



Digital Assessment of Acquired Alexia and Agraphia: On the Relevance of Written Discourse

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The digital revolution has created challenges as well as opportunities for people with acquired reading (= alexia) and writing (= agraphia) impairments. Although it is difficult to validly assess written discourse, it is imperative that people with alexia and agraphia (PwAA) receive reliable diagnostics for the following reasons: (1) discourse in written and oral forms is highly relevant to daily interaction and participation, but there are no established tests or diagnostic procedures to assess written discourse; (2) reliable diagnostic measures are a prerequisite for any language rehabilitation, especially for the complex skills needed for written discourse; and (3) the continuing trend in digitalization offers new opportunities for easily collecting and assessing written discourse via digital means. In our manuscript, we highlight the relevance of written discourse for social participation and in the digital world and argue that in order to improve social participation in general and digital participation in particular for PwAA, remote assessment of written discourse abilities can be the basis for speech and language therapy treatment focused on communicative abilities.

Keywords: alexia, agraphia, digital, assessment, diagnostic, discourse, aphasia

INTRODUCTION

The rapid increase in the use of digital technologies in recent years—and the accelerated development of such technologies in response to the challenges posed by the COVID-19 pandemic—has changed society (cf. Berner et al., 2020; United Nations, 2021), resulting in specific challenges for certain groups of people while also allowing a set of new opportunities. These challenges and opportunities arise particularly for people with acquired reading impairments (= alexia) and writing impairments (= agraphia; people with alexia and agraphia = PwAA).

Alexia and agraphia are common symptoms of acquired language disorders after injury has occurred to the brain, and in 60% of cases they occur in addition to general impairments in language production and reception (= aphasia; see Brookshire et al., 2014; Rapcsak and Beeson, 2015; Riley et al., 2015). The classification of alexia and agraphia differentiates between central and peripheral disorders of written language processing, i.e., “classified as “central” (or linguistic) when it is generated at a level that affects spelling and as “peripheral” when the spelling is correctly generated but the peripheral procedures are not correctly activated” (Silveri et al., 2007, p. 179). Furthermore, it is relevant whether deficits are present in the context of aphasia or as pure alexia or pure agraphia (e.g., Rapcsak and Beeson, 2015; Riley et al., 2015; Schumacher et al., 2020; Sheppard and Sebastian, 2020). Typical symptoms of alexia and agraphia include phonemic, semantic, and morphemic

paralexia as well as graphemic, semantic and formal paraphasia; regularization errors¹ also occur. These symptoms are observed in reading and writing skills at the word and sentence levels as well as in written discourse (e.g., Leff and Behrmann, 2008; Tiu and Carter, 2021).

Discourse skills in general, be they written or oral, take on a special significance in social interaction: they serve to achieve a (communicative) goal as well as exchange/communicate information (cf. Armstrong et al., 2012; Dipper and Pritchard, 2017). Pickering and Garrod's (2004) Alignment Theory is a communication theory that focuses extensively on conversational success. This theory seems particularly suitable as a basis for the analysis of written discourse, since it explicitly includes the underlying levels of language processing, e.g., the lexicon and syntax. Pickering and Garrod assume that an alignment of, for example, the syntactic structure contributes to an alignment of the situation model and thus facilitates conversation. Foltz et al. (2015) were able to show that alignment processes can also be found in written interaction (see also Michel and Cappellini, 2019). Kim et al. (2019) found even more alignment in written vs. oral communication. Since alignment can facilitate the processing of linguistic (written) utterances, Pickering and Garrod's (2004) alignment theory is particularly useful for the analysis of impaired (written) discourse and should be taken into account in the development of diagnostic procedures as a whole as well as for the concrete creation of the task and items.

It is important to note that the processes underlying reading and writing at the word level (cf. e.g., Caramazza and Miceli, 1990; Miceli and Capasso, 2006) are also relevant at the discourse level. As in the context of the Alignment Theory mentioned above, inter-level influences must be assumed. However, the focus of this perspective paper lies on written discourse and its remote assessment possibilities.

OUR PERSPECTIVE

In thinking about (written) discourse, we need to distinguish between different forms, i.e., conversational, procedural, persuasive, personal, descriptive, expository, and narrative discourse (e.g., Dipper and Pritchard, 2017; Zanichelli et al., 2020).

Notably, these different forms of (written) discourse differ in terms of their relevance to everyday life, and discourse types that have a high everyday relevance in oral discourse are not necessarily as relevant for everyday written discourse (cf. Grotlüschen et al., 2020).

Moreover, not all forms of oral discourse can be found in written discourse. Narratives, such as those generated by describing picture stories or personal experiences, or semi-directed interviews (cf. Zanichelli et al., 2020), are not very frequent in written form. Other forms of discourse, such as conversations, are becoming more common in written form, e.g.,

email correspondence or chat communication (e.g., Dietz et al., 2011; Grotlüschen et al., 2020).

