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Early oral language precursors of different types of reading difficulties in a consistent orthography

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The present longitudinal study examined whether early oral language skills of Greek-speaking children assessed in grade 1 can predict the type of reading difficulties (RD) in grade 2. Sixty-six typically developing (TD) children and eighty-seven children with RD were assessed on phonological awareness (PA), morphological awareness (MA), rapid automatized naming (RAN), and vocabulary in the mid of grade 1. Children were classified in the two groups based on whether they scored consistently low (below the 25th percentile) or typically (above the 25th percentile) on standardized measures of text-reading fluency and reading comprehension at the end of grade 1 and the beginning of grade 2. Next, children with RD were assigned to two subgroups: the first group included children (N = 28) with predominantly reading fluency difficulties (RFD) and the second group included children (N = 59) with single reading comprehension difficulties (RCD). A series of binomial logistic regressions showed that children's classification in an RD group than a TD group was predicted by PA, RAN, and vocabulary achievement. Subsequent multinomial logistic regressions indicated that vocabulary, PA, and MA predicted children's classification in the RCD subgroup more than in the TD group. Furthermore, lower PA levels and higher RAN score predicted the classification of children in the RFD group than in the RCD or the TD group. These findings highlight the contribution of early oral language assessment to the identification of children with RD and specific types of RD. Theoretical implications for the role of oral language in reading will be discussed as well as practical implications for implementing customized interventions to match children's educational needs on specific oral language deficits.

KEYWORDS

reading difficulties (RD), phonological awareness (PA), morphological awareness (MA), rapid automatized naming (RAN), vocabulary

Introduction

A substantial body of educational research has systematically shown that oral language skills are a cornerstone of reading acquisition (e.g., Chang et al., 2020; Lyster et al., 2021) and that when they are deficient, reading difficulties (RD) might emerge (e.g., Snowling and Melby-Lervåg, 2016; Snowling and Hulme, 2021). Several studies, which have thoroughly examined RD, support the existence of RD subtypes, which are associated with different underlying deficits in oral language skills (Stothard and Hulme, 1995; Leach et al., 2003; Catts et al., 2006, 2012; Torppa et al., 2007; Koriakin and Kaufman, 2017).

Children's RD subtypes usually refer to difficulties either only on word-level decoding or only on reading comprehension or both (e.g., Leach et al., 2003; Torppa et al., 2007; Catts et al., 2012). In consistent orthographies, like Greek, the majority of children, even those with RD, develop adequate reading accuracy early. As a result, reading fluency is the most sensitive assessment criterion to identify children with poor word-level reading ability (Porpodas, 1999; Seymour et al., 2003; Ziegler et al., 2010). Accordingly, children with RD can be classified into three subtypes: single reading fluency difficulties (RFD), single reading comprehension difficulties (RCD), and mixed difficulties (Koriakin and Kaufman, 2017; Torppa et al., 2020).

There is a general consensus that RD in word-level decoding is mainly associated with deficits in phonological processing skills, such as phonological awareness (PA) and rapid automatized naming (RAN) (e.g., Stothard and Hulme, 1995; Catts et al., 2006; Torppa et al., 2007), while difficulties in reading comprehension are the outcome of inadequately developed language comprehension skills, such as vocabulary and morphological awareness (MA) (e.g., Catts et al., 2006; Nation et al., 2010; Tong et al., 2011, 2014; Spencer et al., 2019).

Less is known about precursors of early RCD (Justice et al., 2013), despite the significant number of studies examining the oral language precursors of word reading/decoding difficulties early on reading development. The early detection of children's RCD is challenging, because their word reading skills, which are an integral part of understanding what they read, are not adequately developed (Koriakin and Kaufman, 2017).

Apart from RCD, examining RD of children at the word level is of equal importance, especially in consistent orthographies. As early as the end of the first grade, assessment of decoding capacity relies heavily upon measures of reading fluency (Seymour et al., 2003; Ziegler and Goswami, 2005). The ability of children with RD to read accurately might conceal the existence of RFD and subsequently delay an early detection. In view of the increased cognitive requirements of reading comprehension after the third grade, competition between processes required for fluent reading and understanding text may give rise to RCD, as well (Chall and Jacobs, 2003; Pikulski and Chard, 2005; Kang and Shin, 2019). However, there is a relative dearth of studies in consistent orthographies that examine the prognostic role of oral language skills for early RFD and their dissociation from RCD (see Torppa et al., 2007 for an exception).

Previous research has highlighted the relative importance of specific oral language skills on later reading failure indexed by various reading outcomes (Hulme and Snowling, 2014), and documented the multidimensionality of oral language skills in the first elementary grades (Mouzaki et al., 2020). However, the predictive value of a wider repertoire of oral language skills for specific RD subtypes remains unclear. Early identification of language precursors of RD and corresponding RD subtypes could facilitate the timely understanding of the structure of learning difficulties in the first stages of learning to read and provide useful insights toward effective intervention. Thus, the aim of the present study was to examine whether oral language skills in grade 1 (i.e., PA, RAN, MA, and vocabulary) could predict children's RD at the beginning of grade 2, as well as, their specific type of RD in the consistent Greek orthography.

The role of oral language skills in early reading development

Research evidence from various orthographies has repeatedly underlined the prominent role of phonological processing skills in early reading development (e.g., Papadopoulos et al., 2009; Caravolas et al., 2012; Melby-Lervåg et al., 2012; Landerl et al., 2019). In particular, PA which is defined as the ability of conscious identification and manipulation of phonological units of spoken words (Gombert, 1992), is a prerequisite for the understanding of the alphabetic principle (Byrne, 1996), which in turn is considered as a milestone for the development of children's early reading skills (Stanovich, 1986). In the early phases of reading acquisition, PA is strongly associated with the development of word reading skills (Muter et al., 2004; Lervåg et al., 2009; Vaessen and Blomert, 2013) as children rely to a greater extent on phonological decoding to read words. As a result, their ability to identify the relations between graphemes and phonemes, and to segment words into their phonemic parts is of crucial importance (Ehri, 2005). However, PA seems to be a stronger predictor of reading accuracy than of reading fluency in consistent orthographies (e.g., Georgiou et al., 2008; Landerl and Wimmer, 2008; Boets et al., 2010; Fricke et al., 2016; Landerl et al., 2019), which is more reliably predicted by RAN (Boets et al., 2010; Landerl et al., 2019).

