 185 | −2.40 | 0.05 |
|  | Dental:AG:Voiceless | −0.63 | 0.24 | 3,278 | −2.62 | 0.01 |
|  | Alveolar:AG:Unstressed | −1.03 | 0.31 | 4,504 | −3.28 | 0.01 |
| Kurtosis | Intercept | 3.76 | 0.19 | 13 | 19.63 | 0.001 |
|  | Dental | 0.45 | 0.17 | 88 | 2.62 | 0.05 |
|  | Alveolar | −2.46 | 0.19 | 118 | −13.23 | 0.001 |
|  | Palatal | −1.24 | 0.29 | 96 | −4.25 | 0.001 |
|  | AG | −1.36 | 0.24 | 138 | −5.71 | 0.001 |
|  | Voiceless | −2.80 | 0.20 | 179 | −14.31 | 0.001 |
|  | Unstressed | 0.47 | 0.18 | 134 | 2.66 | 0.01 |
|  | Dental:AG | 0.78 | 0.22 | 3,729 | 3.54 | 0.001 |
|  | Alveolar:AG | 0.96 | 0.24 | 4,028 | 4.04 | 0.001 |
|  | Palatal:AG | 0.90 | 0.32 | 4,845 | 2.83 | 0.01 |
|  | Velar:AG | 1.48 | 0.30 | 4,758 | 4.93 | 0.001 |
|  | Alveolar:Voiceless | 2.19 | 0.25 | 130 | 8.59 | 0.001 |
|  | Palatal:Voiceless | 0.88 | 0.42 | 173 | 2.11 | 0.05 |
|  | Velar:Voiceless | 1.00 | 0.37 | 107 | 2.71 | 0.01 |
|  | Alveolar:Unstressed | −0.64 | 0.27 | 129 | −2.40 | 0.05 |
|  | Dental:AG:Voiceless | −1.32 | 0.35 | 2,818 | −3.77 | 0.001 |
|  | Alveolar:AG:Voiceless | 0.95 | 0.32 | 3,896 | 2.99 | 0.01 |

and voiceless labiodental, palatal, and velar fricatives are characterized by relatively low skewness. Cypriot Greek alveolars display negative skewness whereas Athenian Greek alveolars are characterized by positive skewness. This issue will be discussed later in section 5. Overall, the dialect had an overall significant effect (see the results of the statistical model in **Table 5**). More specifically, there were significant differences between Athenian Greek and Cypriot Greek fricatives in the
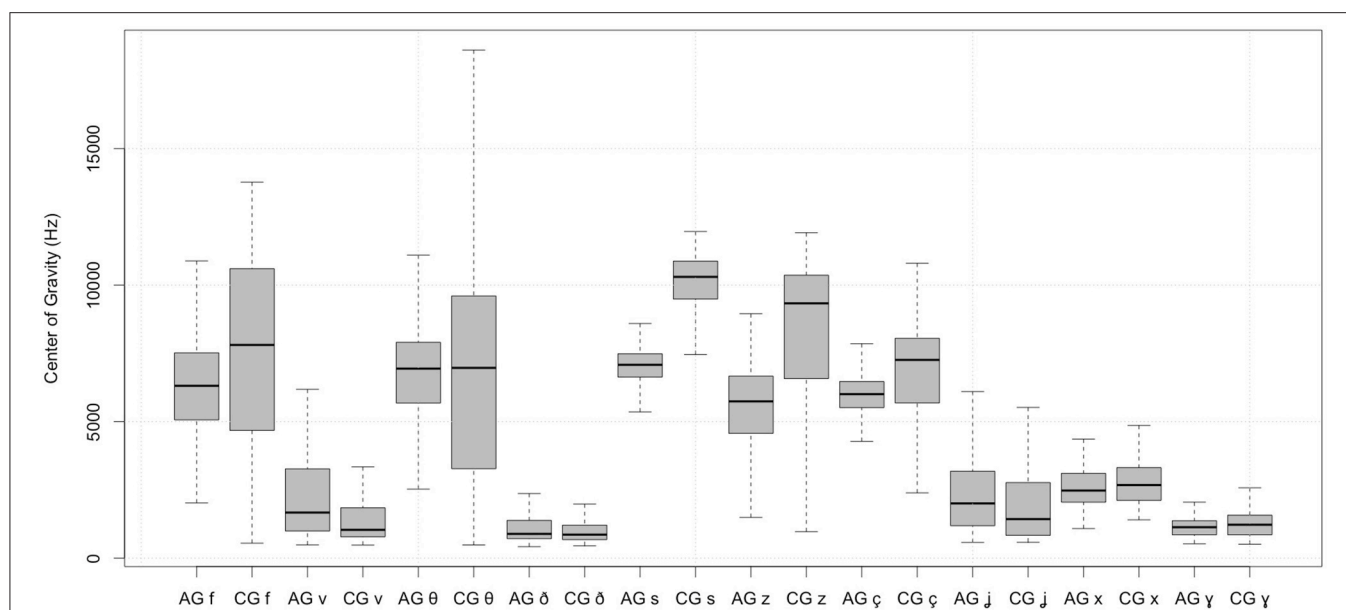
**FIGURE 1 |** Spectral center of gravity of Athenian Greek (AG) and Cypriot Greek (CG) fricatives.
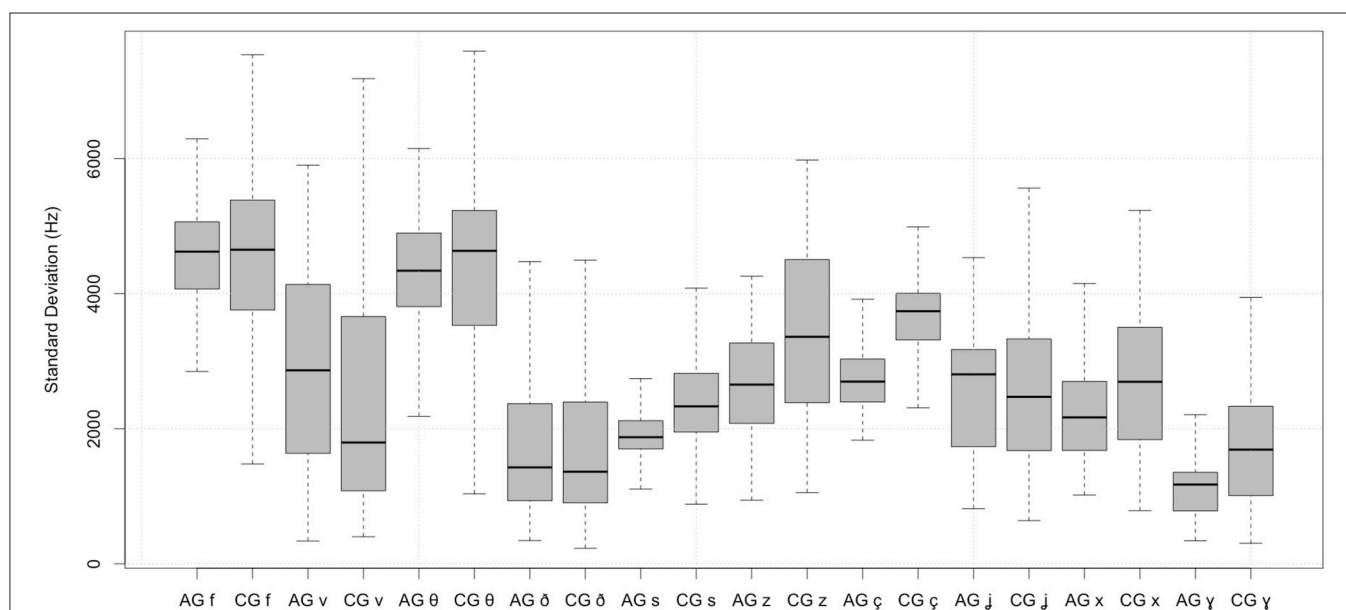


**FIGURE 2 |** Spectral standard deviation of Athenian Greek (AG) and Cypriot Greek (CG) fricatives.

skewness of dental, alveolar, palatal, and velar fricatives. There were also significant effects of the place of articulation on skewness. This is evident for dentals and the alveolars. Also the dialect had a significant effect on the skewness of [θ]. Finally, dialect had significant effects on the stressed vs. unstressed [s] and [z].

*Kurtosis.* The effects of Athenian Greek and Cypriot Greek fricatives on kurtosis are shown in **Figure 4**, which just like **Figure 3**, represents the quantiles of kurtosis using boxplots.

The figure shows that voiced labiodental, dental, palatal, and velar fricatives have an extremely high kurtosis. By contrast, the kurtosis of voiceless fricatives and that of [z] is close to zero. Cypriot Greek fricatives associate with higher kurtosis than the corresponding Athenian Greek fricatives. These effects are more prominent in the voiced condition. Consequently, Athenian Greek and Cypriot Greek fricatives resulted in statistically significant effects on kurtosis (see the results of the statistical model in **Table 5**). Also, there were significant effects
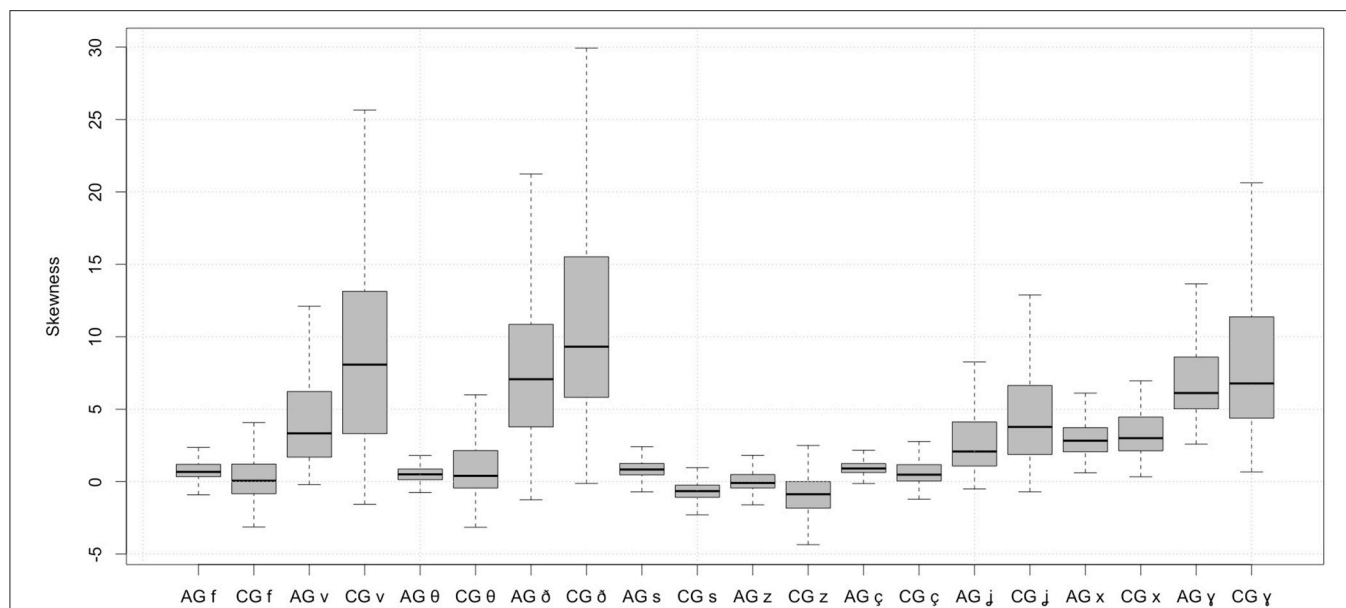
**FIGURE 3 |** Spectral skewness of Athenian Greek (AG) and Cypriot Greek (CG) fricatives.
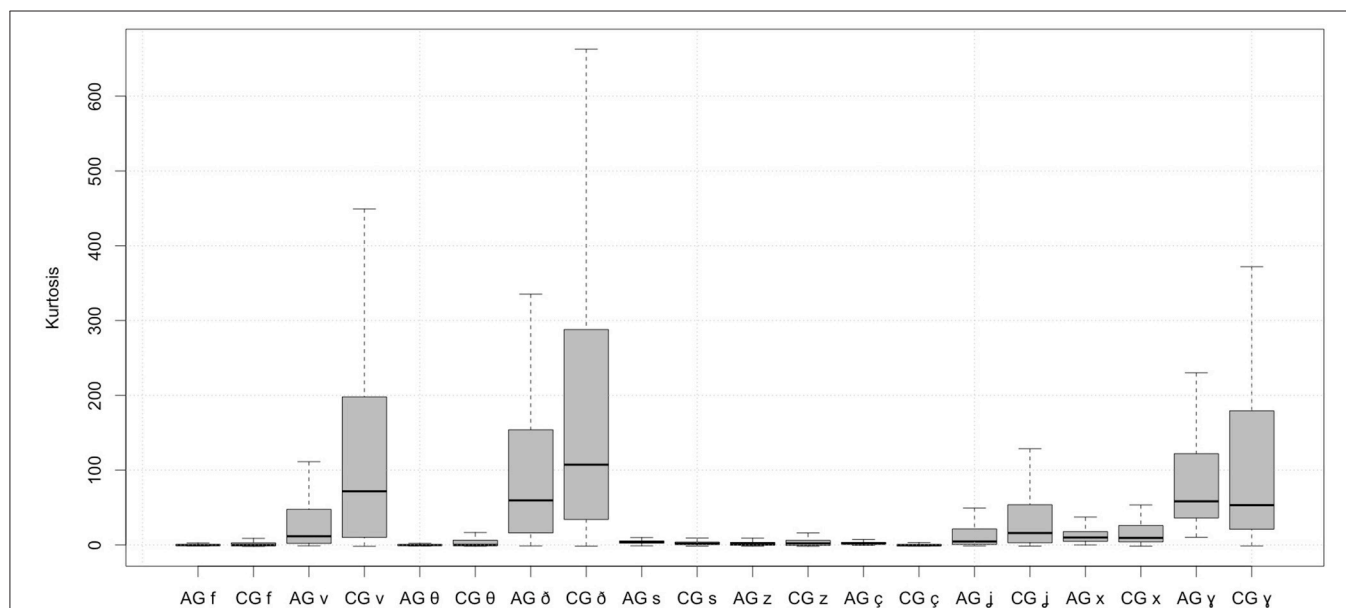


**FIGURE 4 |** Spectral kurtosis of Athenian Greek (AG) and Cypriot Greek (CG) fricatives.

of the dialect on the kurtosis of dental, alveolar, palatal, and velar fricatives. Moreover, voiceless dental, voiceless alveolar, voiceless palatal, and voiceless velar Athenian Greek fricatives differed significantly from the corresponding Cypriot Greek fricatives.

## 2.2.1. Temporal Properties of Fricatives

The statistical analysis shows significant effects of dialect on fricative duration. Overall, Cypriot Greek fricatives are on average longer (96 ms) than Athenian Greek fricatives (92 ms). What stands out in this analysis is the interactions of dialect × place of articulation, dialect × voicing, which showed significantly different effects for Athenian Greek & alveolar fricatives (alveolar fricatives are the longest fricatives) and Athenian Greek & voiceless fricatives on duration. The latter suggests that voiced and voiceless fricatives differ in their duration in Athenian Greek and Cyprio Greek.

There were also significant results from the interactions (1) place of articulation × dialect × voicing, (2) place of articulation × dialect × stress, and (3) place of articulation × dialect × voicing × stress. Specifically, the first interaction resulted in significantly different effects for the Athenian Greek voiceless alveolar ([s]) and palatal ([ç]) fricatives. The second resulted in significantly different effects for the Athenian Greek unstressed palatals ([ç, j]) and velars ([x, ɣ]) and the third interaction resulted in significantly different effects for the unstressed Athenian Greek [ç]. Another factor that influences the duration of fricatives in both varieties is voicing. Specifically, voiceless fricatives are overall longer than the voiced ones.

To conclude, dialect affects fricative spectra systematically as in evident by the effects of dialect on fricatives' spectral moments (e.g., center of gravity, standard deviation, skewness, and kurtosis) and duration. The following section describes Study 2 of this work.

# 3. STUDY 2: FRICATIVE-VOWEL COARTICULATION

Earlier research has demonstrated that the coarticulatory effects of fricatives on a following vowel can provide information about fricatives' place of articulation and voicing (e.g., see Potter et al., 1947; Cooper et al., 1952; Stevens and House, 1956; Harris et al., 1958; Lehiste and Peterson, 1961; Öhman, 1966; Fant, 1969; de Manrique and Massone, 1981b; Kewley-Port, 1982; Beckman et al., 2009). However, the effects of dialect on fricative-vowel coarticulation received so far very little attention. Study 2 aims to provide evidence of the effects of dialect on fricative-vowel coarticulation. Specifically, it investigates the effects of Athenian Greek and Cypriot Greek fricatives on the polynomial coefficients of $F1$, $F2$, $F3$, and $F4$ formant contours. To this purpose, the formants were modeled using second degree polynomial models, which for the purposes of this study have a number of advantages: they represent the starting frequency of the formant, the shape of the overall formant contour, and they reduce the amount of measurements taken across the duration of the vowels into a small number of polynomial coefficients, which facilitates the statistical analysis (see for a discussion of this approach Themistocleous, 2017a). The innovative aspect of this study is that it explores for the first time the effects of dialect on fricative-vowel coarticulation and it is also the first study to investigate these effects in Greek dialects.

## 3.1. Methodology

We employed the same speech material as in Study 1; the specifics of the statistical analysis and the results are described in the following.

### 3.1.1. Statistics

To model formant dynamics, we performed 13 measurements of $F1$, $F2$, $F3$, and $F4$ at 13 equidistant points starting from the 20–80% (included) (see also Jacewicz et al., 2011, p. 686). The measurements of $F1$, $F2$, $F3$, and $F4$ were fitted using a 2nd order polynomial fit. The second degree polynomial results into three coefficients:

- The *zeroth coefficient* ($a_0$), which represents the starting frequency of the vowel formant;
- the *first order coefficient* ($a_1$) and the *second order coefficient* ($a_2$), which determine the shape formant contour.

The outputs of these models are smoothed representations of formant contours; an example is provided in **Figure 5**. Linear mixed effect models were employed to analyze formant dynamics, with the polynomial coefficients as response variables and the dialect, place of articulation, stress, voicing, and vowel as fixed factors. Keyword and speaker were employed as random effects, the resulting model is shown in Equation (1).

$$response \sim Dialect^*Placeofarticulation^*Stress^*Voicing$$
$$^*Vowel + (1|Keyword) + (1|Speaker) \qquad (1)$$

## 3.2. Results

The means of the polynomial coefficients of $F1$ and $F2$ are shown in **Table 6** and of $F3$ and $F4$ are shown in **Table 7**. The results of $F1$ and $F2$ are shown in **Table 8** and those of $F3$ and $F4$ are shown in **Table 8**. **Figures 6**, **7** show an example of the specific interactions of place of articulation, stress, and variety on the coefficients of the stressed and unstressed vowel [a], respectively.

As shown from **Table 6** Athenian Greek fricatives lowered the $F1$ contour as a whole by an estimate of 15.45 Hz. Also, there were significant effects of the place of articulation, which affected all formant coefficients of $F1$. Most notably, there were significantly effects of the dental, labiodental, and velar fricatives on $F1$. So, $F1a_0$ and $F1a_2$ were found to distinguish Athenian Greek velar fricatives from Cypriot Greek velar fricatives. Also, $F1a_2$ can distinguish Athenian Greek dental fricatives from the Cypriot Greek ones.

A finding that stands out is that the starting frequency of the Athenian Greek $F2a_0$ was overall lower than that of the Cypriot Greek $F2a_0$. $F2a_0$, $F2a_1$, $F2a_2$ can distinguish Athenian Greek and Cypriot Greek fricatives at the labiodental place of articulation. These effects suggest that labiodental fricatives affect the overall shape of $F2$, which results at this place of articulation in distinct formant contours depending on the dialect. Also, the dental place of articulation affects $F2a_1$ and $F2a_2$, which again points to different effects of the dental fricatives on $F2$ in Athenian Greek and Cypriot Greek. Moreover, there were effects of the place of articulation on the formant contour (see the effects of the labiodentals and palatals on $F2a_0$ and $F2a_0$).

$F3a_0$ is overall higher in Athenian Greek than in Cypriot Greek by an estimate of 64 Hz. There were also different effects of the dialect on $F3a_1$ and $F3a_2$, which suggests that the $F3$ contour differs in the two varieties; this finding corroborates earlier studies (e.g., see Themistocleous, 2017b). An important finding is that the place of articulation of fricatives affects the overall shape of the $F3$ contour. Specifically, dental fricatives affect both $F3a_0$ and $F3a_1$. Also, the dialect affected the $F3a_0$ and $F3a_1$ following palatal and velar fricatives.

Athenian Greek and Cypriot Greek palatal and velar fricatives had significantly different effects on the $F4a_0$. Also, the two varieties had different effects on the $F4a_0$ when labiodental
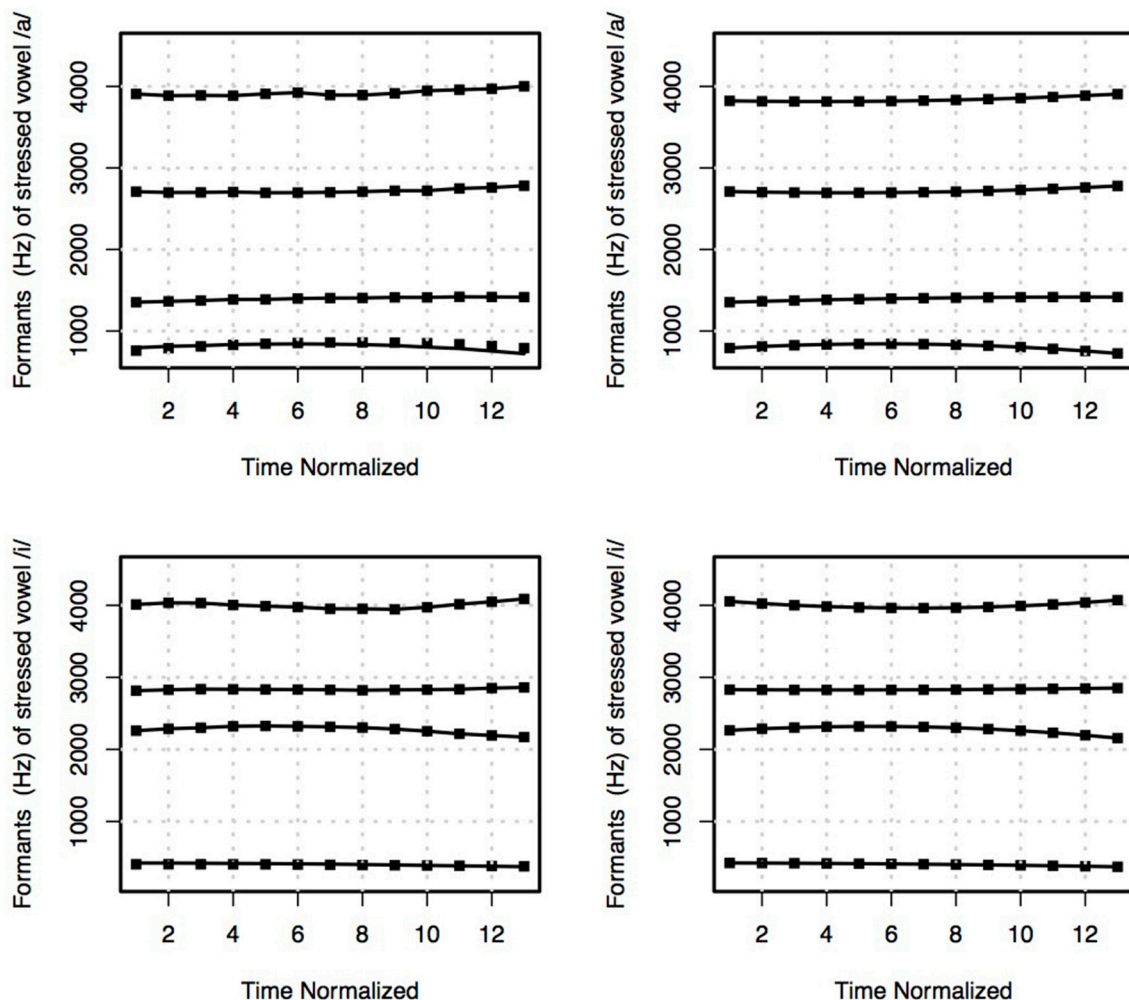
**FIGURE 5 |** Means of F1—F4 (in Hz) of the actual vowel productions (Left panels) of the stressed vowels /a/ (Upper panel) and in /i/ (Lower panel) and the models of F1—F4 (in Hz) that resulted from the polynomial modeling.

fricatives preceded the formant. Overall, these findings are important as they demonstrate that the two dialects have different effects on vowel formants depending on the place of articulation of fricatives that precede the vowel. We did not observe effects of voicing on formant contours, which indicates that the place of articulation has more significant effects on vowel formants than voicing (see also **Table 8**, **9** for the specific effects of vowel, stress and place of articulation on vowel formants).

## 4. STUDY 3: CLASSIFICATION STUDY

The preceding sections reported the effects of dialect, place of articulation, stress, and voicing on the temporal and spectral properties of fricatives. Study 3 aims to determine which acoustic properties of fricatives contribute to classification of the dialect (e.g., Athenian Greek and Cypriot Greek). To this purpose, we employed Quinlan's classification algorithm and decision tree,

C5.0, using winnowing, a feature selection algorithm that selects features that contribute more to the classification. The predictors included the following:

center of gravity + standard deviation + skewness + kurtosis + duration + $F1a_0$ + $F1a_1$ + $F1a_2$ + $F2a_0$ + $F2a_1$ + $F2a_2$ + $F3a_0$ + $F3a_1$ + $F3a_2$ + $F4a_0$ + $F4a_1$ + $F4a_2$.

To this purpose, the data were separated into a train set consisting of the 90% of the data and an evaluation or test set consisting of the 10% of the data. The analysis was performed with a 10-fold cross-validation repeated 10 times (see for a discussion Ambroise and McLachlan, 2002). The accuracy was used to select the optimal model. The statistical analysis and the classification was carried out in R (R Core Team, 2016). The lme4 R-package, which provided functions for fitting generalized linear mixed models (Bates et al., 2014; Kuznetsova et al., 2016), the caret (Kuhn, 2016), and the C5.0, package (Kuhn et al., 2015) were used for the classification. The final values employed in the selection of the model are reported in the Results section.

**TABLE 6 |** Mean and SD of $a_0$, $a_1$, $a_2$ polynomial coefficients of the formant frequencies $F1$ and $F2$ of vowels /a/ and /i/ as a function of fricative consonant and dialect [Athenian Greek (AG) and Cypriot Greek (CG)].

| | | | F1 | | | | | | F2 | | | | | |
| | | | $a_0$ | | $a_1$ | | $a_2$ | | $a_0$ | | $a_1$ | | $a_2$ | |
| | | | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ð | CG | a | 735.26 | 176.41 | 28.90 | 29.93 | −2.01 | 1.96 | 1,525.56 | 215.18 | −0.23 | 46.66 | 0.00 | 3.60 |
| f | CG | a | 812.63 | 124.58 | 19.75 | 27.99 | −1.81 | 1.91 | 1,401.23 | 182.34 | 10.53 | 39.04 | −0.34 | 2.60 |
| ɣ | CG | a | 804.34 | 163.59 | 24.85 | 37.86 | −1.94 | 2.54 | 1,616.46 | 311.74 | −16.01 | 65.98 | 1.93 | 4.55 |
| s | CG | a | 814.59 | 114.17 | 24.93 | 29.20 | −2.03 | 2.07 | 1,587.43 | 233.89 | 0.52 | 62.34 | −0.36 | 4.12 |
| v | CG | a | 775.33 | 125.35 | 32.46 | 28.55 | −2.39 | 1.98 | 1,369.48 | 234.52 | 24.01 | 61.41 | −1.12 | 4.26 |
| x | CG | a | 879.89 | 132.44 | 10.51 | 31.42 | −1.23 | 2.13 | 1,531.78 | 251.88 | −3.58 | 63.54 | 0.10 | 4.07 |
| z | CG | a | 601.56 | 152.52 | 48.13 | 29.12 | −2.74 | 1.87 | 1,613.01 | 159.49 | −3.76 | 50.45 | −0.14 | 3.73 |
| θ | CG | a | 832.01 | 132.22 | 9.54 | 33.82 | −1.10 | 2.65 | 1,566.99 | 152.98 | −1.85 | 56.11 | 0.09 | 4.11 |
| ð | AG | a | 721.60 | 115.99 | 26.93 | 33.27 | −1.66 | 2.66 | 1,513.34 | 134.82 | 10.54 | 34.23 | −0.64 | 2.81 |
| f | AG | a | 755.62 | 86.51 | 23.10 | 23.93 | −2.10 | 1.84 | 1,349.06 | 119.44 | 15.23 | 30.73 | −0.29 | 2.46 |
| ɣ | AG | a | 708.58 | 104.60 | 33.93 | 30.44 | −2.07 | 2.30 | 1,548.40 | 159.06 | −0.47 | 38.72 | 0.72 | 2.82 |
| s | AG | a | 725.92 | 109.20 | 35.56 | 32.49 | −2.33 | 2.36 | 1,647.05 | 158.27 | −18.73 | 40.45 | 0.78 | 2.92 |
| v | AG | a | 707.44 | 92.01 | 32.63 | 24.53 | −2.15 | 1.83 | 1,329.65 | 147.04 | 21.32 | 38.87 | −0.17 | 2.73 |
| x | AG | a | 809.41 | 95.25 | 21.43 | 25.09 | −2.35 | 1.41 | 1,508.41 | 148.40 | −3.37 | 29.16 | 0.35 | 2.06 |
| z | AG | a | 572.68 | 147.03 | 40.53 | 36.46 | −2.10 | 2.62 | 1,712.28 | 132.31 | −16.04 | 36.23 | 0.57 | 2.82 |
| θ | AG | a | 756.51 | 131.46 | 22.97 | 23.45 | −2.10 | 1.57 | 1,524.35 | 119.08 | −6.50 | 28.34 | 0.40 | 1.89 |
| ç | CG | i | 415.61 | 166.49 | 3.27 | 41.55 | −0.30 | 3.40 | 2,620.06 | 338.37 | −0.24 | 134.41 | −1.58 | 8.91 |
| ð | CG | i | 451.25 | 84.32 | −1.51 | 33.18 | −0.12 | 2.32 | 2,270.99 | 458.01 | 46.39 | 105.77 | −3.00 | 6.68 |
| f | CG | i | 413.49 | 380.48 | −2.70 | 105.37 | 0.10 | 7.84 | 2,528.54 | 399.17 | −12.53 | 96.21 | −0.56 | 6.66 |
| j | CG | i | 377.83 | 142.65 | 7.25 | 42.09 | −0.36 | 3.51 | 2,565.12 | 420.07 | 4.01 | 89.15 | −0.80 | 5.71 |
| s | CG | i | 409.00 | 91.14 | 4.17 | 19.77 | −0.43 | 1.49 | 2,489.02 | 333.91 | 9.21 | 107.04 | −1.65 | 8.34 |
| v | CG | i | 417.54 | 50.10 | 2.81 | 11.19 | −0.29 | 0.79 | 2,210.65 | 300.27 | 76.45 | 93.12 | −5.08 | 6.20 |
| z | CG | i | 395.28 | 200.82 | 3.66 | 15.75 | −0.24 | 1.09 | 2,230.58 | 452.61 | 27.37 | 123.24 | −1.39 | 8.25 |
| θ | CG | i | 462.69 | 93.05 | −2.23 | 12.69 | 0.06 | 0.91 | 2,479.16 | 498.24 | 11.60 | 119.36 | −1.32 | 7.77 |
| ç | AG | i | 357.97 | 62.03 | 7.05 | 24.89 | −0.48 | 2.45 | 2,495.79 | 235.85 | 1.37 | 71.63 | −1.30 | 4.93 |
| ð | AG | i | 426.00 | 58.31 | 0.53 | 11.57 | −0.26 | 0.74 | 2,109.28 | 258.39 | 51.81 | 88.25 | −2.37 | 5.97 |
| f | AG | i | 416.91 | 63.12 | −2.20 | 10.20 | −0.09 | 0.77 | 2,227.12 | 314.85 | 33.62 | 106.42 | −2.71 | 7.24 |
| j | AG | i | 337.34 | 71.05 | 7.55 | 12.94 | −0.34 | 0.71 | 2,603.05 | 325.23 | −10.49 | 91.48 | 0.21 | 6.22 |
| s | AG | i | 408.95 | 77.29 | −1.07 | 23.60 | −0.11 | 1.84 | 2,225.70 | 219.94 | 28.07 | 64.14 | −1.72 | 4.91 |
| v | AG | i | 415.12 | 60.15 | 3.11 | 11.83 | −0.47 | 0.73 | 2,074.96 | 235.40 | 60.85 | 69.04 | −2.94 | 4.95 |
| z | AG | i | 373.93 | 60.78 | 6.40 | 14.82 | −0.45 | 1.14 | 2,105.97 | 313.05 | 20.39 | 78.55 | −0.49 | 5.95 |
| θ | AG | i | 420.44 | 50.31 | 0.14 | 8.32 | −0.36 | 0.60 | 2,259.77 | 372.14 | 33.75 | 96.14 | −2.74 | 6.31 |

## 4.1. Results

Specifically, the model had a high classification accuracy 88% (95% CI[0.85, 0.91], kappa = 0.76). The attribute usage was the following:

$$
\begin{aligned}
Classification = \ & 100\% \ duration, \ 100\% \ center of gravity, \ 100\% \ SD, \\
& 100\% \ skewness, \ 100\% \ kurtosis, \ 100\% \ F1a_0, \ 100\% \ F2a_0, \\
& 100\% \ F2a_2, \ 100\% \ F3a_0, \ 100\% \ F3a_1, \ 100\% \ F4a_0, \\
& 99.89\% \ F4a_1, \ 97.75\% \ F3a_2, \ 96.50\% \ F4a_2, \ 94.34\% \ F1a_2, \\
& 93.98\% \ F1a_1, \ 92.43\% \ F2a_1.
\end{aligned}
$$

(2)

Interestingly, the attribute usage shows that all the spectral moments and the duration contribute greatly to the classification of the dialect resulting in high classification accuracy. In contrast, when we use only the spectral moments or only formant values as predictors the accuracy falls greatly. Specifically, a model with the spectral moments alone resulted into a 83% (95% CI[0.80, 0.86], Kappa = 0.66) classification accuracy, which is almost 5% less accurate than the reported model that employs all measured features whereas the model with the polynomial coefficients only resulted in 66% (95% CI[0.61, 0.70], kappa = 0.3), which is 22% less accurate that the model that employs all features. The comparison of the three classification models suggests that the highest accuracy is achieved only when using all the acoustic properties.