It is therefore not very useful to simply transfer established methods for eliciting oral discourse to written language. Instead, there is a need to develop and test tasks that are suitable for eliciting and analyzing written discourse relevant to everyday life (e.g., Steel and Togher, 2019; Johansson-Malmeling et al., 2021).

Although the production of narratives is the most frequently described and studied variant of discourse (e.g., Behrns et al., 2010; Bryant et al., 2017; Steel and Togher, 2019), especially for people with language disorders, the analysis of narratives reveals unanswered questions and challenges.

First, it is not always clear which characteristics of spoken/written language are a result of an idiomatic style and at what point certain conspicuous features or peculiarities, as for example elliptic utterances in chat conversations, should be interpreted as pathological, especially in discourse production (e.g., Obermeyer and Edmonds, 2018; Schweiger, 2018).

Another reason is there are still few formal specifications, and open questions remain concerning the analysis of written discourse competencies: what is rated—the writing process, including self-corrections, or the final written text? (e.g., Johansson-Malmeling et al., 2021). What about the time needed to write or understand an answer or question? How is the influence of the conversation partner included in an analysis of discourse competence?

A further reason underlying the difficulty of analyzing written discourse is there is only limited information about the cognitive prerequisites and processes needed for written discourse, especially in PwAA (e.g., Behrns et al., 2010). There are written task formats (e.g., email facilitated interviews, cf. Egan et al., 2006) where the process of completing the task, which is relevant for a valid assessment and goal-oriented diagnosis, cannot be observed directly (e.g., Johansson-Malmeling et al., 2021). But this type of asynchronous conversation offers the possibility of more time for comprehension and formulation, and it is likely that less working memory capacity is required to complete the task. This again emphasizes the complexity involved in assessing what resources were used to solve a task and what support was available.

Further difficulties concern the even greater influence of education levels on written language competences (e.g., Zanichelli et al., 2020) and organizational and practical reasons in clinical settings such as time limits or data protection issues (e.g., Bryant et al., 2017; Steel and Togher, 2019; Obermeyer et al., 2021).

The factors listed above can be roughly assigned to four categories: (a) cognitive and linguistic questions, e.g., the theories and processes underlying "normal" written discourse, (b) situational and contextual challenges, e.g., the situation and the participants' personality, competences, or motivation, (c) further technological difficulties, e.g., technical equipment and digital methods, and (d) the necessity of having ecological validity.

Although it is challenging to validly assess written discourse, we call for the development of reliable writing-based diagnostics for people with alexia and agraphia (PwAA). In this perspective paper, we will first clarify the need for and advantages of a

¹Regularization errors are present when, "an irregularly spelled word is mispronounced by incorrect application of regular spelling-sound correspondences (e.g., reading plaid as "played"), indicating over-reliance on sublexical grapheme-phoneme correspondences" (Binder et al., 2016, p. 1).

diagnostic for written discourse and then propose one example. Several facts justify our position.

First, written discourse is as relevant for social participation as oral discourse is in everyday communication (e.g., Dietz et al., 2011; Obermeyer et al., 2021), yet there are hardly any tests that specifically assess written discourse (cf. Bryant et al., 2017; Rohde et al., 2018; Steel and Togher, 2019). The analysis of spontaneous speech or oral discourse is a frequent and important component of aphasia diagnostics (cf. Stark et al., 2021). The Aachen Aphasia Test (AAT, Huber et al., 1983) assesses spontaneous speech based on a semi-standardized interview using six 6-level scales (communication, articulation, automated speech, semantics, phonology, syntax). In the Western Aphasia Battery (WAB, Kertesz, 2007) discourse competence is looked at in two subtests. First, six personal questions must be answered, followed by a picture description. The evaluation of both language samples is carried out on two levels (“Information content” and “Fluency, grammatical competence, and paraphasias”). The production and reception of written discourse, in contrast, usually play a minor role in traditional standard procedures (e.g., Bryant et al., 2017). In the AAT, reading and writing are only assessed at the word and sentence level. The WAB goes a step further and includes a test section with a written picture description. Written discourse, be it digital or analog, is meaningfully impaired in alexia and agraphia (e.g., Mortensen, 2005; Behrns et al., 2010; Johansson-Malmeling et al., 2021). Because the everyday linguistic-communicative competences necessary for social participation and a decent (communication-related) quality of life (Neumann et al., 2019) are not limited to oral performance, written language skills must always be taken into account as well (e.g., Mortensen, 2005; Dietz et al., 2011).