RAN refers to children's ability to perform rapid and accurate naming of a series of familiar visual stimuli (e.g., objects, colors, digits, or letters) (Wolf and Bowers, 1999) relying on a wide range of cognitive processes which are equally important to reading development across different orthographies (see Georgiou et al., 2015; Landerl et al., 2019). Two main theories have been proposed to explain the close RAN-reading relationship. The first one suggests that RAN is related to reading because it is an index of how quickly children

can gain access to and retrieve the phonological information of words which are stored in their mental lexicon (Wagner and Torgesen, 1987; Torgesen et al., 1997). The second theory attributes the contribution of RAN to reading development to its association with orthographic processing, claiming that RAN reflects children's sensitivity to frequently encountered orthographic patterns (Bowers and Wolf, 1993; Bowers et al., 1999). Accumulated research evidence has repeatedly shown that RAN is an important predictor of children's early word reading fluency (e.g., Georgiou et al., 2008; Papadopoulos et al., 2009, 2016; Furnes and Samuelsson, 2011; Araújo et al., 2015; Landerl et al., 2019; Huschka et al., 2021).

Apart from phonological processing skills, research has revealed additional oral language skills that may contribute to the development of early reading skills. For instance, MA, which reflects children's ability to intentionally identify and manipulate the smallest units of meaning (morphemes) (Carlisle, 1995; Kuo and Anderson, 2006), seems to uniquely contribute to children's reading development (e.g., Casalis and Louis-Alexandre, 2000; Desrochers et al., 2017; Diamanti et al., 2017; Deacon et al., 2018; James et al., 2020), by helping to integrate semantic, phonological, and orthographic features of words. In this capacity, MA can facilitate the formation of high-quality lexical representations of words (Kirby and Bowers, 2017). A number of studies have highlighted MA's prominent role to predict reading comprehension even in the early phases of reading development (e.g., Carlisle, 1995; Casalis and Louis-Alexandre, 2000; Müller and Brady, 2001; Diamanti et al., 2017; Manolitsis et al., 2017, 2019).

Finally, vocabulary has been also associated with early reading development and particularly has been observed repeatedly as an important predictor of reading comprehension (Muter et al., 2004; Protopapas et al., 2007; Ricketts et al., 2007; Verhoeven and van Leeuwe, 2008; Kim and Pallante, 2012; Diamanti et al., 2017). The importance of vocabulary for reading comprehension is supported by its function in semantic processing, contributing to the construction of high-quality lexical representations, which are in turn crucial for reading comprehension (Perfetti, 2007). On the other hand, the influence of vocabulary on the development of children's word reading skills, over and above the effects of other known language predictors (e.g., PA), is not strongly supported empirically (e.g., Kim and Pallante, 2012; Diamanti et al., 2017), and it seems to be rather restricted to irregular word reading (Ouellette and Beers, 2010).

Reading difficulties

A considerable body of educational research has focused on the examination and early identification of RD (e.g., Torppa et al., 2007; Hulme et al., 2015; Catts et al., 2016). Severe RD, commonly referred to as developmental dyslexia, generally refer to persistent problems with word decoding, despite adequate intelligence and the absence of negative effects from intrinsic or external factors, such sensory problems and socioeconomic adversities (Vellutino et al., 2004; Hulme and Snowling, 2014). The manifestation of children's RD at the word level may significantly depend on the consistency of the orthography that is studied (Ziegler and Goswami, 2005; Niolaki et al., 2014).

In more consistent orthographies children with RD are mainly distinguished by slow and laborious word decoding, as the high levels of regularity on the grapheme-phoneme correspondences enable them to reach adequate reading accuracy levels already from the end of the first grade (e.g., Wimmer, 1993; de Jong and van der Leij, 2003; Seymour et al., 2003; Patel et al., 2004; Ziegler and Goswami, 2005; Zoccolotti et al., 2005; Serrano and Defior, 2008). On the contrary, in less consistent orthographies reading accuracy difficulties may be more protracted and usually accompanied by RFD (Snowling, 2000; Seymour et al., 2003; Ziegler and Goswami, 2005; Share, 2008). However, during the last decades, an increasing number of studies have shown that young readers might present difficulties in reading comprehension despite intact reading accuracy and fluency levels (see Hulme and Snowling, 2014; Nation, 2019). This dissociation has gained particular research attention, and as a result, the research on the field of RD has now acknowledged the existence of two distinct groups of children with RD, namely, poor decoders and poor comprehenders (Elwér et al., 2013).

Furthermore, based on the Simple View of Reading which suggests that reading comprehension is the outcome of two factors–word decoding and oral comprehension skills (Gough and Tunmer, 1986), it has been argued that early identification of RCD could be facilitated by examining in detail the parameters that are related to these two influential factors (Catts et al., 2016). In line with that, it has been systematically shown across different alphabetic languages that the primary causes of RD involve language deficits, as they can negatively affect the development of both word decoding and reading comprehension skills (e.g., Catts et al., 2006; Landerl et al., 2013; Hulme and Snowling, 2014; Hulme et al., 2015; Landi and Ryherd, 2017). Empirical support for the close association between language problems and the manifestation of RD mainly derives from studies assessing differences between children with RD and typically developing (TD) readers on several facets of oral language (e.g., Casalis et al., 2004; Furnes and Samuelsson, 2010; Nation et al., 2010; Torppa et al., 2010; Tong et al., 2011; Berthiaume and Daigle, 2014).

Early oral language skills as precursors of reading difficulties

It is commonly accepted that phonological deficits are robust predictors of severe and persistent difficulties in word

reading and are considered as the primary cause of dyslexia (Vellutino et al., 2004; Boets et al., 2010). It has been suggested that the phonological deficits of children with RD indicate that the phonological properties of words are not adequately depicted in children's lexical representations in their mental lexicon (Snowling, 2000). Deficits in PA and RAN have been identified as the strongest phonological predictors of RD (Landerl et al., 2013) reflecting children's weakness to analyze and process the phonological representations of words (PA deficit), as well as to quickly retrieve them from their long-term memory (Schmidt et al., 2020). The predictive value of early PA and RAN skills to later RD has been revealed by several retrospective longitudinal studies (e.g., Puolakanaho et al., 2007; Boets et al., 2010; Furnes and Samuelsson, 2010; Torppa et al., 2010; see also Snowling and Melby-Lervåg, 2016 for a meta-analytic review).

