Translation and transcription processes in the writing skills of children with Developmental Language Disorder: A systematic review

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Abstract

Children with difficulties in language learning experience considerable problems in writing and spelling. This systematic review explores the research literature that has been conducted with children who have language learning difficulties (Developmental Language Disorder) through the lens of Chenoweth and Hayes' (2003) model of writing. The model proposes that, when writing, ideas are translated into language, are processed through an evaluator/reviser, then undergo transcription. The results of the systematic review indicate a pattern of delay in the development of translation and transcription processes relative to chronologically age-matched peers. Findings are considered with reference to future directions in research and clinical and educational implications.

Keywords: language learning difficulties, Developmental Language Disorder, writing, spelling

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Children with language learning difficulties are a highly prevalent group (Tomblin et al., 1997) and these difficulties are expressed through language production, reception, or a combination of both (Bishop et al., 2016; Nitido & Plante, 2020). These children differ from those who acquire language difficulties or in whom difficulties have a known neurological basis. Terminology has changed over time (e.g., Specific Language Impairment, or SLI, and Language Learning Difficulties, or LLD) with Developmental Language Disorder (DLD), derived through a Delphi study, as the most recently proposed unified description (Bishop et al., 2016, 2017).

The profile of language difficulties that this group of children experience has given rise to several dominant hypotheses. The surface level hypothesis (Leonard, 1989) proposes a form of acoustic perceptual deficit. However, the extended optional infinitive account (Rice et al., 1995) suggests that difficulties in DLD are based primarily in grammar processing difficulties. It is also possible that a form of procedural learning deficit (Ullman & Pierpont, 2005) results in DLD. These accounts often focus on oral language perception, processing, and production, but they are also likely to be applicable to literacy skills. Although literacy skills such as writing, spelling, and reading have received less research attention for children with DLD, these skills have their basis in language.

Studies have indeed found that children with language difficulties also have poorer writing (Koutsoftas & Srivastava, 2020; Mackie et al., 2013; Williams et al., 2013), spelling (Critten et al., 2014; Larkin et al., 2013; Larkin & Snowling, 2008; Silliman et al., 2006; Werfel et al., 2021; Williams et al., 2021), and reading (Snowling et al., 2020) than typical children

matched for chronological age. Because spoken or oral language development precedes literacy development, these studies are based on the assumption that literacy difficulties arise from underlying language difficulties.

Typical children develop writing through a complex set of interlocking skills underpinned by language. Writers learning their craft draw from memory prompts inherent in writing tasks to meet external demands (Bereiter & Scardamalia, 1987; Chenoweth & Hayes, 2003) and develop increasingly sophisticated ways of employing the memories they retrieve (Hayes, 2011). In presenting their work on the page or screen, writers need to represent this information through the language abilities that they have available. In Chenoweth and Hayes' (2003) model of writing production, the translator process generates the word string drawn from ideas that a writer has produced. This process draws on language systems to achieve its goal and, downstream, the transcriber process generates the appropriate spelling and other formatting requirements for the writing product. Between these two processes is a process that evaluates the appropriateness of the text.

Typical children increasingly structure their writing to reflect their thoughts in ways that engage an audience as they develop their writing proficiency (Hayes, 2011). Being able to automatize some translation and transcription processes, they devote more cognitive capacity to expressing their ideas with greater efficiency, effectiveness, and creativity (McCutchen, 2011). As children learn more about the spelling conventions of the language that they are writing, they also improve their ability to convey speech sounds through the page or screen in the written language's accepted orthography (Apel & Masterson, 2001; Treiman & Bourassa, 2000).

In studies of children with DLD, one approach to investigate translation processes has been to contrast oral with written output. The former requires translation of ideas but without a

transcription process, the latter requires the addition of transcription. These studies show that, while all children find writing more difficult than speaking, the pattern differs for children with language difficulties. This group has more difficulty on some spoken language measures as well as on a range of writing measures compared with chronologically age-matched peers (Gillam & Johnston, 1992; Scott & Windsor, 2000; Windsor et al., 2000).

Studies have also shown that children with DLD have difficulties with transcription processes (Broc et al., 2014; Critten et al., 2014; Larkin et al., 2013; Silliman et al., 2006; Williams et al., 2021). One mechanism thought to explain these difficulties, put forward by Williams et al. (2021), is that children with DLD can draw on general knowledge of the written language's orthography. However, they have difficulty accessing, or have lower quality representations, of specific orthographic forms (i.e., the spelling conventions associated with each specific word). Therefore, based on these findings, two language related processes – the translator and the transcriber – are predicted to cause considerable difficulty in producing high quality and fluent writing in children with DLD.

RATIONALE FOR A SYSTEMATIC REVIEW

Systematic reviews contribute to a field by synthesizing the findings of multiple research studies and they offer a method that has higher reproducibility than traditional literature reviews. They attempt to provide a bias neutral standpoint to the gathering and evaluation of research in a field within a theoretically driven framework. As a structured approach to understanding a research field, systematic reviews offer researchers a clearer understanding of the current literature and can point to future directions with which to develop new inquiry (Aromataris & Pearson, 2014).

No previous systematic reviews have been found that focus on children with DLD, in writing and spelling, and in the context of translation and transcription processes. However, two meta-analyses have been conducted, one each for spelling (Joye et al., 2019) and writing (Graham et al. 2020). Furthermore, a systematic review has included literacy skills as part of a wider review of academic achievement (Ziegenfusz et al., 2022). Joye et al. (2019; $k = 32$) found, across the studies they analyzed, that children with DLD produced spelling outputs that were poorer than chronologically age matched peers. However, the scores tended to be in line with language age matched children. Moreover, that phonological skills are a likely contributory factor in differences between these groups. In Graham et al. (2020; $k = 39$), where the focus was writing quality, output, grammar, and vocabulary, they found a similar pattern as that found by Joye et al. (2019). Their study also included an analysis of spelling performance, which was also consistent with the 2019 meta-analysis. Ziegenfusz et al. (2022; $k = 44$) found that children with DLD experienced difficulties across a wide range of academic areas. The findings of their review of literacy skill difficulties supported the findings by Joye et al. (2019) and Graham et al. (2020). Moreover, Ziegenfusz et al. (2022) found children with DLD also experienced difficulties in spoken narratives, reading, and numeracy. Joye et al. (2019), Graham et al. (2020), and Ziegenfusz et al. (2022) drew attention to the tendency for studies to use different criteria for group inclusion (also see Nitido & Plante, 2020). Moreover, Joye et al. (2019) and Graham et al. (2020) highlighted the variety of spelling and writing measures across studies. They noted that both group inclusion and variation in measures are likely to contribute to an observed heterogeneity in findings.