## 5. DISCUSSION

We hypothesized based on perceptual impressionistic evidence that the acoustic structure of Athenian Greek and Cypriot Greek fricatives will differ. To this purpose, we evaluated the

**TABLE 7 |** Mean and SD of $a_0$, $a_1$, $a_2$ polynomial coefficients of the formant frequencies $F3$, and $F4$ of vowels /a/ and /i/ as a function of fricatiVe consonant and dialect [Athenian Greek (AG) and Cypriot Greek (CG)].

| | | | F3 | | | | | | F4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $a_0$ | | $a_1$ | | $a_2$ | | $a_0$ | | $a_1$ | | $a_2$ | |
| | | | M | SD | M | SD | M | SD | M | SD | M | SD | M | SD |
| ð | CG | a | 2,774.22 | 475.41 | −11.46 | 102.81 | 1.03 | 7.90 | 3,905.00 | 858.62 | −6.44 | 141.46 | 0.80 | 10.74 |
| f | CG | a | 2,595.89 | 539.51 | −5.43 | 133.94 | 0.85 | 9.31 | 3,723.81 | 714.02 | −12.88 | 152.17 | 1.64 | 11.32 |
| ɣ | CG | a | 2,836.10 | 562.11 | −68.32 | 115.12 | 5.24 | 7.38 | 4,036.25 | 911.61 | −69.75 | 153.89 | 5.86 | 10.60 |
| s | CG | a | 2,706.70 | 574.57 | −10.70 | 143.49 | 0.88 | 9.41 | 4,010.68 | 741.44 | −46.34 | 145.37 | 3.04 | 9.81 |
| v | CG | a | 2,624.01 | 540.68 | 3.74 | 141.80 | 0.19 | 9.50 | 3,747.70 | 735.82 | 14.83 | 192.45 | −0.32 | 13.14 |
| x | CG | a | 2,637.52 | 540.11 | −3.27 | 137.34 | 0.32 | 8.88 | 4,002.61 | 774.17 | −30.65 | 188.89 | 1.89 | 12.05 |
| z | CG | a | 2,829.60 | 421.96 | −22.05 | 112.39 | 1.33 | 7.99 | 4,134.47 | 804.42 | −43.45 | 169.42 | 2.54 | 12.02 |
| θ | CG | a | 2,742.93 | 440.80 | −13.43 | 116.48 | 1.33 | 7.81 | 3,886.58 | 757.58 | −22.35 | 187.32 | 2.00 | 13.23 |
| ð | AG | a | 2,797.88 | 281.63 | 8.34 | 85.25 | −0.53 | 6.15 | 3,853.63 | 739.57 | 2.90 | 104.34 | 0.06 | 7.50 |
| f | AG | a | 2,703.24 | 294.30 | −5.85 | 66.38 | 1.21 | 4.88 | 3,789.89 | 748.22 | −1.34 | 88.91 | 0.99 | 5.90 |
| ɣ | AG | a | 2,779.39 | 426.28 | −37.56 | 101.49 | 2.75 | 6.46 | 3,874.37 | 467.10 | −35.80 | 103.87 | 2.71 | 7.72 |
| s | AG | a | 2,843.61 | 441.42 | −38.95 | 111.89 | 2.76 | 6.99 | 4,029.19 | 861.63 | −37.12 | 122.15 | 2.53 | 7.91 |
| v | AG | a | 2,750.19 | 381.15 | −16.64 | 106.70 | 1.89 | 7.32 | 3,843.26 | 713.77 | −16.45 | 160.21 | 1.99 | 11.47 |
| x | AG | a | 2,686.71 | 293.36 | −8.74 | 96.60 | 1.53 | 6.27 | 3,877.85 | 420.11 | −13.34 | 118.68 | 1.57 | 7.29 |
| z | AG | a | 3,007.44 | 301.24 | −51.79 | 70.88 | 2.99 | 5.54 | 4,383.61 | 831.56 | −74.22 | 138.24 | 4.07 | 9.89 |
| θ | AG | a | 2,836.62 | 243.75 | −28.07 | 88.98 | 2.37 | 6.14 | 4,053.78 | 939.04 | −26.57 | 126.69 | 1.90 | 8.65 |
| ç | CG | i | 3,363.96 | 285.30 | −20.94 | 75.36 | −0.19 | 5.27 | 4,060.68 | 999.83 | −12.50 | 116.33 | 0.68 | 7.66 |
| ð | CG | i | 2,938.27 | 267.77 | 19.64 | 64.44 | −1.41 | 4.23 | 3,978.51 | 678.79 | 0.35 | 107.67 | 0.29 | 7.36 |
| f | CG | i | 3,004.53 | 320.47 | 3.86 | 77.20 | −0.58 | 5.75 | 3,884.16 | 1085.45 | 9.95 | 127.57 | −0.37 | 8.49 |
| j | CG | i | 3,447.62 | 298.87 | −39.31 | 54.97 | 1.26 | 3.76 | 4,251.87 | 897.64 | −36.48 | 115.06 | 3.00 | 7.82 |
| s | CG | i | 3,083.85 | 275.99 | −2.65 | 64.51 | −0.14 | 5.05 | 4,154.57 | 904.33 | −8.82 | 101.17 | 0.36 | 6.90 |
| v | CG | i | 2,832.56 | 261.75 | 44.74 | 59.52 | −2.64 | 3.80 | 3,918.82 | 641.29 | 22.14 | 117.22 | −0.79 | 7.67 |
| z | CG | i | 3,016.22 | 314.42 | −3.47 | 76.30 | 0.05 | 5.56 | 4,306.86 | 942.18 | −27.44 | 89.78 | 1.32 | 6.21 |
| θ | CG | i | 3,097.39 | 340.06 | −0.42 | 83.26 | −0.45 | 5.62 | 4,002.70 | 586.77 | −8.73 | 105.11 | 0.78 | 7.90 |
| ç | AG | i | 3,233.71 | 184.38 | −43.52 | 48.65 | 2.07 | 3.62 | 4,037.68 | 474.65 | −10.09 | 147.30 | 1.36 | 9.77 |
| ð | AG | i | 2,886.32 | 208.81 | 19.02 | 45.68 | −0.80 | 3.14 | 4,016.28 | 427.79 | 8.15 | 125.94 | 0.31 | 9.21 |
| f | AG | i | 2,834.87 | 209.14 | 0.09 | 53.96 | 0.35 | 3.62 | 4,102.05 | 611.47 | −24.64 | 136.22 | 2.16 | 8.83 |
| j | AG | i | 3,478.42 | 227.53 | −48.26 | 59.10 | 1.52 | 3.96 | 4,264.40 | 788.68 | −37.35 | 151.67 | 2.41 | 10.13 |
| s | AG | i | 2,948.50 | 177.63 | −1.98 | 50.82 | 0.19 | 3.65 | 4,224.17 | 521.44 | −14.79 | 110.20 | 1.19 | 7.23 |
| v | AG | i | 2,767.86 | 270.30 | 20.78 | 60.45 | −0.24 | 4.28 | 4,017.95 | 387.75 | −11.79 | 116.15 | 2.40 | 8.38 |
| z | AG | i | 3,038.69 | 261.89 | −21.76 | 70.70 | 1.31 | 5.34 | 4,341.79 | 615.11 | −18.95 | 102.16 | 1.05 | 7.34 |
| θ | AG | i | 2,909.32 | 252.20 | −1.31 | 65.20 | 0.04 | 4.15 | 4,173.50 | 639.70 | −24.60 | 91.16 | 2.12 | 5.52 |

information provided by the spectral properties of fricatives and the co-articulatory effects of fricatives on vowel formants. The results demonstrated that the two dialects affect multiple spectral properties of fricatives. These properties are not necessarily different from the ones that distinguish the place of articulation, voicing, and stress. This may come as a striking finding in a tradition of linguistic research that aimed to single out acoustic parameters that associate with a specific phonemic category. Take for example the "locus" theory, which is an approach that hypothesizes that the $F2$ of the vowel is a correlate of fricatives' (and other consonants') place of articulation (see for a discussion Lehiste and Peterson, 1961). A great contribution of this study is that it shows that the "locus" theory underestimates the role of higher order formants, such as $F3$ and $F4$ and that it is not just the $F2$ that conveys information about the place of articulation but all spectral properties of fricatives.

We argue that information about the dialect is encoded by several acoustic features of the fricative spectra. As someone can distinguish a dog from a cat by its picture and/or by the sound it makes, the same is true for speech: a listener can identify the dialect by multiple features that make up fricative spectra and by the effects of fricatives on the adjacent sounds. Specifically, the machine learning and classification algorithm C5.0 employed in this study demonstrated that duration, center of gravity, standard deviation, skewness, kurtosis, and the starting frequency of $F1a_0$, $F2a_0$, $F3a_0$, $F4a_0$, as well as first and second polynomial coefficients of $F3$ and $F4$ play a significant role in the classification of Athenian Greek and Cypriot Greek fricatives.
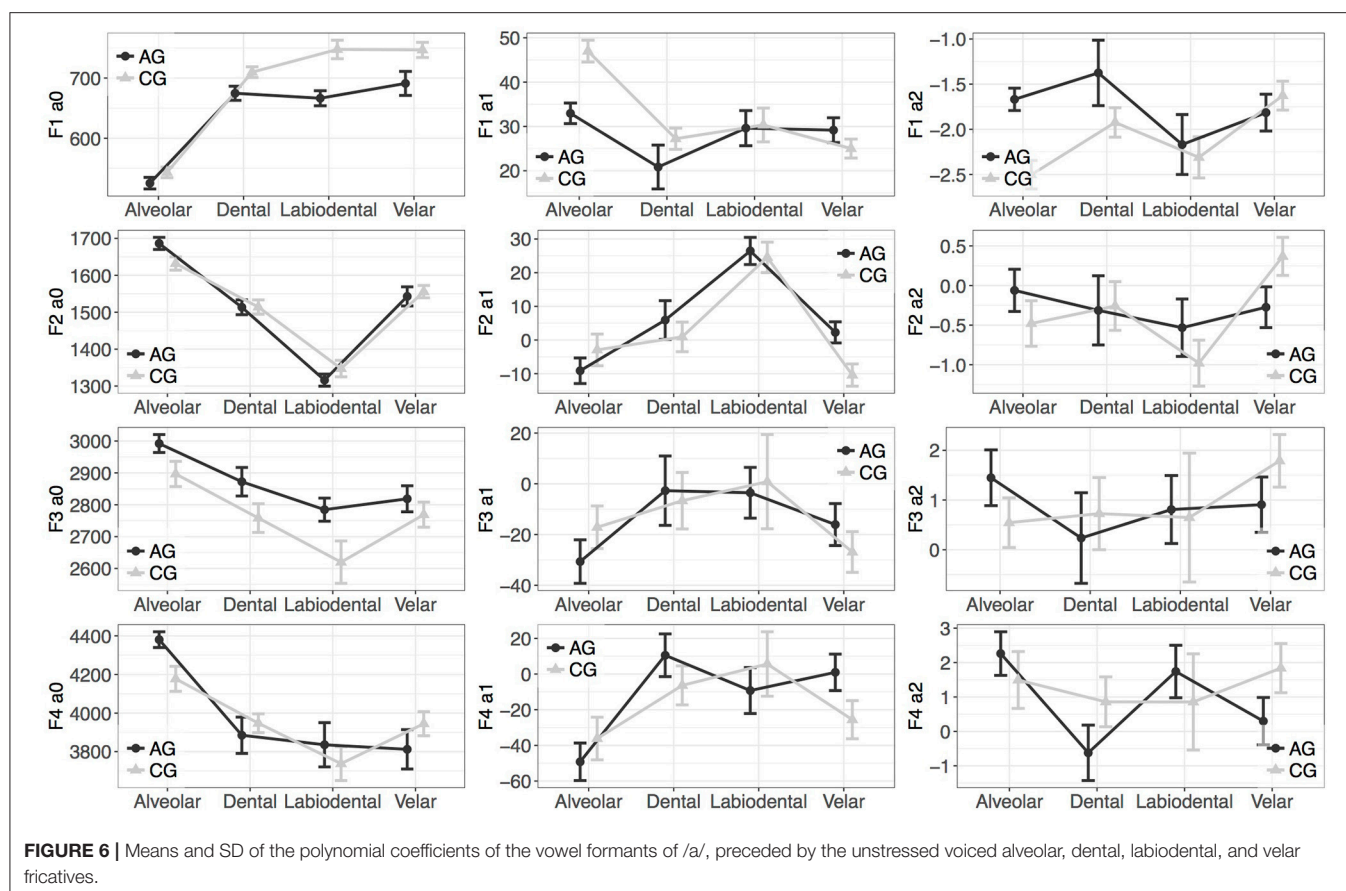
**TABLE 8 |** Effects of dialect [Athenian Greek (AG) and Cypriot Greek (CG)], place of articulation, voicing, stress, and vowel on the three polynomial coefficients of $F1$ and $F2$.

| | | Estimate | SE | df | t value | Pr (>\|t\|) |
|---|---|---|---|---|---|---|
| $F1a_0$ | Intercept | 672.18 | 15.11 | 85.00 | 44.49 | 0.001 |
| | Dental | 71.21 | 15.30 | 65.00 | 4.66 | 0.001 |
| | Labiodental | 53.91 | 15.46 | 68.00 | 3.49 | 0.01 |
| | Velar | 119.17 | 20.22 | 66.00 | 5.89 | 0.001 |
| | AG | −15.45 | 7.27 | 2,143.00 | −2.13 | 0.05 |
| | Voiceless | 50.10 | 10.75 | 60.00 | 4.66 | 0.001 |
| | /i/ | −313.32 | 12.32 | 60.00 | −25.43 | 0.001 |
| | Velar:AG | −22.52 | 10.95 | 7,025.00 | −2.06 | 0.05 |
| $F1a_1$ | Intercept | 34.30 | 3.05 | 66.00 | 11.25 | 0.001 |
| | Dental | −11.05 | 4.03 | 66.00 | −2.74 | 0.01 |
| | Labiodental | −8.27 | 3.85 | 70.00 | −2.15 | 0.05 |
| | Velar | −11.12 | 5.33 | 68.00 | −2.09 | 0.05 |
| | /i/ | −27.80 | 2.36 | 55.00 | −11.76 | 0.001 |
| $F1a_2$ | Intercept | −2.29 | 0.13 | 67.00 | −17.21 | 0.001 |
| | Dental | 0.64 | 0.18 | 78.00 | 3.54 | 0.01 |
| | Labiodental | 0.40 | 0.18 | 99.00 | 2.27 | 0.05 |
| | Velar | 0.54 | 0.24 | 77.00 | 2.25 | 0.05 |
| | /i/ | 1.83 | 0.10 | 46.00 | 18.89 | 0.001 |
| | Dental:AG | −0.56 | 0.21 | 6,625.00 | −2.66 | 0.01 |
| | Velar:AG | −0.64 | 0.28 | 6,135.00 | −2.26 | 0.05 |
| | Labiodental:Unstressed | −0.63 | 0.29 | 97.00 | −2.20 | 0.05 |
| $F2a_0$ | Intercept | 1,629.44 | 37.72 | 74.00 | 43.195 | 0.001 |
| | Labiodental | −116.77 | 44.51 | 61.00 | −2.624 | 0.5 |
| | Palatal | 209.31 | 59.77 | 60.00 | 3.502 | 0.001 |
| | AG | −41.38 | 18.22 | 3,043.00 | −2.270 | 0.05 |
| | Unstressed | −119.74 | 48.13 | 55.00 | −2.488 | 0.05 |
| | /i/ | 771.62 | 28.11 | 54.00 | 27.451 | 0.001 |
| | Labiodental:AG | −63.28 | 25.37 | 7,002.00 | −2.494 | 0.05 |
| | AG:Unstressed | 108.10 | 21.61 | 6,977.00 | 5.003 | 0.001 |
| $F2a_1$ | Intercept | −6.62 | 6.12 | 74.00 | −1.08 | 0.283 |
| | Labiodental | 18.37 | 7.32 | 72.00 | 2.51 | 0.05 |
| | Palatal | −20.00 | 9.29 | 67.00 | −2.15 | 0.05 |
| | /i/ | 27.67 | 5.72 | 58.00 | 4.83 | 0.001 |
| | Dental:AG | 12.39 | 4.93 | 7,054.00 | 2.51 | 0.05 |
| | Labiodental:AG | 16.17 | 5.50 | 7,046.00 | 2.94 | 0.01 |
| $F2a_2$ | Intercept | −0.06 | 0.50 | 64.00 | −0.12 | 0.907 |
| | AG | 0.97 | 0.31 | 951.00 | 3.09 | 0.01 |
| | /i/ | −1.97 | 0.38 | 53.00 | −5.11 | 0.001 |
| | Dental:AG | −1.04 | 0.47 | 7,046.00 | −2.22 | 0.05 |
| | Labiodental:AG | −1.32 | 0.48 | 7,024.00 | −2.73 | 0.01 |
| | Labiodental:AG:Unstressed | 1.64 | 0.79 | 6,983.00 | 2.07 | 0.05 |

We will come back to this issue later in the discussion, let us however investigate more closely the effects of dialect on fricatives' acoustic features.

One interesting finding is that the *center of gravity* for the labiodental fricative [f], the alveolar fricatives [s] and [z], the voiceless palatal [ç], and the velar fricatives is higher in Cypriot Greek than in Athenian Greek. By contrast, Athenian Greek fricatives [θ] and [ð], [v] and [j] have higher center of gravity than the corresponding Cypriot Greek ones (see section 2.2). These differences were significant and suggest that the center of gravity

**FIGURE 6 |** Means and SD of the polynomial coefficients of the vowel formants of /a/, preceded by the unstressed voiced alveolar, dental, labiodental, and velar fricatives.

of fricatives can discriminate the fricative productions of the two varieties. In addition to these effects, Athenian Greek and Cypriot Greek have different effects with respect to stressed vs. unstressed *palatal* fricatives.

Similarly, *standard deviation* varies depending on the dialect. Overall, Cypriot Greek fricatives are characterized by higher standard deviation than Athenian Greek fricatives (e.g., labiodental [v], the dental [ð], the alveolar [s] and [z], the palatals [ç] and [ʝ], and the velars [x] and [ɣ]). This necessarily suggests that Cypriot Greek speakers produce these fricatives with greater variation with respect to the center of gravity than Athenian Greek speakers. By contrast, only the Athenian Greek voiceless labiodental [f] and dental [θ] had higher spectral standard deviation than the corresponding Cypriot Greek fricatives, which suggests that in Cypriot Greek the spectral energy of [f] and [θ] fricative sounds is closer to the center of gravity of these sounds than in Athenian Greek.

Most fricatives are characterized by *positive skewness*; this includes the voiced labiodental, palatal, and velar fricatives. Cypriot Greek fricatives have greater values of skewness than Athenian Greek fricatives. In Cypriot Greek [s] and [z], skewness is negative but positive in Athenian Greek, which suggests that their distribution is left-tailed in Cypriot Greek but right-tailed in Athenian Greek. Another important finding is that *kurtosis* revealed asymmetries in the spectral distribution of Athenian

Greek and Cypriot Greek fricatives: voiced fricatives [v ð ʝ ɣ] had high kurtosis whereas the kurtosis for the corresponding voiceless ones was significantly lower. In all cases Cypriot Greek fricatives had higher kurtosis than the Athenian Greek fricatives.

An interesting finding that emerged from Study 1 is that Cypriot Greek *sibilants* [s z] differ from Athenian Greek sibilants in most acoustic properties. First, they associate with higher center of gravity in Hz than the corresponding Athenian Greek sibilants: the center of gravity for the stressed Cypriot Greek [s] was 10,104 Hz whereas the corresponding Athenian Greek [s] was only 6,933 Hz. Similarly, the stressed Cypriot Greek [z] was 8,462 Hz whereas the corresponding Athenian Greek was only 5,718 Hz. Cypriot Greek sibilants had higher standard deviation from the Athenian Greek sibilants. This can be an effect of a different place of articulation of the Cypriot Greek and Athenian Greek sibilant sounds. They also differ in their duration. These findings account for the impressionistic reports from the speakers of these two varieties that [s] and [z] *sound different in Athenian Greek and Cypriot Greek*.

Voiced fricatives are overall shorter than unvoiced fricatives. This finding broadly supports the work of earlier studies showing that *duration* distinguishes voiced and voiceless fricatives: voiceless fricatives are longer than voiced fricatives (Cole and
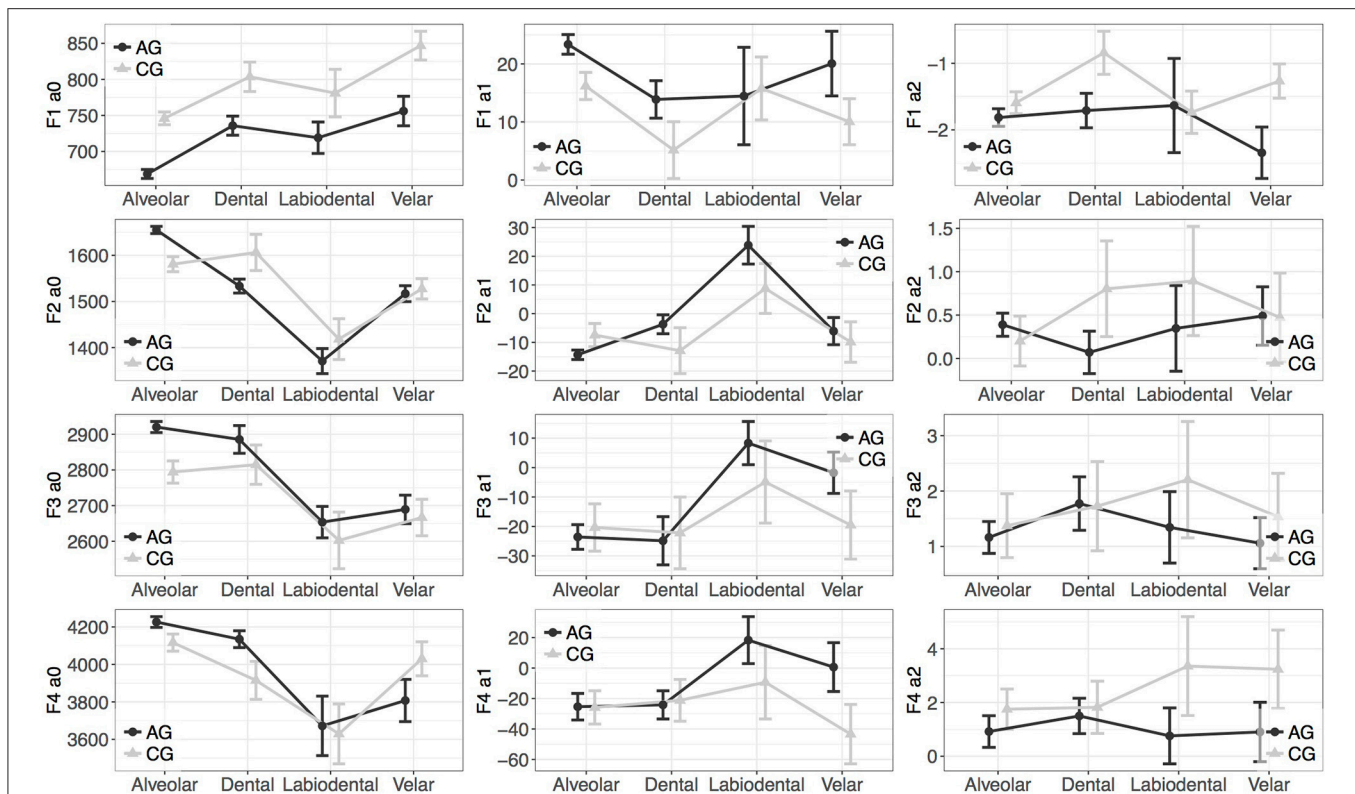
**FIGURE 7 |** Means and SD of the polynomial coefficients of the vowel formants of /a/, preceded by the unstressed voiceless alveolar, dental, labiodental, and velar fricatives.

Cooper, 1975; Klatt, 1976; Silbert and de Jong, 2008)[3]. These durational effects are perceptually silent. For example, in a perceptual study of European Portuguese, Pape et al. (2015) showed that there is systematic association of voicing to shorter duration: "The shorter the fricative duration, the more the listeners judged the stimuli as voiced" (Pape et al., 2015, p. 100). Moreover, the place of articulation had significant effects on fricative duration (Silbert and de Jong, 2008; Pape et al., 2015), as each fricative depending on the place of articulation is realized with a different intrinsic duration (Lehiste, 1970; Jongman et al., 2000; Silbert and de Jong, 2008; Iskarous et al., 2011; Pape et al., 2015).

A compelling finding is that Athenian Greek voiceless fricatives are significantly shorter than Cypriot Greek voiceless fricatives. The short Cypriot Greek fricatives, which we measured in this study, are longer that the Athenian Greek fricatives:

*Athenian Greek fricatives < Cypriot Greek short fricatives < Cypriot Greek long fricatives.*

Especially, the Athenian Greek alveolar [s] and the palatal [ç] were overall shorter than the corresponding Cypriot Greek ones. The different patterns of duration in Athenian Greek and Cypriot

Greek fricatives are captured by the classification model, which ranks the contribution of duration to the classification of dialect higher than all the other features.

These findings might reflect fricative specific duration patterns in the two speech varieties. Evidence from a comparative study of slow and fast productions of Athenian Greek and Cypriot Greek sonorants, that shows that Cypriot Greek singleton sonorants are shorter than Athenian Greek sonorants (Arvaniti, 1999a, 2001), may support this interpretation. Nevertheless, earlier studies on vowels, which show that the Athenian Greek vowels are overall shorter than the corresponding Cypriot Greek vowels (Themistocleous, 2011, 2017a,b), may indicate that the overall Athenian Greek speech is uttered at a faster rate than the Cypriot Greek speech. In any case, further comparative research on the segmental duration of these two varieties is required to establish a proper account of the implications of these findings on fricative duration.

Moreover, there were major progressive coarticulatory effects of fricatives, which affected the starting frequency of $F1$ and its overall shape. $F1$ showed clear effects of voicing, place of articulation, and stress (e.g., see Stevens et al., 1992). This study shows that dialect also affects the $F1$. As was expected, $F2$ interacts with the place of articulation and thus it replicates earlier studies, which show that the place of articulation had significant effects on $F2$, along with voicing and stress (e.g., see

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[3]Note that fricative duration is susceptible to effects of stress and prosodic structure, such as the syllable structure, accentual lengthening, and final lengthening (e.g., de Manrique and Massone, 1981a).

**TABLE 9 |** Effects of dialect [Athenian Greek (AG) and Cypriot Greek (CG)], place of articulation, voicing, stress, and vowel on the three polynomial coefficients of $F3$ and $F4$.

|          |                      | Estimate  | SE    | df       | t value | Pr (>\|t\|) |
|----------|----------------------|-----------|-------|----------|---------|-------------|
| $F3a_0$  | Intercept            | 2,839.63  | 30.03 | 110.00   | 94.54   | 0.001       |
|          | Dental               | −77.62    | 28.72 | 74.00    | −2.70   | 0.01        |
|          | Labiodental          | −195.45   | 31.57 | 115.00   | −6.19   | 0.001       |
|          | Palatal              | 433.00    | 35.47 | 70.00    | 12.22   | 0.001       |
|          | Velar                | −75.84    | 35.67 | 71.00    | −2.13   | 0.05        |
|          | AG                   | 64.05     | 28.32 | 5,759.00 | 2.26    | 0.05        |
|          | /i/                  | 189.31    | 15.01 | 54.00    | 12.61   | 0.001       |
|          | Dental:AG            | −82.37    | 35.23 | 6,728.00 | −2.34   | 0.05        |
|          | Palatal:AG           | −87.26    | 43.37 | 6,833.00 | −2.01   | 0.05        |
|          | Velar:Voiceless      | −106.93   | 53.40 | 109.00   | −2.00   | 0.05        |
|          | AG:Voiceless         | −61.94    | 30.47 | 6,852.00 | −2.03   | 0.05        |
| $F3a_1$  | Intercept            | −24.21    | 6.64  | 77.00    | −3.65   | 0.001       |
|          | Dental               | 19.77     | 8.34  | 67.00    | 2.37    | 0.05        |
|          | Labiodental          | 35.60     | 8.97  | 93.00    | 3.97    | 0.001       |
|          | Palatal              | −28.39    | 10.33 | 64.00    | −2.75   | 0.01        |
|          | AG                   | −17.33    | 7.00  | 3,132.00 | −2.48   | 0.05        |
|          | /i/                  | 20.71     | 4.43  | 52.00    | 4.67    | 0.001       |
|          | Dental:AG            | 23.27     | 9.19  | 6,895.00 | 2.53    | 0.05        |
|          | Velar:AG             | 32.37     | 11.36 | 6,897.00 | 2.85    | 0.01        |
|          | Labiodental:Voiceless| −29.22    | 12.29 | 91.00    | −2.38   | 0.05        |
| $F3a_2$  | Intercept            | 1.16      | 0.53  | 64.00    | 2.17    | 0.05        |
|          | AG                   | 1.26      | 0.37  | 891.00   | 3.40    | 0.01        |
|          | /i/                  | −1.61     | 0.41  | 52.00    | −3.93   | 0.001       |
|          | AG:Unstressed        | −1.38     | 0.50  | 6,989.00 | −2.79   | 0.01        |
| $F4a_0$  | Intercept            | 4,167.67  | 47.94 | 115.00   | 86.94   | 0.001       |
|          | Dental               | −304.74   | 52.96 | 82.00    | −5.75   | 0.001       |
|          | Labiodental          | −378.46   | 59.33 | 140.00   | −6.38   | 0.001       |
|          | Velar                | −239.92   | 65.60 | 77.00    | −3.66   | 0.001       |
|          | Voiceless            | −112.12   | 48.80 | 76.00    | −2.30   | 0.05        |
|          | /i/                  | 125.45    | 27.17 | 55.00    | 4.62    | 0.001       |
|          | Palatal:AG           | −184.67   | 87.70 | 6,859.00 | −2.11   | 0.05        |
|          | Velar:AG             | −183.96   | 88.04 | 6,761.00 | −2.09   | 0.05        |
| $F4a_1$  | Intercept            | −40.22    | 6.89  | 65.00    | −5.84   | 0.001       |
|          | Dental               | 29.08     | 9.79  | 89.00    | 2.97    | 0.01        |
|          | Labiodental          | 38.07     | 9.69  | 116.00   | 3.93    | 0.001       |
|          | /i/                  | 13.40     | 5.22  | 50.00    | 2.57    | 0.05        |
| $F4a_2$  | Intercept            | 2.42      | 0.55  | 60.00    | 4.36    | 0.001       |
|          | Labiodental          | −2.01     | 0.75  | 88.00    | −2.67   | 0.01        |
|          | Labiodental:AG       | 1.71      | 0.83  | 6,785.00 | 2.05    | 0.05        |

Potter et al., 1947; Cooper et al., 1952; Delattre et al., 1955; Stevens and House, 1956; Harris et al., 1958; Lehiste and Peterson, 1961; Öhman, 1966; Fant, 1969; de Manrique and Massone, 1981b; Kewley-Port, 1982; Beckman et al., 2009). However, what this study shows is that the dialect, i.e., Athenian Greek and Cypriot Greek, had significant effects on fricative-vowel coarticulation on $F2$, as well as on $F3$ and $F4$.

So, striking result to emerge from these findings is that the effects of dialect are clearly not isolated on a single acoustic parameter but have manifold effects on fricative spectra. Also, the model suggests that the difference between the fricative productions of a speaker of one dialect from the speaker of another relies on the exact ranking of properties—from more important to less important—and on their interaction. Going

back to the point made at the beginning of this section, namely that all measured acoustic properties contribute to the classification of dialect, we need to highlight the contribution of the machine learning and classification model to the understanding of dialectal effects on fricative acoustic structure. The machine learning model is certainly not a cognitive model of how humans perceive and produce fricatives, yet it may shed light on the aspects of the speech signal that are crucial for the classification of dialects and can potentially trigger the attentional mechanisms of speakers and listeners when identifying each dialect. In other words, it can designate which properties listeners may pay attention to when identifying a speaker of a different dialect (even possibly in settings when that speaker code-switches). A future perceptual study should verify these findings from a perceptual point of view.

# 6. CONCLUSIONS

The present study was designed to determine the effect of two linguistically proximal varieties of Modern Greek, i.e., Athenian Greek and Cypriot Greek, on the spectral properties of fricatives and on the coarticulatory effects of fricatives on the following vowel. Unlike earlier studies that attempt to single out the invariant acoustic properties of linguistic and sociolinguistic

categories in the speech signal, this study reveals a more complex reality where linguistic and sociolinguistic categories influence multiple aspects of the speech signals. A fricative sound depending on the dialect might have higher or lower center of gravity, different degrees of standard deviation, skewness and kurtosis and result on different coarticulatory effects.

# ETHICS STATEMENT

This study was carried out with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

# AUTHOR CONTRIBUTIONS

CT conducted designed and run the experiments, conducted the statistical analysis, and prepared the manuscript.

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# Skewed Sociolinguistic Awareness of a Native Non-standard Dialect: Evidence from the Cypriot Greek Writing of Greek Cypriot Students

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Over the last 50 years, sociolinguistic research in settings in which a regional, social, or ethnic non-standard linguistic variety is used alongside the standard variety of the same language has steadily increased. The educational implications of the concomitant use of such varieties have also received a great deal of research attention. This study deals with regional linguistic variation and its implications for education by focusing on the Greek Cypriot educational context. This context is ideal for investigating the linguistic profiles of speakers of proximal varieties as the majority of Greek Cypriots are primarily educated in just one of their varieties: the standard educational variety. The aim of our study was to understand Greek Cypriot primary school pupils' sociolinguistic awareness via examination of their written production in their home variety [Cypriot Greek (CG) dialect]. Our assumption was that, because written production is less spontaneous than speech, it better reflects pupils' conscious awareness. Pupils were advised to produce texts that reflected their everyday language with family and friends (beyond school boundaries). As expected, students' texts included an abundance of mesolectal features and the following were the ten most frequent: (1) palato-alveolar consonants, (2) future particle [enːá] and conditional [ítan na] + subjunctive, (3) consonant devoicing, (4) CG-specific verb stems, (5) final [n] retention, (6) [én/ éni] instead of [íne], (7) CG-specific verb endings, (8) [én/é] instead of [ðen], (9) elision of intervocalic fricative [ɣ], and (10) CG-specific adverbs. Importantly, in addition to the expected mesolectal features that reflect contemporary CG, students included a significant and unexpected number of basilectal features and instances of hyperdialectism (that are not representative of today's linguistic reality) which rendered their texts register-inappropriate. This led us to conclude that Greek Cypriot students have a skewed sociolinguistic awareness of variation within their first dialect and a distorted impression of their own everyday language. We argue that the portrayal of CG in its basilectal form was performed intentionally by students in an effort to distance themselves from a socially constructed identity of a rural, uneducated, and stigmatized non-standard-dialect speaker. The study is of international relevance as it deals with sociolinguistic issues that pertain to all bidialectal speakers.