For instance, Puolakanaho et al. (2007) examined predictors of RD in Finnish-speaking children from the age of 3.5 years onward using logistic regression analyses, and identified PA and RAN along with family risk and letter knowledge as significant predictors of reading accuracy and/or fluency difficulties at the end of grade 2. Additionally, in a cross-linguistic study, Furnes and Samuelsson (2010) found through separate logistic regression analyses that preschool PA and RAN were significant predictors of reading accuracy/fluency difficulties at the end of grade 1 in both USA/Australian and Scandinavian children. Furthermore, early RAN was also a reliable predictor of RD at the end of grade 2 in both samples, whereas early PA was significantly associated with RD only in the English-speaking sample, possibly, because the effect of PA weakens on the prediction of RD in more consistent orthographies beyond the first elementary grades.

According to the double-deficit hypothesis, children with RD may present either single PA and RAN deficits or joint deficits in both phonological processing skills which are likely to cause more severe RD (Wolf and Bowers, 1999). However, research findings from studies in consistent orthographies question this notion by showing that a single PA-deficit is not strongly related to RD over time, as children manage to improve their reading performance (see Papadopoulos et al., 2009; Furnes et al., 2019).

During the school years, children with RD might present deficits in additional oral language domains beyond phonological processing skills (Nation and Snowling, 2004; Snowling et al., 2020). For example, MA deficits have also been identified as a risk factor for the manifestation of word decoding difficulties (Law and Ghesquière, 2017). Empirical evidence from various alphabetic orthographies has shown that dyslexic children tend to underperform chronological age-matched typical readers on various MA tasks (e.g., Joanisse et al., 2000; Casalis et al., 2004; Berthiaume and Daigle, 2014; Duranovic et al., 2014; Vender et al., 2017; Rothou and Padeliadu, 2019), although this finding was not fully confirmed by studies comparing dyslexic children with younger reading-level-matched controls (e.g., Casalis et al., 2004; Egan and Tainturier, 2011; Robertson et al., 2013). Moreover, in a longitudinal retrospective study conducted by Torppa et al. (2010) results revealed that MA of 3.5-year-old Finnish-speaking children discriminated between those defined as RD and typical readers at the end of grade 2, and directly predicted later reading accuracy and fluency. However, in the cross-sectional study of Rothou and Padeliadu (2019) with Greek-speaking 3rd graders, PA was the only significant predictor of reading status although children with dyslexia manifested MA deficits compared to typical readers.

Vocabulary has also been recognized as a potential predictive factor of dyslexia (van Viersen et al., 2017). Particularly, RD were also predicted by low vocabulary knowledge (Snowling et al., 2003) irrespective of familiar risk (FR) status (e.g., Duff et al., 2015). In their study with Dutch-speaking children van Viersen et al. (2017) found that FR-dyslexic children, identified at the end of grade 2, had lower receptive and expressive vocabulary scores than FR-non-dyslexics and typical controls from 23 months onward and from 17 months onward, respectively. The same pattern of findings emerged from the study of Torppa et al. (2010) with Finnish-speaking children, as FR-dyslexic children were distinguished from FR-non-dyslexic and control children based on vocabulary production. Therefore, it could be argued that vocabulary weaknesses can be present before reading development in poor readers, which suggests that difficulties manifested later in development might not be the direct outcome of limited reading experiences.

There is also evidence from studies mostly conducted in English demonstrating the decisive role of MA in the appearance of difficulties in reading comprehension (e.g., Nation et al., 2005; Tong et al., 2011, 2014; Adlof and Catts, 2015). Specifically, it has been shown that poor comprehenders have lower performance than age-matched good comprehenders in specific inflectional and/or derivational MA tasks (e.g., Nation et al., 2005; Tong et al., 2014; Adlof and Catts, 2015; MacKay et al., 2017). On the other hand, a recent study by Rothou (2019) with Greek-speaking 3rd graders showed that although poor comprehenders were outperformed by good comprehenders on specific inflectional MA skills, group differences did not persist after controlling for the effects of receptive vocabulary. Thus, the complexity of the orthographic system and morphology in different alphabetic languages may affect the role of MA. To our knowledge, there is no framework for the predictive value of early MA skills in discriminating poor comprehenders from average comprehenders.

Finally, several longitudinal studies have shown vocabulary deficits in poor comprehenders who were mainly identified in mid-childhood (e.g., Nation and Snowling, 1998; Catts et al., 2006; Nation et al., 2010). For instance, in a retrospective study Nation et al. (2010) found that poor comprehenders,

identified at the age of 8, were outperformed by TD children of the same age on vocabulary assessed at the age of 6 years. Of particular relevance to the predictive power of vocabulary on subsequent reading comprehension status (i.e., division of children into those with good or poor reading comprehension) are the findings of Catts et al. (2016): they found that receptive vocabulary in kindergarten uniquely predicted RCD at the end of grade 3.

Overall, as shown by the above findings, there is a relative dearth of longitudinal studies that focus on the joint examination of critical oral language skills (PA, RAN, MA, and vocabulary) in predicting not only RD but also the specific type of RD. Specifically, to the best of our knowledge, it has not been adequately assessed across the early school years whether the above language skills differ regarding their importance in predicting difficulties in reading fluency and reading comprehension. The joint examination toward this direction of these skills in the context of Greek language and orthography might facilitate early identification and intervention, while at the same time, it is of particular educational interest for two reasons. First, Greek orthography is distinguished by regular and relatively highly predictable grapheme-phoneme correspondences (the consistency in terms of reading has been calculated to be around 95%) (Protopapas and Vlahou, 2009). Therefore, the primary constraint for children with RD is expected to be in reading fluency (e.g., Papadopoulos et al., 2009; Torppa et al., 2013). Second, Greek language is morphologically rich (Ralli, 2005), as all morphological processes (inflection, derivation, and compounding) are characterized by very high productivity (Ralli, 2003). Thus, it is quite intriguing to assess whether MA has a pivotal role in the early identification of children's RD.

The present study

The aim of the current longitudinal study was to examine in a sample of Greek-speaking children whether early oral language skills (PA, RAN, MA, and vocabulary) assessed in grade 1 can predict RD, as well as the specific type of children's RD, in grade 2. The following research questions and respective hypotheses were addressed by our study.