The systematic review reported here differs in scope from Ziegenfusz et al. (2022) and is focused specifically on translation and transcription processes in writing. Moreover, with regard

to Joye et al. (2019) and Graham et al. (2020), the purpose of a systematic review differs to that of a meta-analysis. Although the latter method incorporates review elements, it focuses on producing a comparable quantified analysis across studies (Joye et al, 2019). The systematic review reported here shared 16 studies with Joye et al. (2019), 16 studies with Graham et al. (2020), and eight studies with Ziegenfusz et al. (2022).

The present review seeks to draw together research literature to address three research questions, through the perspective of Chenoweth and Hayes' (2003) model of writing: (1) What is the profile of spelling and writing difficulties that children with DLD experience?, (2) To what extent are translator processes related to writing difficulties in DLD?, and (3) To what extent are transcription processes related to writing difficulties in DLD?

METHOD

Search strategy and selection criteria

This systematic review was registered on PROSPERO (CRD42022381056). The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; see Table 1) guidelines (Page et al., 2021). There were no major changes to the review protocol during the course of the study. The search strategy adapted the search terms (see Table 2) from Joye et al. (2019) and was applied to each of the following databases: PsycINFO (k = 306), PubMED (k = 142), Web of Science (k = 307), Scopus (k = 210), and ERIC (k = 157). The search terms differed from those used by Joye et al. (2019) in that their meta-analysis included a range of languages and the study reported here constrained the search to English language studies. Following the removal of duplicates, the first author screened the titles and abstracts (k = 829) that met the study inclusion criteria below. The second author reviewed 25% of the titles and abstracts and no discrepancies were identified.

The following inclusion criteria were applied. First, studies had to be conducted with participants with English as a first language. This was so that findings regarding translation and transcription were comparable across studies. Second, studies had to include measures of writing and/or spelling, as this was the focus of our research questions. Third, the participants were children (from four years of age to 17 years of age) and classified as having DLD or an equivalent classification consistent with Joye et al. (2019). Speech sound disorder was included as speech production difficulties are often described in children with DLD (Apel & Lawrence, 2011). Fourth, only studies published as peer reviewed journal articles were included. Other forms of publication such as books, book chapters, review articles, or conference abstracts were excluded. This was so that the standard of publication would be relatively high and ostensibly consistent across the systematic review studies. Finally, the dates of search coverage were any record in each database up through December 2022, recognizing that this would capture the widest range of possible studies.

The first author screened the retrieved full texts (k = 82) of each remaining study against the inclusion criteria and 39 studies met these criteria. Studies were excluded because they did not have children with DLD as participants (k = 8), were not in English (k = 16), were review articles (k = 4), were not peer reviewed (k = 2), were duplicates (k = 3), did not study translation or transcription (k = 8), or were book chapters (k = 2). Figure 1 summarizes the article selection process; no additional methods were employed to identify additional studies (Table 3 reports the study characteristics).

Data extraction

The first author extracted data from each of the studies. These data were entered into a record form designed with fields that mapped to this article's results section and was aligned

towards the research questions. Specifically this included an assessment of study quality; authors and publication year; the participant sample characteristics; how DLD was assessed; whether the study focus was translation, transcription, or both; the translation and/or transcription measures; and translation and/or transcription findings.

Study Quality

Quality was measured using questions from the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet et al., 2004). This assessment has 14 items and each article is scored for study objective, design, method, sample size, appropriate analysis, study bias, controls for confounding variables, the quality of the results reported, and the conclusions drawn from the results. Each item had a possible score of zero, one, or two, with higher scores indicating higher quality. The three intervention questions in Kmet et al. (2004) were removed (questions five, six, and seven) as the articles were not intervention studies, which yielded a maximum quality score of 22 for each article. To measure inter-rater reliability, the first and second authors scored all articles independently, the intra-class correlation was .81.

The mean for quality was 20.64 (SD = 1.51, k = 39); the majority of studies scored 20 or above (k = 35), and the remaining studies scored between 13 - 19 (k = 4). Reviewers are asked to assess potential study bias in question eight of the assessment (Kmet et al., 2004). One study (3%) received a score of one (Avitia et al., 2017), while the remaining 38 studies received a score of two.

RESULTS

Of the 39 studies included, 20 (51%) measured only transcription and nine measured only translation (23%). The remaining 10 studies (26%) measured spelling as an aspect of

transcription plus translation. Publication dates for the studies ranged from 1996 to 2021 and the median publication year was 2013; over half of all the papers were published between 2011 and 2018 (k = 20).

Participant characteristics

Where means were reported (k = 29), participants with DLD were typically nine to ten years of age (k = 17), but a subgroup of five transcription-focused studies had six-year-old participants. The total sample size, accounting for reported shared datasets (k = 6), was N = 934 (M = 31, SD = 21.62, min = 3, max = 111). The sample size calculation excluded Stoeckel et al. (2013), which was a retrospective study of clinical records.

Validation measures

Fifty different language measures were reported to either classify children with DLD or to measure language levels of children who had been referred to a research team as meeting a language difficulties profile. Six studies (15%) did not have clearly reported language measures. The most common assessment was the Clinical Evaluation of Language Fundamentals (CELF; e.g., Wiig et al., 2017), reported in 44% of studies (k = 17). Over time, study participant selection criteria converged on the CELF's core language subtests. For the CELF, a cut-off of below -1SD was reported in 26% (k = 10) of studies (Alloway et al., 2017; Deacon et al., 2014; Dockrell & Connelly, 2015; Larkin & Snowling, 2006; Larkin et al., 2013; Silliman et al., 2006; Werfel et al., 2019; Werfel & Krimm, 2015; Williams et al., 2013; Williams et al., 2021), -1.33SD in one study (Bishop & Clarkson, 2003), and -2SD in four studies (Abbott et al., 2017; Critten et al., 2014; Mackie & Dockrell, 2004; Stuart et al., 2020). Where studies reported a standardized measure of nonverbal ability (k = 22; 56%), this most often was the matrices

subtest of the British Ability Scales (e.g., Elliot et al., 1996; *k* = 9; 23%) or the Test of Nonverbal Intelligence (e.g., Brown et al., 1990; *k* = 7, 18%).