Keywords: bidialectism, sociolinguistic awareness, written performance, non-standard varieties, language policy

# INTRODUCTION

Research in settings where regional, social, or ethnic linguistic varieties are used alongside a standard variety of the same language has burgeoned in recent years. Indeed, the issue of bidialectism is increasingly being viewed as a priority. Researchers have particularly aimed to identify whether the bilingual advantage, which has strong empirical support (Bialystok, 1988; Bialystok et al., 2012), extends to speakers of proximal dialectal varieties (Antoniou et al., 2014, 2016). In pursuit of this aim, a flourishing area of research has grown up around the premise that dialectal diversity may often have favorable outcomes and, in particular, that there is merit in assessing the potential for bidialectal programs in formal educational settings to produce beneficial learning outcomes. In Cyprus, Yiakoumetti (2006, 2007) demonstrated that the experimental introduction of bidialectal education (deploying the Cypriot Greek (CG) dialect alongside Standard Modern Greek) led to improved learning of the targeted standard variety. In Australia, Malcolm and Truscott (2012) provided evidence of positive influences on repertoire building when a bidialectal program (deploying Australian Aboriginal English alongside Standard Australian English) was introduced. Similarly, in Canada, improvement in Standard Canadian English reading skills was recorded when Canadian Aboriginal English was used alongside Standard Canadian English in bidialectal programs (Battisti et al., 2011; Ball and Bernhardt, 2012). In the Creole setting of Guinea-Bissau, Benson (1994, 2004) discovered that more students spoke in class and that there was less reliance on rote learning when bidialectal programs (deploying the native Crioulo alongside Standard Portuguese) were introduced. (For a review of studies on the outcomes from expanded use of Pidgins and Creoles in education, see Siegel, 2012.)

Research on bidialectal education has thus far focused exclusively on the effects of such education on educational linguistic varieties in bidialectal settings. In other words, bidialectal programs such as the ones just described targeted performance in students' second variety, the educational standard. This is understandable considering that language policy goes hand in hand with power and prestige and that educational varieties are particularly prone to being associated with such value-laden concepts (Bourdieu, 1991; Spolsky, 2004).

This study focuses on the first dialect of speakers of proximal varieties. Specifically, it aims to explore bidialectal primary-school students' sociolinguistic awareness as it is reflected in their written performance in their native non-standard regional dialect. The Greek Cypriot educational context served as vantage point for our exploration. This setting is ideal for investigation as it is representative of most bidialectal settings in which language policy disproportionately focuses on students' educational standard variety. Traditionally, educational settings in which speakers employ the use of proximal varieties have been characterized by the anachronistic ideology that promotes exclusive use of an educational monolingual standard variety (Yiakoumetti, 2012). Both directly and indirectly, inclusion of varieties other than the prescribed standard is usually discouraged. In many cases, the very existence of these varieties

is ignored and, in some cases, such varieties are openly banned from the classroom (Ndemanu, 2014).

Our research treatment was to encourage students to write in their dialectal native variety. The ultimate aim of this activity was to identify students' sociolinguistic awareness via their written performance in a variety which can only be described as both (a) their most familiar variety but also (b) a variety which has never formed part of their formal education. In other words, students were asked to write in a variety which is their native variety but which they do not consider as being associated with formal writing or for formal use when writing in a school setting (Papapavlou and Pavlou, 2005). Our research facilitated an investigation of students' written performance in the absence of any support (as current language policy comprehensively neglects students' first dialect). Importantly, the project reflected students' opinions as to what constitutes their first dialect and the policy's effects on these opinions.

# MATERIALS AND METHODS

## Setting of the Study
### Greek Cypriot Sociolinguistic Landscape

Two linguistically related varieties are primarily used in Greek-speaking Cyprus: the CG dialect and Standard Modern Greek (SMG). (Similarly, Cypriot Turkish and Standard Turkish are used in Turkish-speaking Cyprus.) CG is the naturally acquired mother tongue of virtually all Greek Cypriots who go on to learn SMG via formal education. CG is widespread on the island as it represents the universal medium of everyday informal communication. SMG is the educational language variety.

Cypriot Greek is characterized by internal variability (Tsiplakou et al., 2016). Early descriptive studies (Contosopoulos, 1969; Menardos, 1969; Newton, 1972, 1983) presented CG as a geographical continuum which consisted of a set of basilects placed in opposition to a geographically defined acrolect, that of ελληνικά, Greek (Newton, 1972; Tsiplakou et al., 2006). Post-1974, these continuum varieties started to exhibit homogenization. This was primarily due to rapid demographic and social changes (as a result of the Turkish military occupation) and to heightened exposure to metropolitan SMG. Dialect leveling and koineization processes are still ongoing (Rowe and Grohmann, 2013). Today's CG koine is almost entirely free of local variation as infrequent regional variants are fast becoming obsolete at phonological, morphosyntactic, and even lexical levels (Terkourafi, 2005; Tsiplakou, 2014). Some researchers argue that now CG can best be described in terms of a register or a stylistic continuum (rather than a geographically defined continuum) (Tsiplakou et al., 2016).

Contemporary CG is employed by all Greek Cypriots independently of their socioeconomic backgrounds. Various researchers on the island argue that today's CG has expanded in domains which previously dismissed the dialect as inappropriate: its use has taken over both formal and informal domains replacing the use of SMG in a substantial number of cases (Themistocleous, 2009, 2010; Papapavlou, 2010, 2017). For example, contemporary CG (or at least its acrolectal levels) are

now used in formal or semi-formal domains such as the court, public speeches, university lectures and the media. The dialect is indeed allocated an increasingly larger space in the current Cypriot mediaspace via the broadcasting of Cypriot sitcoms and telenovelas which are enjoying high popularity. We note that this recent expansion of CG is primarily associated with oral production. The emergence of CG in traditionally SMG domains has naturally granted the dialect more visibility and legitimization (Tsiplakou and Ioannidou, 2012).

Cypriot Greek speakers recognize a hierarchy of linguistic varieties which range from 'heavily peasanty' to SMG (Tsiplakou et al., 2006; Katsoyannou et al., 2006; Papapavlou and Sophocleous, 2009). (We further address this hierarchy in our Methods where we outline the various levels of language use along a continuum.) It must be emphasized here that the sociolinguistic and linguistic realities on the island offer its speakers a varied linguistic repertoire. Greek Cypriots have a wide range of features at their disposal. Their choices are therefore aligned to the context of the event of communication and may vary along the contemporary CG continuum.

In addition to the linguistic varieties already mentioned above (Cypriot Greek, Standard Modern Greek, Cypriot Turkish, and Standard Turkish), English is prominent in various domains such as the civil service and legal system. Western Armenian and Maronite Arabic are minority languages recognized within the European Charter for Regional or Minority Languages. Kurbetcha, a variety of Romani which is not well studied, is present but not recognized in the Charter (Hadjioannou et al., 2011).

In spite of linguistic diversity that is characteristic of Cyprus, the Greek Cypriot language policy treats SMG as the sole formal language of the national curriculum. The 2010 curriculum proved to be both an innovative and an abortive document. It was innovative for condoning the use of CG within formal education (Tsiplakou, 2015; Ministry of Education and Culture [MoEC], 2010). It was abortive in that its acknowledgment of CG led to heated debates which resulted in the rapid production of a replacement document which once again contained no reference to CG.

### CG in Writing

Cypriot Greek is considered to be a spoken variety while SMG is the variety associated with writing. Apart from a number of improvised orthographic conventions (Chatziioannou, 1996; Yiangoullis, 2009; Katsoyannou et al., 2013; Coutsougera and Georgiou, 2014) that have been developed by poets, writers and lexicographers in an attempt to reflect unique dialectal sounds which do not exist in SMG (i.e., post-alveolar fricatives, post-alveolar affricates), the dialect is not codified and it does not have an established standard orthographical system.

Although rare, when writing occurs in the dialect, it is usually restricted to everyday informal communication events and involves forms of writing that are closer to speech such as instant messaging and online text-based communication among teenagers and young adults (Themistocleous, 2009, 2010; Sophocleous and Themistocleous, 2010). Due to the wide use of the Roman alphabet in online interactions, a romanized version

of written CG (rather than one based on the Greek alphabet) is also very often employed, adding further to the multiplicity of writing systems that exist for the dialect. Research on the written form of the dialect has highlighted the repercussions of the lack of a unified way to represent the dialect and pointed out the need for its codification and standardization (Armosti et al., 2014; Papadima et al., 2014).

## Participants

One hundred and nineteen Greek Cypriot bidialectal students (63 boys and 56 girls) participated in the study. Students were in the fifth grade of primary education and all resided in the urban and semi-urban Limassol district. Their age range was 10–11 and all students' native variety was CG. The participants formed a sociolinguistically homogeneous group as they were all born and raised in Limassol and all had Greek Cypriot parents. Students without Greek Cypriot parents and/or whose first variety was not CG were excluded from the analysis. In compliance with advice provided by the Cypriot Ministry of Education and Culture, we limited our sampled population to fifth graders as final-year sixth-grade pupils have additional demands associated with final exams. Our study was carried out in accordance with the recommendations of our institution's Ethics Committee as well as those of the Cypriot Ministry of Education and Culture, with written informed consent from school headteachers and students' parents or legal guardians. Access to information associated with students' familial socioeconomic and educational profiles was not available so the influence of these factors on sociolinguistic awareness could not be considered.

## Primary Data-Collection Tool: CG Writing Task

Students' sociolinguistic awareness was assessed via written texts which they were expected to produce in their native CG. Our assumption was that, because written production is less spontaneous than speech, it better reflects pupils' conscious awareness. The task aimed to shed light on students' ability to choose and produce the mesolectal register of contemporary Cypriot Greek.

During the design stages of the written task, we considered it essential for the language of the completed tasks to be characterized by non-test language (Luoma, 2004). We thus chose to develop a task that would simulate the usage of written CG in a real-life situation. To achieve this, a dialog between peers was chosen as the basis and the following scenario was presented to students for their responses.

Scenario: "Pambos and Koullis are two Cypriot pupils. Pambos lives with his family in Nicosia but they are soon relocating to Limassol. Pambos is apprehensive about this change and worries about feeling lonely in Limassol. He thus sends a message on MSN/Facebook or calls Koullis who resides in Limassol to share his worries."

Instruction: "Imagine you are Koullis! Write the imaginary dialog you would have with Pambos. What do you think you would tell him to comfort him?"

It was thus inferred that the language of the tasks may be closely related to daily oral speech and it may also contain oral features that typically occur in online chat rooms or in telephone conversations. To assist students, explicit instructions regarding the linguistic variety they were expected to produce were provided. This guidance was as follows: (i) to write in the way they normally speak everyday outside of school with family members and friends and (ii) to use the Standard Greek alphabet to represent their pronunciation. In addition, the first three sentences of the script were provided as part of the task description such that students could continue on from these example sentences: "Γειά σου Κούλλη, ο Πάμπος είμαι! ΄Ιναμπου κάμνεις;;;; Έπιασα σε τηλέφωνο να σου πω κάτι... (Hello Koulli, it's Pambos! How are you? I called you to tell you something ....)". We note that the written guidance on how to conduct the task was provided in SMG to conform with usual classroom practice. However, as the request to write in the home variety was unusual, we also ensured that students were told orally what was requested of them. This was performed in CG.

The actual topic of the task ensured that the language of the text would reflect students' everyday CG. While the instructions allowed for certain freedom to incorporate individual language choices, the scenario of the task clearly placed the target language event closer to mesolectal registers of CG (thus excluding language close to formal SMG but also excluding language close to basilectal CG). Despite the fact that compartmentalization of variants and registers is hazy (Tsiplakou et al., 2006), previous research has identified that Greek Cypriot speakers distinguish and recognize at least three levels of use (Sophocleous, 2006; Tsiplakou et al., 2006; Papapavlou and Sophocleous, 2009): (i) basilectal CG which corresponds to 'heavy Cypriot, peasanty, βαρετά κυπριακά', (ii) mesolectal CG which corresponds to 'correct, tidied-up Cypriot, σωστά, σισταρισμένα κυπριακά', and acrolectal CG which, despite approximating SMG, does not concide with it and perhaps corresponds to what has been named Cypriot Standard Greek (Arvaniti, 2010). If SMG were to be placed alongside the aforementioned levels, it would occupy the acrolectal end of the continuum (with the case of the language of school textbooks being a characteristic example). In light of this hierarchy, we note that formal SMG (primarily found in school textbooks), daily mesolectal CG (the form of language Greek Cypriots use in their daily lives), and basilectal CG (heavy Cypriot that includes features which are not part of Greek Cypriots' active repertoire) clearly require the use of a distinct set of variants with which students are expected to be familiar.

In essence, our hypothesis was that the writing task would tend to encourage students to identify and correctly deploy (i) CG and not SMG and (ii) contemporary mesolectal CG and not basilectal CG. The students thus needed to resort to their repertoire and retrieve the unique structural features which constitute today's mesolectal CG. This task may, at first glance, seem straightforward but the fact that contemporary mesolectal CG (which is employed by Cypriot Greeks on a daily basis) is almost exclusively associated with oral speech renders the task quite demanding. Indeed, students were often rather baffled when asked to write in their familiar home variety (D1) and this is a phenomenon which has also been observed previously by other researchers (Tsiplakou and Hadjioannou, 2010).

To conclude, the writing task aimed to elicit information on students' perceptions about what is distinctively CG, thereby providing a richer insight into the nature of their register awareness.

## Secondary Data-Collection Tool: Interviews

Interviews were conducted to complement the writing task data. A subset of eight students, four boys and four girls, were randomly selected and interviewed individually. A semi-structured format was employed allowing for flexibility in the development of a casual, informal conversation. The issues covered in the interviews fell under two broad topics: (i) students' perceptions of their two varieties and (ii) students' views on their own language use.

## Data Codification and Analysis

The corpus of written scripts was scanned and imported into NVIVO 10 qualitative analysis software. The corpus was manually tagged for distinctive dialectal grammatical and lexical features as well as dialectal expressions as these formed the unit of analysis. Dialectal forms were identified according to the main and most marked characteristics of CG based on previous research. Specifically, to compose a list of features, both descriptive as well as empirical studies on CG that focus on individual CG phenomena were taken into account (Newton, 1972; Arvaniti, 1999; Pavlou and Papapavlou, 2004; Tsiplakou, 2004, 2006; Varella, 2006). In addition, three linguists who were native speakers of CG acted as independent raters and provided comments about the nature of a variety of features. This included assigning the features to the appropriate CG register (mesolect, acrolect, or basilect).

The resulting data were statistically analyzed via a general linear model approach to establish whether gender and/or class contributed significant effects. Response variables for (i) mesolectal, (ii) basilectal and (iii) hyperdialectal production were derived by weighting the number of instances per script over the total number of words in each script. As no significant effects were detected ($P > 0.24$ (1,115) for all potential predictors), these analyses are not reported. However, descriptive statistics including the mean number of mesolectal instances ($\pm 95\%$ CI) and the percentages of scripts containing each of the three types of language use are provided.

## RESULTS

Data from students' CG texts highlighted two types of findings: (i) the expected mesolectal CG use and (ii) the unexpected non-mesolectal CG use. Both types are presented below.

## Mesolectal Features of Contemporary CG: 10 Most Common CG Items in Students' D1 Writing

All 119 scripts contained mesolectal CG features. The mean number of mesolectal items per script was 27.8 ± 2.5 (95% CI) and the mean number of words per script was 96.4 ± 4.6 (95% CI). As each script is the discrete work product of a single and unique student, script is the appropriate sampling unit. The frequency of each item is thus presented as the percentage of scripts containing the item. The most common features are presented in the text below and in **Figure 1** (in order of frequency).

(1) Palato-alveolar consonants: In their attempt to render their writing as CG as possible, 98 out of the 119 students used /tʃ/, / ʃ/ and /ʒ/ (palatal fricatives and affricates) 451 times. (Examples: ´Eσσει καμιά μπαράκα να τες βάλω μέσα; [éʃi kaмɲá mbaɾáka na tes válo mésa] is there any shed in which I can put them? Φέρε τες κότες **τζ**ιαι τες τσούρες μου. [féɾe tes kótes tʃe tes tsʰːúɾes mu] bring.IMP my chickens and my goats)

(2) Future particle [enːá] and conditional [ítan na] + subjunctive: the two morphological items were used by 97 students and occurred 386 times. (Examples: **Ενά** μετακομίω στη Λεμεσό [ená metakomío sti lemesó] I'm going to move to Limassol. ´**Hταν να σου πω** ότι **εννά** μετακομήσω στη γητωνιά σου.[ítan na su po óti enːá metakomíso sti ɣitoɲːá su] I wanted to tell you that I'll be moving to your neighborhood)

(3) Consonant devoicing: 87 students produced 202 instances of sequences of obstruents that followed the CG phonological process of voice assimilation. (During this process, the first voiced consonant changes into a voiceless consonant to assimilate with the adjacent voiceless /k/ sound.) (Example: παιχνί**θκ**ια [pexníθca] games)

(4) CG-specific verb stems: 79 students produced a total of 159 such instances which involved verbs that differed morphologically from SMG. (Example: **κάμν**ετε [kámnete] doing.2PL)

(5) Final [n] retention: the tendency to add a [n] sound at the end of a number of words was another strong CG phonological indicator. 70 students used this feature in 204 instances. (Example: την παρασκευή**ν** [tin paraskevín] on Friday)

(6) [én/ éni] instead of [íne]: The use of the CG form [én/éni] to express the 3rd person singular of the copula verb [íne]. This item was used by 67 students and occurred 150 times in total. (Example: **εν** τόσο ωραία [en tóso oréa] it's so good)

(7) Cypriot Greek-specific verb endings: This type of feature appeared in the scripts of 64 students and occurred 117 times in total. (Example: πά**εις** σχολείο [páis sxolío] go.2SG to school)

(8) [én/ é] instead of [ðen]: the form [én/ é] was found to be used in the place of the SMG [ðen] to express negation. It occurred in 63 students' scripts 117 times. (Example: **εν** πάω μόνον άμαν είμαι άρρωστη [en páo mónon áman íme árosti] I don't go only when I'm unwell)

(9) Elision of intervocalic fricative [ɣ]: such instances were encountered in the scripts of 59 students 152 times. (Example: σί(γ)ουρα [sí(ɣ)ura] surely)

(10) Cypriot Greek-specific adverbs (lexical features). 55 students used adverbs that are specific to the dialect 95 times in their scripts. (Example: **δαμέ** [ðamé] here)

As can be seen from the list above of the ten most frequently used mesolectal CG features, the vast majority of the items found in students' CG scripts are morphological and phonological. No syntactic features were found among the 10 most recurrently used items, while only one type of lexical item was recorded.

## Non-mesolectal CG Use

(1) Basilectal use: 55.5% of scripts included at least one basilectal CG instance. Items found under this category were dated or obsolete and not representative of contemporary CG. Some are restricted to isolated rural areas and others are almost entirely extinct. (Examples: σκολείο [skolío] school, χέλω [çélo] want.1s, εγιώ [ejió] I, γρόνια [ɣróɲːa] years, ευκαριστόσε [efkaɾistóse] thank you, τσίρης [tsʰːíɾis] father, ρα [ɾa] (form of address for female), ποά [poá] here).
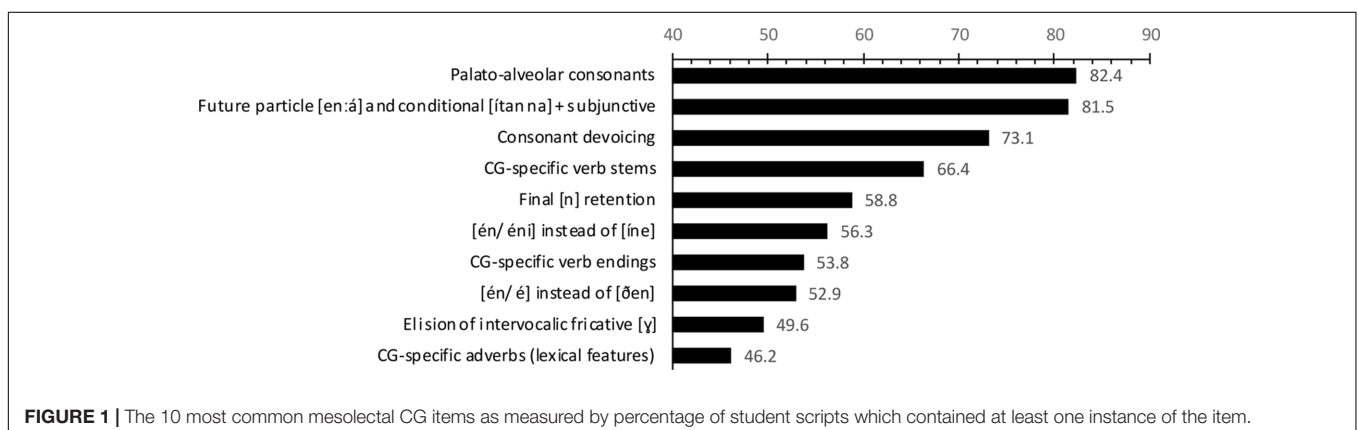


**FIGURE 1 |** The 10 most common mesolectal CG items as measured by percentage of student scripts which contained at least one instance of the item.

(2) Hyperdialectism: 15.1% of scripts included at least one hyperdialectal CG instance. Hyperdialectisms were only ever present in scripts which also contained basilectal instances. Students showed a propensity to construct regional or pseudo-regional words mostly in terms of morphophonology by over-applying, re-introducing, and mis-adapting obsolete phonological and morphological features. Students' hyperdialectism does not constitute part of contemporary CG or older stages of CG. (Examples: τηλεχωνο [tilexono] telephone.1s, τους γικούς μου φίλους [tus jikús mu fílus] my own friends, ζωολογικός τζίπος [z:oolojikós tʃípos] zoo, ποχω σε [poxo se] desire.1s you, Λεμεόν [lemeón] Limassol, τοράτεν [toráten] now).

## Sample Script

A sample script is provided below.

– Ηνταπουνε το ευκάριστο; [indapune to efkáristo] what's the good news?
– Ένα μετακομίω στη Λεμεό [éna metakomío sti lemeó] I'm moving to Limassol
– Ινταπουνη;; εν χέλω να μετακομίεις στη Λεμεσό. [indapuni en çélo na metakomíis sti lemeó] what? I don't want you to move to Limassol
– Εναργά τωρά γιατί ετοιμαζούμαστε για να φίουμεν. [enaɾɣá toɾá jatí etimaz:úmaste ja na fíumen] it's too late now because we are getting ready to leave
– Ενά πάεις σκολείο τωράτεν στη Λεμεσό. [ená páis skolío toráten sti lemeó] are you now going to go to school in Limassol?
– Ε ναι βέβεα. Ενά σε πεχιμίο. [e ne vévea ená se peçimío] Surely. I'm going to miss you
– Εγιό να εις πελέ. [ejó na is pelé] me too, crazy.
– Ένα ξεκινίο τοράτεν να πάω στη χώρα στη Λεμεσό. [éna ksecinío toráten na páo sti xóɾa sti lemeó] I'm going to start going now to Limassol
– Θα σε πιάσω τηλεφονίω όταν φτάω Λεμεόν. [θa se pcáso tilefonío ótan ftáo lemeón] I'll call you when I arrive in Limassol
– Εντά φιλούιν μου [endá filúin mu] OK (presumed), my friend
  Μετά από 3 ώρες [metá apó 3 óɾes] After 3 hours (narrative voice)
– Κούλη εφτάσαμεν το σπίτι μας εν τέλειο. Έσιει ένα μιάλο πάρκο δίπλα που το έσο μου. [kúli eftásamen to spíti mas en téljo éʃi éna m?álo páròko ðípla pu to éso mu] Koulli, we arrived. Our house is perfect. There is a big park next to my home
– Μακάρι να περνάς καλά τις μέρες σου στο κενούρκον έσο σου. [makári na peɾnás kalá tis méɾes su sto cenúròkon éso su] May you spend good days in your new home
– Θα περνάω καλά φιλαράκο. [θa peɾnáo kalá filaɾáko] I will have a good time, friend
– Να μηλούμεν φίλε μου. [na milúmen fíle mu] Let's stay in touch
– Μπάι. [mbái] Bye

The script features a number of mesolectal items such as the CG future particle [éna], the negative particle [en], and final [n] retention. An example basilectal item is the word [çélo]. This word has been replaced by its standard equivalent [θélo] in contemporary speech. [to?áten] is a hyperdialectism. The phrases [ðípla pu to éso mu] and [sto cenúròkon éso su] do not conform to either mesolectal or basilectal CG use and they may be thus also be considered as hyperdialectisms despite the fact that the words in these phrases are not individually hyperdialectal.

## DISCUSSION

### Students' Sociolinguistic Awareness

The participants were successful in employing an abundance of mesolectal features in their CG writing tasks. The most common mesolectal CG items recorded in students' writing were phonological and morphological. This is not surprising considering the high number of differences between the two varieties that fall under these two categories (Tsiplakou et al., 2006; Hadjioannou et al., 2011). In addition, the marked and stigmatized character of many phonological and morphological features makes them easily noticed and, subsequently, acquired and produced by CG speakers. This finding is in agreement with previous research which demonstrated that speakers are especially sensitive to phonological CG features due to the fact that these features do not form part of the SMG inventory (Karyolemou and Pavlou, 2001).

However, in addition to mesolectal CG items, the language choices of many of the students were characterized by the use of an unexpected register (with 55.5% of scripts including basilectal and hyperdialectal items). Such linguistic behavior was also observed by others (Coupland, 2001, 2007; Eckert, 2001; Tsiplakou, 2011; Tsiplakou and Ioannidou, 2012). This basilectal and hyperdialectal use rendered students' scripts register-inappropriate. This amounts to telling evidence of skewed sociolinguistic awareness. The independent raters involved in this study unanimously concurred with this judgment despite the predominance of mesolectal features. It could well be that it was the emblematic use of marked variants that led the researchers and independent experts to characterize items as non-mesolectal and thus inappropriate (Tsiplakou et al., 2006).

Naturally, a key question is why did students stylise texts in this way when they were instructed simply to write down their language as they commonly use it? Was the use of hyperdialectism and basilectal CG an intentional practice and, if so, what is the meaning of this linguistic choice? One possible explanation may be that students' production stems from a limited linguistic and metalinguistic awareness of what the term 'Cypriot dialect' encompasses. Supplementary information drawn from interview data provided additional evidence to substantiate the claim that the students had a very vague understanding of the nature of the language that they use. Students themselves admitted that they were unable to evaluate

their own language in one word and they frequently resorted to ambivalent definitions like σχεδόν ελληνικά (almost Greek), περίπου ελληνικά (more or less Greek), όι ακριβές ελληνικά αλλά ούτε κυπριακά (not exactly Greek but not Cypriot either). These comments highlight that, while students were aware that their speaking diverges sufficiently from the standard variety spoken in Greece, they were nevertheless reluctant to identify their speech with the Cypriot dialect. For them, the dialect was perceived in its basilectal form alone. Consequently, they often seemed to perceive that whatever is not Cypriot is standard Greek. This finding accords well with Tsiplakou's (2011) finding that Greek Cypriot students tend to claim that they do not speak κυπριακά as they implicitly define CG as the basilect.

A second and related possible explanation for students' use of marked dialectal items was that their language choices were conscious and intentional. We argue that students' choices were guided by underlying intentions and were thus not random. Students' choice of text style was an instrument which allowed them to construct the identity that they perceived the task to be requesting. This is a conclusion that other researchers have also drawn (Tsiplakou and Ioannidou, 2012). The scripts provide evidence that students' perceptions were considerably skewed in that, although they were asked to write in the mesolectal register, basilect, and hyperdialect were used extensively. By including features that are highly marked, negatively evaluated, or even satirized by folk media, students may well be reflecting deeply entrenched societal attitudes. Attitudinal studies carried out in Cyprus highlight that, while SMG traditionally enjoys appreciation and respect, CG is seen as an inferior linguistic system. Of course, such negative attitudes toward non-standard dialects are common worldwide. For instance, even non-standard-speaking parents prefer their children to be educated in the standard varieties and, in many cases, they view their own dialects as inferior (McGroarty, 1996). Other parents, although desirous for their home varieties to be recognized and respected in schools, concomitantly believe that teaching these varieties would negatively affect their children's learning of the educational standard (Epstein and Xu, 2003).

In an attempt to distance themselves from negative associations that accompany the dialect, students may have chosen to employ highly marked basilectal items and hyperdialectalism in their scripts. These conscious choices may be demonstrative of a desire to downplay the divergences between their own language and that of Greeks. This phenomenon has also been noted and discussed by Tsiplakou and Ioannidou (2012).

We hasten to add that, although it was hypothesized that the task would tend to elicit mesolectal CG, the observed phenomenon of bundling together of Cypriot forms is also quite predictable. As already mentioned, students were inexperienced in this sort of activity so perhaps the mixing of registers was inevitable. However, it is surprising that there was a high number of participants who produced hyperdialectisms and basilectal CG.

## How Were Students Able to Produce CG Features That Are Now Obsolete?

The question that logically arises is how did students gain access to variants that have long fallen out of use and are no longer considered part of the contemporary CG? One plausible explanation might be the extensive coverage of CG in the media that was contemporaneous with our study. At the time of data collection, regional basilectal forms of the dialect (and the respective culture that accompanies them) were extensively featured in popular Cypriot sitcoms: the satirical element of such shows relied heavily on the language of the script. It was precisely this divergence from contemporary CG and associated lifestyle that ascribed comical qualities to these productions. The students' exposure to these shows may have played a significant role in making them at least loosely acquainted with older forms of the dialect. The data reveal that, in students' minds, the dialect was equated solely with speech forms such as those used in the media. The vast discrepancy between students' CG and the actors' CG perhaps led students to the erroneous assumption that what they themselves speak cannot be labeled 'Cypriot dialect'. This would explain why the students emulated and reproduced basilectal obsolete variants although they were specifically asked to use contemporary CG in their scripts.

We do not believe that students' use of basilectal CG is in itself an indication of basilectal dialect awareness or acquisition (Tsiplakou, 2009). Indeed, we suggest that it was their limited knowledge that led to exaggerated imitations and hypercorrections.

## Implications

Our investigations proved to be especially informative with regard to (i) how students conceptualize contemporary CG and (ii) their level of awareness concerning the internal variation and appropriate use of CG. Consequently, we can conclude that students seem to be unaware of the multiplicity of registers that compose the CG. In addition, they were unsuccessful in processing contextual information and appropriately representing mesolectal registers of their native variety in writing.

What effect does lack of sociolinguistic awareness and limited written proficiency in learners' native varieties have on linguistic cognitive development? Naturally, we do not argue that speakers need to be proficient in writing: besides, there are languages with oral-only traditions. However, it is legitimate to ask this question in relation to the speakers of the study. It would be most unfortunate if, primarily due to the deficiencies of Cypriot language policy, speakers were undergoing semidialectism. We use this term after 'semilingualism' (Baker, 2001) to denote limited competence in their two proximal varieties. Studies on the island have already identified that students' written SMG is laden with CG features (Yiakoumetti, 2006, 2007). Our study sheds light on the linguistic realities of students with proximal varieties: in the absence of language-policy support for harnessing and promotion of their native varieties, students seem to be left alone to identify crosslinguistic differences and similarities between

the various varieties and this lack of support can comprise their linguistic repertoires.

## CONCLUSION

The Greek Cypriot sociolinguistic reality requires and supports linguistic diversity. This is due to the facts that proximal varieties are concurrently used on a daily basis and that knowledge and manipulation of these varieties is a requisite skill for Greek Cypriots. Looking at the discourse of our participants, there is a mismatch between the way that they speak and their understanding of the true features of their native variety. The participants' language choices as captured via their written production seem both outdated and unrepresentative of their current daily oral language use. This is not to say that the outdated language they produced is not valuable. On the contrary, ideally, students should be exposed to both current and bygone forms of their native variety to better appreciate its living character and the fact that linguistic varieties evolve to better serve their speakers. Students' scripts may however have served as an accurate reflection of the limitations and deficiencies of the current language educational system. The fact that students did not choose to reproduce in writing the language they use daily, whether consciously or because of inaccurate understanding of what CG entails, highlights the need for formal education about dialectal issues for speakers of proximal varieties. Students were not in a position to successfully complete the task at hand. This statement may sound extreme considering that participants did produce an abundance of mesolectal features. However, a great number of them did include a number of basilectal and hyperdialectal features which we consider to be the cause of the register-inappropriate scripts. This is disappointing considering that students were expected to write in the variety most familiar to them, their native variety. If students cannot fulfil such requests, how can they be expected to confidently and appropriately express themselves in a variety with which they are less familiar (such as a standard variety)? Support of the current language-education status quo is thus difficult to justify (Yiakoumetti, 2015). Students should both

be able to write their home variety and to be proud of it. This is especially important in bidialectal communities where linguistic varieties have powerful associations with empowerment and opportunities. When educational policies do not support, maintain, and promote home varieties, how can we expect bilingual advantages to transfer into bidialectal settings? If natural bootstrapping from the home variety is not facilitated, it may well be unreasonable to demand proficiency in two linguistically related varieties. We argue that speakers of proximal varieties ought to be educated in and about these varieties to become better users of all their varieties. This recommendation accords well with UNESCO's strong commitment to quality education for all and to cultural and linguistic diversity in education (UNESCO, 2003). The theoretical justification for the incorporation of the mother tongue in education is well developed and supported (Cummins, 2000). In addition, there is abundant empirical evidence, mainly from bilingual settings but also from experimental interventions in bidialectal settings that demonstrate that utilizing the mother tongue in formal education can be incredibly beneficial (see Lucas and Yiakoumetti, 2017).