Do oral language skills in grade 1 predict children's reading difficulties in grade 2?

Based on accumulated research documenting the critical role of oral language skills on reading development (e.g., Chang et al., 2020; Lyster et al., 2021) and that oral language deficits are the primary cause of RD (e.g., Hulme and Snowling, 2014; Snowling and Melby-Lervåg, 2016; Snowling and Hulme, 2021), we hypothesized that poor oral language skills in grade 1 will significantly predict the classification of children with RD in grade 2 (H1). Particularly, it was expected that low levels of PA and RAN (e.g., Puolakanaho et al., 2007; Furnes and Samuelsson, 2010; Torppa et al., 2010), as well as of MA (e.g., Casalis et al., 2004; Torppa et al., 2010) and vocabulary (e.g., Catts et al., 2016; van Viersen et al., 2017) will be significant predictors of difficulties in learning to read.

Do oral language skills in grade 1 predict the type of children's reading difficulties in grade 2?

Given that poor PA and RAN skills are considered as the distinctive characteristic of severe and persistent difficulties in reading fluency (Vellutino et al., 2004; Landerl et al., 2013) and that they can also predict children's word RD (e.g., Stothard and Hulme, 1995; Catts et al., 2006; Puolakanaho et al., 2007; Furnes and Samuelsson, 2010; Torppa et al., 2010), we hypothesized that low PA and high RAN scores in grade 1 will significantly predict children's RFD in grade 2 (H2). Additionally, in light of evidence showing that RCD are related to broader language deficits focused on reading features that are associated with meaning and in particular lexical-semantic knowledge (e.g., Nation et al., 2005, 2010; Catts et al., 2006; Tong et al., 2011, 2014; Spencer et al., 2019), we hypothesized that low levels of MA and vocabulary in grade 1 will significantly predict children's RCD in grade 2 (H3).

Materials and methods

Participants

The sample of the present study was part of a larger longitudinal study which followed approximately 260 first-grade children from 23 public mainstream elementary schools in the city of Heraklion, Greece, through grade 2. Participants were selected after asking classroom teachers to nominate from the pool of children with written parental consent those they considered as most likely to display literacy difficulties in the long term, and were native speakers of Greek without any formal diagnosis of intellectual, neurodevelopmental, or sensory disorder. For each nominated child, we selected at random one of his/her classmates with the same gender and with written parental consent. For the purpose of the present study, we selected 153 children (70 females; mean age = 79.13 months; SD = 3.45, at the first time of assessment) who met the selection criteria to be assigned to one of the three groups (i.e., RFD, RCD, and TD).

Measures

Non-verbal intelligence

Non-verbal intelligence was measured with the Greek standardization of Raven's Colored Progressive Matrices

(Raven, 1956; Sideridis et al., 2015). Cronbach's alpha in the standardization sample was 0.90 (Sideridis et al., 2015).

Phonological awareness

Two *Elision tasks*, one with real words and one with pseudowords, and one *Blending task* were administered to assess PA. Elision tasks (see Manolitsis et al., 2019) comprised four practice items and 24 experimental items, each. Items were equally distributed in four blocks of increasing difficulty. Children listened to one item at a time and were asked to extract a particular onset, rime, syllable, or phoneme from it and say what was left. Each task was discontinued after four errors in a given block. The *Blending task* consisted of four practice items and 28 experimental items in ascending order of difficulty and was adapted from Manolitsis and Georgiou (2015). A series of distinct sounds were orally presented and the children were asked to join them together to form a whole word. In the first three items, they had to combine two syllables, in the next six an onset and a rime, and in the remaining items a sequence of two to ten phonemes. The task was terminated after four consecutive errors. Cronbach's alphas for the PA tasks in our sample were 0.94, 0.94, and 0.90, respectively. A participant's score in each task was the percentage of correct responses.

Rapid automatized naming

A *Digit Naming* task was used for the assessment of RAN adopted from Landerl et al. (2019). Children were instructed to name from left to right as fast and precisely as they could the names of four repeated digits (5, 4, 7, and 2) which were semi-randomly arranged on two separate cards in four rows of six. To confirm children's familiarity with the names of the presented digits, a practice trial was administered. The corresponding names of the four digits in Greek are /ˈ*pende*/ for five, /ˈ*tesera*/ for four, /*eˈfta*/ for seven, and /ˈ*ðio*/ for two. A participant's score was the average time in milliseconds to name both cards.

Morphological awareness

Three oral tasks were used for the assessment of MA adopted from Manolitsis et al. (2017). The *Word Analogy* task consisted of 20 items which were evenly distributed to evaluate awareness of inflectional and derivational morphology. Children had to recognize the morphological relation in a presented pair of words and then to use that relation to complete a second pair of words [e.g., /aˈrxizo/ : /aˈrxizume/ :: /ðuˈlevo/: (/ðuˈlevume/)–"I start" : "We start" :: "I work": ("We work") and /ˈskavo/ : /ˈskapsimo/ :: /ˈtrexo/ : (/ˈtreksimo/)–"I dig": "the digging" :: "I run" :: ("the running")]. Prior to formal testing, two practice items for each morphology condition were presented. A discontinuation rule of six consecutive errors was applied. Cronbach's alpha reliability coefficient was 0.92. The *Manipulation of Derived Word Forms* task included a derivation and a decomposition subscale and was used to assess children's awareness of derivational morphology. Both subscales consisted of ten items. In the derivation subscale, children were instructed to produce the correct derived form of a presented base word by altering it with suffixation to complete a sentence [e.g., /ˈxroma/ : /i iˈkones ˈine (xromatiˈstes)/–"color" : the images are ("colored")]. In the decomposition subscale, children had to transform a derived word into a base word to complete a sentence [e.g., /isixazo/ : /eˈɣo ˈime (ˈisixos)/–"I quieten" : "I am" ("quiet")]. For each subscale, two practice items preceded formal testing. The task was discontinued after six consecutive errors. Cronbach's alpha was 0.88. The third task was the *Compound Word Production* task which consisted of 15 items evaluating children's awareness of lexical compounding. Children were asked to orally produce the compound word, that could result from a presented pair of words, by properly modifying the target words into stems to pronounce correctly the resulting compound [e.g., "How could we say?" /ti ˈfluða tis paˈtatas/ "the peel of the potato" > (/pataˈtofluða/ "potato peel") or /ˈmia xriˈsi ˈmiɣa/ "a golden fly" > (/xriˈsomiɣa/ "may beetle")]. The task was discontinued after four consecutive errors. Cronbach's alpha was 0.89. A participant's score in each task was the percentage of correct responses.