Group terminology

Of the 39 studies, the most common term for the participant group was SLI (SLI: *k* = 15; 38%, S/LI: *k* = 1; 3%), but 69% of the studies (*k* = 27) were published before Bishop et al. (2017). The studies after 2017 reflect a shift away from SLI (after 2017: *k* = 2; 5%). LLD remained consistently reported throughout (before 2017: *k* = 3; 8%; after 2017: *k* = 3, 8%).

Translation tasks

Writing prompts

All the studies with a focus on written expression used some form of prompt (*k* = 18; 46%), although one study (Sanders et al., 2018) required participants to write to a standardized sentence task from the Weschler Individual Achievement Test, 3rd edition (Wechsler, 2009). Participants were provided with two sentences and asked to write a new sentence with ideas drawn from both presented sentences. Across studies, the types of prompts fell into three categories: written, picture, and film. The studies that provided written prompts predominantly used one of the two Weschler Objective Language Dimensions (WOLD; Rust, 1996) prompts (*k* = 5, 13%; Dockrell et al., 2007, 2009; Dockrell & Connelly, 2015; Stuart et al., 2020; Williams et al., 2013). Of those that did not use a WOLD prompt, studies (*k* = 2) either used sentence starters (Connelly et al., 2012; Kim et al., 2015), or a starting idea (*k* = 2), which provided participants with a subject area about which to write (Koutsoftas & Petersen, 2017; Koutsoftas & Srivastava, 2020). Five studies (13%) used a picture prompt and typically picture sequences were employed to prompt writing (*k* = 3, Bishop & Clarkson, 2003; Fey et al., 2004; Mackie et al., 2013). However, one study presented a single picture (McFadden & Gillam, 1996) and another

used the Picture Language Story test (Mackie & Dockrell, 2004). Finally, two studies (Scott & Windsor, 2000; Windsor et al., 2000) asked their participants to provide a written summary of films presented by the researchers.

Participants were only asked to consider explicitly the audience of their writing in the WOLD prompts (e.g. writing a letter to a friend; Stuart et al., 2020). Only one study (Shen & Troia, 2018) invited participants to plan and revise.

Writing quantity measures

Where studies measured the quantity of writing, they routinely reported the total number of words (k = 12; 31%). A further measure of productivity was the number of words completed within a period of time, representing an aspect of writing fluency (Mackie et al., 2013; Scott & Windsor, 2000). An alternative measure, either in addition to (e.g. Mackie et al., 2013; Williams et al., 2014) or in place of (Fey et al., 2004), total number of words was the diversity of words in a text. Scott and Windsor (2000) also measured the number of T-units, a unit of sentence and clause production. Studies have also reported measurements for word properties, such as number of verbs (Dockrell et al., 2009; Stuart et al., 2020) or the number of cohesive ties within sentences (Koutsoftas & Petersen, 2017).

Writing quality measures

Twelve studies measured writing for quality, five–in line with their writing prompts, measured writing using the six WOLD elements: (1) ideas and development, (2) organization, unity, and coherence, (3) vocabulary, (4) sentence structure and variety, (5) grammar and usage, (6) capitalization and punctuation (Dockrell et al., 2007, 2009; Dockrell & Connelly, 2015; Stuart et al., 2020; Williams et al., 2013). Three studies used Education Northwest's (2001, 2006) 6+1 writing traits rubric: (1) ideas, (2) organization, (3) word choice, (4) sentence fluency,

(5) voice, (6) conventions, and (+1) presentation. Of these, Kim et al. (2015) used two (ideas and organization) and Koutsoftas and Srivastava (2020) used six traits, omitting presentation, while Shen and Troia (2018) used four of the six traits (ideas, organization, word choice, sentence fluency). Two studies employed researcher-generated scales. Fey et al. (2004) measured quality on a six element rubric (character, physical setting, ending, language sophistication, and plot complexity) and McFadden and Gillam (1996) used a four category holistic measure (weak, adequate, good, and strong). An alternative researcher-generated approach (Mackie et al., 2013) was to count whether narratives included three story elements (initiation, action, and resolution).

Transcription tasks

Although transcription tasks were often designed to focus on spelling, handwriting speed using the Detailed Assessment of Speed of Handwriting (DASH) was observed in three studies (Abbott et al., 2017; Berninger et al., 2015; Sanders et al., 2018). The most common spelling task was researcher developed (k = 11; 28%). Most tasks were in response to particular research questions, such as pseudoword spelling (Williams et al., 2021; Wolter et al., 2011; Wolter & Apel, 2010), spelling of derivational morphemes (Critten et al., 2014; Deacon et al., 2014), or spelling of inflectional morphemes (Critten et al., 2014; Larkin & Snowling, 2008). The most often reported standardized spelling task was the British Ability Scales (2nd edition) spelling subscale (Connelly et al., 2012; Critten et al., 2014; Dockrell et al., 2009; Dockrell & Connelly, 2015; Larkin et al., 2013; Williams et al., 2013).

Across the studies reviewed, there were 38 transcription measures. The majority reflected standardized measures and reported some form of correct/incorrect scoring (k = 19, 49%). In some studies, spelling attempts were scored based on the phonemes within words, using the Spelling Sensitivity Score method (Apel & Lawrence, 2011; Werfel & Krimm, 2015). Others

reflect the purpose of inquiry, for example how inflectional morphemes (Critten et al., 2014; Deacon et al., 2014; Larkin et al., 2013) and derivational morphemes (Critten et al., 2014; Deacon et al., 2014) are used, the application of phonological knowledge in spelling (Bishop & Clarkson, 2003; Goulandris et al., 2000; Larkin & Snowling, 2008; Williams et al., 2021), or the use of orthographic knowledge to spell more complex words (Bishop & Clarkson, 2003; Larkin et al., 2013; Williams et al., 2021).

Within written texts, the number, or proportion, of spelling errors was often reported (Koutsoftas & Petersen, 2017; Mackie et al., 2013; Mackie & Dockrell, 2004; Williams et al., 2013). Others went further in order to classify the type of spelling error (Bishop & Clarkson, 2003; Dockrell & Connelly, 2015; Mackie et al., 2013). For example, Dockrell and Connelly (2015) classified spelling errors as orthographically and phonologically inaccurate, Mackie et al. (2013) counted the number of inflectional morphemes omitted by participants. For handwriting (DASH; k = 3, 8%), the measure reported was the number of correctly formed letters in a time limit.

Study findings

What is the profile of writing and spelling difficulties that children with DLD exhibit?