Our findings provide a salutary reminder that, if we wish for speakers of proximal varieties to be in a position to fully benefit from advantages associated with linguistic variation, we then ought to start celebrating linguistic diversity. Language policies that ignore bidialectal students' native varieties (on the grounds of lack of standardization and prestige) are failing to fully serve these students. It is very often said that education is a key to success. Equally, many educational language policies first need to be unlocked such that they embrace current sociolinguistic realities and facilitate access to the linguistic richness that exists in bidialectal settings.

## AUTHOR CONTRIBUTIONS

IA substantially contributed to research design and conduct, analysis, interpretation, structure, and write-up of manuscript. AY substantially contributed to research design, analysis, interpretation, structure, and write-up of manuscript.

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# A Sentence Repetition Task for Catalan-Speaking Typically-Developing Children and Children with Specific Language Impairment

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It is common to find that so-called minority languages enjoy fewer (if any) diagnostic tools than the so-called majority languages. This has repercussions for the detection and proper assessment of children with Specific Language Impairment (SLI) brought up in these languages. With a view to remedy this situation for Catalan, I developed a sentence repetition task to assess grammatical maturity in school-age children; in current practice, Catalan-speaking children are assessed with tests translated from Spanish, with disregard of the fact that the markers of SLI may differ substantially from one language to another, even between closely related languages. The test proposed here is inspired by SASIT [School-Age Sentence Imitation Test – English], designed for English by Marinis et al. (2011); some of the constructions targeted are challenging in a subset of languages, but not others, and are included because they are indeed affected in Catalan SLI; other constructions appear to be disrupted universally. The test involves canonical SVO sentences, sentences with third person accusative clitics (known to be problematic in Catalan SLI, but not in Spanish), passives, wh- interrogatives, subordinate clauses, subject and object relatives and conditionals. The test was administered to thirty typically developing 6- and 7-year-olds (as reported in Gavarró et al., 2012b), and five children diagnosed with SLI (mean age 10;7). The results of the task were scored under two systems: (i) identical vs. non-identical repetition and (ii) identical, grammatical and ungrammatical repetition, with detail regarding the error type. The results for typically developing and SLI children showed differences between the groups: identical repetition was found in 88.9% of cases for typically developing children but only 48% for SLI children. Ungrammatical productions were higher for the SLI group, and so were grammatical but different repetitions, a trend which was found in every child individually. The results are compared to those available in the literature for similar languages and I discuss the impact of grammatical variation in language performance, in both typical and impaired development.

**Keywords: specific language impairment, sentence repetition task, Catalan**

# A SENTENCE REPETITION TASK FOR CATALAN: MOTIVATION AND GOALS

Specific Language Impairment (SLI) is a developmental deficit affecting spoken language in the absence of hearing impairment, neurological damage or intellectual disability (Leonard, 2003). It is well known that, in spite of stemming from a genetic condition (Stromswold, 2001; Bishop, 2002; Bishop et al., 2006), SLI manifests itself differently in different grammars. One classical example of such variation is the production of optional infinitives beyond the age at which these constructions disappear in typically-developing (TD) children, between ages 3 and 4. Optional infinitives are thus a reliable marker of SLI in English (Rice et al., 1995; Rice and Wexler, 1996). It is also known that optional infinitives are confined to non-null subject languages, both in TD and SLI children; in languages with null subjects, such as Greek, Italian and Catalan, optional infinitives are not generally found in child production (see Guasti, 2017 for a review of TD development). As a consequence, lack of finite inflection is not a universal marker; this has been widely shown, for example, in Italian (Leonard et al., 1992; Bottari et al., 1996 and others). On the other hand, in the null subject languages, omission of clitics and determiners have been reported to be reliable markers of SLI (see Bottari et al., 1998; Jakubowicz et al., 1998; Arosio et al., 2014). In general terms, markers of SLI are language-specific and therefore do not translate.

While tools to identify SLI have been developed for many languages, for other languages such tools are not available, and in some cases mere translations of tests designed for other languages are used, with detrimental consequences for diagnosis. To pursue the case of optional infinitives, if tense marking were to be used in a language like Italian, the vast majority of children with SLI would go undetected, judging by the results by Bottari et al. (1996). In addition, the lack of diagnostic tools is aggravated in the so-called minority languages and the problem goes well beyond SLI, as it affects other linguistic pathologies such as aphasia (for a recent review, see Fyndanis et al., 2017).

Together with the variable manifestations of SLI cross-linguistically, in an increasingly multilingual Europe there is a large population of early L2 learners whose linguistic level of attainment varies as a function of several complex factors. These factors comprise age of onset of acquisition (AoO), length of exposure (LoE), and socio-economic status (SES) (see Chiat et al., 2013 and references therein). For these L2 learners, language impairment is difficult to diagnose and may be misread as an effect of L2 acquisition. Likewise, L2 acquisition may be mistaken for language impairment. Both under-diagnosis and over-diagnosis are a source of concern for educators, clinicians and families[1].

Tests to evaluate the linguistic competence of monolingual and bilingual children are scarce for many languages of the world, Catalan included (see Thordardottir, 2015 for a survey). In a large

collaborative effort involving 30 countries, COST Action IS0804 "Language Impairment in a Multilingual Society: Linguistic Patterns and the Road to Assessment" set out to develop tools for the linguistic assessment of multilingual children and thus remedy the situation of multilingual children with SLI, an understudied and vulnerable group. The LITMUS [Language Impairment Testing in Multilingual Settings] battery of tests, still partly underway, is the outcome of this effort (see for further details, Armon-Lotem et al., 2015). Amongst the tools developed there were several sentence repetition tasks (SRT); this type of task has proven very effective in identifying children with SLI (Conti-Ramsden et al., 2001; Stokes et al., 2006; Bishop et al., 2009). SRTs vary in the way they are constructed and may as a consequence differ in the linguistic and cognitive abilities they measure (Crosnier, 2013), but researchers agree that grammatical reconstruction is necessary for sentence repetition to take place (Lust et al., 1996; Marinis and Armon-Lotem, 2015; Polišenská et al., 2015; see also Klem et al., 2015 for an overview of different views on exactly what SRTs measure). Even if e.g. short-term memory is recruited in sentence repetition, the task also reflects grammatical abilities.

The goal of this study is to present a sentence repetition task designed for Catalan, and to provide arguments for the inclusion of certain structures in the task and not others. The task was inspired by a similar one designed for English by Marinis et al. (2011), SASIT [School-age sentence imitation test – English], and developed as part of IS0804. However, the strength of the task presented here is that it is not a mere translation, but rather an adaptation grounded in the grammatical properties of Catalan and what is known about the manifestations of SLI in Catalan, which differ in many respects from English SLI. As illustrated below, even two closely related languages like Catalan and Spanish display different features in SLI, and thus the need for language-specific tools should not be underestimated (see Oetting et al., 2016 and references therein about the need for specific SRT for SLI in nonmainstream varieties of English).

What is the rationale behind the SRT proposed? Given that Catalan is a null subject language, one would expect an absence of optional infinitives and no general delay with finiteness. This is indeed what was found in a study by Gavarró (2012), where the spontaneous productions of two children with SLI at two stages in development were examined (data source: CHILDES). In the verbal production of these two children, aged 43 and 45 months in the first transcript, and 57 and 58 in the second, respectively, only 1.25% of optional infinitives were attested (computed over 556 verbal productions). On the other hand, in two studies of Italian-speaking children with SLI, even though optional infinitives were absent from the child productions, some problems with the production of third person plural verb morphology were encountered (Bortolini et al., 2002, 2006). The reason for this delay, which was specific to plural inflection, is not clear, though it is unlikely to have stemmed from the same source as optional infinitives, since only plurals were affected. Nonetheless, in light of these findings of Italian, canonical SVO sentences with compound or simple verb forms were kept in the SRT for Catalan as control items.

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[1] The problem of misdiagnosis is not new: it is extensively documented for the immigrant population reaching the US in the first half of the Twentieth century—and on that occasion children were often misdiagnosed as mentally retarded (see Romaine, 1989).

Much more characteristic of Catalan SLI is the omission of third person object clitics, exemplified in (1). This phenomenon was first identified for French SLI by Jakubowicz et al. (1998). Object clitic omission had been previously attested in TD children up to the age of 3–4 in French (Jakubowicz et al., 1996) and Italian (Schaeffer, 2000).

(1)  Fico [e] aquí dins. (TD, Pep, 2;03,10)
     put-1s here inside
     "I put (it) here."

Gavarró et al. (2010) argued that third person object clitic omission of the kind found in French and Italian was not universal, but rather due to language-specific checking operations—the very same checking operations that had been invoked to account for optional infinitives (Wexler, 1998). The prediction then was that if a language did not require such checking operations[2] to take place in the derivation of object clitic constructions, clitics would not be omitted, but produced in an adult-like manner. This prediction was fulfilled, as Spanish-speaking children at age 2 did not omit clitics while Catalan-speaking children did so until age 3;6 (Gavarró et al., 2010). The prediction was further substantiated with results from Greek (Tsakali and Wexler, 2004), Romanian (Babyonyshev and Marin, 2006) and Spanish again (Elliot and Pirvulescu, 2016). Wexler (1998, 2014) argued that the checking mechanisms underlying clitic omission/optional infinitives were subject to maturation and that the optional stage finished during the third year of life, but persisted in children with SLI (see also Rice et al., 1995; Rice and Wexler, 1996).

Optional omission of third person object clitics is attested in SLI for French, Italian (Bortolini et al., 2002, 2006; Arosio et al., 2014) and Catalan (Gavarró, 2012). There is no evidence of clitic omission in Greek SLI in the studies by Terzi (2007) and Manika et al. (2011)—but see references therein reporting contradictory results. For Spanish, while the literature refers to deficits in clitic production (Bedore and Leonard, 2001), under closer scrutiny errors affect morphological markers (gender, number) rather than the production of the clitic itself, and the deficit is quantitatively minor compared to that seen in Catalan, French and Italian (see for recent results leading to the same conclusion, Martínez-Nieto and Restrepo, 2017). I conclude that clitic omission is not a marker of SLI in Spanish—or Greek. Uncontroversially, for Catalan it is a good candidate to serve as a clinical marker of SLI, as it has been shown to be in Italian (Arosio et al., 2014).

Though SLI child speakers of all three languages—French, Italian, and Catalan—show deficits in clitic production, the patterns of omission and replacement differ somewhat. The earliest results for French by Jakubowicz and colleagues showed that, when the target third person object clitic was not elicited, children with SLI produced alternatively a full DP (between 8 and 37.6%) or reflexive clitic (between 0.8 and 21.7%), or omitted the clitic altogether (between 4.7 and 66.4%). Later on Gavarró (2012) showed on the basis of experimental data from five Catalan-speaking children with SLI that these children failed

to produce the target third person object clitic until age 5, at which point they produced a dative clitic instead, as illustrated in (2). By hypothesis, this dative clitic did not require the feature elimination that a third person object clitic required.

(2)  … perquè la mare *li* pentina.
     because the mother clDAT combs
     "… because the mother combs his/her hair."

More recently, Arosio et al. (2014) ran an object clitic elicitation task with 16 Italian-speaking children with SLI and found that they produced fewer target clitics than their age- and language-matched controls; instead, they produced more full DPs (35.94%), as well as some dative clitics (1.56%) or omitted object clitics altogether (8.98%). This varying performance that occurs when a third person object clitic is expected unravels which constructions are less problematic in each language. Arosio et al. (2014) found no difference as a function of age in their SLI group (aged 6;0 to 9;11). They pointed out, however, that a study with younger Italian children with SLI, that of Bortolini et al. (2006), showed higher rates of third person object clitic omission instead of full DP production. Therefore, the Catalan- and Italian-speaking children with SLI changed in performance over time (omission occurring first, replacement with a dative clitic or a full DP occurring with older children). For the purposes of the SRT it is clear that object clitics should be included, as they give rise to persistent problems in SLI.

For the same reasons that underlie third person object clitic omission, partitive clitics are omitted in early Catalan in TD children, but not beyond the age of 4 (Gavarró et al., 2006, 2011). By hypothesis, partitive clitic omission derives from the same underlying mechanisms as third person object clitic omission, and so under the same assumptions omission would be predicted for an extended period in SLI. Partitive clitics were therefore included in the task.

The SRT also included passive sentences. The comprehension of passive sentences is delayed in TD children, as studies in many languages over the years have attested (Maratsos et al., 1985 for English, Pierce, 1992 for Spanish, amongst others, see for a summary, Deen, 2011). Several hypotheses have been put forward to account for the delay (Wexler, 2004; Hyams and Snyder, 2005; Orfitelli, 2012, to cite only some of the recent ones), and most of them attribute the delay to some principle being subject to maturation; the maturational character of the emergence of passives is corroborated by the heritability effects discovered in twin studies (Ganger et al., 2005). Unlike third person object clitic production, however, passives are under-investigated in SLI, with only a few studies in English (van der Lely, 1996; Leonard et al., 2006; Marinis and Saddy, 2013). These studies confirm that passives are miscomprehended for an extended period in children with SLI. Given that Catalan shares the underlying syntax of passives with English and several other languages (raising of the object to the subject position), and that Catalan passives are misunderstood until age 6;6 by TD children (Parramon, 2016; Gavarró and Parramon, 2017), one would expect passives to be further delayed in Catalan SLI too. For this reason—despite their relative infrequency in the typical linguistic input

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[2]In more contemporary terms, instances of uninterpretable feature elimination.

received by small children—passives were included in the SRT.

Another structure that was included in the SRT is biclausal sentences. Biclausal sentences are part of the English SASIT (Marinis et al., 2011) and of the French LITMUS SR (Fleckstein et al., 2016). The rationale for including them is that complement clauses have been reported to be problematic for children with SLI in a number of studies, especially when the embedded clauses are finite, and that children with SLI produce fewer embeddings in their spontaneous productions than TD children (Scheidnes and Tuller, 2014). One particular case that has received much attention in the literature is that of relative clauses. There is an asymmetry in the comprehension of subject and object relative clauses, with subject relatives being better understood and produced than object relatives (at least in the head initial languages), as has been shown for many languages over the years (see Brown, 1971 for English, Labelle, 1990 for French, Arnon, 2005 for Hebrew, Arosio et al., 2009 for Italian, Gavarró et al., 2012a for Catalan, Girbau and Schwarz, 2007; Torrens, 2017 for Spanish). An analogous asymmetry is found in production. In a seminal paper, Friedmann et al. (2009) argued that the asymmetry could be accounted for in terms of intervention effects and Relativized Minimality, which would be stricter in childhood (until age 6 at least). Alternatively, processing analyses have been put forward; see for example Omaki and Lidz (2015) and Choe and Deen (2016). Without entering the discussion as to the nature of the asymmetry, Novogrodsky and Friedmann (2006) also show that object relatives in Hebrew SLI are more problematic than subject relatives and to a larger extent than in TD children, a finding that has been replicated for a number of languages (Delage et al., 2008 for French, Jensen de López et al., 2014 for Danish, Stavrakaki et al., 2015 for Greek, to mention a few). For this reason, repetition of subject and object relatives is included in the Catalan SRT, the expectation being that subject relatives will be less problematic than object relatives.

In a similar fashion, under the assumptions of Friedmann et al. (2009), wh- questions would be subject to stricter intervention effects in child grammar and the prediction therefore would be that, in a language with overt wh- movement such as Catalan, object wh- questions would be more taxing for children than subject wh- questions, an effect that would be prolonged in children with SLI. Amongst object wh- questions, in an experiment on Hebrew SLI by Friedmann and Novogrodsky (2011), *which* questions were more compromised than *who* object questions; this was captured by arguing that intervention effects hold only when the moved and the intervening element share the same features: in *which* questions, an NP specification, *which NP*, as opposed to *who*, as illustrated in (3).

(3)  a. Et mi ha-xatul noshex?
         ACC who the-cat bites "Who is the cat biting?"
     b. Et eize kelev ha-xatul noshex?
         ACC which dog the-cat bites "Which dog is the cat biting?"

Again, these findings have been replicated in other experiments with children with SLI (Fleckstein et al., 2016). Note that the claim by Friedmann and Novogrodsky (2011) and Friedmann et al. (2009) is that the deficit in comprehension and production in SLI has to do with wh- movement and is structural, not derived from the presence of an embedded CP, contrary to the claims of Scheidnes and Tuller (2014).

On the basis of this background, the goals of the present paper are:

(i)  To detail an SRT for Catalan with a strong motivation in our current knowledge of the grammatical characteristics of SLI in Catalan, and

(ii) To provide results for TD children and children with SLI indicating that the SRT is sufficiently robust to meet the standard requirements of sensitivity and specificity (namely, the ability to reliably identify children with SLI and exclude children without it).

Before proceeding to a full description of the SRT task, let me mention that non-word repetition is a well-known task that discriminates between language-impaired and TD children (Bishop et al., 1996; Newbury et al., 2005). Still, the literature shows that the ability to repeat non-words may be impaired in only a subset of children with SLI (Bishop et al., 2006; Friedmann and Novogrodsky, 2008) and therefore cannot be the sole tool to identify children with SLI. Importantly, non-word repetition is spared in L2 although it is affected by language-specific differences between L1 and L2 (Polišenská, 2011), as the phonological words of the L2 may differ substantially from those of the L1 in phonological feature specifications, syllable structure and so on[3].

## METHOD

Modeled on the similar instrument developed for English by Marinis et al. (2011), the proposed SRT for Catalan initially involved a total of 60 sentences classified into three levels of linguistic complexity, each level comprising 20 sentences. What is meant in Marinis et al. by complexity is not made explicit, and by the discussion in section 1 it is clear that some sentence types in level 1 may actually be very taxing in SLI in some languages.

In the current SRT each sentence ranges from six to eleven words and from seven to fifteen syllables (in the English SRT of (Marinis et al., 2011) the length of the items goes from seven to eleven words, and from eight to thirteen syllables)[4]. The proportion of different word lengths in the SRT was calculated: 0.23 of content words are monosyllabic, 0.45 are disyllabic and 0.31 are multisyllabic across the whole test; this matches quite closely the proportion in which these different word lengths are found in child speech (0.27 monosyllabic words, 0.53 disyllabic

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[3]For Spanish there exists a non-word repetition task consisting of twenty pseudowords, four of each syllable length, one to five (Girbau and Schwarz, 2008; Girbau, 2016). (See also Aguado et al., 2006). To my knowledge, no such tool exists for Catalan, although a screening test which was being developed for Catalan, GAPS (van der Lely et al., 2010) included a short non-word repetition task with two monosyllabic control items and eight test items of increasing difficulty, from one to four syllables.

[4]Vinther (2002) argues that for grammatical analysis to be necessarily involved in sentence repetition, sentences should be longer than 6–8 syllables.

words, 0.19 multisyllabic words, see Guasti and Gavarró, 2003). Still, matching of experimental items was based on number of syllables per item, not on the length of content words, as in Marinis et al. (2011).

Frequency of the content words in the experimental items was taken into account, and the sentences include high frequency content words, based on the *Diccionari de freqüències* of Rafel i Fontanals (2006). Of the 118 content words in the SRT, 110 had a relative frequency between 1.985015 and 0.000511% in a corpus of 107,897 words found in the spoken language; this placed these 110 words in the task amongst the 8.8% most frequent words in the corpus. The remaining 8 words (including *mico* "monkey," *cocodril* "crocodile," *zoo* "zoo" and *pentinar* "comb") were less frequent, but this result may stem from the fact that the corpus is not based on child and child-directed speech. The corpus of the vocabulary of 10 children in the CHILDES database by Serra et al. (2000) attested to the presence of most of them in child production in the period of 12–23 months. The frequency of words was matched across the three levels of the task.

Level 1 targets the following sentence types (in parentheses, the number of items for each sentence type):

(i) Canonical SVO sentences with an overt or a null subject, and a finite verb or a verb preceded by an inflected tense marker/verbal periphrasis (i.e., with additional functional vocabulary) (#8)
(ii) Sentences with a third person object (accusative) clitic (#8)
(iii) Sentences with a partitive clitic (#4)

Level 2 targets the following sentence types:

(i) Long passive sentences (#8)
(ii) Wh- questions headed by *què* "what" or *quin* "which" (#8)
(iii) Sentences with finite and non-finite complement clauses (#4)

Level 3 targets two sentence types, relative clauses and biclausal sentences with temporal dependencies between them:

(i) Subject relative clauses (#6)
(ii) Object relative clauses (#10)[5]
(iii) Sentences with a conditional clause (#4)

The sentences appear in the SRT in pseudorandom order, with sentences from levels 1, 2, and 3 intermingled, so that tiredness cannot especially affect sentences of level 3. Examples of each sentence type appear in **Table 1**.

## Procedure

The procedure in the administration of this task is the same as that described in Marinis et al. (2011) and in all the LITMUS-SRTs, the only difference being that items were not recorded but read out by the experimenter, at a normal utterance pace and clearly articulated. The advantage of recording the items is

arguable, as it disrupts communication between the child and the person carrying out the testing, while a live voice helps engage children in the task (Frizelle et al., 2017); for this reason recording of the sentences was avoided, even though this has the disadvantage of providing less homogeneous input to the children. The procedure is detailed in (4).

(4) – *Sentiràs unes frases i m'agradaria que repetissis exactament el que sents. No pateixis si no ho recordes tot, però mira de dir tot el que recordis, i de dir-ho clar.* [You will hear some sentences and I would like you to repeat them exactly as you hear them. Do not worry if you do not remember everything, but repeat everything you remember and do so as clearly as possible.] *Primer farem una frase de prova. Recorda de repetir tot el que puguis recordar. Estàs a punt?* [First we will do a rehearsal. Remember to repeat everything you hear. Are you ready?] The experimenter produces Sentence 1. If the child does not repeat it, the experimenter asks:
– *Que pots repetir-la?* [Can you repeat it?]
  Otherwise, the experimenter continues:
– *Molt bé. Ara en farem més de la mateixa manera. Estàs a punt?* [Very good. Now we'll continue the same way. Are you ready?] and sentences up to 60 are repeated.

In the course of the test, the experimenter makes positive, encouraging comments to the child (*Molt bé, continuem!* "Very good! Let's continue!"), independently of how successful his/her repetitions are, at least every 10 items. According to the procedure, the experimenter may give some advice to the child (*Mira de parlar clar, més a poc a poc, para atenció* "Try to speak clearly, a bit more slowly, pay attention"). In principle the child hears each sentence only once, but the sentence may be read a second time if there is a noise or another source of distraction or the child does not repeat the sentence after hearing it the first time. If the child corrects himself/herself, it is the second production that is recorded (whether it is correct or not).

It is relatively standard to ask participants to count up to three in repetition tasks to avoid mere phonological repetition; this request was not made of the children tested, following the procedure of Marinis et al. (2011), who considered that counting up to three would tax the children's memory beyond what is advisable, given the length of the sentences.

## Coding

Two methods can be applied to code the results. The first method consists of coding responses as either correct (1) or incorrect (0), where correct designates a response that is identical to the original (ignoring minor dialectal differences, like for example *meua* "mine" instead of *meva*, since both are well formed in Catalan and one would not expect a speaker of a variety using *meua* to use *meva* when repeating what had been said by a speaker of a variety using *meva*). In this coding method, all responses that are not identical are considered incorrect, even if they are well-formed. This method is widely used for coding SRTs not only because it is easy to apply, but also because it has proven to be very reliable in distinguishing children with SLI from those without (see the discussion in Chiat et al., 2013).

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[5]In addition to the contrast between subject relatives and object relatives, there is a contrast between subject-modifying and object-modifying relative clauses, where the subject-modifying clauses are easier to process than the object-modifying ones (see Stavrakaki et al., 2015 for a summary of the findings). Subject-modifying and object-modifying relatives were equally represented in the subject relative and object relative items.

**TABLE 1 |** Contents of the STR proposed for Catalan.

| Structure type | Subtype | Example | Length in words and syllables |
|---|---|---|---|
| Canonical SVO | Finite verb | *El gat perseguia la rata amunt i avall.* "The cat chased the rat up and down." | 6–8 words 11–13 syllables |
| Canonical SVO | Verbal periphrasis | *Ja pots portar els plats a taula.* "Now you can take the plates to the table." | 6–10 words 8–14 syllables |
| Accusative clitic | | *La mare crida el nen i el banya.* "The mother calls the child and bathes him." | 5–11 words 9–13 syllables |
| Partitive clitic | | *De pomes, n'he menjat tres.* "Apples, I have eaten three." | 6–8 words 7–11 syllables |
| Long passive sentences | | *L'ós va ser caçat pel rei.* "The bear was hunted by the king." | 7–10 words 7–13 syllables |
| Wh- interrogatives | *qui/què* interrogatives | *Què van trobar ahir sota la neu?* "What did they find yesterday under the snow?" | 6–8 words 8–11 syllables |
| Wh- interrogatives | *quin* "which" interrogatives | *Quina fotografia vas fer al parc?* "Which picture did you take in the park?" | 6–8 words 9–11 syllables |
| Complement clause | Finite | *La mestra va decidir que aniríem al museu.* "The teacher decided that we would go to the museum." | 6–9 words 13–14 syllables |
| Complement clause | Non-finite | *Vam oblidar-nos de preparar l'esmorzar.* "We forgot to prepare breakfast." | 6–9 words 11–12 syllables |
| Relative clause | Subject | *El tren que ha sortit va a París.* "The train that left goes to Paris." | 8–10 words 8–15 syllables |
| Relative clause | Object | *L'ànec que el gat empaita no pot volar.* "The duck that the cat is chasing cannot fly." | 6–10 words 9–14 syllables |
| Conditional clause | | *Els nens tindran un premi si netegen la classe.* "The children will get a prize if they clean the classroom." | 6–9 words 12–15 syllables |

The second method is more sensitive to considerations of grammaticality, as answers are classified into four categories: (i) identical answer; (ii) grammatical but non-identical repetition, exemplified in (5); (iii) ungrammatical answer, exemplified in (6); and (iv) fragment (incomplete, unfinished repetition), exemplified in (7). Under this scoring method, errors are kept separate depending on the structure tested (e.g., errors in wh-interrogatives are scored separately from errors in object clitic production, etc.).

(5) Per què fa el dinar, el pare?
    for what makes the lunch, the father
    "Why is Dad making lunch?"
    (instead of *Per qui fa el dinar, el pare?* "Who is Dad making lunch for?"
(6) No *(l')he vist des de fa deu anys.
    Neg cl3s have-1s seen from 10 years
    "I haven't seen (him) for 10 years."
(7) Vam decidir anar a la platja.
    PAST1pl decide go to the beach
    (instead of *Vam decidir anar a la platja a nedar* "We decided to go to the beach to swim.")

## A PILOT STUDY WITH TD CHILDREN

A pilot study with 30 school-aged children aged 6 and 7 was carried out by Gavarró et al. (2012b). The children were from Sant Cugat and Sabadell, in the metropolitan area of Barcelona, where Central Catalan is spoken. They were recruited in their primary schools, and their parents or tutors gave written consent for testing. All the children were native speakers of Catalan, also speakers of Spanish, since children learn Spanish in the Catalan schooling system (and so bilingual and multilingual children were not excluded), with no hearing or language impairment. They were identified by their teachers as Catalan-dominant. No additional exclusion and inclusion criteria were adopted. Details of the participants appear in **Table 2**.

In what follows I present the results for the whole group and by age. **Table 3** summarizes the results under the first scoring method, taking into account whether repetitions were identical or not.

**Table 4** shows the results obtained when the second scoring method was applied.

The results obtained indicate a high proportion of identical repetitions by the 6- and 7-year-olds for whom the task was designed (0.89 on average, ranging from 0.8 to 0.93 depending on sentence type), and a very low presence of ungrammatical repetitions, as well as a negligible number of fragments.

Let us now examine the results broken down by grammatical structure. Results for 6- and 7-year-olds are given together, given the small difference between the two groups. **Table 5** provides the results for level 1 items.

**Table 6** for level 2 items.

**Table 7** provides results for level 3 items.

The incidence of ungrammatical repetitions was very low, under 3% for all item types except for conditionals (where they amounted to 3.3%) and sentences with partitive clitics. This last case deserves special consideration, as one would expect

**TABLE 2 |** Participants.

|  | # | Gender | Age range | Mean age |
|---|---|---|---|---|
| 6-year-olds | 14 | 10 f, 4 m | 5;7,5–6;11,24 | 6;5,20 |
| 7-year-olds | 16 | 10 f, 6 m | 7;0,16–8;0,19 | 7;4,16 |
| Total | 30 | 20 f, 10 m | 5;7,5–8;0,19 | 6;11,14 |

**TABLE 3 |** Raw number and percentage correct repetitions.

|  | Identical repetitions | Percentage identical(%) |
|---|---|---|
| 6-year-olds | 748/840 | 89.05 |
| 7-year-olds | 855/960 | 89.06 |
| Total | 1603/1800 | 89.06 |

**TABLE 4 |** Raw number and percentage of each answer type (identical repetition, grammatical but non-identical repetition, fragment and ungrammatical repetition).

|  | Identical repetitions | Grammatical repetitions | Fragments | Ungrammatical repetitions |
|---|---|---|---|---|
| 6-year-olds | 89.05 | 63/840 (7.5%) | 14/840 (1.67%) | 15/840 (1.79%) |
| 7-year-olds | 89.06 | 71/960 (7.4%) | 4/960 (0.42%) | 30/960 (3.13%) |
| Total | 89.06 | 134/1,800 (7.44%) | 18/1,800 (1%) | 45/1,800 (2.5%) |

**TABLE 5 |** Answer type, level 1 items.

|  | Identical repetition | Grammatical repetition | Fragments | Ungrammatical repetition |
|---|---|---|---|---|
| **Finite SVO sentences** | | | | |
| 6- and | 213/240 | 20/240 | 1/240 | 6/240 |
| 7-year-olds | 88.75% | 8.33% | 0.42% | 2.5% |
| **Third person object clitics** | | | | |
| 6- and | 210/240 | 19/240 | 6/240 | 5/240 |
| 7-year-olds | 87.5% | 7.92% | 2.5% | 2.08% |
| **Partitive clitics** | | | | |
| 6- and | 110/120 | 1/120 | 0 | 9/120 |
| 7-year-olds | 91.67% | 0.83% | | 7.5% |

**TABLE 6 |** Answer type, level 2 items.

|  | Identical repetition | Grammatical repetition | Fragments | Ungrammatical repetition |
|---|---|---|---|---|
| **Passives** | | | | |
| 6- and | 223/240 | 9/240 | 3/240 | 5/240 |
| 7-year-olds | 92.92% | 3.75% | 1.25% | 2.08% |
| **WH- questions** | | | | |
| 6- and | 222/240 | 13/240 | 1/240 | 4/240 |
| 7-year-olds | 92.5% | 5.42% | 0.42% | 1.67% |
| **Subordinate clauses** | | | | |
| 6- and | 110/120 | 7/120 | 2/120 | 1/120 |
| 7-year-olds | 91.67% | 5.83% | 1.67% | 0.83% |

**TABLE 7 |** Answer type, level 3 items.

|  | Identical repetition | Grammatical repetition | Fragments | Ungrammatical repetition |
|---|---|---|---|---|
| **Subject relatives** | | | | |
| 6- and | 164/180 | 13/180 | 0/180 | 3/180 |
| 7-year-olds | 91.11% | 7.22% | | 1.67% |
| **Object relatives** | | | | |
| 6- and | 240/300 | 47/300 | 5/300 | 8/300 |
| 7-year-olds | 80% | 15.67% | 1.67% | 2.67% |
| **Conditional clauses** | | | | |
| 6- and | 111/120 | 5/120 | 0 | 4/120 |
| 7-year-olds | 92.5% | 4.17% | | 3.33% |

(8) Els bebès sempre tenen gana. El meu sempre *en* té!
the babies always have hunger the mine always PARTcl has
"Babies are always hungry. Mine always is!"

(9) (*)… El meu sempre té!
the mine always has

(10) (*)… El meu sempre *en* té gana!
the mine always PARTcl has hunger

Pursuing the same line of research, Gavarró (in press) considered constructions that systematically relate to partitive clitic production in the nominal domain (11) and reached conclusions consistent with those of Perpiñán (2017): depending on the linguistic background of the speaker (Catalan-dominant or Spanish-dominant) partitivity is either overtly marked in the syntax, or it is not, as in contemporary Spanish. Therefore, partitive clitic omission may reflect more the variety of Catalan that the child is exposed to than any risk of language impairment.

(11) La mare porta una maleta gran i una *(de) petita.
the mother carries a suitcase big and one of small
"Mother carries a big suitcase and a small one."

As a consequence, it seemed preferable to suppress partitive clitics from the SRT as a possible source of confound. Likewise, the initial version of the SRT was modified after the pilot study to eliminate some lexical items (*lleter* "milkman," *abocar* "pour") that rendered repetition unduly difficult simply because the

partitive clitics to be omitted for an extended period in Catalan SLI, as mentioned in section 1. However, there is also some indication in the literature that partitive clitics, under transfer from Spanish in bilingual speakers, may be omitted giving rise to productions that are ungrammatical in monolingual Catalan. Perpiñán (2017) reports that partitive clitic production (8) was judged grammatical by a group of Spanish-dominant bilingual speakers, but partitive omission (9) was also accepted at rates that differed significantly from those of Catalan-dominant bilinguals; likewise, ungrammatical clitic doubling with partitives (10) was accepted more often by Spanish-dominant than Catalan-dominant speakers. The contrast between the two groups was found, and to an even greater extent, in production.

lexical items were possibly not part of the children's vocabulary. The final version of the SRT involves only 56 items, as the four partitive clitic items were excluded[6].

Individual results for the initial version of the task can be found in Gavarró et al. (2012b) and are open-access. They show that there is little individual variation; in particular, ungrammatical repetition is low for all the children (with at most one or two errors for the children who produced any error at all). Only one child produced as many as four ungrammatical repetitions out of 60 sentences (a 6.6% error rate).

## SENTENCE REPETITION IN CATALAN SLI

The revised version of the SRT for Catalan was administered to five children diagnosed with SLI in Sabadell, Sant Sadurní d'Anoia and Vilanova i la Geltrú, where Central Catalan is spoken. They were all male, their ages ranged from 6;6 to 17;4 (mean age: 10;7), and they were all native speakers of Catalan. Although all of them had knowledge of Spanish and could be considered bilingual, they had been identified as Catalan-dominant by their teachers. They were attending state schools and were undergoing treatment with a speech therapist after having been diagnosed with SLI. They were recruited through CREDA (speech therapy units, initially aimed at children with hearing deficits, run by the Catalan education authority). The intelligence tests administered to them (Wechsler Intelligence Scale for Children-Revised, WISC-R, Wechsler, 1974) indicated scores within the normal range (individual scores n.a.).