Vocabulary

Expressive vocabulary was measured with the "*Vocabulary*" subscale of the Greek standardization of the Wechsler Intelligence Scale–Fifth Edition (WISC-V^{GR}; Stogiannidou et al., 2017), comprised of four picture items for oral naming (i.e., scored with 1 point for correct answers) followed by 25 words (i.e., scored with 2, 1, and 0 points) evaluating children's vocabulary depth knowledge, as children were asked to verbally define them. The task was discontinued after three consecutive 0-point responses. For each participant, the maximum score on this scale was 54. The average split-half reliability coefficient (odd vs. even items) across all age groups in the standardization sample was 0.83 (Stogiannidou et al., 2017).

Reading fluency

The *Text-Reading Fluency* subscale of a Greek standardized measure for the assessment of reading skills (Padeliadu et al., 2019) was used to measure reading fluency. A 247-word passage about an ancient Greek myth was presented to children and they were instructed to read it as fast and precisely as they could in 1 min. A participant's score was the total number of correctly read words within 1 min. Test–retest reliability in the standardization study was $r = 0.98$ (Padeliadu et al., 2019).

Reading comprehension

Two different Greek-standardized sentence-completion tests were used to assess reading comprehension in each grade. Sentence comprehension tasks were preferred instead of passage-based tasks as participants were in the early phases of learning to read. Both included sentences in ascending order of difficulty, with respect to word number and semantic

information. In the first grade, the "Reading and Sentence Completion Test" (Porpodas, 2008) was administered, which consisted of 16 items and children had to complete a sentence with a missing word by selecting among three alternatives the one that matched. Testing was terminated after three consecutive errors. Similarly, in the second grade, the "Screening Test of Reading Ability" (Tafa, 1995) was used, which included 42 items, and children were instructed to choose among four options the one that correctly completed a sentence with a missing word within a time limit of 40 min. Cronbach's alphas were 0.94 and 0.87, respectively.

Procedure

Measures were administered by trained research assistants (postgraduate students of psychology or education) in a quiet room at children's schools at three measurement time points. In the first measurement (M1), non-verbal intelligence and oral language skills were evaluated during two 20-min individual sessions in the mid of grade 1 (January–March). In the second measurement (M2), reading fluency was assessed in a short individual session and reading comprehension in a group session of 10 children at the end of grade 1 (May–June). Finally, in the third measurement (M3) reading fluency and reading comprehension were assessed again at the beginning of grade 2 (November–December) during an individual session and a 40-min group session of 10 children in each group, respectively. The study had the approval of the Ministry of Education in Greece and the Ethics Committee of the University of Crete.

Statistical analysis

Participants were, initially, classified into RD and TD groups, based on their performance on standardized measures of reading fluency and reading comprehension, excluding those who scored below 70 on non-verbal intelligence (five children in total and four of them belonged to the RD group). The RD group (N = 87; 39 females) comprised children performing below the 25th percentile on tests of reading fluency and/or reading comprehension in both M2 and M3. Children who performed at or above the 25th percentile on reading fluency and reading comprehension in both M2 and M3 were assigned to the TD group (N = 66; 31 females).

In addition, children with RD were classified into two subgroups: one with predominantly RFD (N = 28; 15 females) and one with single RCD (N = 59; 24 females). The RFD group consisted of those children who performed below the 25th percentile on reading fluency in both M2 and M3, irrespective of their performance on reading comprehension. It should be mentioned that among children with RFD the majority (N = 25) scored below the 25th percentile on reading comprehension, as well, in both M2 and M3, while there were only three children with single RFD (i.e., reading comprehension performance equal or above the 25th percentile either in M2 or M3). On the other hand, the RCD group encompassed those children who scored below the 25th percentile on reading comprehension, but not on reading fluency, in both M2 and M3.

To examine whether oral language skills in grade 1 could predict which children were more likely to present RD in grade 2, as well as the specific type of children's RD, binomial and multinomial logistic regressions were conducted, respectively, with oral language skills as the independent variables and children's group classification (i.e., RD vs. TD and RFD vs. RCD vs. TD) as the dependent one. Before that, an examination of the oral language variables used in the analyses showed no missing values and extreme outliers. Moreover, composite scores for MA and PA in grade 1 were created, by averaging the percentage correct scores of the respective component tasks. Cross correlations among PA component tasks were $r > 0.70$ and among MA component tasks were $r > 0.46$.

Results

Preliminary analyses

Tables 1–4 present the descriptive statistics for the four reading groups (i.e., RD, TD, RFD, and RCD) for all the measures used in the present study. Independent-samples t-tests with Bonferroni adjustment corroborated that children with RD performed significantly lower than TD children on reading fluency and reading comprehension in both grades (see **Table 1**), as well as on all measures of oral language skills (see **Table 3**). Interestingly, regarding the differences in reading performance between children with RFD and RCD, the results from the independent-samples t-tests with Bonferroni adjustment revealed that although the latter group outperformed the former on reading fluency in both grades and on reading comprehension in grade 1, there was no statistically significant difference between them on reading comprehension in grade 2 (see **Table 2**). Finally, it was also indicated that although children with RCD outperformed children with RFD on all PA and RAN tasks, there was no statistically significant difference between them in MA and vocabulary measures (see **Table 4**).

Oral language skills predicting reading difficulties

A binary logistic regression was performed to examine whether oral language skills measured in grade 1 could predict children's RD in grade 2. Results indicated that our model was statistically significant $\chi^2(4) = 107.02$, $p < 0.001$ and explained

TABLE 1 Means (M) and standard deviations (SD) for the reading measures assessed in the first two grades for the RD and the TD group.

Measures	RD group				TD group				t-test[1] grade 1	t-test[1] grade 2
	Grade 1		Grade 2		Grade 1		Grade 2			
	M	SD	*M*	SD	*M*	SD	*M*	SD		
Text-reading fluency	21.61	10.16	33.32	14.72	46.64	17.05	64.26	18.06	10.59*** $d = 1.78$	11.67*** $d = 1.91$
Reading comprehension[2]	7.25	4.88	10.72	2.71	14.94	0.78	23.85	6.05	14.45*** $d = 2.20$	16.42*** $d = 2.80$

[1]Bonferroni correction was performed for two comparisons in both grades ($p < 0.025$).
[2]Two different measures were used for the assessment of reading comprehension in grades 1 and 2.
RD, children with reading difficulties; TD, typically developing children.
***$p < 0.001$.