The writing product of children with DLD was often characterized as having a similar number of ideas as chronologically age-matched children (Kim et al., 2015; Mackie & Dockrell, 2004; Williams et al., 2013), though an exception was noted by Dockrell et al. (2007), who observed that idea scores for their sample of children with DLD were towards the lower end of their scale. Children with DLD tended to produce texts with fewer words (Dockrell et al., 2009; Kim et al., 2015; Mackie & Dockrell, 2004; Williams et al., 2013) and with a less diverse range of words (Fey et al., 2004; Williams et al., 2013). Their writing also tended to have fewer

complex features (Fey et al., 2004; Koutsoftas & Petersen, 2017), such as Koutsoftas and Petersen's (2017) finding that, compared with typical children, children with DLD had a greater reliance on common cohesive ties within sentences. A consistent theme in the quality of writing is that the texts produced by children with DLD are scored significantly more poorly on organization or structure (Dockrell et al., 2009; Fey et al., 2004; Kim et al., 2015; Mackie & Dockrell, 2004; Williams et al., 2013). When researchers have observed the writing process, those with DLD tend to pause for similar durations compared with chronologically age-matched controls, but with shorter bursts of writing (Connelly et al., 2012).

At word level analysis, Mackie and Dockrell (2004) reported significantly more orthographic errors by children with DLD compared with typical controls. Deacon et al. (2014) reported that children with DLD produced spellings, controlled for morphological properties, in line with a spelling age control group but significantly below that of chronological age controls (see also Critten et al., 2014). Larkin and Snowling (2008) found children with DLD produced fewer phonologically plausible spelling, a finding supported by Bishop and Clarkson (2003). However, the nature of the language difficulty might also be a consideration, McCarthy et al. (2012) found that children who had more pronounced literacy deficits struggled more with spelling. They found that fourth-grade children with DLD had similar spelling performance to chronological age peers. This DLD group had higher scores than children of a comparison group who had both DLD and dyslexia.

Although children with DLD often have poorer spelling and writing outcomes compared to chronologically age-matched children, children with DLD are often found to produce outputs that are in line with either language age-matched children (writing output: Connelly et al., 2012; Mackie & Dockrell, 2004; spelling output: Alloway et al., 2017; Williams et al., 2021), spelling

age-matched children (writing output: Williams et al., 2013; spelling output: Deacon et al., 2014; Larkin et al., 2013), or reading age-matched children (spelling output: Mackie et al., 2013). However, in some circumstances children with DLD performed less well than language, or spelling, or age-matched peers. Larkin et al. (2013) found children with DLD made spelling attempts that had significantly lower phonetic plausibility than spelling age-matched children. Critten et al. (2014) found that, in their derivational morpheme spelling task, children with DLD produced significantly more phonologically implausible spelling attempts than language-age matched children.

Overall, as with both meta-analyses (Joye et al., 2019 in spelling; Graham et al., 2020, in writing), the findings of this systematic review support the view that children with DLD perform below chronologically age-matched participants and in line with reading, spelling, or language age matched controls. However, in some controlled circumstances, children with DLD also perform more poorly than these controls.

To what extent are translator processes related to writing difficulties in DLD?

Two key themes arise from writing outputs related to translation. First, working memory was associated with writing outcomes in children with DLD (Bishop & Clarkson, 2003; Sanders et al., 2018; Williams et al., 2013), although Dockrell et al. (2007) did not find an association between writing outcomes, as measured by the WOLD, and working memory. The second theme was an association between writing and vocabulary, which was reported in Dockrell et al. (2007, 2009). Specifically, the path analysis reported by Dockrell et al. (2009) indicated that vocabulary, measured at eight years of age, was indirectly associated with writing quality at 16 years of age through several paths. For example, vocabulary (age 11), oral language production (age 14), and writing (age 14).

To what extent are transcription processes related to writing difficulties in DLD?

The studies reporting transcription findings highlight three spelling ability concepts, the acquisition of spelling knowledge, the employment of this knowledge, and the outcomes arising from acquisition and employment. Overall, children with DLD had lower spelling scores compared with typical children of the same chronological age but they were able to acquire and employ spelling knowledge. Although Critten et al. (2014) observed that children with DLD employed phoneme-to-grapheme correspondences in their spelling attempts, Werfel et al. (2019) demonstrated that, as with typical children of the same chronological age, mental graphemic representations were concurrently associated with spelling accuracy. Moreover, early childhood acquisition of graphemic representations predicted later spelling outcomes at 10 years of age in children with DLD, as was the case for typical children (Wolter et al., 2011). Williams et al. (2021) found that children with DLD were able to employ orthographic information to inform their accuracy of pseudoword spelling. However, the children with DLD's scores on spelling measures, without clues, was significantly lower, suggesting that they were less able to use the information already in their mental lexicon or, as noted by, Wolter and Apel (2010), that these lexical representations were not well specified.

DISCUSSION

Given that linguistic skills relate to crafting good quality writing and accurate spelling, it follows that there is a high likelihood that children with difficulties in learning language also have difficulties in these literacy skills. This is borne out by findings across the studies in this systematic review. Many children who took part in these studies had received specialist language support (e.g., from speech-language pathologists) throughout their primary school, or early grade

school, education. At around ten years of age, their writing and spelling skills were often delayed relative to their chronological peers.

The framework used in this systematic review devised to illuminate the extent to which the findings from these studies reflect translation and transcription processes in the model of writing proposed by Chenoweth and Hayes (2003). Translation, the ability to convert ideas to appropriate linguistic formulations, was assessed through writing to a prompt. Forms of spelling to dictation, or handwriting speed measures, captured transcription processes. Prompted writing also provided a basis for exploring transcription, through the speed of written production and through analysis of the spelling errors children made.

A dominant theme in the writing quality assessments for children with DLD was the prevalence of less organized texts. Organization, as an assessment of the whole text, was reported in five studies. It is unclear to what extent translation and/or transcription processes affect organization. However, Chenoweth and Hayes' (2003) model would lead to the prediction that organization occurs downstream of idea generation and therefore involves translation, transcription, and even revision processes. Therefore, an acoustic perceptual deficit (Leonard, 1989) might result in low quality phonological information being stored in the mental lexicon, which would affect a writer's ability to covert ideas into language and/or transcription through spelling processes. Difficulties in processing grammar (Rice et al., 1995) could affect translation. A deficit in the rate of procedural learning (Ullman & Pierpont, 2005) could affect the acquisition of writing skill across the whole framework. Moreover, shorter bursts of writing, relative to peers, might also reflect less capacity to transcribe fluently (Connelly et al., 2012). Furthermore, working memory (Bishop & Clarkson, 2003; Sanders et al., 2018; Williams et al., 2013) and vocabulary (Dockrell et al., 2007, 2009) are likely constraining factors in writing for

children with DLD, as both are placed under considerable demand when writing (McCutchen, 2011). A plausible account is that the delicate interplay of writing processes, disrupted by a language disorder through either a perceptual (Leonard, 1989), grammar (Rice et al., 1995), or procedural learning (Ullman & Pierpont, 2005) deficit, would manifest as shorter, less lexically diverse, and less organized writing outputs.