Second, the analysis of written language must go beyond the word and sentence level and include discourse. The major deficits in written discourse in PwAA reinforce the need for reliable diagnostics at the discourse level. Tests that do check reading and writing skills in acquired alexia or agraphia often refer only to the word or sentence level. A typical example is the newly established procedure DYMO (DYslexien MOdellorientiert, Schumacher et al., 2020), which was developed from the two-route model of Coltheart et al. (1993) to examine acquired reading disorders in German. In several subtests, many components of reading are tested, but only at the word level. In order to be able to address written language competences at all relevant levels from function to activity, and hence from word to discourse level, a well-founded diagnostic is necessary [e.g., National Stroke Foundation, 2010; Rohde et al., 2018]. Only in this way can relevant dysfunctions be identified and restrictions in participation be reliably detected. This is one of the essential prerequisites for individual therapy planning, which also includes the personal resources of the person concerned (Gerhards et al., 2022).

Third, our society is being shaped by the ongoing process of digitalization, and as new technologies become more and more important, we experience an increasingly written environment. Despite this, the degree of digitalization is only beginning in speech and language therapy with PwAA (cf. Bilda et al., 2016; Weidner and Lowman, 2020). Nevertheless, we should use

the advantages and possibilities of digitalization for complex diagnostic issues (e.g., Jonas and Jaecks, 2021), as in the case of written discourse in PwAA. In an increasingly digital environment (e.g., when people use messaging services and online portals to get in touch with each other), written discourse plays an ever more important role. Similar to the consequences of functional illiteracy on social participation (Cree et al., 2012; Vágvölgyi et al., 2016), there are clear disadvantages and difficulties for PwAA in a “written world,” no matter whether digital or analog.

Here we briefly introduce two possible test situations that enable the analysis of written discourse. One of the challenges of everyday life is communicating with virtual agents or bots on the Internet. A conceivable diagnostic scenario close to everyday life, for example, is a chat in a complaint or customer care portal. EVA Park (cf. Marshall et al., 2020) is an online virtual world designed for people with acquired language disorders. Although it was not developed for diagnostic purposes, the virtual environment contains various therapeutic tasks and group session opportunities. An everyday communication test scenario could be programmed within this platform, e.g., the PwAA is tasked with buying a ticket and answering questions presented by a virtual agent. This type of assessment involves high ecological validity and aspects of social participation.

A second everyday scenario that also requires written discourse is communicating with family or friends via instant messaging services (see Overlach et al., 2020 for an example of therapeutic use). A diagnostic task can also be set here, such as negotiating and agreeing on an appointment time and place with one or more people. Both scenarios can be transferred directly from real life to the diagnostic situation.

As in everyday life, the examiner communicates with the PwAA via the medium, i.e., the virtual world, the messenger service or a specific website, and all reactions are saved and subsequently available for analysis. Depending on the technical conditions, it may also be possible to automate the interaction—and thus the diagnostic procedure—using adaptive algorithms.

The advantage of an automated analysis would also be that “normal” idiomatic aspects of an individual PwAA could be better identified and contrasted with pathological parts on the basis of big data analysis [see for example (Savoy, 2020) for advanced models for stylometric applications].

However, the strict data protection regulations, especially with regard to PwAA, are a challenge. Since a large amount of data is needed as a basis for standardization studies, automated analyses and the recognition of language peculiarities, creating an underlying database is correspondingly complex and will take time. Nevertheless, this approach to digital diagnostics is very promising and should be pursued further (e.g., Kohlschein et al., 2018; Torre et al., 2021).

While over recent years researchers and practitioners have developed concepts for telemedical therapy, there is almost no evidence of remote assessment of language disorders following cerebrovascular diseases (e.g., Weidner and Lowman, 2020), including for the diagnosis of alexia and agraphia (Jaecks and Jonas, 2021). However, given that digital written discourse is technically easy to collect, i.e., via remote assessment, virtual

reality settings, and other new technologies, the analysis of written discourse in PwAA can benefit from the advantages of digitalization.

Written discourse skills are much more important in the digital world than oral discourse skills. Reduced (digital) participation caused by agraphia and alexia leads to difficulties in daily communicative activities, and in turn to restrictions in all important areas of life (self-determination, educational and vocational qualifications, social contacts, etc.; cf. Grotlüschen et al., 2020; Vishal, 2021).

CONSEQUENCES

The long-term goal must therefore be the remote assessment of written discourse, based on the concept of the ICF (WHO, 2001). Moreover, communicative activities involving written discourse have to be reliably recorded. The type of written discourse and its specific relevance to everyday life, as well as the possibility of drawing conclusions for therapy, are the factors that determine the choice of survey methods. This applies

to the development of the diagnostic procedure in general as well as to the use of diagnostics in individual patients. We require a digital diagnostic procedure for written discourse that can be used as an unconventional remote screening tool for PwAA following cerebrovascular incidents and allows prompt and direct access to telemedical rehabilitation, which is essential for social participation.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

PJ and KJ contributed equally to the conceptualization and writing of the manuscript. All authors contributed to the article and approved the submitted version.

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