TABLE 2 Means (M) and standard deviations (SD) for the reading measures assessed in the first two grades for the two RD subgroups.

Measures	RFD group				RCD group				t-test[1] grade 1	t-test[1] grade 2
	Grade 1		Grade 2		Grade 1		Grade 2			
	M	SD	*M*	SD	*M*	SD	*M*	SD		
Text-reading fluency	10.14	3.33	18.36	9.33	27.05	7.37	40.42	11.01	14.73*** $d = 2.96$	9.15*** $d = 2.10$
Reading comprehension[2]	4.57	4.05	10.36	3.50	8.53	4.75	10.90	2.26	3.80*** $d = 0.87$	0.75 $d = 0.18$

[1]Bonferroni correction was performed for two comparisons in both grades ($p < 0.025$).
[2]Two different measures were used for the assessment of reading comprehension in grades 1 and 2.
RFD, children with predominantly reading fluency difficulties; RCD, children with single reading comprehension difficulties.
***$p < 0.001$.

67.5% of the variance (Nagelkerke R^2) in our sample, classifying correctly 85.6% of the children. Furthermore, the sensitivity and specificity levels of our model were quite satisfactory, as it predicted correctly 87.4% of the children with RD and 83.3% of the children without RD, respectively. Children's RD status was significantly predicted by the vast majority of oral language skills, except for MA, which presented borderline statistical significance ($p = 0.052$) (see Table 5). Particularly, results showed that the lower the performance on PA and vocabulary the more likely it was to belong in the RD group, as a one-unit score increase decreased the odds of presenting RD by a factor of 0.95 and 0.84, respectively. In addition, children who performed worse at RAN tasks were more likely to present RD, with a one-unit increase increasing the odds of presenting RD by a factor of 1.21.

Furthermore, a multinomial logistic regression was, initially, conducted to examine whether oral language skills assessed in grade 1 could predict the type of children's RD (i.e., RFD or RCD) in grade 2. PA, MA, RAN, and vocabulary were used as

TABLE 3 Means (M) and standard deviations (SD) for all the measures of oral language skills and non-verbal intelligence assessed in the first grade for the RD and the TD group.

Measures	RD group		TD group		t-test grade 1
	M	SD	*M*	SD	
Non-verbal IQ	92.59	11.71	105.30	12.80	6.39** $d = 1.04$
Phonological awareness[a]	36.57	17.44	70.38	18.68	11.52** $d = 1.88$
Word elision[1]	33.67	22.12	72.47	21.59	10.86** $d = 1.77$
Pseudoword elision[1]	27.73	21.94	65.72	25.59	9.87** $d = 1.61$
Blending[1]	48.32	16.10	72.94	17.04	9.14** $d = 1.49$
Morphological awareness[a]	35.37	15.29	61.19	20.24	8.66** $d = 1.44$
Word Analogy[1]	33.56	23.61	58.03	29.49	5.70** $d = 0.93$
Derivation[1]	55.69	21.69	77.05	21.94	6.00** $d = 0.98$
Compounding[1]	16.86	16.10	48.48	25.98	8.70** $d = 1.46$
Vocabulary[b]	11.52	3.59	14.88	3.18	6.02** $d = 0.98$
RAN digits	20.31	4.53	16.03	2.83	7.16** $d = 1.13$

[a]Composite percentage score.
[b]Raw score.
[1]Bonferroni correction was performed for three comparisons in each grade ($p < 0.016$).
RD, children with reading difficulties; TD, typically developing children.
**$p < 0.001$.

TABLE 4 Means (M) and standard deviations (SD) for all the measures of oral language skills and non-verbal intelligence assessed in the first grade for the RFD and the RCD group.

Measures	RFD group		RCD group		t-test grade 1
	M	SD	*M*	SD	
Non-verbal IQ	91.61	12.55	93.05	11.37	0.54 $d = 0.12$
Phonological awareness[a]	24.98	11.10	42.07	17.26	4.79** $d = 1.10$
Word elision[1]	22.47	16.01	38.98	22.74	3.45* $d = 0.79$
Pseudoword elision[1]	12.80	13.70	34.82	21.62	4.93** $d = 1.13$
Blending[1]	39.67	14.26	52.42	15.37	3.70** $d = 0.85$
Morphological awareness[a]	35.81	12.87	35.16	16.42	0.20 $d = 0.04$
Word Analogy[1]	39.64	19.48	30.68	24.97	1.83 $d = 0.40$
Derivation[1]	55.89	22.15	55.59	21.66	0.06 d = 0.01
Compounding[1]	11.90	11.81	19.21	17.38	2.30 $d = 0.49$
Vocabulary[b]	12.07	3.55	11.25	3.61	0.99 $d = 0.23$
RAN digits	23.76	4.13	18.67	3.74	5.75** $d = 1.32$

[a]Composite percentage score.
[b]Raw score.
[1]Bonferroni correction was performed for three comparisons in each grade ($p < 0.016$).
RFD, children with predominantly reading fluency difficulties; RCD, children with single reading comprehension difficulties.
*$p < 0.01$; **$p < 0.001$.

TABLE 5 Results of binary logistic regression predicting children's RD.