Studies also provided evidence for difficulties in transcription in children with DLD. These were seen in prompted text writing and spelling tests. Children with DLD had lower spelling scores, typically in line with language age-matched peers. Where studies controlled the word lists used for specific linguistic properties, the profile of these difficulties suggested children with DLD find difficulty with employing phonological knowledge (to create phonologically plausible spellings), but also applying morphological information and specific orthographic knowledge. Although the wider evidence supporting a procedural learning deficit (Ullman & Pierpont, 2005) in DLD is unclear (West et al., 2021), one developmental mechanism put forward by Wolter and Apel (2010) is that acquisition of graphemic representations in long-term memory takes place at a slower rate in children with DLD than in children with typical development. This is in line with findings that show children with DLD are drawing on less well represented morphological awareness (Deacon et al., 2014) and specific orthographic awareness (Williams et al., 2021).

There are limitations that are reflected across the studies we reviewed. Studies often used small sample sizes, although this was often to produce matched comparison groups. The sheer number of studies also was small, which reflects in part that research in DLD literacy development is quite limited, even though children with DLD are prevalent in schools and writing is an important life skill. There is also, as noted by other researchers (Graham et al.,

2020; Joye et al., 2019; Nitido & Plante, 2020), heterogeneity in the exclusion and inclusion criteria for a DLD group, as well as cut-offs employed to identify these children. However, there appears to be some convergence towards using the CELF to assess a presumed DLD group, along with a nonverbal IQ measure to exclude children with obvious cognitive impairment. It means, however, even where reviews of studies are restricted to one language, some caution is best exercised when presuming a study's sample reflects the same disorder as another study's sample.

Researchers routinely develop prompts to assess writing outcomes. However, the features of these prompts vary and writers adapt their form of writing to address different prompts (Windsor et al., 2000). It is likely that these adaptations explain some of the variation in outcomes that are measured. Moreover, less than a third of writing prompts invited participants to consider their audience but this is often an important factor in skilled writing (Midgette, et al., 2008). Clearer rationales for the prompts used in studies, drawn from guidance such as Kroll and Reid (1994), may help better contextualize findings.

Studies we reviewed with writing tasks tended to reflect a single draft of text production approach. Relative to the model put forward by Chenoweth and Hayes (2003) there are few findings about the role of the evaluator/reviser in children with DLD. Children rarely spontaneously plan or revise their written work, but prompting these activities can affect subsequent written output (Koutsoftas & Gray, 2013; Williams et al., 2019). One DLD study taught and measured the effects of planning and revising on writing outcomes with three children (Shen & Troia, 2018). They found increases in planning and writing activity, over the duration of the taught sessions, and improvements in writing quality over time. A finding that aligns with studies that have taught children with learning difficulties planning and revising skills (De la Paz

& Sherman, 2013; Troia & Graham, 2002). Further studies that examine planning and revision are likely to offer insight into developing interventions, as both provide ways of reducing pressure on translation processes.

Some transcription research has begun to show insights about what kinds, and how many, errors children with DLD produce in their spelling (Deacon et al., 2014; Larkin et al., 2013), what linguistic knowledge they are aware of, how they might employ this knowledge (Williams et al., 2021), and the nature of their spelling representation acquisition (Wolter & Apel, 2010; Wolter et al, 2011). Given that accurate spelling requires the contribution of a number of forms of knowledge, this gives rise to opportunities to develop future studies that systematically explore this in single real words and psuedowords and extended texts serving different purposes.

Conclusion

Writing is language expression and performance on paper and on screen; studies are helping to give us insight into the specific challenges that children with DLD face when they wish to participate in the written world. This systematic review of the current literature offers a narrative that children with DLD demonstrate delay in translation and transcription processes relative to chronological peers with typical development. This is reflected in a range of written product measures, such as writing quality, writing productivity, and spelling outcomes. The studies suggest delay in translation and transcription processes, relative to chronologically age-matched peers, and reflect a range of linguistic resources children with DLD are able to employ in writing and spelling, albeit acquired at a slower rate than their typical peers. Future research focused on a range of writing processes might help to better understand and develop interventions to support writing in children with language learning disorders.

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*Asterisks indicate studies included in the systematic review.

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Table 1 PRISMA checklist.

Section	Item #	Checklist Item	Location Where Item Is Reported
TITLE			
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p. 3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p. 5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p. 5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p. 5; Figure 1
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	p. 5; Table 2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, • including how many reviewers screened each record and • each report retrieved, • whether they worked independently, • and if applicable, details of automation tools used in the process.	p. 6
Data collection process	9	Specify the methods used to collect data from reports, including • how many reviewers collected data from each report, • whether they worked independently,	pp. 5-6

Section	Item #	Checklist Item	Location Where Item Is Reported
		• any processes for obtaining or confirming data from study investigators, and if applicable, • details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	pp. 6-7
	10b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	pp. 6-7
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p. 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	pp. 5-6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	NA

Section	Item #	Checklist Item	Location Where Item Is Reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	NA
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p. 5, p. 7; Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	NA
Study characteristics	17	Cite each included study and present its characteristics.	Table 3
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	NA
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g., confidence/credible interval), ideally using structured tables or plots.	NA
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	pp. 12-15

Section	Item #	Checklist Item	Location Where Item Is Reported
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	pp. 15-19
	23b	Discuss any limitations of the evidence included in the review.	pp. 17-18
	23c	Discuss any limitations of the review processes used.	pp. 17-18
	23d	Discuss implications of the results for practice, policy, and future research.	p. 18-19
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p. 5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p. 5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA

Section	Item #	Checklist Item	Location Where Item Is Reported
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	As part of report
Competing interests	26	Declare any competing interests of review authors.	As part of report
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA

Table 2 Search terms used for data extraction.