The procedure was as described above. The children were tested individually by the author in the schools they were attending, except for one child who was tested at home. The parents or tutors of the participants gave prior written consent to testing, which was conducted following the ethical principles of the Declaration of Helsinki. The session in which the SRT was administered included no further testing, and took between 20 and 30 minutes.

The sample of children tested is small, due to the limited number of children with SLI that could be recruited through CREDA and who also fulfilled the condition of being Catalan-dominant; for this reason, the results for all the participants tested are reported, in spite of age variability. An anonymous reviewer points out that it would have been useful to have fuller information about the participants (both SLI and TD children in the previous study), particularly information on the non-verbal abilities of the participants, type of bilingualism (simultaneous or sequential), length of exposure to Spanish, as well as information on their socio-economic status. However, gaining access to a wider sample and gathering these additional data would have required resources that were not readily available; it remains for future research to avoid both of these shortcomings.

The individual and overall results as obtained under the first scoring method appear in **Table 8**.

The same data scored according to the second scoring method yielded the results displayed in **Table 9**.

Two observations can be made about these results. First, these children with SLI produced a high number of grammatical but non-identical repetitions, and ungrammatical repetitions. Second, there is wide variation within the SLI group: as shown in **Table 8**, grammatical non-identical repetitions range from 14.3 to 50% and ungrammatical repetitions from 5.4 to 33.9%.

Focusing on the ungrammatical productions, one may wonder in which grammatical constructions children with SLI failed more often. A summary of the errors found appears in **Table 10**. As can be seen, object relative clauses are the constructions in which more errors are found, and also the single construction in which all the children in our sample fail (object relatives are also the construction in which TD children only succeed in identical repetition in 80% of cases; see **Table 7** above). Ungrammatical third person object clitic omission and determiner omission are also found, although in the youngest two children, as well as problems in the repetition of passive sentences. The remaining error types are less common. Determiner agreement errors and determiner omission do not appear in the SRT as separate categories, as determiners are found in all sentence types, but they were relatively common and were therefore tallied separately.

The results for the children with SLI are graphically represented in **Figure 1** together with those obtained by the TD group once the partitive clitic items are removed (so that the calculations for both groups are based on 56 rather than 60 items per child).

Because of the small number of subjects in the study, no statistical comparisons were carried out between the results for

**TABLE 8 |** Identical repetition, raw scores and percentage, SLI children.

|         | Identical repetitions | Percentage identical(%) |
|---------|-----------------------|-------------------------|
| SLI1    | 29/56                 | 51.8                    |
| SLI2    | 16/56                 | 28.6                    |
| SLI3    | 15/56                 | 26.8                    |
| SLI4    | 42/56                 | 75                      |
| SLI5    | 32/56                 | 57.1                    |
| Total   | 134/280               | 47.85                   |

**TABLE 9 |** Raw number and percentage for each answer type (identical repetition, grammatical but non-identical repetition, fragment and ungrammatical repetition).
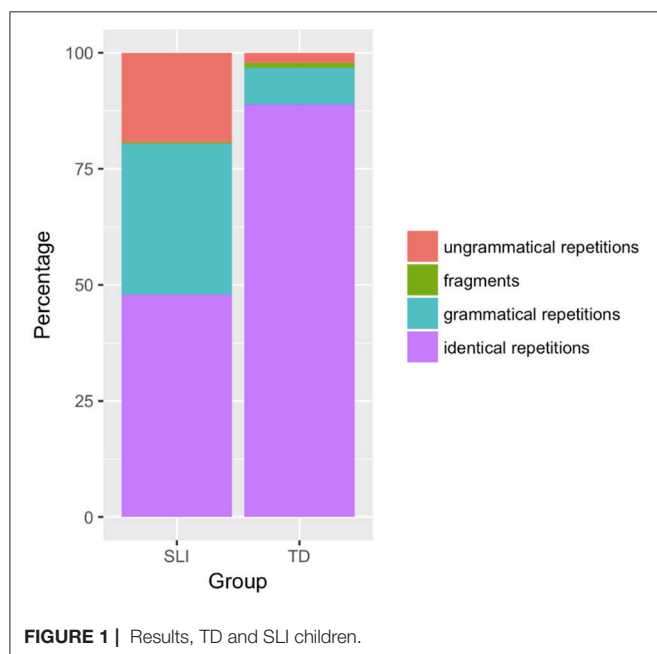
|       | Identical repetitions | Grammatical repetitions | Fragments | Ungrammatical repetitions |
|-------|-----------------------|-------------------------|-----------|---------------------------|
| SLI1  | 29/56 51.8%           | 8/56 14.3%              | 0         | 19/56 33.9%               |
| SLI2  | 16/56 28.6%           | 24/56 42.8%             | 0         | 16/56 28.6%               |
| SLI3  | 15/56 26.8%           | 28/56 50%               | 1/56 1.8% | 12/56 21.4%               |
| SLI4  | 42/56 75%             | 11/56 19.6%             | 0         | 3/56 5.4%                 |
| SLI5  | 32/56 57.1%           | 20/56 35.7%             | 0         | 4/56 7.1%                 |
| total | 134/280 47.85%        | 91/280 32.5%            | 1/280 0.35% | 54/280 19.28%           |

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[6]The complete revised version of the SRT can be found at: http://filcat.uab.cat/clt/publicacions/reports/pdf/GGT-12-02.pdf.

**TABLE 10 |** Error types, children with SLI.

|  | SLI1 | SLI2 | SLI3 | SLI4 | SLI5 | Total |
|---|---|---|---|---|---|---|
| Finite verb | 2 | 3 |  |  |  | 5 |
| Accusative clitic omission | 3 | 3 | 1 |  |  | 7 |
| Long passive sentences | 1 | 1 |  | 1 | 3 | 6 |
| Wh- interrogatives |  |  | 1 |  |  | 1 |
| Complement clause | 1 |  | 1 |  |  | 2 |
| Subject relative clause |  | 2 | 2 | 1 |  | 5 |
| Object relative clause | 5 | 4 | 3 | 1 | 1 | 14 |
| Conditional |  |  | 3 |  |  | 3 |
| D omission | 4 | 3 |  |  |  | 7 |
| DP agreement | 1 |  | 1 |  |  | 2 |



**FIGURE 1 |** Results, TD and SLI children.

TD children and children with SLI. The overall scores for the two groups show a contrast: identical repetition occurs in 88.9% of cases for 6- and 7-year-old TD children, but only 47.8% for children with SLI. Under the second scoring method, where error type is taken into account, grammatical but non-identical repetitions amount to 7.9% for TD and 32.5% for SLI children, and ungrammatical repetitions represent 2.1% of answers for TD children but 19.28% for children with SLI (fragments are marginal for both groups: 1.1% for TD children, 0.35% for children with SLI). However, turning to individual performance, one child with SLI, SLI4, produced identical repetitions at a rate of 75%, above the 70% rate of the TD child with the lowest score; another TD child produced a 75% rate of identical repetitions, like SLI4. As a consequence, although at the group level TD and SLI children performed differently, there is overlap in their performance, as shown in **Figure 2**. The age factor is relevant here: comparing TD and SLI children of the same age, the TD children perform consistently better than the SLI children; the

only child with SLI with performance similar to the TD 6- and 7-year-olds is much older. Although some of the 6- and 7-year-old TD children have reached ceiling performance, as a group they have not. Therefore, testing older TD and SLI children would clarify the relation between age and performance on the SRT. With the results available, for clinical purposes, the SRT may be insufficiently accurate in terms of specificity. I consider this further in the discussion.

## DISCUSSION AND CONCLUSIONS

In this section I consider comparable results in the literature on SRTs. Limiting the comparison to the Romance family, SRTs have been designed and administered in several languages closely related to Catalan. In Italian, Devescovi and Caselli (2007) designed a task aimed at children as young as 2; their goal was not to discriminate between TD children and children at risk or with SLI, but to observe language development by means of repetition rather than production. Given the different nature of their goals and participants with respect to those of the present study, I do not pursue a comparison of the results. A more accurate comparison is possible with the LITMUS SRT designed for French, also under the auspices of COST IS0804, as described in Fleckstein et al. (2016). The sentence types tested in French were (i) finite clauses in the present tense, (ii) finite clauses in the past tense, (iii) object wh- questions, (iv) finite and non-finite complement clauses, and (v) subject and object relative clauses. There is therefore considerable overlap between structures covered by their SRT and those put forward here, although in the French SRT more emphasis is placed on verbal finiteness (French being a non-null subject language). Fleckstein et al. (2016) tested 37 monolingual TD children (aged 5;7 to 6;5) and 13 monolingual children with SLI (aged 6;11 to 8;4), as well as bilingual children. Their results appear in **Table 11**. I include the results for monolingual and bilingual children, although I would argue that the Catalan-speaking children in the sample here are closer in profile to the monolinguals than the bilinguals, given that they are Catalan-dominant.

Monolingual TD children scored very high, generally higher than the Catalan TD children, even though their ages are similar. In any event, TD children in both language groups achieved over 90% identical repetition for all the sentence types tested except, in French, non-finite and finite complement clauses and object relatives and, in Catalan, finite clauses, third person object clitics, and object relative clauses. The contrast in performance with the children with SLI is evident for all sentence types. Comparing the results in **Table 11** with those for Catalan, object relatives stand out as the one construction which cross-linguistically shows the effects of SLI (object clitic production was not included in the SRT in French in spite of it being delayed in SLI).

Fleckstein et al. (2016) tested 47 bilingual children (French-Arabic, French-English): 35 with typical development, 12 with SLI. Overall, TD bilinguals and monolinguals showed identical repetition rates of 81 and 93%, respectively, and SLI bilinguals and monolinguals showed rates of 41.9 and 48.5%, respectively (compared to results on the Catalan SRT of 88.9% for TD and 47.85% for SLI children). The difference in performance between
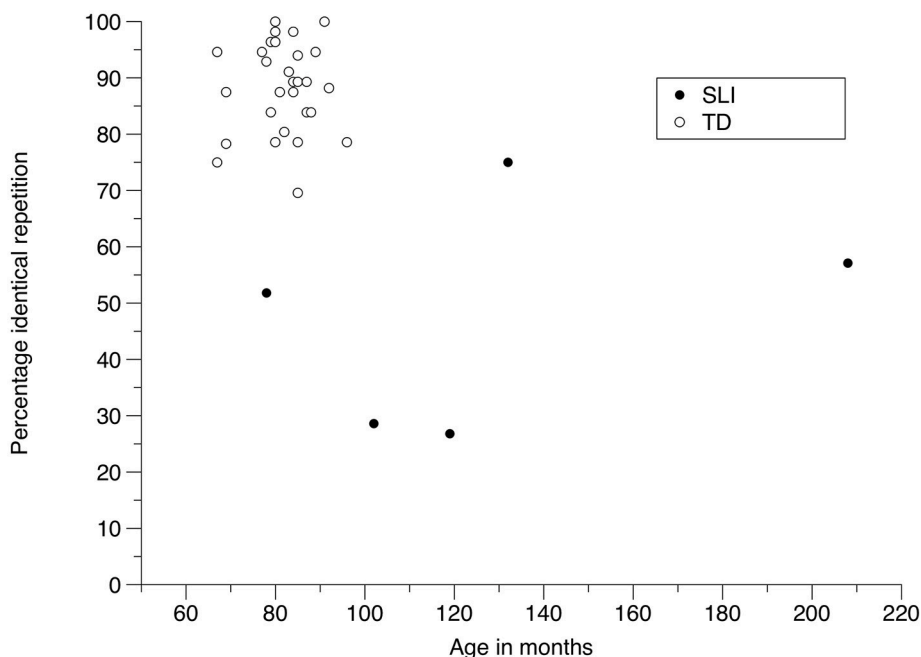
**FIGURE 2 |** Scatterplot of percentage of identical repetition as a function of age for TD and SLI children.

**TABLE 11 |** Percentage of identical repetition by monolingual (Mo) and bilingual (Bi) TD and SLI children, French (Fleckstein et al., 2016).

| Structure subtype | Mo-TD (%) | Bi-TD (%) | Mo-SLI (%) | Bi-SLI (%) |
|---|---|---|---|---|
| Present 3sg | 98.2 | 96.2 | 76.9 | 75 |
| Present 3pl | 95.5 | 82.9 | 48.7 | 38.9 |
| Past 3sg | 98.2 | 90.5 | 64.1 | 63.9 |
| Past 3pl | 95.5 | 76.2 | 43.6 | 16.7 |
| Who question | 100 | 100 | 76.9 | 80.6 |
| Which question | 96.4 | 94.3 | 56.4 | 58.3 |
| Non-finite complement | 84.7 | 70.5 | 30.8 | 27.8 |
| Finite complement | 75.7 | 53.3 | 10.3 | 5.6 |
| Subject relative | 96.4 | 80.9 | 51.3 | 33.3 |
| Object relative | 89.2 | 65.7 | 25.6 | 19.4 |

the four groups was statistically significant. Regarding individual performance, the LITMUS-SRT developed for French had, for monolinguals, a specificity of 91.9% and a sensitivity of 92.3%. For bilinguals, measures for both specificity and sensitivity were lower, but still above 80%, a rate which is considered acceptable by Plante and Vance (1994).

The results for Catalan are much more limited than those for French, but, together with the quantitative resemblance, they bear a promising similarity to those of French in two respects: the ability to distinguish TD from SLI children, and the ease with which they can be obtained: an SRT for which identical vs. non-identical repetition is computed. The facility in performing and scoring the task is an advantage for participants and for the professionals involved, and a simple scoring method also makes

results more reliable (compare this method to that required to score different error types, which necessitates highly trained clinicians and is likely to give rise to many more dubious cases).

With the partial results available at present one can observe overlap in the performance of the Catalan-speaking children with TD and SLI, even if, as pointed out, the child with SLI with the highest score (75% identical repetition) was older by more than 3 years than the oldest TD child in the study. The children with SLI matched in age with the 6- and 7-year-old groups performed worse and there was no overlap in performance between TD and SLI participants. Despite the scarcity of studies of SLI in adulthood (Stothard et al., 1998; Clegg et al., 2005), there is evidence that the linguistic behavior of individuals with SLI varies with age, quantitatively and qualitatively (see above, for the case of third person object clitics through childhood, Gavarró, 2012; Arosio et al., 2014). As already indicated, testing a broader age range and conducting a proper comparison of age-matched groups of TD and SLI children remains for future research[7].

The next step is for the SRT for Catalan proposed here to be normalized and run with a large number of children with SLI. Only then will it be possible to take measures of sensitivity and specificity. At a later stage, testing with late bilingual children should be undertaken. Caution is necessary since no experimental work on Catalan L2 tells us if the constructions in the SRTs are vulnerable in L2 (or in the L2 of a subset of children, depending on their L1). For example, in the case of third person

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[7]Girbau (2016), in her non-word repetition task, tested a group of children of ages 8;0 to 9;11, and to my knowledge no study on Catalan SLI goes beyond that age.

object clitics, there is evidence from other, related languages that omission may also be found in L2 (see Grüter, 2005 for French), although the source of this omission would be different in nature from that seen in TD young children and SLI (transfer from a null object language, etc.).

The two groups for whom results have been reported here were bilingual (or multilingual) to varying extents. Our inclusion criterion was that they should be raised natively in Catalan, but there is the possibility that one of their parents raised them as native speakers of another language. The Catalan schooling system implements immersion in Catalan, but Spanish is also taught as part of the curriculum and children have plenty of opportunity to be exposed to Spanish through the media, acquaintances, friends and relatives. In this kind of context it is difficult to control for the kind of linguistic exposure that children get in terms of AoA, LoE, etc., although it should still be possible by means of a parental questionnaire.

One of the issues addressed in this topic is whether bilingual advantage (Bialystok et al., 2012) is attested in children like those in our sample, and whether it is detectable in both TD and SLI children alike. Bilingual advantage is argued to play a role in receptive and expressive vocabulary, verbal working memory and executive function in general. These areas, therefore, are the ones in which bilingual advantage would be predicted for TD and SLI bilinguals. The grammatical domain on which this paper focuses, on the other hand, appears to be orthogonal to bilingual advantage. When we set out to characterize how SLI manifests itself in Catalan speakers, we aim at core syntactic features (or phonological features, for phonological SLI) that are affected in SLI and remain unaltered due to an underlying disorder. To my knowledge no study so far has claimed that syntactic features or operations are subject to bilingual advantage. While bilingualism affects cognition and has a neurological impact, the core syntactic features of SLI seem to remain constant and depend mainly on the grammatical features of the language acquired, as we have shown.

To summarize, I have provided an SRT strongly motivated in our current knowledge of SLI in Catalan and closely related languages, mostly French and Italian for third person object clitic constructions, Italian for finiteness, languages with post-nominal relatives for relatives, and languages with verbal passives for passives. The results so far are just a first step, but indicate that the task has the potential to serve as a reliable and efficient tool to discriminate between TD children and children with SLI.

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# Impact of Diglossia on Word and Non-word Repetition among Language Impaired and Typically Developing Arabic Native Speaking Children

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The study tested the impact of the phonological and lexical distance between a dialect of *Palestinian Arabic* spoken in the north of Israel (SpA) and Modern Standard Arabic (StA or MSA) on word and non-word repetition in children with specific language impairment (SLI) and in typically developing (TD) age-matched controls. Fifty kindergarten children (25 SLI, 25 TD; mean age 5;5) and fifty first grade children (25 SLI, 25 TD; mean age 6:11) were tested with a repetition task for 1–4 syllable long real words and pseudo words; Items varied systematically in whether each encoded a novel StA phoneme or not, namely a phoneme that is only used in StA but not in the spoken dialect targeted. Real words also varied in whether they were lexically novel, meaning whether the word is used only in StA, but not in SpA. SLI children were found to significantly underperform TD children on all repetition tasks indicating a general phonological memory deficit. More interesting for the current investigation is the observed strong and consistent effect of phonological novelty on word and non-word repetition in SLI and TD children, with a stronger effect observed in SLI. In contrast with phonological novelty, the effect of lexical novelty on word repetition was limited and it did not interact with group. The results are argued to reflect the role of linguistic distance in phonological memory for novel linguistic units in Arabic SLI and, hence, to support a specific *Linguistic Distance Hypothesis* of SLI in a diglossic setting. The implications of the findings for assessment, diagnosis and intervention with Arabic speaking children with SLI are discussed.

Keywords: Arabic, specific language impairment (SLI), language disorders, diglossia, non-word repetiton, linguistic distance, pseudo word learning

## INTRODUCTION

Specific language impairment (hereafter, SLI; also referred to as Language Disorder, LD) affects ≈3.5–7% of the children (Tomblin et al., 1996) and is defined as "persistent difficulties in the acquisition and use of language... [when] the difficulties are not attributable to hearing or other sensory impairment, motor dysfunction, or another medical or neurological condition, and are not better explained by intellectual disability or global developmental delay" (American Psychiatric Association, 2013, p. 42). SLI can have a variegated phenotype and children with

SLI demonstrate very heterogeneous profiles (Leonard, 1998), including lower than expected for-their-age vocabulary: expressive and receptive and grammar: basic and complex (Leonard and Bortolini, 1998; Dromi et al., 1999; Bedore and Leonard, 2001; Stavrakaki, 2001; Friedmann and Novogrodsky, 2004, 2007, 2011; Marshall et al., 2007; Penke, 2009; van der Lely et al., 2011). SLI children also reveal remarkable phonological deficits when compared with their age-matched controls, including deficits in auditory phonological processing and memory (Gathercole and Baddeley, 1990; Tallal et al., 1991, 1993; Joanisse and Seidenberg, 1998; Newbury et al., 2005), phonological representations and awareness (Thatcher, 2010; Claessen and Leitão, 2012; Rispens and Baker, 2012), phonological decoding in word reading (Conti-Ramsden and Durkin, 2007; Tambyraja et al., 2015), and phonological learning.

## Word Repetition Deficits in SLI

Given a variegated phenotype, several theories were proposed to capture the etiology of SLI. According to one theory, SLI results from a deficit in input processing capacity, such as phonological short-term memory (Gathercole and Baddeley, 1990) or auditory or phonological processing (Tallal et al., 1991, 1993; Joanisse and Seidenberg, 1998). This theory predicts that impaired phonological processing in SLI will result in word/non-word repetition deficits, especially when the repetition tasks target long words and non-words. This is because repetition, especially of long items mostly targeted by earlier research, requires the temporary storage and processing of phonological information in memory[1]. This hypothesis received strong support in the finding that children with language impairment performed significantly more poorly than their age-matched typically developing peers on repetition tasks (Gathercole and Baddeley, 1990; Montgomery, 1995; Dollaghan and Campbell, 1998; Edwards and Lahey, 1998; Weismer et al., 2000; Newbury et al., 2005). The question that follows from this finding, however, pertains to the specific nature of the repetition deficit. Namely, the specific phonological skills implicated in word repetition, and the extent to which it might be influenced by linguistic structural factors (such as phonotactic probabilities, morphological structure, etc.) *vis-a-vis* functional sociolinguistic factors (such as spheres of use, experience, practice, etc.). Both sets of factors are expected to impact phonological processing in memory and might, thus, be associated with intrapersonal and inter-personal differences in repetition capacities.

Research on word/non-word repetition task performance has thus far focused primarily on structural linguistic factors to the exclusion of sociolinguistic functional factors. This research endeavor has shown that language-specific linguistic factors, such as phonotactic probability, syllabic length, and phonological similarity with real words influence repetition performance (Gathercole and Baddeley, 1990; Gathercole, 1995, 2006). Moreover, it has been shown that SLI and TD children may

vary in degree of sensitivity to these factors, with SLI children's repetition being more vulnerable to linguistic manipulations affecting the word-likeness of stimuli (Munson et al., 2005; Graf Estes et al., 2007; Armon-Lotem and Chiat, 2012), probably because functional exposure to input, which is critical for constructing proper phonological representations, is limited in SLI (Armon-Lotem, 2017). These findings imply that word and non-word repetition tasks are not free of lexical influences and might implicate lexical factors such as linguistic representations stored in long-term memory. In turn, the repetition deficits observed in SLI might not reflect phonological memory storage and processing deficits only, but also impaired or low-quality (e.g., inaccurate, fuzzy, unstable) lexical representations (Swan and Goswami, 1997; Perfetti, 2007).

Several researchers have argued that deficits in phonological processing in working memory may couch in difficulties in establishing, accessing, and retrieving phonological representations from long-term memory (Gathercole and Adams, 1993; Dollaghan and Campbell, 1995; Weismer et al., 2000; Sutherland and Gillon, 2007; Pennington and Bishop, 2009; Claessen and Leitão, 2012; Rispens and Baker, 2012). Evidence supporting this position comes partly from research showing that repetition of non-words, especially wordlike non-words, is correlated with vocabulary size, though the nature of the relationship between the two abilities is yet unclear (Gathercole and Baddeley, 1989; Service, 1992; Service and Kohonen, 1995; Dufva and Voeten, 1999; Masoura and Gathercole, 1999; Metsala, 1999; Conti-Ramsden, 2003; Gathercole, 2006; Hoff et al., 2008; Rispens and Baker, 2012; Engel de Abreu et al., 2013). Relatedly, it has been shown that non-word repetition is influenced by the wordlikeness of items (Gathercole and Baddeley, 1990; Dollaghan and Campbell, 1995; Gathercole, 1995, 2006; Munson et al., 2005). These effects suggest that phonological processing in working memory is impacted by knowledge stored in long term memory, and are in keeping with Baddeley's (2003) multi-componential model of working memory. These effects are also in keeping with the *Lexical Restructuring Model*, which captures the development of phonological representations in the lexicon of typically developing children and suggests a positive influence of growth in vocabulary size on phonological representational quality and, in turn, on phonological processing (Metsala, 1997a,b, 1999; Metsala and Walley, 1998).

*Word-likeness* (Gathercole, 1995), as a phonological property of non-words, has thus far been operationalized mainly in terms of the compositional phonological structure of non-word items, and the extent to which this structure abides by the linguistic patterns of the language under question (e.g., phonotactic probabilities, morphological structure, stress, etc.). Thus, word-likeness has not yet been operationalized in any systematic way in terms of the identities of the phonological structures within the non-word items; specifically of whether items depict novel structures that are not within the spoken linguistic repertoire of children. In effect, it has mostly been agnostic of variations in extent of experience and practice with specific phonological structures, and the effect of this factor on repetition capacity. Gibson et al. (2015) addressed the role of language experience

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[1] As argued by some (e.g., Snowling and Hulme, 1989; Snowling et al., 1991), quantitative phonological memory limitations may not be the only phonological factors that go into repetition tasks. Other factors may include phonological segmentation, phonological blending, and assembly of articulatory motor programs.

on repetition capacity among Spanish-dominant and English-dominant Spanish–English bilingual 5-year-old children. They found the Spanish-dominant group performed better than the English-dominant group for both Spanish and English non-words. Moreover, Spanish non-words were produced more accurately than English non-words overall. These findings were argued to reflect the extra practice the dominant Spanish speakers had with producing multisyllabic words.

Arabic diglossia offers another natural setting in which within-subject variations in extent of language experience on repetition ability may be tested. This is because native speakers in Arabic diglossia, and even the young ones among them, acquire two linguistic systems for two complementary sets of social functions: one for everyday speech and another for formal speech and writing. As a result, for most of the words they know, Arabic speakers store two phonological forms: one spoken/colloquial and another standard/written. Moreover, the two forms of many words in their lexicons may vary in just one constituent phoneme, with the standard word embodying a standard novel phoneme that is not within the spoken variety of children. This property can be authentically manipulated in constructing word and non-word repetition tasks in order to shed light on the role of this specific phonological feature on repetition ability. Furthermore, manipulating phonemic novelty, as a sociolinguistically based factor, in the selection of Arabic words, and in the construction of non-words, allows an investigation of whether SLI and TD children are equally affected by this factor. This question will have important implications for the nature of the phonological constraints on repetition ability, as well as the nature of the underlying phonological deficit in SLI, and its susceptibility to language experience.

Relatedly, in Arabic diglossia, it is possible to tease apart phonological novelty from lexical novelty. Because words may have two different phonological forms, the lexical store of Arabic speaking children may be broken down into four types of words: (a) lexically and phonologically non-novel, (b) lexically non-novel but phonologically novel, (c) lexically novel but phonologically non-novel, and (d) lexically and phonologically novel (Saiegh-Haddad, 2004; Saiegh-Haddad and Spolsky, 2014). In turn, it is possible to test the independent contribution of lexical and phonological novelty to word repetition. Furthermore, in the case of non-words, it is possible to test non-word repetition not only for non-words whose compositional phonemic form is novel, namely they string together non-novel phonemes in a novel order (which is how non-words are usually created) but also for non-words whose internal phoneme(s) are novel. This will allow an examination of the independent effect of these two aspects of phonological novelty on word repetition in TD and in SLI children.

## Diglossia: Impact on Language Processing

Arabic is a prototypical case of the concept diglossia as it was first outlined by Ferguson (1959): "a relatively stable language situation in which, in addition to the primary dialects of the language (which may include a standard or regional standards), there is a very divergent, highly codified (often grammatically more complex) superposed variety …. which is learned largely by formal education and is used for most written and formal spoken purposes but is not used by any section of the community for ordinary conversation" (p. 336). Ordinary everyday conversation in Arabic is conducted using a specific local spoken vernacular, collectively referred to as Spoken Arabic (or Colloquial Arabic). This variety is acquired naturally as a mother tongue. In contrast, the modern standard variety: Modern Standard Arabic (StA) is the language of conventional literacy tasks (reading and writing), as well as formal speech, and is learnt mainly in the formal classroom setting with special focus on grammatical accuracy; It is a modern descendant of Classical Arabic and of Literary Arabic and is to a high degree uniform across the Arabic speaking world.

Hence, in all regions in the Arabic-speaking world, once children enter school they are intensively and extensively exposed to Modern Standard Arabic as the language of reading and writing. Spoken interactions, even inside the classroom, remain to be conducted in Spoken Arabic, or in a semi-standard variety known as *Educated Spoken Arabic* (Badawi, 1973), except probably during Arabic lessons, where Standard Arabic is more dominant, at least in aspiration (Amara, 1995). The great majority of Arabic speaking Palestinian citizens of Israel are native speakers of Arabic and the great majority of them enroll in Arabic-medium schools (preschool throughout high-school). In these schools, Arabic is the only language of instruction and textbooks, and all school subjects are taught exclusively in Arabic, including math and science. Hebrew and English are both taught as second/foreign languages starting in the third and fourth grades, respectively (For more, see Saiegh-Haddad and Everatt, 2017).

Despite such deceivingly dichotomous context, and while Spoken Arabic is undoubtedly the primary spoken language, native speakers of Arabic, including young children, are actively and constantly engaged with Standard Arabic as well; they pray, do their homework and study for their exams in Standard Arabic, and they also watch many TV programs and dubbed series in this variety. Thus, besides proficiency in using Spoken Arabic, linguistic development in Arabic involves, from an early age, concurrent acquisition of Standard Arabic[2].

Because StA is the language of formal speech and reading/writing, it permeates the speech of many speakers, and this dynamic infusion happens in all linguistic domains (phonology, syntax, morphology, lexicon). As a result, it is often difficult to draw clear boundaries between the spoken and written norms. In fact, though Ferguson proposes a dichotomy between the spoken and written varieties, he himself recognizes that this is just an abstraction. Rather, the complex linguistic situation in Arabic diglossia has been described in terms of levels, or even a continuum, with speakers shifting between what may be conceived of as an infinite number of varieties

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[2]It is noteworthy that electronic writing in the social media, such as Facebook and SMS, are often conducted in the local spoken dialects using either the Roman alphabet along with a few numerals representing some of the unique Arabic sounds, or a modified version of the Arabic alphabet. The use of this variety for reading and writing in the electronic media emerges naturally among users and no formal instruction in using it is provided.

(Bassiouny, 2009) ranging between colloquial/vernacular and literary/standard forms (Blanc, 1960; Badawi, 1973; Meiseles, 1980; Boussofara-Omar, 2006).

A conspicuous feature of Arabic diglossia is a phonological and a lexical distance between Standard Arabic and Spoken Arabic (for a comprehensive discussion, see Saiegh-Haddad and Henkin-Roitfarb, 2014). This distance might take different forms in different Arabic-speaking regions. Yet, no Spoken vernacular shares the exact set of phonemes, or the same set of lexical items with Standard Arabic (Maamouri, 1998). For instance, in the domain of phonology, Standard Arabic comprises 28 consonantal phonemes and six vowel phonemes: three short vowels: low /a/, high front /i/, and high back /u/, and three corresponding long vowels: /a:/, /i:/, and /u:/. Moreover, all syllables in Standard Arabic must begin with a single consonant (C) serving as the syllable onset and followed by a vowel (V), as the syllable nucleus/peak. Yet, this phonological structure is at variance with that of many varieties of Spoken Arabic which usually comprise a smaller set of consonants and a larger set of vowels. To illustrate, interdental consonants are not within the phonemic inventory of many dialects of *Palestinian Arabic* spoken in the north of Israel. As a result, *Cognate words*, which are StA words that are also used in these dialects, acquire a different phonological form than that used in StA with StA interdental phonemes substituted for by corresponding phonemes used in these varieties of Spoken Arabic (StA /θaʔlab/; SpA /taʔlab/ "fox"). Similarly, the glottal stop phoneme, especially when preceded by a long vowel, is not preferred in a word-final position in these dialects. Therefore, cognate words ending in a glottal stop often delete this phoneme and reduce the preceding vowel (StA /sama:ʔ/; SpA /sama/ "sky"). Finally, consonantal cluster codas, which are widespread in monosyllabic StA words (in *pausal* non-inflected form) are not preferred in these dialects and, therefore, such clusters are usually broken through the insertion of an epenthetic vowel (StA /baħr/; SpA /baħir/ or /bahar/ "sea").

The lexical distance between Standard and Spoken Arabic is pervasive. To assess the scope of this distance, Saiegh-Haddad and Spolsky (2014) analyzed a corpus of 4,500 word-types derived from a pool of 17,500 word-tokens collected from 5-year-old native speakers of a local dialect of *Palestinian Arabic* spoken in the center of Israel. This study showed that only 21.2% of the words in the child's spoken lexicon were *Identical words*, that is words that keep an identical lexico-phonological form in SpA and StA (e.g., /na:m/ "slept"; /daftar/ "notebook"), whereas the remaining words were approximately evenly divided between *Cognate words*, which are shared by the two varieties, yet keep partially overlapping phonological forms in each of them (e.g., SpA /dahab /vs. StA /ðahab/ "gold"), and *Unique SpA words*, which have a unique lexico-phonological form in SpA completely different from its form in StA (e.g., SpA /juzda:n/ vs. StA /ħaqi:ba/ "bag").

The study of the impact of diglossia, namely the linguistic distance between SpA and StA on language and literacy development is scarce. Yet, it is receiving increasing attention, especially within the framework of *comparative linguality* and

its effect on language development and metalinguistic skills in bilingual and bilectal children (Rowe and Grohmann, 2013, 2014; Grohmann and Kambanaros, 2016; Grohmann et al., 2016). With focus on literacy development, Saiegh-Haddad and colleagues (Saiegh-Haddad, 2003, 2004, 2005, 2007; Saiegh-Haddad et al., 2011; Saiegh-Haddad and Schiff, 2016; Schiff and Saiegh-Haddad, 2017) tested the impact of the linguistic distance between Spoken and Standard Arabic on the development of literacy-related skills in Standard Arabic, including phonological awareness, pseudo word decoding, and word reading. These studies showed that the development of literacy-related phonological skills in StA Arabic is impacted by the phonological distance between SpA and StA. For instance, Saiegh-Haddad (2003) compared children's phonological awareness for Spoken Arabic as against Standard Arabic phonemes and found that, even after children's production of StA phonology had normalized, children had more difficulty isolating StA than SpA phonemes. Moreover, the decoding of pseudo words encoding letters that map StA phonemes was found to challenge first graders. These effects, formalized as the *Linguistic Affiliation Constraint* (Saiegh-Haddad, 2007) or a diglossia-effect (Saiegh-Haddad, 2017) were found to persist across the early elementary grades, to surface equally strongly on production and recognition tasks (Saiegh-Haddad et al., 2011) and to show cross- dialectal external validity (Saiegh-Haddad, 2007). Research has also endorsed the role of phonological distance in letter naming (Asaad and Eviatar, 2013), as well as in reading accuracy and speed in typically developing and in disabled readers (Saiegh-Haddad and Schiff, 2016; Schiff and Saiegh-Haddad, 2017).