Measures	*B*	SE	Wald	OR	CI
Constant	3.37	2.04	2.73	29.07	–
Phonological Awareness[a]	−0.05**	0.02	10.18	0.95	0.92–0.98
Morphological Awareness[a]	−0.03	0.02	3.77	0.97	0.94–1.00
Vocabulary	−0.17*	0.08	4.57	0.84	0.72–0.99
RAN	0.19*	0.08	5.29	1.21	1.03–1.43

[a]Composite percentage score.
RD, children with reading difficulties; TD, typically developing children; SE, standard error; OR, odds ratio; CI, 95% confidence interval.
*$p < 0.05$; **$p < 0.01$.

predictors of children's membership in the RFD or RCD groups, with TD as the reference category. The model was statistically significant, −2 log likelihood = 167.108 and $\chi^2(8) = 151.42$, $p < 0.001$, and explained 71.8% of the variance (Nagelkerke R^2) in children's group membership, classifying correctly 73.9% of them. The classification accuracy of our model for each one of the three groups (i.e., RFD, RCD, and TD) was 57.1, 69.5, and 84.8%, respectively. Moreover, results indicated that children who performed lower on vocabulary, PA, and MA, were more likely to belong in the RCD group than in the TD group, with a one-unit increase in these three oral language skills decreasing the odds of presenting RCD by a factor of 0.83, 0.96, and 0.97, respectively (see **Table 6**). On the other hand, children's classification in the RFD group than in the TD group was predicted by lower scores on PA and RAN performance, as a one-unit increase in PA decreased the odds of presenting RFD by a factor of 0.87, while a one-unit increase in RAN task performance increased the odds of presenting RFD by a factor of 1.60 (see **Table 6**).

Discussion

The current study longitudinally examined whether oral language skills (PA, RAN, MA, and vocabulary) assessed in grade 1 could predict RD, as well as the different RD subtypes (RFD or RCD), in grade 2. Overall, the pattern of our findings showed that (a) PA, RAN and vocabulary were strong predictors of children's RD in the early phases of learning to read in Greek and (b) individual differences in specific oral language skills play a key role in children's classification in specific RD groups (i.e., RFD or RCD). Particularly, PA, MA, and vocabulary distinguished the RCD from the TD group, whereas only PA and RAN contributed significantly in distinguishing the RFD from the TD group. Below, we discuss these findings in accordance with each research question and corresponding hypotheses.

Early oral language skills as predictors of reading difficulties

Our findings indicated that children with RD had lower performance than TD children on all oral language skills assessed in the middle of grade 1. In general, this evidence seems to support further the view that RD are associated with earlier deficits in oral language skills (e.g., Vellutino et al., 2004; Hulme and Snowling, 2014; Snowling and Melby-Lervåg, 2016; Snowling and Hulme, 2021) and reinforces the existing findings from *ex post* facto studies comparing children with RD and TD (e.g., Torppa et al., 2010; Dandache et al., 2014; Law and Ghesquière, 2017; Kargiotidis et al., 2021).

However, our findings partially confirmed the first hypothesis (H1) as they indicated that the classification of children with RD in grade 2 was jointly predicted only by PA, RAN, and vocabulary, but not by MA. Surprisingly, in our study, we expected that MA would predict group membership given that the vast majority of children with RD had RCD. However, the presence of children who also had deficits in reading fluency may have reduced the contribution of MA. Indeed, research evidence in Greek has repeatedly shown that early MA skills do not predict word reading fluency as opposed to reading comprehension (e.g., Diamanti et al., 2017; Manolitsis et al., 2017, 2019). On the other hand, in the more consistent Finnish orthography, Torppa et al. (2010) showed that preschoolers' MA was one of the oral language skills that distinguished children with RD from TD.

TABLE 6 Results of multinomial logistic regression predicting children's type of RD.

	RFD group					RCD group				
Measures	*B*	SE	Wald	OR	CI	*B*	SE	Wald	OR	CI
Intercept	−2.53	2.80	0.81	–	–	3.92	2.10	3.49	–	–
PA[a]	−0.14***	0.03	18.63	0.87	0.82–0.93	−0.05**	0.02	7.37	0.96	0.92–0.99
MA[a]	−0.02	0.03	0.50	0.98	0.93–1.03	−0.03*	0.02	4.07	0.97	0.94–1.00
Vocabulary	−0.07	0.12	0.37	0.93	0.74–1.18	−0.19*	0.08	5.07	0.83	0.70–0.98
RAN	0.47***	0.12	15.04	1.60	1.26–2.03	0.15	0.09	2.78	1.16	0.98–1.37

[a]Composite percentage score for phonological awareness (PA) and morphological awareness (MA).
RD, reading difficulties; RFD, children with predominantly reading fluency difficulties; RCD, children with single reading comprehension difficulties; SE, standard error; OR, odds ratio; CI, 95% confidence interval. Reference category = Typically developing children.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Nevertheless, based on our results early oral language skills seem to contribute to the identification of RD in Greek-speaking children in line with previous findings in other consistent orthographies (Puolakanaho et al., 2007; Furnes and Samuelsson, 2010; Torppa et al., 2010). This finding supports the notion (Nation and Snowling, 2004; Snowling et al., 2020) that oral language deficits of children with RD are not limited to the phonological domain (see also Torppa et al., 2010). In our results, vocabulary was an additional significant predictor of children's RD status. Vocabulary deficits in RD as compared to TD children have been found previously in consistent orthographies (Torppa et al., 2010; van Viersen et al., 2017, but see Rothou and Padeliadu, 2019 for an exception in vocabulary differences between dyslexics and non-dyslexics in grade 3). Differences between studies might be due to the different sample age ranges. Also, taking into account the nature of children's RD in the present study, as previously mentioned, we consider that further longitudinal research in Greek should be undertaken from preschool years to upper primary school grades to investigate whether the underlying deficit in early vocabulary skills may signify subsequent pure RD rather than broader literacy difficulties.

Early oral language skills as predictors of different reading difficulties subtypes

Further analyses indicated that children's early oral language skills in grade 1 are differentiated regarding their importance in predicting later difficulties in different reading outcomes (i.e., reading fluency and reading comprehension). Specifically, we found that PA and RAN emerged as significant predictors of children's classification in the RFD (in comparison to the TD) group in grade 2, confirming our second hypothesis (H2). This finding seems to converge with the findings of previous retrospective studies in consistent orthographies (Puolakanaho et al., 2007; Boets et al., 2010) in which young dyslexic children had scored significantly lower on both phonological skills as compared to their non-dyslexic peers at an earlier point in time. In fact, our data corroborate the study of Puolakanaho et al. (2007) on Finnish-speaking children, which indicated that PA and RAN were powerful predictors of children's dyslexia status, as defined primarily by poor reading fluency in grade 2.

Although in consistent orthographies PA did not emerge as a reliable longitudinal predictor of reading fluency across grades 1 and 2 (e.g., Georgiou et al., 2010; Furnes and Samuelsson, 2011; Fricke et al., 2016; Landerl et al., 2019), its predictive power in group membership for learning difficulties is not surprising. PA and RAN are well-established strong concurrent predictors of severe and persistent difficulties in word reading (Papadopoulos et al., 2009; Landerl et al., 2013; Moll et al., 2016). Rothou and Padeliadu (2019) in their work with dyslexic Greek-speaking children in grade 3, provided evidence for the predictive power of PA to distinguish between dyslexic children with a weakness in text reading fluency from typical developing readers.