Terms	Area	Reference
"specific language impair*" OR "language impair*" OR "language defici*" OR "primary language impair*" OR "language learning disab*" OR "language learning difficult*" OR "language learning impair*" OR "language delay*" OR "language disorder*" OR "developmental dysphas*" OR dysphas* OR "developmental language impair*" OR "developmental language disorder*" AND child* OR "school child*"	Developmental Language Disorder	Joye et al. (2019)
AND spell* OR orthograph* OR writ*	Spelling and Writing	Adapted from Joye et al. (2019)
NOT ("hearing loss" OR "hearing impair*" OR deaf* OR "deep dysphas*" OR "otitis media" OR "cleft palate" OR aphasia OR aphonia OR asperger OR autis* OR ADHD OR hyperlex* OR "motor skills" OR treatment OR therapy OR "preschool child*" OR kindergarden OR adult* OR geriatric* OR AAC OR "mental retardation" OR stutter* OR blindness OR OME OR Alzheimer OR stammer* OR chinese OR korean OR french OR greek OR hebrew OR dutch OR spanish OR portug*)	Exclusion	Adapted from Joye et al. (2019)

Table 3 Study characteristics.

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
Abbott et al. (2017)	Transcription	TL: *n* = 18 Dysgraphia: *n* = 21 Dyslexia: *n* = 40 OWL LD: *n* = 14	Not reported	**DLD Criteria:** Below -2/3*SD* on 2 x language assessment Parental Report **Diagnostic Assessment:** WJ III: Oral comprehension CELF-4: Formulated Sentences	DASH: Best Handwriting
Alloway et al. (2017)	Transcription	SLI: *n* = 40 Dyslexia: *n* = 24 TD: *n* = 50	SLI: *M* = 9.96 Dyslexia: *M* = 11.28 TD: *M* = 9.87	**DLD Criteria:** Score of 85 or below **Diagnostic Assessment:** CELF: Composite Language Score	WIAT II: Spelling
Apel & Henbest (2020)	Transcription	Second grade SSD: *n* = 16 CAM: *n* = 15 Third grade SSD: n = 14 CAM: n = 15	Second grade SSD: *M* = 7.91 CAM: *M* = 8 Third grade SSD: *M* = 8.87 CAM: *M* = 8.93	**DLD Criteria:** Practitioner referral **Diagnostic Assessment:** None reported	Researcher developed spelling test
Apel & Lawrence (2011)	Transcription	SSD: *n* = 44 TD: *n* = 44	SLI: *M* = 6;09 TD: *M* = 6;08	**DLD Criteria:** Below 15th percentile: articulation Typical range: nonverbal **Diagnostic Assessment:** GFTA KBIT-2	TWS (4th edition): Spelling
Avitia et al. (2017)	Transcription	LI: *n* = 59 LI-C: *n* = 40 LDRW: *n* = 67 LDRW-C: *n* = 67	LI: *M* = 4.7 LI-C: *M* = 4.7 LDRW: *M* = 9.2 LDRW-C: *M* = 9.2	**DLD Criteria:** None reported **Diagnostic Assessment:** None reported	KTEA (3rd Edition): Spelling

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
Berninger et al. (2015)	Transcription	OWL LD: *n* = 13 Dysgraphia: *n* = 26 Dyslexia: *n* = 38 Control: *n* = 11	Not reported	**DLD Criteria:** Below -2/3*SD* on language measures Parent report **Diagnostic Assessment:** Not reported	DASH: Best Handwriting DASH: Fastest Handwriting WIAT III: Spelling WJ III: Spelling WJ III: Writing Fluency
Bishop & Clarkson (2003)	Translation and Transcription	SLI: *n* = 48 TD: *n* = 161	SLI: *Range* = 7.5-13 TD: *Range* = 7-13	**DLD Criteria:** Below -1.33*SD* on one or more language measures, 20pts difference between lowest language measure and nonverbal measure. **Diagnostic Assessment:** RCM / RPM WF: Expressive vocabulary TROG WISC-R: Comprehension CELF-R: Recalling Sentences NWRT EAT BAS: Word reading	Writing: researcher developed picture sequence prompt VWST: Spelling
Bishop et al. (2005)	Transcription	LI (Group S): *n* = 11 LI (Group M): *n* = 11	*Range* = 8-13	**DLD Criteria:** Below -1*SD* one or both language measures **Diagnostic Assessment:** TROG-2 ERRNI	WORD: Spelling
Connelly et al. (2012)	Translation and Transcription	SLI: *n* = 33 CAM: *n* = 33 LAM: *n* = 33	SLI: *M* = 9;10 CAM: *M* = 9;10 LAM: *M* = 8;1	**DLD Criteria:** Criteria on CELF-4 Typical range: nonverbal **Diagnostic Assessment:**	Writing: sentence start prompt BAS-II: Spelling

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
				CELF-4: Core Language Scale BAS-II: Matrices	
Critten et al. (2014)	Transcription	SLI: *n* = 33 CAM: *n* = 33 LAM: *n* = 33	SLI: *M* = 9;10 CAM: *M* = 9;10 LAM: *M* = 8;1	**DLD Criteria:** CELF-4: Core Language Scale Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Core Language Scale BAS-II: Matrices	BAS-II: Spelling Researcher developed spelling test
Deacon et al. (2014)	Transcription	SLI: *n* = 17 SAM: *n* = 17 CAM: *n* = 17	SLI: *M* = 9;02 SAM: *M* = 7;05 CAM: *M* = 9;00	**DLD Criteria:** Below -1*SD* CELF-4 Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Core Language Scales TONI-2	WRAT-4: Spelling Researcher developed spelling test
Dockrell & Connelly (2015)	Translation and Transcription	SLI: *n* = 23 CA: *n* = 23 VLM: *n* = 23	SLI: *M* = 10;05 CA: *M* = 10;5 VLM: *M* = 7;11	**DLD Criteria:** Below -1*SD* CELF-R Typical range: nonverbal **Diagnostic Assessment:** CELF-R: receptive and expressive language scales BAS-II: Nonverbal ability	Writing: WOLD (ideal house) BAS-II: Spelling
Dockrell et al. (2007)	Translation	SLI: *N* = 64	T1 SLI: *M* = 8;03 T2 SLI: *M* = 10;08	**DLD Criteria:** Practitioner referral **Diagnostic Assessment:** Not reported	Writing: WOLD (ideal house) BAS-II: Spelling
Dockrell et al. (2009)	Translation and Transcription	SLI: *N* = 64	T1 SLI: *M* = 8;03 T2 SLI: *M* = 10;08 T3	**DLD Criteria:** Practitioner referral **Diagnostic Assessment:** Not reported	Writing: WOLD (ideal house) BAS-II: Spelling