Research on SLI in Arabic is rather limited (however, see Abdalla and Crago, 2008; Aljenaie, 2010; Abdalla et al., 2013; Fahim, 2017; Mahfoudhi and Abdalla, 2017; Qasem and Sircar, 2017; Shaalan, 2017) and it has not yet addressed the role of diglossia in impaired language development. The current study is one step in this direction. Specifically, it examines the impact of the lexical and phonological distance between SpA and StA on phonological memory, as indexed by performance on word and non-word repetition, in SLI and TD children, and operationalized by comparing repetition of novel vs. non-novel lexical and phonological structures. The study addresses the following questions:

1. Do Arabic SLI children underperform age-matched TD children on word and non-word repetition tasks?
2. Does the lexical and phonological distance between StA and SpA impact word and non-word repetition in TD and SLI Arabic speaking children? Specifically,

   a. Is word repetition in TD and SLI children affected by lexical and phonological novelty?
   b. Is non-word repetition in TD and SLI children affected by phonological novelty?

Two hypotheses will be tested. The first is the *General Phonological Deficit* hypothesis according to which SLI children are predicted to underperform TD age-matched controls on all repetition tasks regardless of linguistic distance, or novelty. This hypothesis derives from earlier evidence indicating impairment

in phonological processing in SLI children compared with their age-matched peers. The second hypothesis is the *Specific Linguistic Distance* hypothesis, according to which, while both SLI and TD children are predicted to find novel StA phonological and lexical units significantly harder to process than non-novel SpA structures, SLI children are expected to show particularly severe difficulty with novel linguistic structures. This prediction follows from research demonstrating that literacy-related phonological processing skills in Arabic are impacted by the *Linguistic Affiliation* of the target phonological unit (Saiegh-Haddad, 2007) with StA structures being more difficult to access than SpA structures (for a review and a model, see Saiegh-Haddad, 2017), as well as evidence suggesting that reading disabled children may be more impacted by linguistic distance than TD children (Schiff and Saiegh-Haddad, 2017). Even though earlier research in this respect has focused on literacy-related skills and has, thus, targeted phonological awareness and word-level reading tasks, it is predicted that similar patterns of effects will be observed on word and non-word repetition tasks due to shared reliance on similar underlying phonological factors. Moreover, if phonological memory for StA structures is compromised, it might be reasonable to argue that previously reported difficulties with phonological awareness and reading in StA may be attributed, at least partly, to difficulties with phonological processing in memory.

## METHODS

### Participants

The sample of the study consisted of a total of one hundred children: 50 SLI (25 Senior Kindergarten, SK, 1 year before the first grade, mean age 5:09, 10 Females; 25 First Grade, mean age 6;11, 10 Females) and 50 TD (25 SK, mean age 5;10, 13 Females; 25 First Grade, mean age 6;11, 10 Females). TD children were sampled from public schools in the north school district in Israel and SLI children were sampled from the same area; SLI children were recruited from *Language Centers*, which are kindergarten and day care centers serving children diagnosed by a speech and language pathologist as having developmental language disorders; First Grade SLI children were former enrolls to *Language Centers* who attend public schools in the same area. All children had normal IQ and normal hearing levels. No child had reported developmental, neurological, or psychological problems. Data collection took place during the winter-spring of 2016. Authorization was obtained from the office of the chief scientist of the Ministry of Education. Written parental consent was obtained from all children participating in the study.

In order to confirm earlier screening and to validate the specificity of the SLI children's difficulties in the domain of language in comparison to the age-matched TD control group, all children were screened with ALEF (*Arabic Language: Evaluation of Function*), a language screening battery created by a US team and validated based on a normative sample of children 3–9 years of age from Saudi Arabia (Kornilov et al., 2016). Six ALEF tasks were used to screen for SLI: word articulation, expressive vocabulary, non-word repetition, non-word discrimination, sentence completion, and sentence imitation task. Rapid naming

using RAN for colors and Forward Digit Span were also used for screening. ANOVA models conducted on the screening data showed that SLI children performed significantly lower than TD children on all eight tasks in both kindergarten and first grade samples. Moreover, a significant two-way interaction of grade by group was observed. In general, the interaction resulted from a larger gap between the two groups (SLI and TD) in kindergarten than in first trade. Word articulation, RAN and Digit Span only managed to discriminate between SLI and TD children in kindergarten but not in first grade. On all screening tasks, the performance of the SLI children fell below two standard deviations of the performance of the TD sample. Summary statistics and repeated measure ANOVA results for all screening tasks are summarized in **Table A1**.

## Experimental Tasks

### Word Repetition

The study used a word repetition task that targeted two facets of the linguistic distance between SpA and StA: lexical distance and phonological distance. The impact of lexical and phonological distance was operationalized by comparing children's word repetition for four types of words: (a) *Identical* (−L−P: Lexically non-novel and Phonologically non-novel) e.g., /ʔasad/ "lion"; (b) *Cognate* (−L+P: Lexically non-novel, because the word is also used in SpA but Phonologically novel because it encodes one StA phoneme), e.g., /buːðˤa/ "ice cream"; (c) *Lexically Unique* (+L−P: Lexically novel, because it is not used in SpA but Phonologically non-novel, because it does not encode any StA phoneme), i.e., /sitaːra/ "curtain"; and (d) *Lexically and Phonologically Unique* (+L+P: Lexically novel, because it is not used in SpA and Phonologically novel, because it encodes one StA phoneme), i.e., /liθaːm/ "veil". All four StA consonantal phonemes that are not used in the dialect of *Palestinian Arabic* targeted in this study were manipulated: interdental fricatives: voiced /ð/, voiceless /θ/, emphatic /ðˤ/, and uvular stop /q/. Words within each of the four categories varied systematically in length (1–4 syllables) in order to test the possible interaction between linguistic distance and word length on word repetition (Total $N = 80$ items, 20 items per category, five words per syllable-length condition). Note that each word, short and long, encoded just one StA phoneme. All words employed simple SpA syllabic structure (no consonantal clusters) and varied only in number of syllables. No case or mood inflections on ends of words were marked. Children were asked to repeat each word immediately after they had heard it presented by the experimenter, a native speaker of the SpA vernacular spoken by the children. One score was assigned for each accurate repetition and a zero score for inaccurate performance. Inaccurate performance included mispronouncing the target StA phoneme. *Alpha Cronbach* reliability across all tested words α = 0.96.

### Non-word Repetition

The impact of linguistic distance on non-word repetition was only addressed by targeting phonological distance. This is obviously because non-words do not have any lexical status. The effect of the phonological distance was operationalized by comparing non-word repetition for two types of words: (a)

Phonologically novel (+P: encoding one StA phoneme), e.g., /ma:ħiΘ/ and (b) Phonologically non-novel (−P, depicting only SpA phonemes), e.g., /fanazu:n/ (Total N items = 56 items, 28 items per category, 7 items per syllable-length condition). Non-words within each category varied systematically in length (1–4 syllables), so as the possible interaction of phonological distance by word length may be tested. All words employed simple SpA syllabic structure and varied only in syllabic length. Children were asked to repeat each non-word after it had been presented orally by the experimenter, a native speaker of the SpA vernacular spoken by the children. One score was assigned for accurate performance and a zero score for inaccurate performance. *Alpha Cronbach* reliability across all tested items α = 0.95.

### Method and Analytical Strategy

To test our hypotheses, we used aggregate scores for the four study measurements, that is, we aggregated successful responses over the number of trials into scores per each task, and then compared children of different groups (SLI, TD) and in different grade-levels (Kindergarten, First Graders). This generated scores on a scale of zero to one hundred percent success. As this scale was within a finite range, we used the Logit transformation [i.e., $\log_e(p/(1-p))$, where p represents percent correct answers], which transforms 0–1 values into $(-\infty, +\infty)$. To simplify the analysis, we created four groups in order to rank children's performance: SLI-Kindergarten, TD-Kindergarten, SLI-First Graders, TD-First graders. We used a repeated measure ANOVA model and a *post-hoc* ranking with the Bonferroni correction ($\alpha/4$) to determine higher vs. lower performing groups (significance difference subject to $p < 0.05$). For the repeated measure we used, mainly, the word type scores: 1. identical, 2. cognate, 3. lexically unique, and 4. lexically and phonologically unique. The four repeats appeared under two variables: lexical novelty [1(3,4) vs. 2(3,4)], and phonological novelty [3(1,2) vs. 4(1,2)]. For each performance measurement, one way, two-way, and three-way repeated measure ANOVA models were performed to capture group ranking, and the interactions between group, lexical novelty and phonological novelty, if existed. Note that actual sub-group means of success rates are reported, which include ranking using the Latin letter method ("a" for the lowest rate, and so on) as superscript. Tests for main and interaction effects (*F*-tests) are reported based on the log transformed scale.

## RESULTS

### Overall Differences between SLI and TD Children

The first question addressed in this study pertained to differences between kindergarten and first grade SLI and TD children in word and non-word repetition. **Table 1** presents sub-group means and standard deviations for total scores as well as *post-hoc* ranking results.

**Table 1** shows all sub-group means of success rates. *Post-hoc* mean ranking as represented by Latin letters shows that, for word repetition, kindergarten SLI children achieved the lowest grades on average (a) and kindergarten

TD children were the second lowest (b); first grade SLI children aligned with their kindergarten counterparts (b), whereas first grade TD children received the highest scores among all groups (c). As for non-word repetition, kindergarten SLI children always received the lowest scores, but kindergarten TD children performed better than SLI first graders (c over b). TD first graders were highest on non-word repetition (d).

## Word Repetition: Lexical and Phonological Distance Effects

The second and main question addressed in this study pertained to the effect of the lexical and phonological distance between SpA and StA on repetition in Arabic diglossia. In order to address this question in the repetition of real words, a series of repeated measure ANOVA models were conducted on items within each syllable-length condition separately; These analyses compared, in addition to the four groups, the two sets of lexical and phonological categories, and two-way and three-way interaction effects across the categorical sets. **Table 2** provides summary statistics and by group ranking. **Table 3** provides the ANOVA model main and interaction effects on the word repetition scores.

**Table 2** shows a consistent pattern of ranking across syllable length sets. Younger SLI children in kindergarten yielded the lowest scores (a); older SLI children at first grade performed similarly to younger TD children at kindergarten (b), and older TD children at first grade performed the highest in word repetition (c). Beyond the group main effect across all syllable lengths (1–4 syllables), **Table 3** shows that lexical novelty had a significant effect on word repetition only for shorter (1 syllable) words ($F = 9.54$, $p < 0.01$). In contrast with lexical novelty, phonological novelty had a consistent effect on word repetition across all syllable-length conditions (1 syllable: $F = 154.18$, $p < 0.001$; 2 syllables: $F = 115.88$, $p < 0.001$; 3 syllables: $F = 265.12$, $p < 0.001$; 4 syllables: $F = 78.63$, $p < 0.001$). Moreover, the two-way interaction of phonological novelty by group was significant across all syllable-length conditions as well (1 syllable: $F = 20.34$, $p < 0.001$; 2 syllables: $F = 31.27$, $p < 0.001$; 3 syllables: $F = 19.01$, $p < 0.001$; 4 syllables: $F = 3.20$, $p < 0.05$). The interaction between lexical and phonological novelty was found significant in two, three, and four syllable words. As the focus of this study is on the group main and interactive effect with novelty, we did not proceed with decomposing the latter interaction. Moreover, interactions that do not involve the group effect might suggest that performance differences were due to a hidden group effect. We present the sources of the former interactions in **Figure 1**. **Figure 1** presents the major sources of these interaction effects. In this figure and the following figures for decomposing interactions, the double head arrows represent two significantly different sub-group means, where each head marks one sub-group mean. The usual $p < 0.05$ criterion was used to show group differences. **Figure 1** shows that across syllable lengths, SLI children at both kindergarten and first grade, as well as kindergarten TD children performed differently when items were phonologically novel vs. non-novel.

**TABLE 1 |** Summary Statistics and *post-hoc* ranking results for word and non-word repetition.

| | Kindergarten | | | First Grade | | | Both | | | Group Effect |
|---|---|---|---|---|---|---|---|---|---|---|
| | SLI-SK (N = 25) | TD-SK (N = 25) | Both (N = 50) | SLI-Gr.1 (N = 25) | TD-Gr.1 (N = 25) | Both (N = 50) | SLI (N = 50) | TD (N = 50) | All (N = 100) | $F \eta_p^2$ |
| Word Repetition | 63.30[a] (14.28) | 88.45[b] (9.72) | 75.88 (17.54) | 90.15[b] (8.89) | 97.80[c] (3.27) | 93.98 (7.67) | 93.13 (8.60) | 84.93 (16.25) | 76.73 (17.96) | 59.24*** 0.65 |
| Non-word Repetition | 46.36[a] (14.27) | 82.79[c] (12.20) | 64.57 (22.61) | 71.21[b] (11.85) | 92.86[d] (5.97) | 82.04 (14.34) | 87.82 (10.78) | 73.30 (20.78) | 58.79 (18.06) | 52.28*** 0.62 |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Superscripted letters indicate post-hoc mean ranking subject to Bonferroni correction. Standard deviations in parentheses.

The sources of these interactions became stronger as number of syllables increased. That is, differences between performance of repeating phonologically novel vs. non-novel words were clear across the groups, but when words were of four syllables, a difference in words with non-novel phonemes was also found between SLI-SK, on the one hand, and both TD-SK and SLI-GR1. Lastly, we decomposed the sources of the three-way interaction between group, lexical novelty, and phonological novelty. We found that except for a major success rate reduction in word repetition among kindergarten SLI children when novel and non-novel phonemes in lexically non-novel words, the other potential sources were similar.

## Non-word Repetition: Phonological Distance Effects

Performance on the non-word repetition task was analyzed using the repeated measure ANOVA model on each syllable length condition separately. **Table 4** shows descriptive statistics separated by syllable length and sub-group mean ranking. Regardless of syllable length, SLI children at kindergarten performed consistently lower in comparison to others (a) First grade SLI children performed higher than their kindergarten SLI counterparts (b) across all syllable lengths, but as syllable length increased (2–4 syllables), kindergarten TD children performed more successfully than both SLI groups (c); first grade TD children were the most successful in non-word repetition across all syllable lengths (d). **Table 5** presents the ANOVA model results.

Results show a large and consistent group difference on all syllable-length conditions (1 syllable: $F = 28.52$, $p < 0.001$; 2 syllables: $F = 46.90$, $p < 0.001$; 3 syllables: $F = 62.11$, $p < 0.001$; 4 syllables: $F = 45.02$, $p < 0.001$). Phonological novelty main effect was found significant across all syllable lengths as well (1 syllable: $F = 87.10$, $p < 0.001$; 2 syllables: $F = 81.62$, $p < 0.001$; 3 syllables: $F = 98.88$, $p < 0.001$; 4 syllables: $F = 82.21$, $p < 0.001$). The interaction of group by phonological novelty was significant only when non-words were short (1 syllable: $F = 19.69$, $p < 0.001$; 2 syllables: $F = 12.63$, $p < 0.001$). **Figure 2** presents the sources of these interactions. Differences between non-words with non-novel and novel phonemes were found in the first three sub-groups: SLI-SK, SLI-Gr1, TD-SK, as in the word repetition analysis. Moreover, 1-syllable and 2-syllable non-words with novel phonemes yielded significantly lower scores in the SLI group than in the TD group at both

kindergarten and first grade. The same pattern was observed in 2-syllable non-novel non-words. As for three and four syllable non-words, no interactions in non-word repetition were found.

## DISCUSSION

The current study is an investigation of the impact of diglossia on phonological memory in Arabic speaking SLI children and in TD age-matched controls. Specifically, it examines the impact of the lexical and phonological distance between SpA and StA on phonological memory, indexed as performance on word and non-word repetition, and operationalized as a comparison between items depicting novel vs. non-novel lexical and phonological structures. The current study defines novelty in functional sociolinguistic terms, rather than in absolute structural terms, as availability of a certain linguistic unit in the standard/written language but not in everyday spoken speech. In turn, according to this definition, non-novel units are expected to be associated with more active practice in speaking and more exposure and entrenchment. This sociolinguistically-defined phonological property, is characteristic of the linguistic reality of children raised in Arabic diglossia, and is probably also applicable to children in many other bilectal and bilingual settings. The aim of the current study is to test the role of novelty, as defined above, on developmental language impairment in Arabic.

## General Phonological Memory Deficits in Arabic SLI

The current study set out to investigate phonological deficits in Arabic SLI with particular focus on the impact of linguistic distance. One hypothesis that the current study tested was the *General Phonological Deficit* hypothesis according to which SLI children are expected to underperform TD children on all tasks requiring phonological processing in memory: word repetition and non-word repetition, especially for long words, and regardless of linguistic distance, or novelty. This hypothesis derives from research indicating that, when compared with their age-matched controls, SLI children show clear phonological deficits, including deficits in auditory phonological processing and memory (Gathercole and Baddeley, 1990; Tallal et al., 1991, 1993; Joanisse and Seidenberg, 1998; Newbury et al.,

**TABLE 2 |** Means and standard deviations of word repetition by group, word type, and syllabic length.

| | Kindergarten | | | 1st grade | | | Both | | |
|---|---|---|---|---|---|---|---|---|---|
| | SLI-SK ($N = 25$) | TD-SK ($N = 25$) | Both ($N = 50$) | SLI-Gr.1 ($N = 25$) | TD-Gr.1 ($N = 25$) | Both ($N = 50$) | SLI ($N = 50$) | TD ($N = 50$) | All ($N = 100$) |
| **1 SYLLABLE** | | | | | | | | | |
| Identical words (−L−P) | 98.40 (8.00) | 100 (0.00) | 99.20 (5.66) | 100 (0.00) | 100 (0.00) | 100.00 (0.00) | 100.00 (0.00) | 99.20 (5.66) | 99.60 (4.00) |
| Cognate words (−L+P) | 60.80 (23.44) | 87.20 (16.21) | 74.00 (23.99) | 88.00 (17.32) | 88.40 (8.00) | 93.20 (14.35) | 92.80 (13.86) | 74.40 (24.59) | 83.60 (21.91) |
| Lexically Unique (+L−P) | 96.80 (7.48) | 99.20 (4.00) | 98.00 (6.06) | 100 (0.00) | 100 (0.00) | 100.00 (0.00) | 99.60 (2.83) | 98.40 (5.48) | 99.00 (4.38) |
| Lexically and Phonologically Unique (+L+P) | 57.60 (24.03) | 80.00 (19.15) | 68.80 (24.30) | 86.40 (17.05) | 96.00 (10.00) | 99.00 (4.38) | 88.00 (17.14) | 72.00 (25.23) | 80.00 (22.92) |
| Total | 78.40[a] (11.15) | 91.60[b] (7.32) | 85.00 (11.47) | 93.60[b] (6.70) | 98.60[c] (3.69) | 96.10 (5.92) | 95.10 (6.74) | 86.00 (11.91) | 90.55 (10.66) |
| **2 SYLLABLES** | | | | | | | | | |
| Identical words (−L−P) | 97.60 (6.63) | 100 (0.00) | 98.80 (4.80) | 100 (0.00) | 100 (0.00) | 100.00 (0.00) | 100.00 (0.00) | 98.80 (4.80) | 99.40 (3.43) |
| Cognate words (−L+P) | 31.20 (26.51) | 80.00 (28.87) | 55.60 (36.88) | 84.00 (23.09) | 98.40 (5.54) | 91.20 (18.14) | 89.20 (22.57) | 57.60 (36.28) | 73.40 (34.00) |
| Lexically Unique (+L−P) | 96.80 (7.48) | 100 (0.00) | 98.40 (5.48) | 100 (0.00) | 99.20 (4.00) | 99.60 (2.83) | 99.60 (2.82) | 98.40 (5.48) | 99.00 (4.38) |
| Lexically and Phonologically Unique (+L+P) | 43.20 (28.10) | 87.20 (18.15) | 65.20 (32.28) | 84.80 (17.59) | 98.40 (8.00) | 91.60 (15.17) | 98.40 (5.48) | 64.00 (31.30) | 78.40 (28.38) |
| Total | 67.20[a] (14.00) | 91.80[b] (11.17) | 79.50 (17.65) | 92.20[b] (9.47) | 99.00[c] (3.23) | 95.60 (7.80) | 95.40 (8.91) | 79.70 (17.30) | 87.55 (15.80) |
| **3 SYLLABLES** | | | | | | | | | |
| Identical words (−L−P) | 96.00 (10.00) | 99.20 (4.00) | 97.60 (7.71) | 99.20 (4.00) | 100 (0.00) | 99.60 (2.82) | 99.60 (2.83) | 97.60 (7.71) | 98.60 (63.40) |
| Cognate words (−L+P) | 29.60 (24.58) | 64.80 (26.63) | 47.20 (30.97) | 70.40 (25.90) | 88.80 (15.36) | 79.60 (23.03) | 76.80 (24.70) | 50.00 (32.39) | 63.40 (31.66) |
| Lexically Unique (+L−P) | 92.80 (11.37) | 99.20 (4.00) | 96.00 (9.04) | 97.60 (6.63) | 99.20 (4.00) | 98.40 (5.48) | 99.20 (3.96) | 95.20 (9.53) | 97.20 (7.53) |
| Lexically and Phonologically Unique (+L+P) | 28.80 (31.13) | 70.40 (27.15) | 49.60 (35.74) | 76.80 (27.50) | 93.60 (13.81) | 85.20 (23.14) | 82.00 (24.33) | 52.80 (37.85) | 67.40 (34.89) |
| Total | 61.80[a] (15.47) | 83.40[b] (12.22) | 72.60 (17.59) | 86.00[b] (11.99) | 95.40[c] (6.91) | 90.70 (10.78) | 89.40 (11.55) | 73.90 (18.36) | 81.65 (17.13) |
| **4 SYLLABLES** | | | | | | | | | |
| Identical words (−L−P) | 63.20 (30.38) | 99.20 (4.00) | 81.20 (28.11) | 98.40 (5.54) | 100 (0.00) | 99.20 (3.96) | 99.60 (2.83) | 80.80 (27.98) | 90.20 (21.93) |
| Cognate words (−L+P) | 32.00 (24.49) | 74.40 (24.17) | 53.20 (32.23) | 81.60 (21.54) | 95.20 (8.72) | 88.40 (17.65) | 84.80 (20.82) | 56.80 (33.89) | 70.80 (31.32) |
| Lexically Unique (+L−P) | 56.80 (28.68) | 93.60 (12.54) | 75.20 (28.73) | 93.60 (11.14) | 100 (0.00) | 98.80 (8.44) | 96.80 (9.35) | 75.20 (28.45) | 86.00 (23.70) |
| Lexically and Phonologically Unique (+L+P) | 31.20 (25.22) | 80.80 (24.14) | 56.00 (34.99) | 81.60 (23.04) | 97.60 (6.63) | 89.60 (18.62) | 89.20 (19.47) | 56.40 (34.92) | 72.80 (32.60) |
| Total | 45.80[a] (23.88) | 87.00[b] (13.23) | 66.40 (28.25) | 88.80[b] (11.30) | 98.20[c] (3.19) | 93.50 (9.49) | 92.60 (11.08) | 67.30 (28.52) | 79.95 (25.00) |

+L, Lexically Novel; −L, Lexically non-novel; +P, Phonologically Novel; −P, Phonologically Non-novel; SK, Senior Kindergarten. Superscripted letters indicate post-hoc mean ranking subject to Bonferroni correction. Standard deviations in parentheses.

2005), phonological representations and awareness (Thatcher, 2010; Claessen and Leitão, 2012), phonological decoding (Tambyraja et al., 2015), and phonological learning. This was demonstrated in English monolinguals, as well as in monolingual speakers of several other languages (e.g., Newbury et al., 2005; de Bree et al., 2007; Dispaldro et al., 2013). Phonological deficits were also reported in the two languages of bilingual SLI children (e.g., Gutiérrez-Clellen and Simon-Cereijido, 2010; Windsor et al., 2010).

In line with the above, the results of the current study focusing on word and non-word repetition show that Arabic speaking SLI children, who are raised in a diglossic (bilectal)

**TABLE 3 |** Repeated measure ANOVA model results of Word Repetition by each word length set separately: Lexical and Phonological Novelty are used as within subject factors.

| | Df | 1 syllable | | 2 syllables | | 3 syllables | | 4 syllables | |
|---|---|---|---|---|---|---|---|---|---|
| | | F | $\eta_p^2$ | F | $\eta_p^2$ | F | $\eta_p^2$ | F | $\eta_p^2$ |
| Group | 3.96 | 35.89*** | 0.53 | 39.59*** | 0.55 | 31.22*** | 0.49 | 65.94*** | 0.67 |
| Lexical Novelty | 1.96 | 9.54** | 0.09 | 2.21 | 0.02 | 1.47 | 0.23 | 0.34 | 0.004 |
| Lexical Novelty X Group | 3.96 | 0.76 | 0.02 | 1.63 | 0.05 | 1.86 | 0.14 | 0.86 | 0.03 |
| Phonological Novelty | 1.96 | 154.18*** | 0.62 | 155.88*** | 0.62 | 265.12*** | 0.73 | 78.63*** | 0.45 |
| Phonological Novelty X Group | 3.96 | 20.34*** | 0.39 | 31.27*** | 0.49 | 19.01*** | 0.37 | 3.20* | 0.09 |
| Lexical Novelty X Phonological Novelty | 1.96 | 2.31 | 0.02 | 6.26* | 0.06 | 12.00** | 0.11 | 17.28*** | 0.15 |
| Lexical Novelty X Phonological Novelty X Group | 3.96 | 0.51 | 0.02 | 2.82* | 0.08 | 0.50 | 0.02 | 1.13 | 0.034 |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; Repeated, word novelty, phonological novelty. Group (SLI-SK, TD-SK, SLI-Gr1, TD-Gr1) is used as a between subject factor.
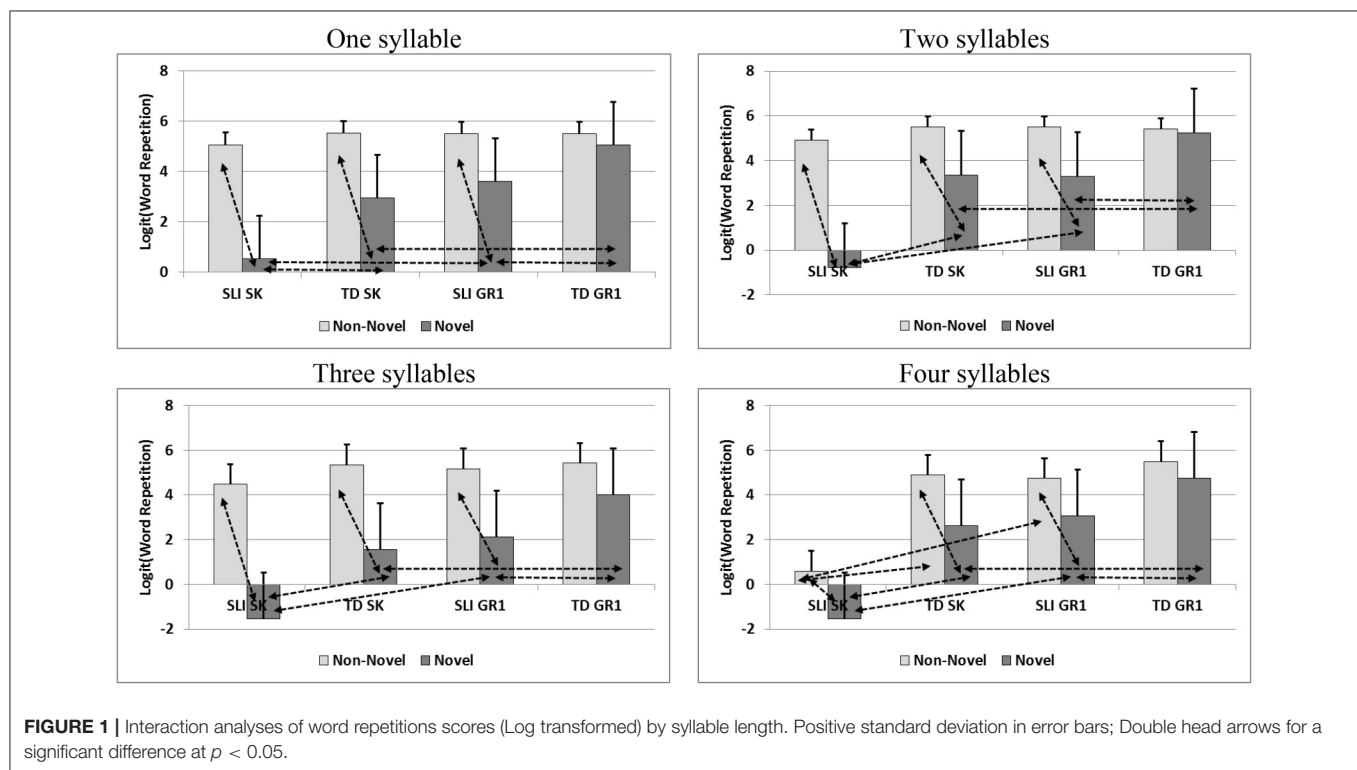


**FIGURE 1 |** Interaction analyses of word repetitions scores (Log transformed) by syllable length. Positive standard deviation in error bars; Double head arrows for a significant difference at $p < 0.05$.

setting, fare significantly lower than their age-matched controls on both tasks implicating phonological processing in memory: word repetition and non-word repetition, and even when the phonological forms targeted are limited to SpA. These results accord with the *General Phonological Deficit hypothesis* and extend earlier findings in demonstrating that Arabic speaking SLI, like monolingual SLI children raised with just one language or language variety, show a deficit in phonological memory. These findings align with theories of processing deficits which posit that SLI may be grounded in a deficit in input processing capacity (Gathercole and Baddeley, 1990; Tallal et al., 1991, 1993; Joanisse and Seidenberg, 1998).

Whereas phonological deficits were observed in the SLI group at both kindergarten and first grade, the results showed that, in both SLI and TD groups, the performance of first grade children was higher than the performance of their kindergarten peers. Moreover, while SLI first graders aligned with TD kindergarteners in word repetition, non-word repetition of SLI children at first grade was lower than the performance of TD children at kindergarten. Altogether, these findings indicate a positive impact of first grade exposure to StA and to the shallow vowelized Arabic orthography on phonological processing in Arabic in both SLI and TD children, yet a weaker effect for SLI children. It is noteworthy that evidence for the impact of literacy on phonological processing among English speaking SLI children is not clear. For instance, Thatcher (2010) found no gains in phonological awareness in SLI children, as opposed to TD age-matched peers, between kindergarten and first grade.

**TABLE 4 |** Means and Standard Deviations for Non-word Repetition by group, phonological novelty, and syllable length.

| | Kindergarten | | | 1st grade | | | Both | | |
|---|---|---|---|---|---|---|---|---|---|
| | SLI-SK (N = 25) | TD-SK (N = 25) | Both (N = 50) | SLI-Gr.1 (N = 25) | TD-Gr.1 (N = 25) | Both (N = 50) | SLI (N = 50) | TD (N = 50) | All (N = 100) |
| **1 SYLLABLE** | | | | | | | | | |
| Phonologically non-novel −P | 94.29 (10.10) | 98.29 (4.74) | 96.29 (8.07) | 96 (7.74) | 100 (0.00) | 98.00 (5.78) | 99.15 (3.43) | 95.14 (8.95) | 97.14 (7.03) |
| Phonologically novel +P | 39.43 (23.79) | 85.14 (21.22) | 62.29 (32.11) | 81.14 (23.59) | 99.43 (2.86) | 90.29 (19.02) | 92.29 (16.63) | 60.29 (31.52) | 76.29 (29.79) |
| Total | 66.86[a] (13.66) | 91.71[b] (11.79) | 79.29 (17.81) | 88.57[b] (12.71) | 99.71[c] (1.43) | 94.14 (10.57) | 95.71 (9.24) | 77.71 (71.57) | 86.71 (16.37) |
| **2 SYLLABLES** | | | | | | | | | |
| Phonologically non-novel −P | 89.71 (13.98) | 98.86 (3.96) | 94.29 (11.18) | 93.14 (8.37) | 100 (0.00) | 96.57 (6.81) | 99.43 (2.83) | 91.43 (11.55) | 95.43 (9.28) |
| Phonologically novel +P | 31.43 (20.62) | 78.29 (23.73) | 54.86 (32.32) | 72.00 (24.22) | 99.43 (2.86) | 85.71 (21.98) | 88.86 (19.85) | 51.71 (30.26) | 70.29 (31.57) |
| Total | 60.57[a] (14.30) | 88.57[c] (11.48) | 75.57 (19.10) | 82.57[b] (12.39) | 99.71[d] (1.43) | 91.14 (12.29) | 94.14 (9.86) | 71.57 (17.29) | 82.86 (18.02) |
| **3 SYLLABLES** | | | | | | | | | |
| Phonologically non-novel −P | 57.14 (27.97) | 96 (7.74) | 76.57 (28.24) | 82.29 (11.87) | 98.29 (6.28) | 90.29 (12.39) | 97.14 (7.07) | 69.71 (24.77) | 83.43 (22.77) |
| Phonologically novel +P | 20.00 (19.78) | 68.00 (26.17) | 44.00 (33.39) | 45.14 (24.98) | 85.71 (15.97) | 65.43 (29.16) | 76.86 (23.25) | 32.57 (25.66) | 54.71 (32.99) |
| Total | 38.57[a] (21.03) | 82.00[c] (12.90) | 60.29 (27.91) | 63.71[b] (14.57) | 92.00[d] (9.29) | 77.86 (18.72) | 87.00 (12.22) | 51.14 (21.95) | 69.07 (25.24) |
| **4 SYLLABLES** | | | | | | | | | |
| Phonologically non-novel −P | 30.86 (27.87) | 84.57 (16.96) | 57.71 (35.46) | 65.71 (16.50) | 82.29 (19.02) | 74.00 (19.51) | 83.43 (17.88) | 48.29 (28.70) | 65.86 (29.63) |
| Phonologically novel +P | 8.00 (13.09) | 53.14 (27.51) | 30.57 (31.22) | 34.29 (25.75) | 77.71 (17.54) | 56.00 (30.93) | 65.43 (25.99) | 21.14 (24.19) | 43.29 (33.45) |
| Total | 19.43[a] (18.27) | 68.86[c] (19.55) | 44.14 (31.20) | 50.00[b] (17.98) | 80.00[c] (16.62) | 65.00 (22.87) | 74.43 (18.82) | 34.71 (23.67) | 54.57 (29.17) |

*Superscripted letters indicate post-hoc mean ranking subject to Bonferroni correction. Standard deviations in parentheses.*

**TABLE 5 |** Repeated measure ANOVA model results for Non-word Repetition for each syllable-length condition separately.

| | df | 1 syllable | | 2 syllables | | 3 syllables | | 4 syllables | |
|---|---|---|---|---|---|---|---|---|---|
| | | F | $\eta_p^2$ | F | $\eta_p^2$ | F | $\eta_p^2$ | F | $\eta_p^2$ |
| Group | 3.96 | 28.52*** | 0.47 | 46.90*** | 0.59 | 62.11*** | 0.66 | 45.02*** | 0.59 |
| Phonological Novelty | 1.96 | 87.10*** | 0.00 | 81.62*** | 0.46 | 98.88*** | 0.51 | 82.21*** | 0.46 |
| Phonological Novelty X Group | 3.96 | 19.69*** | 0.00 | 12.63*** | 0.28 | 0.88 | 0.03 | 2.44 | 0.07 |

*\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001; Repeated, phonological novelty.*

This finding, however, has to be interpreted within the context of literacy instruction in English. Literacy instruction in English speaking children (at least in the US) starts in kindergarten, and this might reduce the extent of gain observed between kindergarten and first grade. In the Arabic context in Israel, very little exposure to StA and instruction in literacy in StA takes place in kindergarten. Rather, StA language and literacy instruction starts mainly in the first grade. This difference, together with the phonological disparity between Spoken Arabic and Standard Arabic, including in the consonantal system which was targeted in the current study, might be responsible for the different patterning of results. In other words, because some of

the Standard Arabic phonemes are absent from the phonological system of Spoken Arabic, exposure to literacy in the first grade might help children represent these phonemes more accurately, especially as learning to read entails learning the different letters that map these phonemes. Thus, the specific gain in phonological processing observed in the first grade in our sample might reflect the combined effect of two factors: (a) intensive exposure to StA in the first grade in the light of diglossia and (b) experience with the shallow orthography of vowelized Arabic which maps Standard Arabic phonology. These factors might impact on both input and output phonological skills, including quality of phonological representations, efficiency of phonemic encoding,
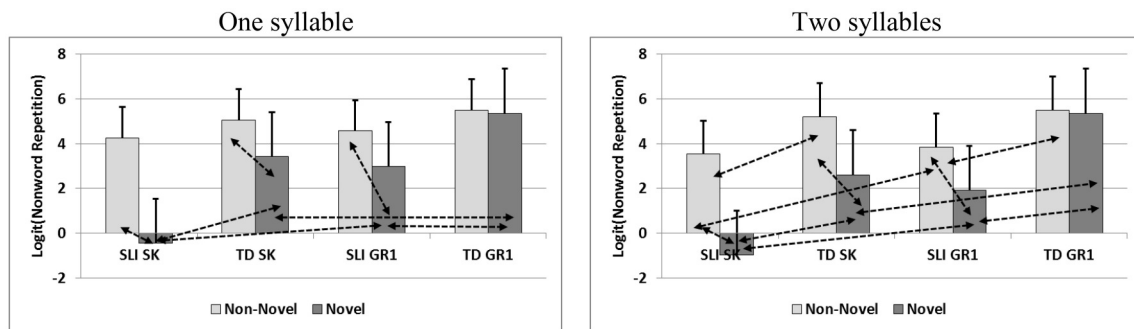
**FIGURE 2** | Interaction analyses of nonword repetitions scores (Log transformed) by syllable length. Positive standard deviation in error bars; Double head arrows for a significant difference at $p < 0.05$.

phonemic segmentation and blending, as well as articulatory motor planning (Hassunah et al., 2017; Saiegh-Haddad, 2017). Indeed, earlier research on Arabic reports marked first grade gains in phonological awareness for production tasks, such as phoneme isolation among TD children (Saiegh-Haddad, 2003). Future research is warranted that tests the contribution of first grade exposure to StA and of experience with vowelized Arabic on input and output phonological skills among TD vs. SLI children, especially in light of the phonological disparity in Arabic between SpA, the language of everyday speech and StA, the language encoded in print. This research should try to address the problem of ceiling levels of performance, especially among TD kindergarten children, which surfaced in the current study and which limit the validity and generalizability of conclusion regarding impact of literacy on phonological memory in SLI vs. TD children.