Furthermore, we found that PA, MA, and vocabulary were significant predictors of children's classification into the RCD group (by comparison to the TD group) in grade 2. We hypothesized that oral language skills related to meaning, like MA and vocabulary, could predict children's RCD (H3). Interestingly, our results supported a predictive role for PA, possibly due to the nature of the reading comprehension test used in the present study in grade 2, which may assess both reading comprehension and fluency due to the time limit needed for its completion. Previous research evidence in Greek has shown the contribution of PA to children's performance on this test (Manolitsis et al., 2017; Pittas, 2017).

Our finding on the predictive value of MA toward RD subtype classification extends previous research showing MA deficits among poor reading comprehenders. However, most of the studies in this field have been conducted in English with mid-childhood children (e.g., Nation et al., 2005; Tong et al., 2014; Adlof and Catts, 2015; MacKay et al., 2017). At that age, according to Nation (2019), MA difficulties of poor reading comprehenders might be a consequence of reading comprehension failure. On the contrary, we assessed MA skills at a time when Greek students have not fully developed basic reading skills (grade 1). Undoubtedly the contribution of different facets of early MA to reading comprehension in the early phases of reading development is well-established (Carlisle, 1995; Casalis and Louis-Alexandre, 2000; Müller and Brady, 2001; Diamanti et al., 2017; Manolitsis et al., 2017). Present findings provide further support for the role of MA in RCD especially if we consider the nature of the tasks involved that did not require higher order thinking processes. Specifically, early reading comprehension was assessed through sentence completion tasks that depended highly upon morphosyntactic awareness. It seems that the rich morphological system of the Greek orthography necessitates the employment of morphological skills and strategies from early on for achieving text understanding-especially at the sentence level. Similarly, our results highlighted the importance of vocabulary in classifying children in the RCD group, in line with studies conducted in English (e.g., Nation et al., 2010; Catts et al., 2016) and Greek (Rothou, 2019). Although a different research design was followed in these earlier studies, both receptive vocabulary (Catts et al., 2016; Rothou, 2019) and expressive vocabulary (Nation et al., 2010) were found to be associated with difficulties in reading comprehension. In the present study, we found that expressive vocabulary may accurately distinguish children with RCD from TD children. Future research is needed to examine the predictive value of different types of vocabulary indices toward identifying RCD, given that receptive vocabulary may be more weakly related to RD than expressive vocabulary (see Ouellette, 2006). Overall, the above findings suggest that

early weaknesses in semantic language skills, such as MA and vocabulary, may place children at risk for later RCD.

Limitations

There are some potential limitations to this study which might serve as a basis for further research. Firstly, our findings regarding RD and RD subtypes should be interpreted in the context of the diagnostic criteria and measures used here to classify children in these groups. For instance, assessing reading comprehension only with close tasks might not allow for a more precise estimation of children's RCD and their associated skills, because children's performance on this particular type of task depends more on lower-level skills (e.g., decoding) than on more demanding higher-level processes (e.g., inference making) (Kendeou et al., 2012; Collins et al., 2017). Thus, future research could implement a wider repertoire of measures to assess reading comprehension together with additional oral language and cognitive skills (e.g., listening comprehension and inference making) which are critical for its development. Secondly, the vast majority of children in the RFD subgroup did not present single RFD. They also presented accompanying difficulties in reading comprehension in both grades. Thirdly, all oral language skills examined here were not measured before the start of formal reading instruction and, therefore, these skills may have been affected by the method of reading instruction children received. Moreover, in contrast to PA and MA, RAN and vocabulary were assessed by a single measure, which may have affected the validity of the assessment of these oral language skills. Finally, assessment of oral language skills has not included listening comprehension evaluation, which is a well-known predictor of literacy difficulties and reading comprehension (Conti-Ramsden and Durkin, 2012), and might influence some of the effects emerged in the present study.

Educational implications

Our findings have substantial psychoeducational implications for the early identification of children with RD and particularly of children with specific types of RD. The present study underlines that deficits in oral language skills other than phonological skills could contribute to the early identification of children with RD, aligning better with a multiple-deficit model (Pennington et al., 2012; Ring and Black, 2018). Also, it underlines that deficits in specific oral language skills could distinguish children with different RD types (i.e., RFD or RCD) from typical readers. Therefore, the implementation of a comprehensive preventive model aiming to enhance a broad array of oral language skills seems essential for children with RD. Moreover, the implementation of an intervention policy that will focus on specific oral language skills could assist children with different types of RD to overcome their underlying linguistic limitations.

Conclusion

In summary, this is the first study focused on the joint examination of critical oral language skills (PA, RAN, MA, and vocabulary) in predicting RD and the specific type of RD in the Greek language. Three findings of the present study are of particular interest. First, we found that the evaluation of oral language skills at the beginning of primary school (grade 1) provides a powerful tool for the early identification of children who will display RD later (grade 2). Second, in line with a growing number of studies suggesting that a deficit in the phonological domain of language alone is not sufficient to predict RD, we found that PA and RAN along with vocabulary may accurately distinguish children with RD from TD children. Third, in line with other sources of evidence showing the existence of different RD subtypes with underlying deficits in different oral language skills, we found that PA and RAN could discriminate children with RFD, while PA, MA, and vocabulary could discriminate children with RCD, as compared to TD children. Overall, these findings highlight the underlying broader linguistic deficits of children with RD, which are not limited to the phonological domain. Therefore, a more suitable conceptualization of multiple deficits instead of a deficit in a single domain, as suggested by Pennington (2006), should guide the future research in RD.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

The study was approved by the Ministry of Education in Greece as well as the Research Ethics Committee of the University of Crete. Written consent from parents and schools was also obtained prior to testing. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

IG wrote most part of the manuscript and was responsible for the coordination of writing this manuscript. AK developed the measures of this study, collected the data in schools, ran the analyses, and wrote parts of the manuscript. AM supervised the data collection and contributed to the writing of the manuscript.

GM conceptualized the research project, supervised the data collection, and contributed to the interpretation of the findings and the writing of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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