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
			SLI: *M* = 12;01 T4 SLI: *M* = 13;11 T5 SLI: *M* = 15;10		
Fey et al. (2004)	Translation	TL: *n* = 262 SLI: *n* = 111 NLI: *n* = 75 LNIQ: *n* = 90	TL: *M* = 5;11 SLI: *M* = 6;0 NLI: *M* = 6;1 LNIQ: *M* = 6;0	**DLD Criteria:** Kindergarten: Below -1.25*SD* on 2 of 5 scores Second Grade: Below -1.14*SD* on 2 of 5 scores. Typical range: nonverbal **Diagnostic Assessment:** Five composite scores made up of: Kindergarten TOLD-2 NRT Second Grade CELF-3 PPVT-R CREVT: Expressive Vocabulary	Writing: researcher developed picture sequence prompt
Goulandris et al. (2000)	Transcription	Dyslexia: *n* = 20 SLIr: *n* = 19 SLIp: *n* = 20 YC: *n* = 18 OC: *n* = 19	Dyslexia: *M* = 15.79 SLIr: *M* = 15.44 SLIp: *M* = 15.62 YC: *M* = 10.39 OC: *M* = 15.68	**DLD Criteria:** History of speech and language difficulties **Diagnostic Assessment:** None reported	Researcher developed spelling task
Kim et al. (2015)	Translation and Transcription	SLI: *n* = 46 Other subgroups sample size not reported	Whole sample: *M* = 6.18 Subgroup ages not reported	**DLD Criteria:** School records **Diagnostic Assessment:** None reported	Writing: researcher developed sentence start prompt Researcher developed spelling task

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
Koutsoftas & Petersen (2017)	Translation and Transcription	LLD: *n* = 25 TD: *n* = 25	LLD: *M* = 10.79 TD: *M* = 10.32	**DLD Criteria:** School records **Diagnostic Assessment:** None reported	Writing: researcher developed story idea prompt
Koutsoftas & Srivastava (2020)	Translation	LLD: *n* = 25 TD: *n* = 25	LLD: M_{months} = 129.52 TD: M_{months} = 123.80	**DLD Criteria:** Referral from speech and language specialist **Diagnostic Assessment:** None reported	Writing: researcher developed story idea prompt
Larkin & Snowling (2008)	Transcription	LI: *n* = 23 RI: *n* = 22 CAM: *n* = 23 RAM: *n* = 15	LI: *M* = 10.76 RI: *M* = 10.44 CAM: *M* = 10.99 RAM: *M* = 7.73	**DLD Criteria:** Below -1*SD* language and vocabulary **Diagnostic Assessment:** CELF-3: recalling sentences BPVS-2	Researcher developed spelling task
Larkin et al. (2013)	Transcription	SLI: *n* = 15 SAM: *n* = 15 CAM: *n* = 15	SLI: M_{months} = 113.07 SAM: M_{months} = 91.13 CAM: M_{months} = 112.67	**DLD Criteria:** Below -1*SD* on 2 of 3 language measures Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Recalling Sentences BPVS TROG-2 BAS-II: Matrices	BAS-II: Spelling Researcher developed spelling task
Mackie & Dockrell (2004)	Translation and Transcription	SLI: *n* = 11 CA: *n* = 11 LA: *n* = 11	SLI: *M* = 11;00 CA: *M* = 11;2 LA: *M* = 7;3	**DLD Criteria:** Below -2*SD* on language measure Typical range: nonverbal **Diagnostic Assessment:** CELF-R	Writing: Picture Language Story Test

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
				RPM	
Mackie et al. (2013)	Translation and Transcription	SLI: *n* = 46 CA: *n* = 46 LA: *n* = 46 RA: *n* = 46	SLI: *M* = 10;8 CA: *M* = 11;0 LA: *M* = 8;5 RA: *M* = 7;8	**DLD Criteria:** School records **Diagnostic Assessment:** BPVS TROG BAS: Matrices	Writing: researcher developed picture sequence prompt
McCarthy et al. (2012)	Transcription	SLI: *n* = 43 Dyslexia: *n* = 21 SLI and dyslexia: *n* = 18 TD: *n* = 47	Not reported	**DLD Criteria:** None reported **Diagnostic Assessment:** Not reported	TWS (3rd Edition): Spelling
McFadden & Gillam (1996)	Translation	LD: *n* = 10 CA: *n* = 10 LA: *n* = 10 RA: *n* = 10	LD: *M* = 10;7 CA: *M* = 10;7 LA: *M* = 7;11 RA: *M* = 7;9	**DLD Criteria:** Below age scores: language Typical range: nonverbal **Diagnostic Assessment:** DTLA-2: Verbal aptitude composite TONI	Writing: researcher developed picture prompt
Sanders et al. (2018)	Translation and Transcription	OWL LD: *n* = 18 Dysgraphia: *n* = 25 Dyslexia: *n* = 60	Not reported	**DLD Criteria:** At least two language measures below 15th percentile. Parent/school report **Diagnostic Assessment:** None reported	DASH: Best Handwriting WIAT III: Spelling WJ III: Spelling WJ III: Writing Fluency WJ III: Writing Sentence Combining
Scott & Windsor (2000)	Translation	LLD: *n* = 20 LA: *n* = 20 CA: *n* = 20	LLD: *M* = 11;5 LA: *M* = 8;11 CA: *M* = 11;6	**DLD Criteria:** Language: -1*SD* or below **Diagnostic Assessment:** TOLD-I	Writing: researcher developed film prompt