## Diglossia Reflexes on Word and Non-word Repetition of Novel Phonological and Lexical Forms in Arabic

The results discussed in the previous section are based on overall scores and do not take into account possible differences in phonological memory that may be associated with linguistic distance, namely availability or not of the linguistic unit in the spoken variety used by children in everyday speech. This question is receiving increasing attention especially within the framework of *comparative linguality* and effects on language development and metalinguistic skills in bilingual and bilectal children (Rowe and Grohmann, 2013, 2014; Grohmann and Kambanaros, 2016; Grohmann et al., 2016). Arabic diglossia offers a natural setting for testing this question in developmental language impairment. The current study focuses on phonological and lexical distance and on its effect on phonological processing in memory. Phonological memory is tested using word and non-word repetition, and the impact of phonological and lexical distance is operationalized by comparing memory for novel StA phonological and lexical structures that are not within the spoken repertoire of children with non-novel SpA units.

To address the impact of lexical and phonological distance on real word repetition four types of words were compared:

(a) *Identical* (−L−P: Lexically non-novel and Phonologically non-novel); (b) *Cognate* (−L+P: Lexically non-novel but Phonologically novel); (c) *Lexically Unique* (+L−P: Lexically novel but Phonologically non-novel); and (d) *Lexically and Phonologically Unique* (+L+P: Lexically novel and Phonologically novel). Moreover, because phonological memory is sensitive to the effect of word length (Gathercole and Baddeley, 1990), an attempt was made to dissociate the effect of this factor from the effect of novelty by manipulating phonological and lexical distance within each of four syllable-length conditions (1–4 syllable long items) independently. The results obtained from the manipulation of phonological and lexical novelty on real word repetition reveal a significant effect of lexical novelty on word repetition for short words (1-syllable long), and no interaction with group. The lexical novelty effect was reflected in the finding that word repetition of Identical and Cognate words was more accurate than the repetition of Unique words, both phonologically novel and phonologically non-novel. This effect, however, was limited to short one-syllable words and did not extend to longer words. This means that when the word was lexically not novel and short, it was easier for children to repeat than a lexically novel word, and regardless of phonological novelty. This finding mimics the word frequency/familiarity effect observed in the literature (Garlock et al., 2001; Gathercole, 2006); Identical and Cognate words are used in SpA and are thus familiar to children, whereas lexically novel words which are only used in StA are naturally less familiar, and it implies reliance on lexical feedback to aid storage and processing in memory for lexically non-novel short words. However, when the word was both longer than one syllable and lexically novel a bottleneck effect was observed and lexical feedback could no longer avert memory decay. Interestingly, the results did not show these patterns to be unique for SLI children, or even more prominent in SLI than in TD children, probably indicating general, rather than SLI-specific patterns of quantitative memory span and qualitative lexical distance effects.

Unlike lexical distance, large, and consistent effects were observed for phonological distance on word repetition among SLI children at both kindergarten and first grade, as well as among TD kindergarten children. This effect was evident

across all syllable-length conditions: short and long, and it interacted group. Non-word repetition showed a similar effect of phonological distance in the same groups of children and across all syllable-length sets, yet a significant interaction with group for only 1-syllable and 2-syllable non-words. In other words, across syllable-length sets, SLI children at both kindergarten and first grade performed more poorly when the word encoded a StA phoneme than when it only encoded SpA phonemes. This was not the case among TD children who only showed this pattern in kindergarten but not in first grade. These results imply a strong role of phonological distance in impeding phonological memory in children in general, but also a stronger effect among SLI than TD children. These findings are in harmony with earlier reports of the effect of phonological distance on literacy-related phonological skills, including phonological awareness (Saiegh-Haddad, 2003, 2004, 2007; Saiegh-Haddad et al., 2011), phonological naming (Asaad and Eviatar, 2013), phonological recoding of pseudo words (Saiegh-Haddad, 2005), as well as word decoding accuracy and speed in typically developing children (Saiegh-Haddad and Schiff, 2016) and in developmental dyslexia (Schiff and Saiegh-Haddad, 2017). More importantly, the results accord with the *Linguistic Distance Hypothesis* stipulating a stronger impact of linguistic distance on SLI children's phonological memory skills. Given the observed patterns of results according to which lexical distance was found to show a limited effect on the repetition of short word only, and no interaction with group (SLI vs. TD), it might be more appropriate to refer to a *Specific Phonological Distance* hypothesis rather than a *Specific Linguistic Distance* Hypothesis. Future research should test the role of other aspects of phonology and lexicon on phonological processing in SLI in order to corroborate this hypothesis.

It is noteworthy that the results of the current study reveal a significant difference between memory for phonologically novel and non-novel words in SLI children in kindergarten as well as in first grade, yet only in kindergarten among TD children but not in the first grade. Moreover, while the repetition of phonologically novel words and non-words improved significantly between kindergarten and first grade among TD children yielding a non-significant difference between the two types of stimuli, the difference between the two sets of words remained significant in the SLI first grade children. This finding implies yet again a weaker effect of exposure to StA and to literacy in Arabic on SLI than on TD children's general phonological memory, and on memory for novel StA phonological units in particular. We reiterate that this interpretation must be treated with great caution given ceiling levels of performance, especially among TD kindergarteners, and specifically when words were non-novel.

Besides the observed effect of phonological and lexical distance, the results of the current study reveal different patterns of interactions of these factors with group in stimuli that vary in syllabic length. These patterns imply that linguistic distance and word length might constitute two different processing constraints on phonological processing in Arabic. The results showed that in the case of non-novel items, the repetition of 1–3 syllable words and 1-syllable non-words yielded similar repetition accuracy scores in SLI and in TD children, in kindergarten and in first grade, failing hence to discriminate between the two groups; non-novel words managed to tease the groups apart at kindergarten only when they were 4-syllables long, and non-words managed to do so at both kindergarten and first grade when they were 2-syllables long. These results are not commensurate with those reported among English speaking children where monosyllabic non-words (which are comparable to the non-novel non-words used in our study; they did not encode any novel phoneme but only depicted a novel composition of phonemes) were found to yield significant differences between SLI and TD children (Gathercole and Baddeley, 1990). Differences between the patterns observed in the current study and those reported for English speaking children might be attributed to differences between the two languages in phonological complexity with English monosyllabic words depicting complex clustered onsets and codas, in contrast with Arabic where such clusters are limited and were thus excluded (Gibson et al., 2015). At the same time, Gathercole and Baddeley (1990) report that while the word repetition deficit among SLI children was observed in monosyllabic words, it became more robust when longer 3–4 syllable words were used (Dollaghan and Campbell, 1998). This observation is corroborated by our findings which reveal that phonologically non-novel Arabic words became sensitive to language impairment, in kindergarten and first grade children, only when they were 4-syllables long; Shorter phonologically non-novel words failed to tease apart an SLI from a TD child in both grades. It is interesting to note that Arabic is a multi-syllabic language, it is a consonantal root-pattern based language with most content words and even some function words made up through the indigitation of consonantal roots within mutlisyllabic prosodic templates. An analysis of the phonological structure of Spoken Arabic revealed that only 16.5% of the words in the Spoken Arabic lexicon of 5-year-old children were monosyllabic words, whereas 61.1% were bi-syllabic words, 21.3% were tri-syllabic (Saiegh-Haddad and Spolsky, 2014). Moreover, the multisyllabic lexicon of Arabic is organized and constrained by highly regular morpho-phonological templates— derivational and inflectional word-patterns functioning as fixed phonological/prosodic word envelopes and capturing the syllabic structure of the word (Saiegh-Haddad and Geva, 2008; Saiegh-Haddad and Henkin-Roitfarb, 2014). This morpho-phonological property has been shown to result in word patterns being accessed and employed rather early in linguistic processing amongst Arabic speaking children (Saiegh-Haddad, 2013, 2017; Taha and Saiegh-Haddad, 2016, 2017; Saiegh-Haddad and Taha, 2017). Given this, it would be reasonable to expect Arabic speaking children, both SLI and TD, to show relative ease in processing longer words, and regardless of linguistic distance. This conclusion is in accordance with earlier research showing that speakers of a multi-syllabic language, like Spanish, find it easier to process long strings of verbal input in both Spanish and English than those coming from a linguistic background that does not feature as many multi-syllabic words (Gibson et al., 2015).

Phonologically novel words and non-words were found to behave genuinely differently from non-novel words and to show sensitivity to language impairment even in the case of

short words. In the case of both words and non-words, the results show that repetition of even the shortest 1-syllable novel word yielded a significant difference between SLI and age-matched TD controls, both in kindergarten and in the first grade. These results highlight the role of phonological distance, as it is defined in this study, as an important linguistic constraint on phonological processing in diglossic Arabic, and as a phonological complexity factor that is particularly sensitive to language impairment in this language setting. These results also imply that the quantitative word length factor and the qualitative phonological distance factor might constitute two independent constraints on phonological memory. This has important theoretical and clinical implications. To name just a few, the results imply that diagnosis of SLI should treat length and phonological distance separately. Short words encoding a novel phoneme prove successful in discriminating between SLI and TD children at both kindergarten and first grade. However, it is only when the word is very long (4 syllables long) that a phonologically non-novel real word can dissociate the two groups, and only at kindergarten. In the same way, a non-novel non-word need be 2-sylalbles long to manage to tease the groups apart. Moreover, these constraints should be manipulated in different ways to diagnose groups in kindergarten vs. first grade. Note that phonologically non-novel 4-syllable words failed to tease SLI and TD children apart at first grade but they managed to do so in kindergarten.

Children with specific language impairment are particularly sensitive to phonological complexity in their language and their performance drops when complexity increases (dos Santos and Ferré, 2016). The current results demonstrate a particular complexity that Arabic SLI children are confronted with. This is phonological distance which was found to have an overarching effect on the repetition of all words: real words and non-words, short and long. This finding is remarkable because linguistic distance parameters are usually not heeded when phonological complexity is defined and when measures of phonological representation, processing, or awareness are used with bilectal or bilingual children (Russak and Saiegh-Haddad, 2011, 2017). Research has shown that linguistic factors impact phonological processing skills in typically developing and in SLI children (Munson et al., 2005; Graf Estes et al., 2007). SLI children were even found to be more sensitive than typically developing children to linguistic manipulations within tasks (Munson et al., 2005). This is probably due to the genuinely linguistic nature of their deficit, and due to the effect of the quality of the long-term store of linguistic structures on phonological processing (Newbury et al., 2005; Zourou et al., 2010). The current study showed that lexical distance is another important factor that has an impact on the repetition of words, short real words in particular, among bilectal children. These effects should, therefore, become an indispensable part of the characterization of the repetition deficit in SLI and in specifying its underlying cognitive and linguistic basis.

Two issues are in order. First, the linguistic distance factor that the current study has targeted may be genuinely different from the familiarity/novelty factor often manipulated when wordlikeness is tested. This is because linguistic distance does not imply absolute lack of familiarity with a given linguistic unit. Rather, gradable levels associated with degree of language experience and practice, as well as quantity and quality of spheres of use of the two language varieties. This is a sociolinguistic variable that characterizes the linguistic reality of language development in diglossia (Saiegh-Haddad, 2012). Second, with respect to phonological distance, even when an analogy with wordlikeness is held up, phonological distance was operationalized differently in the current study and it referred to whether the phonological form of the word encoded a novel StA phoneme, rather than whether the compositional structure of the word was novel. This aspect of novelty has not been tested before, and the results of the current study show that it has a strong and persistent effect on phonological processing in children and especially so in SLI children. This finding has clear theoretical implications, as well as important practical implications.

Theoretically, the results imply that theories of language development and impairment cannot be agnostic to the sociolinguistic context within which language acquisition is embedded and to the distributional nature of linguistic knowledge and representation that is true of bilingual and bilectal children. Moreover, the findings imply that cognitive deficits, such as memory and metalinguistic skills are not purely cognitive or insensitive to language-specific linguistic factors. Rather, they are impacted by linguistic representations, and in as much as these linguistic representations are inaccurate or unstable any operation on or access to these representations should be expected to be more difficult to demonstrate (Swan and Goswami, 1997; Foy and Mann, 2001).

In terms of practical and clinical implications, the results demonstrate that the phonological deficits observed in SLI are exacerbated in the Arabic context by linguistic distance making phonological processing particularly challenging for Arabic speaking children. In turn, early intervention with Arabic speaking SLI children should probably suspend attention to these units and should begin, instead, with those phonological and lexical units that are familiar to children from their spoken Arabic vernacular. At the same time, after some basis of phonological representations and processing has been established, particular focus to the phonological distance between SpA and StA should be given particular attention, especially when children start learning to read and given the fact that literacy acquisition in Arabic happens only in the standard variety (Saiegh-Haddad and Everatt, 2017).

Another practical implication concerns diagnosis of and intervention with SLI. The results of the study indicate that novel phonological units are particularly difficult for SLI children and in kindergarten in particular, and this effect surfaces even when short words are employed. For instance, the results of the non-word repetition task showed that one syllable non-novel non-words yielded similar repetition scores in all four groups tested, whereas the repetition of two syllable non-novel non-words and 1–2 syllable novel non-words, yielded different scores in the four groups. All this implies that to diagnose young children with SLI, attention to novel phonological units in conjunction with word length is warranted, and it should be given thorough attention in task construction and performance

interpretation, especially as the two factors may be used to make different inferences regarding the nature of the underlying difficulty and hence different implications for intervention. Word length is a quantitative constraint on memory capacity and an effect of length in the absence of a phonological distance effect might imply difficulty with memory span. In contrast, phonological distance effect even in the case of short words might imply phonological representational quality problems disrupting storage and processing in memory. The effect of this factor is naturally exacerbated in longer words as our results show.

## CONCLUSION AND LIMITATIONS

The results of the current study show that two factors that pertain to Arabic diglossia affect phonological storage in working memory in Arabic speaking TD and SLI children. These are lexical distance and phonological distance. Moreover, the impact of these factors on phonological memory surfaces in different ways in shorter and longer words implying, hence, an interaction between the quantitative length memory span factor and the qualitative linguistic distance representational factor.

It is to be remembered that the evidence we report in this article is based on a small sample size and on a cross-sectional design. These are two critical limitations on the generalizability

of the results we report. Moreover, the results of the current study are based on Arabic native speaking children living in Israel, and they should be replicated among speakers of Arabic in other regions in the Arabic-speaking world. Finally, phonological and lexical distance was operationalized in this study based on a local dialect of *Palestinian Arabic* vernacular spoken in the north of Israel; Linguistic distance is a variable concept and it is realized differently in different regions and with different spoken Arabic vernaculars. Future research that replicates the design of the current study but targets other phonological and lexical structures is warranted in order to demonstrate the external validity of the results reported in this study. Finally, despite the fact that our SLI sample was screened based on various language tasks, including phonology and lexicon, many more of these tasks tapped into phonological processing. Thus, the possibility that our SLI sample had more phonological deficits than other language deficits cannot be precluded.

## AUTHOR CONTRIBUTIONS

This paper was co-authored by ES-H and OG-D and is based on a doctoral dissertation conducted by the second author under the supervision of the first author.

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# APPENDIX A

**TABLE A1 |** Screening tasks: summary statistics and repeated measure anova results.

| | SLI-SK ($N = 25$) | TD-SK ($N = 25$) | SLI-G1 ($N = 25$) | TD-G1 ($N = 25$) | $F_{(1, 96)}$ (Grade) | $F_{(1, 96)}$ (Group) | $F_{(1, 96)}$ (Group*Grade) |
|---|---|---|---|---|---|---|---|
| RAN for Colors (s) | 2.10[ac] (0.80) | 1.34[b] (0.24) | 1.52[d] (0.44) | 1.16 (0.25) | 14.80*** $\eta_p^2 = 0.13$ | 32.49*** $\eta_p^2 = 0.25$ | 4.11* $\eta_p^2 = 0.04$ |
| Forward Digit Span | 10.88[ac] (5.78) | 19.60[b] (4.72) | 18.84[d] (5.50) | 21.72 (4.07) | 24.79*** $\eta_p^2 = 0.21$ | 32.83*** $\eta_p^2 = 0.26$ | 8.32** $\eta_p^2 = 0.08$ |
| Word Articulation | 82.52[ac] (9.59) | 99.65[b] (1.20) | 99.57[d] (1.54) | 100 (0.00) | 78.96*** $\eta_p^2 = 0.45$ | 80.55*** $\eta_p^2 = 0.46$ | 72.77*** $\eta_p^2 = 0.43$ |
| Expressive Vocabulary | 51.89[ae] (10.82) | 76.60[b] (4.72) | 65.26[cf] (6.35) | 75.23[d] (6.98) | 14.40*** $\eta_p^2 = 0.13$ | 120.28*** $\eta_p^2 = 0.56$ | 21.72** $\eta_p^2 = 0.19$ |
| Sentence Completion | 26.00[ag] (11.60) | 57.41[bc] (7.79) | 55.53[eg] (10.16) | 71.65[df] (6.46) | 140.73*** $\eta_p^2 = 0.59$ | 165.98*** $\eta_p^2 = 0.63$ | 17.19*** $\eta_p^2 = 0.15$ |
| Sentence Repetition | 26.21[ae] (18.46) | 83.35[b] (6.679) | 54.00[cf] (15.90) | 90.32[d] (4.56) | 32.64*** $\eta_p^2 = 0.25$ | 99.63*** $\eta_p^2 = 0.51$ | 11.38*** $\eta_p^2 = 0.11$ |
| Non-word Repetition | 37.88[ae] (18.33) | 80.47[b] (15.77) | 60.59[cf] (16.66) | 85.88[d] (7.35) | 21.57*** $\eta_p^2 = 0.18$ | 125.71*** $\eta_p^2 = 0.57$ | 8.16** $\eta_p^2 = 0.08$ |
| Non-word Discrimination | 15.30[ag] (22.01) | 82.88[bc] (9.89) | 59.93[eh] (19.80) | 99.65[df] (1.24) | 96.60*** $\eta_p^2 = 0.50$ | 294.96*** $\eta_p^2 = 0.75$ | 19.89** $\eta_p^2 = 0.17$ |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Superscripted letters indicate Bonferroni Pairwise test results.

# From First Steps to Full Acquisition: Comprehension of Subjunctive Clauses in Bilectal Children With Down Syndrome and Typical Language Development

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Previous work on linguistic abilities of individuals with Down syndrome (DS) suggests severe impairment of complex syntactic structures in a number of languages. Given difficulties reported with comprehension and production of relative clauses and object clitics in typically developing Greek Cypriot bilectal children (acquiring Cypriot Greek and Standard Modern Greek), one could hypothesize that the bilectal environment in which children with DS grow up may cause an added difficulty in the acquisition of other complex syntactic structures, such that of the understudied syntactically complex subjunctives. This study examines whether Greek Cypriot bilectal children and adolescents with DS evidence an impairment with the comprehension of subjunctive clauses, corroborating arguments for an overall syntactic impairment from past research on DS. It also explores possible parallel development of subjunctives across the two groups. We aim to provide a developmental trajectory of the comprehension of subjunctive clauses for the two populations. Using an act-out priming task, followed by a picture selection task, subjunctive clauses were examined in 30 children and adolescents with DS and 53 children with typical language development. Full analysis of the comprehension data evidenced high means of accuracy, with parallel performance across the two groups. As a foretaste of this research program, a preliminary analysis on subjunctive production and comprehension in a small subgroup of five participants per group was also conducted. Results revealed that accuracy means for production were lower than those for comprehension, suggesting that both subgroups are lagging behind in performance but are acquiring the subjunctive in a parallel manner. The linguistic differences between Cypriot and Standard Modern Greek do not appear to affect the acquisition of subjunctives. Rather, it appears that the acquisition of this complex syntactic structure seems to be facilitated by the fact that the subjunctive is formed in the same way in both varieties, thus eliminating potential confusion caused by variable inputs.

Keywords: down syndrome, acquisition of syntax, production, comprehension, subjunctive clauses

## INTRODUCTION

Previous studies on the grammar of individuals with Down Syndrome (DS) have mainly reported difficulties with the inflectional system and complex syntactic structures. However, there is a small number of studies which do show near-ceiling performance on a number of phenomena, especially morphosyntactic marking (e.g., Eadie et al., 2002 for English; Schaner-Wolles, 2004 for German; Christodoulou, 2011, 2013 for Cypriot Greek).

Problematic production and even comprehension of complex syntactic structures have been reported to be impaired cross-linguistically, including languages such as Greek (Cypriot

(1)  O                        Jan-is              ce          i                    Mar-ia ...
     *DET.MASC.SG.NOM*        *John-MASC.SG.NOM*  *and*       *DET.FEM.SG.NOM*     *Maria-FEM.SG.NOM*
     ... θel-un               **na**              **pek-s-un**  s-ton              cip-o.
     *want.IMPF-PRES.3.PL*    *SUBJ*             *play-PRF-DEP.3.PL*  *in-DET.MASC.SG.ACC*  *garden-MASC.SG.ACC*
     'John and Mary want to play in the garden.'

and Standard Modern Greek), Dutch, English, French, German, Italian, Portuguese, Serbo-Croatian, and Spanish. Fowler et al. (1994) and Chapman et al. (1998), among others, argued that the linguistic abilities of individuals with DS are much lower than the DS suggested mental-age peer groups; children with DS aged 5–8 years have linguistic abilities equivalent to those of 2-year-old children with typical language development. These studies argued that older children and adults reach the linguistic capabilities of only a 3-year-old typically developing (TD) child. Numerous other studies also showed delayed development of both inflectional markers and complex syntactic structures such as passives and *wh*-questions (Gordan and Panagos, 1976; Fowler, 1990, 1995; Ring and Clahsen, 2005; Caselli et al., 2008; Rondal, 2009).

Even though most studies group together all syntactic structures and inflectional environments that have been studied, arguing for an overall syntactic impairment, no study to date has examined the performance of individuals with DS with one of the most complex syntactic structures, subjunctive clauses, which function like simultaneous infinitives in English, where the embedded event is interpreted as occurring simultaneously to the matrix event (Christodoulou and Wiltschko, 2012). Research on Greek individuals with DS has already shown that comprehension of binding conditions in subjunctive constructions presented the lowest accuracy rates of all tested structures (Stathopoulou, 2009), suggesting that the mechanisms involved in forming the subjunctive add an extra complication, compared to the other complex structures examined, like relative clauses.

The subjunctive is one of the three moods in Greek, alongside indicative and imperative. It is formed by means of the subjunctive marker *na* and a verb. There are two types of subjunctive constructions: optional and obligatory control. Control over the tense and subject–verb agreement features of the verb in the subjunctive is imposed by the verb in the main clause of a sentence. The verb θ*elo* "want" used in our experimental task imposes the obligatory use of a verb carrying

the dependent tense value in the subjunctive clause and matching subject–verb agreement with the verb of the main clause, as in (1). For a theoretical analysis of subjunctive clauses (see e.g., Christodoulou and Wiltschko, 2012). Note that the subjunctive is formed in the same way across the two varieties, Cypriot Greek and Standard Modern Greek, which means that for the purposes of the current study, the bilectal language acquisition context, as briefly presented in the Background section, may not have a direct effect on the acquisition of the syntactic structure itself. However, one may hypothesize that bilectal variation with other elements that may be used in the structure such as phonetic or morphosyntactic variation, and other linguistic divergence, may affect development.

The study of the comprehension and production of subjunctive clauses in a highly inflected language is facilitated by overt inflection, allowing us to observe whether a structure is used appropriately or not. It may also be possible that it is acquired earlier, given all the morphological cues available. This, however, could also mean that young speakers are presented with more morphosyntactic processes, which in turn children will need to use to successfully comprehend and produce a subjunctive clause. Thus, children have much more to observe, manage and later use in the process of acquisition of the subjunctive. The acquisition of this complex syntactic structure in a bilectal environment may create an additional difficulty, as minor or major variation in the input could create confusion. The goal of the current work was to examine whether Greek Cypriot children and adolescents with DS manifested an impairment with the subjunctive construction or have fully acquired the syntactic mechanisms pertaining to the acquisition of subjunctive clauses, such as comprehending morphosyntactic marking, processing restrictions imposed by the verb in the main clause appropriately, and so on. Through this research we also aim to investigate whether the two groups studied present a parallel development of subjunctive clauses and at what age they reach full comprehension. The ultimate objective of this study is to create the first developmental trajectory of the comprehension of subjunctive clauses for the two populations, from the very first signs of comprehension to full acquisition.

## BACKGROUND

Cypriot Greek (CG) is the dialect spoken in Cyprus, a speech community traditionally characterized by a diglossic holding of the official language, Standard Modern Greek and CG whose speakers are thus bilectal (Rowe and Grohmann, 2013). Bilectalism in diglossic Cyprus is used here to characterize the situation in which children of Greek Cypriot parents, with CG-speaking family and friends, grow up, yet get exposed to Standard Modern Greek from an early age; first through media such as

TV cartoons, later through public schooling starting in nursery and kindergarten, and becoming gradually more systematic in primary school. In the absence of a separate CG orthographic system, Greek can only be taught through the medium of the standard variety. In the absence of systematic studies on the exact linguistic and lectal input young children receive, we generalize on solid grounds that Greek Cypriot children acquire CG natively from birth and Standard Modern Greek from fairly early. Theodorou et al. (2016) call this the "standard path of language development" by CG children. For further discussion, background, and references (see e.g., Rowe and Grohmann, 2013; Grohmann and Kambanaros, 2016; Grohmann et al., 2016). In support of this, there is also a growing body of evidence that bilectal language development does differ from very early on Taxitari et al. (2015), and it differs not only from monolingual, but also from bilingual children (Antoniou et al., 2016).

Research on the acquisition of complex syntactic structures in Cypriot Greek is very recent. As the following overview on the acquisition of complex syntax in DS shows, some of the existing research is relevant; however, it is not so clear that bilectalism plays as prominent a role in language development of children with DS as it does for bilectal TD children. It is expected that future research targeting parallel environments with and without diversity across the two dialects will provide a more definitive answer to this question.

The first complex syntactic structure we discuss is *wh*-questions. CG-speaking adults with DS have shown considerably higher percentages of comprehension over production (Christodoulou and Grohmann, 2014). This phenomenon is frequently recorded in studies on children with typical language development between 3 and 6 years of age, with individual variation (for a comparable task involving referential and non-referential *wh*-questions, see Varlokosta et al., 2015 for Standard Modern Greek and Varnava and Grohmann, 2014 for CG). Tsakiridou (2006) showed the comprehension of (non-)referential subject and object *which*-NP and *who*-questions, to be problematic for Greek-speaking individuals with DS, with object *who*-questions being the most problematic. Using the same task, Stathopoulou (2009) recorded relatively high accuracy rates with the comprehension of *wh*-questions, with accuracy rates ranging between 73% and 85%, in which *who*-object questions yielded the highest accuracy rates.

Stathopoulou (2009) also examined relative clauses in four conditions: subject head–subject gap, subject head–object gap, object head–subject gap, and object head–object gap. She found difficulties with the comprehension of relative clauses in all four conditions, noting an accuracy rate of 43% (69/160 items) for overall comprehension and 18% (22/121) for overall production. The subject head–object gap condition produced the lowest performance for both production and comprehension; a tendency to resolve toward simple main clauses was observed. Theodorou and Grohmann (2013) investigated the comprehension and production of subject and object relative clauses in TD children ranging from 6 to 9 years. Subject relatives come with at-ceiling performance already at age 5, while object relatives are not fully acquired even as late as 9 years of age. Concerning the comparison between comprehension

and production, the authors noted that object relative clause production is mastered earlier than comprehension, in line with reported cross-linguistic findings. However, they also argue that the gap between comprehension and production accuracy is smaller than the existing literature suggests, which might be because they counted as correct those responses that use resumptive pronouns as a strategy, an acceptable option in the adult grammar.

With regard to pronoun use, participants with DS in Stathopoulou (2009) presented low accuracy rates with the comprehension of clitic and reflexive use in subjunctive clauses, over other tested syntactic structures, suggesting that the syntactic mechanisms involved in the formation of subjunctive clauses could potentially cause an additional difficulty. Sanoudaki and Varlokosta (2014) also showed that the comprehension of reflexive pronouns was challenging for Greek-speaking individuals with DS, though the same was not recorded with clitics and strong pronouns. They argued that the cross-linguistic difficulty with reflexive pronouns is not rooted in an incomplete acquisition with the pronoun system, but rather a DS impairment with the properties of reflexive elements. Concerning the role of object clitics in typical and atypical language development in CG, see Grohmann (2014) for a comprehensive overview.

With regard to research on other languages, English-speaking individuals with DS presented problematic performance with a variety of complex syntactic structures. Through a sentence repetition task, Gordan and Panagos (1976) found problematic production of simple-active declarative, negative, passive, and negative-passive sentences, with the latter presenting the most problematic performance. Errors included word omission, substitution, addition, transposition, transformation, and morpheme modification. Thordardottir et al. (2002) found problematic production with 10 different types of complex structures in narrative discourse, including conjoined and multiple embedding clauses. However, the authors determined that individuals with DS were as competent in using complex sentences as their TD controls matched for mean length of utterance. The production of *wh*-questions in English-speaking children with DS was found to be almost non-existent, with an accuracy rate of only 6%, whereas comprehension was recorded at relatively higher rates (43%) (Joffe and Varlokosta, 2007). The comprehension of active and passive sentences was also recorded at parallel rates, with a mean score of 45% across all sentence types. A cross-linguistic difficulty in the comprehension of reflexives but not pronouns, not only for English but also for Serbo-Croatian, led Perovic (2004, 2006) to argue that the comprehension of reflexives in individuals with DS is fundamentally deviant from that of TD children. She suggested that the problem lies either in the lexical knowledge or pragmatics.

There is only a handful of studies examining complex syntactic structures in languages other than Greek and English. Schaner-Wolles (2004) shows that German-speaking individuals with DS and TD children rarely used (finite and non-finite) verbs in clause-final position, where only non-finite verbs can be used. She argued that when participants with DS used non-finite verbs in finite clauses they essentially succeeded in

restructuring the grammatical pattern to accommodate a verb second structure. This observation is crucial because it implies that German individuals with DS were able to apply alternative methods to achieve the production of a structure with which they were experiencing morphosyntactic difficulties, such as omission of arguments. French-speaking individuals with DS presented low accuracy rates with subordinate and relative clauses, negation, and passive constructions (Tager-Flusberg, 1994). Difficulties with passive constructions were also reported for Portuguese-speaking individuals with DS (Coelho de Barros and Rubin, 2006). Similarly to Greek and English, Bol and Kuiken (1990) found low rates with interrogative structures for Dutch-speaking individuals with DS. The authors also reported overuse of verb–object constructions and stated that their participants avoided the use of negation and subject–predicate constructions. The production of Spanish-speaking individuals with DS was characterized by shorter, simple utterances, with lower morphosyntactic complexity (Galeote et al., 2013). Similar results, with simpler, telegraphic sentences, were also reported for Italian-speaking children with DS (Vicari et al., 2000, 2002; Caselli et al., 2008), though few details are provided by studies on either language.

## METHODS

### Participants

The DS group originally consisted of 40 children and adolescents, aged 5–18, previously diagnosed with DS and moderate mental disability by a certified psychologist. Participants were either studying in public schools, spending most of their time in special education classes, or public special education schools for children and adolescents with cognitive disabilities. Participants received speech–language therapy weekly. Note that in the public-school system in Cyprus, children are entitled to receive up to 60 min of speech–language therapy or intervention overall, at a maximum of 2 times a week. The amount of time and content of intervention sessions a child needs is entirely determined by the speech–language pathologist. A TD group was used for comparison purposes. This included 53 children ranging from 2 to 6 years of age, not diagnosed with any language disability at the time of data collection. Participants were recruited from schools all across Cyprus and came from families with a parallel socio-economic and educational background, as we were able to determine from the questionnaire given to parents along with the consent form. All participants were bilectal speakers of the two varieties spoken in Cyprus, Cypriot Greek, and Standard Modern Greek.

We ensured that potential hearing challenges would not affect the participants' performance. Participants with DS received a hearing test prior to data collection as part of their annual battery of health tests. As an additional measure, we administered two auditory tests—a repetition test and a picture selection test—to all participants. In the repetition task, participants were asked to repeat 20 words exactly as they were produced at normal speech rate by the experimenter. The picture selection task, consisted of 15 minimal pairs sensitive to stress (e.g., /ˈkọ.lɾɐ/ 'sheet of paper' vs. /kọ.ˈlːɐ/ 'it sticks') and a singleton vs. geminate

distinction (e.g., /ˈku.pɐ/'savory snack' vs. /ˈkupʰːɐ/, 'bowl'). Two pictures showing each item in the minimal pair were presented to the participants and they, in turn, had to select which picture representation matched the experimenter's production. One participant with DS who used a hearing aid was allowed to participate, since they passed the doctor's hearing test and our mandatory auditory screening tests.

After obtaining informed consent, an initial, informal 5 min interaction with basic questions was conducted by the experimenter, prior to the two hearing tests. The goal of this interaction was to determine if children will be able to follow the experimenter's instructions to perform the tasks and to conclude whether they met the inclusion criteria. Other than the brief interaction, we used information from our questionnaire to decide if children met the inclusion criteria. Those included being bilectal (as defined above), falling within the chronological age range, being diagnosed with trisomy 21 or not being diagnosed with any linguistic or cognitive disability, based on the group they belonged to, having adequate hearing and communication skills, and having the ability to comprehend instructions in order to perform the tasks. In order to assess the participants' cognitive abilities, we administered the Raven's Colored Progressive Matrices (Raven et al., 2000). Participant information is provided in **Table 1**. For TD children, we aimed to have at least 5 children for each 6-month age group. Given that individuals with DS were not found as easily at such numbers, we could not ensure a parallel breakdown. We had at least 2 participants per year, with a gap between 6;0 and 7;11. An exact breakdown is given in the results section in **Figures 4**, **5**.

## Materials and Procedure

We examined the comprehension and production of subjunctive clauses, with transitive and (obligatory or optionally) intransitive verbs, using a customized syntactic priming task with puppets for the production portion and a picture selection task for the comprehension portion. The experiment included two practice items and 18 test stimuli. A prime was used with both practice and targeted structures, namely the production of a verb (plus object if transitive) as a stimulus to trigger the formation of a specific structure. The first practice item was the intransitive verb *kolimb-o* "(I) swim" and the second one the transitive verb *pin-o* "(I) drink" along with the noun *ner-o* "water." We used the verb *θel-o* "(I) want" for the main clause, yielding obligatory control on the subordinate verb's aspect (perfective) and tense (dependent). In our stimuli, *θel-o* also yields obligatory use of third person singular for the subject–verb agreement, to match the main verb's subject–verb agreement inflection. However, this is not always the case.

### Experimental Design and Procedure

Participants were presented with two puppets, a cat and a dog. They were told that the puppets did not know how to speak, they could only whisper. Winnie the Pooh was the only one who could understand their whispers. Therefore, in order for the cat or the dog to communicate and express what they ***wanted*** to do they had to whisper in *Winnie*'s ear. In turn, *Winnie* would report what

**TABLE 1 |** Participant Information for CG children with DS and CG children with TD.

| Groups | N | Gender | | Age range | CA | | RCPM (max. score 36) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *F* | *M* | | *Mean* | *SD* | *MA* | *Raw score* | *SD* |
| CG_DS | 30 (40)* | 11 (16)* | 19 (24)* | 5;0–18;8 | 12;3 | 3.6 | 4;3 | 13 | 4.2 |
| CG_TD | 53 | 24 | 29 | 2;0–6;6 | 4;2 | 1.3 | 4;9 | 14 | 6.5 |

*N = (Raw) Number; CA = Chronological Age; SD = Standard Deviation; RCPM = Raven's Colored Progressive Matrices; F = Female; M = Male; MA = Mental Age (calculated based on the recently standardized Greek norm; a norm for Cypriot Greek children is in the process of being constructed by the first author).* *Ten participants with DS were excluded because they presented no verbal communication skills or lower verbal communication skills than our inclusion criteria required.*

the puppet said in one or more words (i.e., provide the prime), depending on whether an intransitive (one word, i.e., the verb) or a transitive verb (two or more words) was used. For example, the experimenter would say:

(2)  ja na ðume ti **θeli na kani/kami** to skillaki mas simera.
    '*Let's see what our little dog **wants to do** today.*'

The experimenter would then put the dog puppet to Winnie's ear and bark, imitating the dog. Then she would ask Winnie:

(3)  Winnie, ti ipe to skillaki mas oti **θeli na kami**?
    '*Winnie, what did our little dog say that he **wanted to do?**'

Winnie would respond with the prime in two words, as in (4), given that the targeted verb in the subjunctive clause in this case was transitive. In the case of an intransitive verb like *xorevo* "I dance," Winnie would only produce a one-word prime, i.e., the verb *xorevo*. Verbs would be given in their lexical entry form: imperfective, present, first person, singular.

(4)  Potiz-o                luluð-ja.
    *water.**IMPF-PRES.1.SG**   flower-NEU.SG.ACC*
    '*(I) water flowers.*'

The experimenter would first provide the two practice items, in order to explain the procedure and give the participants a chance to practice, before moving on to the test items. During the presentation of the practice items, participants were instructed to start their sentences as in (5), depending on which puppet was whispering in Winnie's ear. The use of the formulaic main clause would enforce the use of the main–subjunctive clause combination, as opposed to the production of an isolated subjunctive clause, or a single main clause. The latter would be marked as an incorrect performance of the task. This information was given only for the practice items and was not repeated throughout the duration of the actual testing, before or after the presentation of each prime. Participants were asked to produce a full main–subordinate utterance expressing what the animal wanted to do.

(5)  i                ɣat-a              /o                skil-os              θel-i              na . . .
    *DET.FEM.SG.NOM   cat-FEM.SG.NOM    DET.MASC.SG.NOM   dog-MASC.SG.NOM     want.IMPF-PRES.3.SG   SUBJ*
    '*The cat/the dog wants to . . .*'

The participants were asked to repeat each practice stimulus. The experimenter encouraged participants to try the second practice item alone to ensure that they understood the task. If the

participant seemed unsure or produced an incorrect production, the experimenter administered the practice items again. Once the experimenter was confident that the participant understood what they needed to do, she moved on to the test items. For the prime given in (4), the participant needed to produce the example given for transitive verbs in **Table 2**.

After the completion of each production, the experimenter would repeat the targeted structure in its correct form, regardless of whether the participant produced an utterance matching the target or an alternative structure. This was done to ensure that the participants had heard the correct structure, for which they needed to choose the matching picture. The experimenter would then move on to the comprehension part, presenting a picture booklet to participants. Participants were presented with four pictures and asked to choose the picture that matched the produced utterance. Pictures included four conditions:

 I. agent–match/action–match (Target)
 II. agent–match/action–mismatch
III. agent–mismatch/action–match
IV. distractor

Note that for all agent mismatch cases, the agent was always the other puppet. For example, if the targeted agent was the dog, the cat would be the puppet in the agent mismatch case. To avoid any confusion, given that elicitation sessions were only audio recorded, participants were provided with a sheet of sizable 3D stickers (2″-5″ diameter), before being presented with the prime. They were asked to position the sticker in the box of the image that best matched the target (**Figure 1**), instead of pointing to the picture. Items were randomized in Excel. Responses and relevant comments were noted on a score sheet. Examples of targeted and produced utterances as well as pictures from the picture-selection task are included in **Table 2**. A total of approximately 20 min was needed to administer both tasks.

## Data Analysis/Coding

Participant productions were extracted and entered separately into a Relational DataBase Management System. Utterances varied in length depending on whether children produced a main–subjunctive clause, a main clause, or only a subjunctive clause. In an attempt to control for every related or external

**TABLE 2 |** Structural environments tested by the act-out priming production task[a].

| Prime | Examples of targeted utterances | Examples of utterances produced by participants | Examples of four conditions and picture selection |
|---|---|---|---|
| **Intransitive** | i ɣat-a… | i ɣat-a… **INCORRECT** |  |
| | *DET.FEM.SG.NOM cat-FEM.SG.NOM* | *DET.FEM.SG.NOM cat-FEM.SG.NOM* | |
| | θel-i **na xorep-s-i**. | θel-i **na xore-[ts]-i**. | |
| Xorev-o | *want.IMPF-PRES.3.SG SUBJ dance-**PRF-DEP**.3.SG* | *want.IMPF-PRES.3.SG SUBJ dance-**PRF-DEP**.3.SG* | |
| '(I) dance' | 'The cat wants to dance.' | 'The cat wants to dance.' **[DS29]** | |
| **Transitive** | o scil-os … | o scil-os … **CORRECT** |  |
| | *DET.MASC.SG.NOM dog-MASC.SG.NOM* | *DET.MASC.SG.NOM dog-MASC.SG.NOM* | |
| | θel-i **na poti-s-i** … | **potiz-i ta luluð-ja**. | |
| Potiz-o | *want.IMPF-PRES.3.SG SUBJ water-**PRF-DEP**.3.SG* | *water.**IMPF-PRES**.3.SG DET.NEU.PL.AC flower-NEU.PL.ACC* | |
| '(I) water' | **ta luluð-ja**. | 'The dog is watering the flowers.' **[DS4]** | |
| luluð-ja | *DET.NEU.PL.ACC flower-NEU.PL.ACC* | | |
| 'flowers' | 'The dog wants to water the flowers.' | | |
| **Ditransitive** | i ɣat-a … | i ɣat-a… **CORRECT** |  |
| | *DET.FEM.SG.NOM cat-FEM.SG.NOM* | *DET.FEM.SG.NOM cat-FEM.SG.NOM* | |
| | θel-i **na ðo-s-i** … | θel-i **na ðo-s-i** … | |
| ðin-o | *want.IMPF-PRES.3.SG SUBJ give-**PRF-DEP**.3.SG* | *want.IMPF-PRES.3.SG SUBJ give-**PRF-DEP**.3.SG* | |
| '(I) give' | **luluð-ja s-tin**… | **luluð-ja (s-tin** … | |
| luluð-ja | *flower-NEU.PL.ACC to-DET.FEM.SG.ACC* | *flower-NEU.PL.ACC to-DET.FEM.SG.ACC* | |
| 'flowers' | **all-i ɣat-a.** | **all-i ɣat-a).** | |
| all-i at-a | *other-FEM.SG.ACC cat-FEM.SG.ACC* | *other-FEM.SG.ACC cat-FEM.SG.ACC* | |
| 'other cat' | 'The cat wants to give flowers to the other cat.' | 'The cat wants to give flowers to the other cat.' **[DS21/2]**[b] | |

[a]*A "virtual sticker" has been placed on the targeted picture.*
[b]*The first participant produced the structure with the indirect object, while the second participant did not.*



**FIGURE 1 |** An example of a child performing the task. He first selected the sticker, listened to the prime, produced the utterance, and was then asked to place the sticker on the picture illustrating the produced task, after the experimenter reproduced the targeted utterance.

factor that could have potentially affected the results, each word in each utterance was tagged for information on its phonetic, phonological, morphosyntactic, and structural properties. Given the well-attested phonetic and phonological limitations of individuals with DS, a detailed phonological analysis prior to data analysis was considered critical to eliminate non-morphosyntactic factors that could affect results. For the comprehension part, each participant was given only one opportunity to place the sticker. Their first placement was the one evaluated. All data from score sheets were also entered in a DataBase System for analysis. Data were coded in the following way: 1 for *correct*, 0 for *incorrect,* and 2 for the rare instances of

*no answer*, with a total of 18 responses per participant. Means of correct responses were calculated out of the total of 18 test items.

### Reliability

An experienced experimenter (the first author) conducted all data collection. Initial narrow transcriptions, acoustic analyses, and morphosyntactic analyses were performed by the experimenter and two coders. A third coder transcribed and analyzed 43% of the overall collected data. Reliability between coders in terms of transcription accuracy was achieved at 97%. Discrepancies between coders were resolved by an independent coder. Response evaluation for the picture selection

(comprehension) task was performed by a separate coder and verified by the first author.

The project was fully approved by the Cyprus National Bioethics Committee (EEBK/EΠ/2012/29) and underwent ethics evaluation (at the beginning of the project, after data collection, and at its completion) by an independent ethics advisor to ensure that it adhered to the European Commission's Research Executive Agency (REA) ethical guidelines. Parents received a written and informed consent form outlining the purpose of the study, procedure, benefits, and risks. They were also assured that the collected data as well as all information concerning them and their children in the consent form they signed would remain confidential. Parents and/or the legal guardian of all participants had to sign each page of the consent form and complete the questionnaires on the first and last pages of the consent form.

## Statistical Analysis

Sample size was calculated based on previous published work on parallel populations. The estimated sample size was 33 for the DS population and 55 for TD children. Means of subjunctive comprehension were calculated for each participant from each group (all 30 children with DS and 53 TD children). A confidence level of 95% was applied, making the cut-off point 0.05.

# RESULTS

The full project generated a massive amount of data that are still being transcribed and analyzed. **Figure 2** shows results only on the comprehension portion of the experiment. Means were submitted to a Lineal Regression Model in R (R Core Team, 2017) with *subjunctive accuracy* as the dependent variable, i.e., the mean of correct responses over incorrect responses (out of a total of 18 items), per participant, per group, and *group* (DS vs. TD) and *age* as independent variables. The results showed a parallel performance across the two groups (DS: $M = 83.3\%$, $SD = 15.6$; TD: $M = 87.8\%$, $SD = 16.6$), $R^2 = 0.18$, $F(1, 81) = 1.48$, $p = 0.228$. Results did reveal an interaction of *age with group*: $R^2 = 0.13$, $F(3, 79) = 4.08$, $p = 0.010$, suggesting that while the two groups present parallel performance, there is across as well as within group variation with regard to age, as we clearly see in the developmental trajectories presented in **Figures 4**, **5**.

As a preview to the next steps of our research, data from a subgroup of 5 children with DS and a subgroup of 5 TD children, matched on MA, were compared to test for potential interactions with comprehension and production across the two groups (**Figure 3**). The statistical analysis provided below was to merely observe any potential tendencies that might assist with future analysis. It is possible that the current picture might change once full analysis of the data is completed. Data from the two subgroups were submitted to a Linear Regression Model in R, with *subjunctive accuracy*, as the dependent variable and *group* (DS vs. TD) and *age* as factors (i.e., independent variables), separately for each task/ability. Results revealed no *group* effect for either production, $R^2 = 0.005$, $F(1, 8) = 0.04$, $p = 0.854$, or comprehension $R^2 = 0.265$, $F(1, 8) = 2.88$, $p = 0.128$.

With the aim of creating a developmental curve for the comprehension of subjunctive clauses, we plotted the



**FIGURE 2 |** Mean percentage of subjunctive comprehension in Cypriot Greek (bilectal) children and adolescents with DS and typical language development.
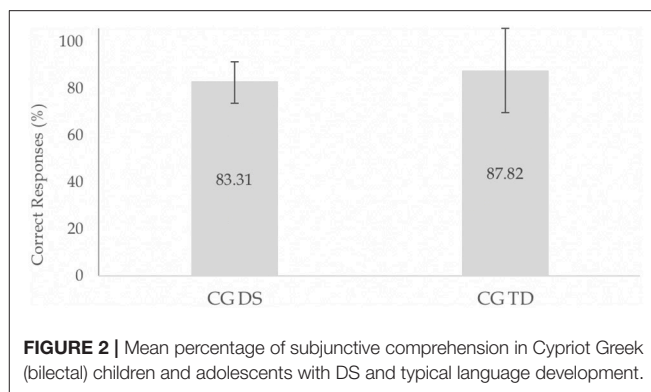
participants' performance across different ages. Results are shown in **Figures 4**, **5**.

The performance of children and adolescents with DS seemed to be more on a spectrum of individual abilities than on a maturational/developmental scale based on age. That is, we had more "high functioning" children with DS at age 5 ($M = 83.3\%$) than we did at age 8 ($M = 55.6\%$) and again children with DS aged 9 ($M = 87.0\%$) and 10 ($M = 88.9\%$) rather than those aged 11 ($M = 69.4\%$). In addition, the variation across participants within each DS subgroup was slightly greater than in the TD subgroups. A prime example is the subgroup for 13-year-olds, with two participants scoring 66.7% and two scoring 100%.

In contrast, TD children's means of accuracy across different ages were more "gradually ascending." That is, we see a slow increase in means of accuracy as we move from one 6 month group to the next (top panel). Results did evidence a relative plateau, with a slight variation of ±1.5%, for three age groups of TD children (bottom panel), aged 3;6–3;11 ($M = 95.8\%$), 4;0–4;5 ($M = 95.5\%$), and 4;6–4;11 ($M = 94.4\%$). Children in the 5;0–5;5 age group performed closer to the oldest age group ($M = 99.1\%$) (i.e., near ceiling) than the following two age groups. When the final group was further divided in TD children aged 6;0–6;5 and at 6;6, results revealed 100% accuracy with children at 6;6, showing the exact age of mastery (full acquisition). The same was also true for individuals with DS, for 17- and 18-year-olds, with teenagers at 18;0 and up showing 100% accuracy. However, both populations also show signs of full acquisition at an earlier age: 13;0–13;11 for DS and 5;0–5;5 for TD children, with the latter being much closer to ceiling.

# DISCUSSION

The first goal of the present study was to examine whether Cypriot Greek-speaking children and adolescents with Down syndrome present an impairment with the comprehension of subjunctive clauses. Given the high accuracy rates presented by our DS group, these results contradict arguments of an overall syntactic impairment from previous research on DS on numerous other languages and complex syntactic structures, such as Stathopoulou (2009), Thordardottir et al. (2002), and
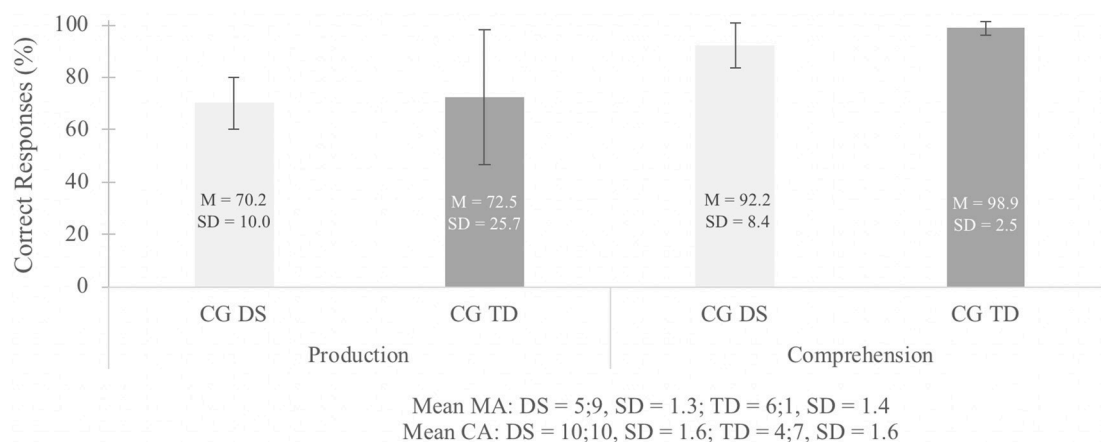
**FIGURE 3 |** Subjunctive production and comprehension for a subgroup of five participants per group.
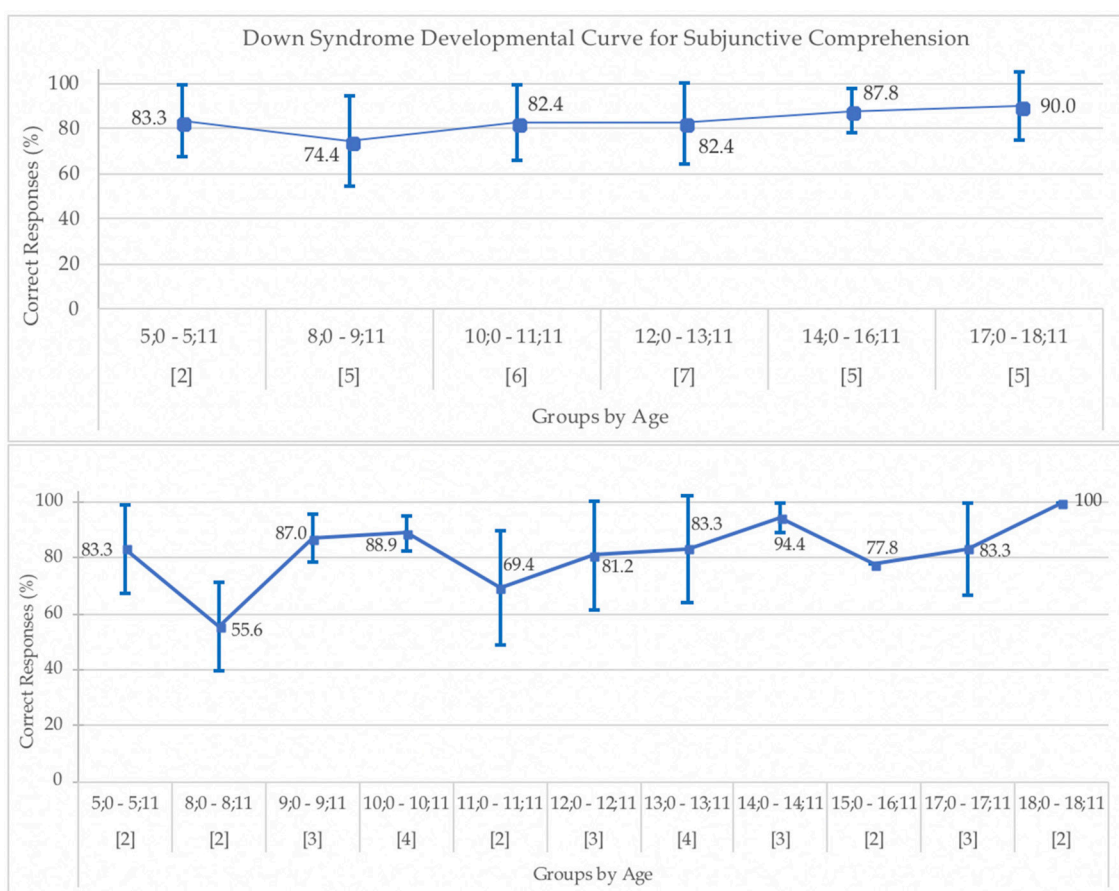


**FIGURE 4 |** Developmental Trajectory of the comprehension of subjunctive clauses in DS. In each graph, the **(Top)** of each figure shows a broader breakdown of each group by age, while the **(Bottom)** shows a more detailed breakdown of each group by age. The number of participants per group/age is noted in square brackets [ ] underneath each age range. Each data point represents the mean percentage of the participants' means whose age falls within each respective age range. For example, in the top panel of this figure, 83.3% is the average of the combined means for the two participants in that age group (72.22% and 94.44%).

others, showing accuracy with numerous complex syntactic structures being lower than or at chance level. Despite the complexity of the structure and the fact that the embedded

verb's inflectional marking depends on the matrix verb—with the same subject–verb agreement marking, but different tense marking—participants with DS presented highly accurate
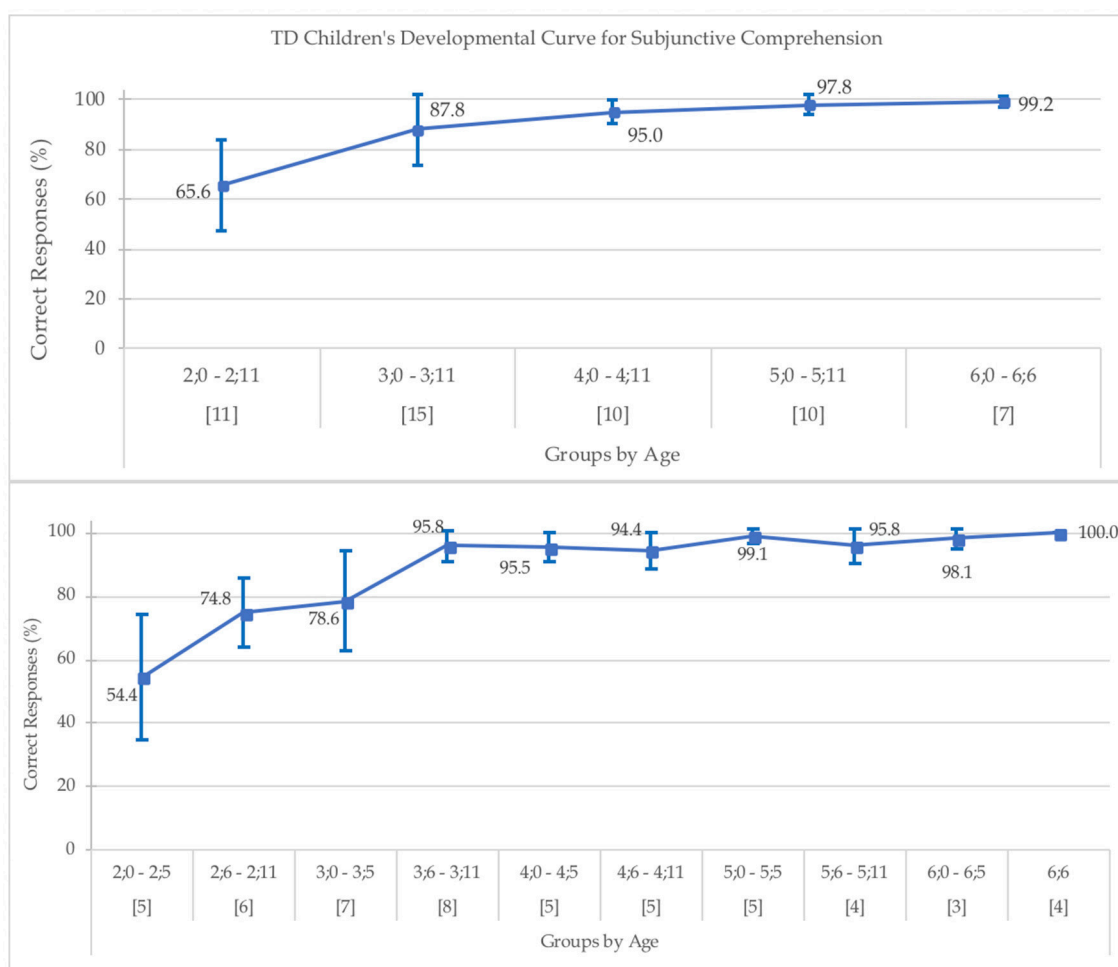
**FIGURE 5 |** Developmental Trajectory of the comprehension of subjunctive clauses in TD children.

performance. The present results also are at odds with results from Stathopoulou (2009), where DS presented poor comprehension of clitics and reflexives in subjunctive clauses, with accuracy at much lower rates than any of the other complex structures examined.

Our second objective was to compare participants with DS to young typically developing children and determine whether the two groups present parallel development. Differences across the two groups were not statistically significant, even though slightly higher accuracy rates were recorded for the TD children (83.3% vs. 87.8%). Even though there is a large chronological age gap between the two groups, results suggest that full acquisition of this complex syntactic structure is possible for individuals with DS, even if it does not happen until their teenage years, much later than for TD children. As an introduction to the next steps of this research program, we also presented results from a small subgroup of participants (5 + 5). Results indicate higher accuracy rates with the comprehension over the production of subjunctive clauses which may suggest that both groups have grammatical knowledge of the subjunctive structure but do not

always follow in performance (as means of production were slightly lower). However, given the number of participants for which both production and comprehension data were analyzed, no generalized conclusions can be drawn.

Our third and fourth objectives concerned age of acquisition. Initially, we wanted to determine what is the age by which we can safely say that the two populations present full comprehension of subjunctive clauses. We thus aimed to provide a developmental curve for the comprehension of subjunctive clauses in our two populations. The developmental trajectories constructed when plotting participants' performance across various age groups revealed that, even though both groups showed signs of near-ceiling performance at younger ages, we determined the full acquisition age to be 18 for individuals with DS and 6;6 for TD children. A gradual increase of accuracy means was noted when moving from younger to older ages, suggesting that the two groups may follow a developmental trajectory where their abilities improve with age. However, a closer look at the results, with a more detailed breakdown by age, showed variation within subgroups, with higher means for younger ages, who

exhibited higher linguistic and cognitive abilities overall, and lower performance for children whose age group was somewhere in the middle. This was more evident for the DS group, though the small number of participants per subgroup on the finer breakdown may best explain this seeming individual variation. While there still is a significant age gap between the two groups, matched on *MA* and other factors, the present results show that even with individual variation, the performance of individuals with DS matched that of TD children at a much older age than previously argued. Specifically, 5-year-old children with DS had a higher performance than 3-year-old TD children, reaching full acquisition at age 18 and 6;6, respectively, and therefore contradicting previous studies on adults with DS suggesting that their linguistic abilities do not surpass those of 3-year-old TD children (Fowler et al., 1994; Chapman et al., 1998). Our findings are in agreement, though, with previous results on CG-speaking adults with DS, who presented high accuracy rates not only for inflectional marking (Christodoulou, 2011, 2013; Christodoulou and Wexler, 2016), but also the comprehension of complex syntactic structures like *wh*-questions (Christodoulou and Grohmann, 2014).

As noted, our participants are raised in a bilectal environment, which—pending further research—may be taken to indicate confusion due to variable inputs related to phonetic/phonological, morphosyntactic, and structural differences and therefore possibly create confusion in early language development. Yet, the participants in this study exhibited high accuracy rates, with gradual progression toward full acquisition. This finding may suggest that these differences on the multiple linguistic levels of language analysis between Cypriot and Standard Modern Greek do not create any such confusion for the learner in the case of subjunctive clauses. It thus stands in contrast to other instances of linguistic differences such as clitic placement (Grohmann et al., 2017). The fact that this complex syntactic structure is formed in a parallel manner across both varieties of Greek eliminates any potential confusion or complication.

## Clinical Implications

Efficacy in both diagnosis and intervention plans are prospective clinical implications of this study. Given that when intervention for DS is delayed even by 2 months it can have less successful results (Sanz and Menendez, 1995), prior knowledge of what needs to be addressed and by what age can be critical. The current developmental trajectories show not only the level of acquisition per age for individuals with DS but also for TD children. Creating a developmental trajectory of production as well will help us document potential developmental levels for each group, from the initial steps of production to full acquisition, as with the one on comprehension presented in the current paper. Therefore, these trajectories will not only be invaluable for diagnosis for children with DS, but also a potential language impairment in children not diagnosed with a language disability or diagnosed with any other language difficulty. Clinicians will now have a clear indication as to what level of acquisition a TD child is expected to have at what age. Being able to determine whether the subjunctive is fully acquired or not, may help clinicians

with rehabilitation plans, as they will be able to determine whether, in the case inaccurate performance, the subjunctive construction is fully acquired, or there are other elements in a structure that may cause incorrect production. This will facilitate more targeted and efficient intervention plans, avoiding loss of invaluable time.

## CONCLUSIONS

The results of this paper add to the growing body of cross-linguistic literature investigating the acquisition of complex syntactic structures across children with DS and TD children and provide the first ever developmental trajectories on subjunctive comprehension in children with DS and TD children. The fact that these results show high accuracy levels with the comprehension of subjunctive clauses, compared to results from other languages, raises a number of questions on the linguistic abilities of individuals with DS in general, and especially arguments of severe syntactic impairment, as well as issues related to the theoretical complexity of this syntactic structure and what may be proven complex for individuals with DS. Additional issues regarding why results from the current study contradict results from previous work concern the methodology used in testing complex structures and language-specific characteristics that might create an added difficulty in the comprehension and production of these structures. Phonetic, morphosyntactic, and structural diversities across the two linguistic varieties did not appear to affect the acquisition of this complex syntactic structure. The fact that subjunctives are formed in a parallel way across the two varieties of Greek spoken in Cyprus could have facilitated a better understanding of the mechanisms involved in the formation of the structure and, in consequence, its more timely acquisition, thus eliminating any potential confusion caused by variable inputs.

Moving forward, after full transcription and subsequent analysis of the production data, a parallel attempt to construct a developmental trajectory of production results might provide a better understanding on whether the development of subjunctive clauses improves with age or whether it depends on each participant's overall linguistic abilities. We will also be able to compare the trajectory of production to that of comprehension one and determine whether there is a consistent gap between production and comprehension and whether that becomes narrower as participants are getting closer to full acquisition. Further categorization with transitive and intransitive verbs may determine whether transitivity has a significant effect on the participants' comprehension or production of the subjunctive clauses. The study of the theoretical implications this work has along with additional complex syntactic structures, such as imperative constructions, *wh*-questions and relative clauses, would provide a clearer insight into the level of grammatical abilities these two groups may reach and potentially address the issue of overall, severe syntactic impairment in individuals diagnosed with Down syndrome. However, we maintain that the small piece of the puzzle presented in

this paper is a significant one, given the complex structural and morphosyntactic processes involved in the formation of subjunctive clauses.

## AUTHOR CONTRIBUTIONS

CC conceived of and carried out the study as a Marie Curie postdoctoral research fellow under KG's supervision. She also wrote a first draft of the paper, which both authors then equally contributed to for the original submission, and was in charge of the revision process.

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