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
Shen & Troia (2018)	Translation	LLD: *N* = 3	*Range*$_{months}$ = 115-129	**DLD Criteria:** Either language measure below -1.25*SD* Typical range: nonverbal **Diagnostic Assessment:** TONI-3 OWLS-II: Listening Comprehension, Oral Expression	Writing: researcher developed contrasting prompt
Silliman et al. (2006)	Transcription	LLD: *n* = 8 SA: *n* = 8 CA: *n* = 8	*Range* = 6-11	**DLD Criteria:** Criteria on CELF-4 **Diagnostic Assessment:** CELF	Researcher developed spelling task
Stoeckel et al. (2013)	Translation	S/LI: *n* = 294	Not applicable	**DLD Criteria:** Referral records **Diagnostic Assessment:** None reported	Not reported
Stuart et al. (2020)	Translation	DLD: *n* = 30 CA: *n* = 30 LA: *n* = 30	DLD: *M* = 9;11 CA: *M* = 9;10 LA: *M* = 8;1	**DLD Criteria:** Below -2*SD* on language Typical range: nonverbal **Diagnostic Assessment:** CELF-4: core language scores BAS-II: Matrices	Writing: WOLD (ideal house) BAS-II: Spelling
Werfel & Krimm (2015)	Transcription	SLI: *n* = 31 TL: *n* = 28	SLI: M_{months} = 111.97 TL: M_{months} = 104.29	**DLD Criteria:** Criteria on CELF-4 Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Core Language Index TONI-4	TWS (4th Edition): Spelling, first 20 words
Werfel et al. (2019)	Transcription	SLI: *n* = 32 TL: *n* = 32	SLI: M_{months} = 112.06	**DLD Criteria:** Criteria on CELF-4	TWS (4th Edition): Spelling, first 20 words

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
			TD: M_{months} = 105.19	Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Core Language Index TONI-4	
Werfel et al. (2021)	Transcription	SI: *n* = 23 LI: *n* = 16 SI & LI: *n* = 11 TD: *n* = 479	SI: *M* = 6;4 LI: *M* = 6;4 SI & LI: *M* = 6;3 TD: *M* = 6;2	**DLD Criteria:** School referral **Diagnostic Assessment:** None reported	WJIII: Spelling
Williams et al. (2013)	Translation and Transcription	SLI: *n* = 15 SAM: *n* = 15 CAM: *n* = 15	SLI: M_{months} = 113.07 SAM: M_{months} = 91.13 CAM: M_{months} = 112.67	**DLD Criteria:** Below -1*SD* on 2 of 3 language measures Typical range: nonverbal **Diagnostic Assessment:** CELF-4: Recalling Sentences BPVS TROG-2 BAS-II: Matrices	Writing: WOLD (daytrip) BAS-II: Spelling
Williams et al. (2021)	Transcription	DLD: *n* = 37 CAM: *n* = 37 LAM: *n* = 37	DLD: M_{months} = 101.27 CAM: M_{months} = 102.24 LAM: M_{months} = 74.27	**DLD Criteria:** Criteria on CELF-5 **Diagnostic Assessment:** CELF-5: Core Language Index	Researcher developed spelling task
Windsor et al. (2000)	Translation	LLD: *n* = 20 LA: *n* = 20 CA: *n* = 20	LLD: *M* = 11;5 LA: *M* = 8;11 CA: *M* = 11;6	**DLD Criteria:** Below -1*SD* on language measure **Diagnostic Assessment:** TOLD-I	Writing: researcher developed film prompt
Wolter & Apel (2010)	Transcription	LI: *n* = 25 TD: *n* = 31	LI: *M* = 6;1 TD: *M* = 6;3	**DLD Criteria:** Below -1*SD* on language measure **Diagnostic Assessment:**	Researcher developed spelling task

Authors and Year	Theme	Sample Size	Age	Diagnosis	Writing Prompts and/or Spelling Tasks
				School referral TOLD-P3: Relational vocabulary, Sentence Imitation KBIT: Matrices	
Wolter et al. (2011)	Transcription	LI: *n* = 36 TL: *n* = 42	LI: *M* = 10;0 TL: *M* = 10;3	**DLD Criteria:** Below -1*SD* on language measure Typical range on nonverbal **Diagnostic Assessment:** TOLD-P3: Relational vocabulary, Sentence Imitation KBIT: Matrices	Researcher developed spelling task

Note. Participants: CA: Control Age (match); CAM: Control Age Match; DLD: Developmental Language Disorder; LA: Language Age (match); LAM: Language Age Match; LD: Language Disorder; LDRW: Learning Disability in Reading and Writing; LDRW-C: LDRW Control; LI: Language Impaired; LI-C: LI-Control; LLD: Language Learning Disorder; LNIQ: Low Nonverbal IQ; NLI: Nonspecific Language Impairment; OC: Older Controls; OWL LD: Oral and Written Language Disorder; RA: Reading Age (match); RAM: Reading Age Match; RI: Reading Impaired; S/LI: Specific/Language Impaired; SA: Spelling Age (match); SAM: Spelling Age Match; SI & LI: Speech Impaired and Language Impaired; SI: Speech Impaired; SLI: Specific Language Impairment; SLIp: SLI persistent; SLIr: SLI resolved; SSD: Speech Sound Disorder; TD: Typically Developing; TL: Typical Language; VA: Vocabulary Age (match); VLM: Vocabulary Level Match; YC: Young Controls.

Diagnostic Tests: Language (or subtests used from): BPVS/BPVS-2: British Picture Vocabulary Scale; CELF/CELF-R/CELF-3/CELF-4/CELF-5: Clinical Evaluation of Language Fundamentals; CNWRT: Children's Nonword Repetition Test; CREVT: Expressive Vocabulary; DTLA-2: Detroit Test of Learning Aptitude; EAT: Edinburgh Articulation Test; ERRNI: Expression, Reception and Recall of Narrative Instrument; GFTA: Goldman-Fristoe Test of

Articulation; NRT: Narrative Retell Task; OWLS-II: Oral and Written Language Scales; PPVT-R: Peabody Picture Vocabulary Test; RCM: Raven's Coloured Matrices; RPM: Raven's Progressive Matrices; TOLD-2: Test of Language Development; TOLD-I: Test of Language Development–Intermediate; TOLD-P3: Test of Language Development–Primary; TROG/TROG-2: Test for Reception of Grammar; WF: Word-Findings; Nonverbal (or subtests used from): BAS/BAS-II: British Ability Scales; KBIT-2: Kaufman Brief Intelligence Test-2; TONI/TONI-2/TONI-3/TONI-4: Test of Nonverbal Intelligence; WISC-R: Wechsler Intelligence Scale for Children. Spelling and/or Writing Prompts: DASH: Detailed Assessment of Speed of Handwriting; KTEA: Kaufman Test of Educational Achievement (3rd Edition); TWS (3rd Edition)/TWS (4th Edition): The Test of Written Spelling; VWST: Vernon Word Spelling Test; WIAT II/WIAT III: Wechsler Individual Achievement Test; WJ III: Woodcock-Johnson III; WORD: Weschler Objective Reading Dimensions; WRAT-4: Wide Range Achievement Test.

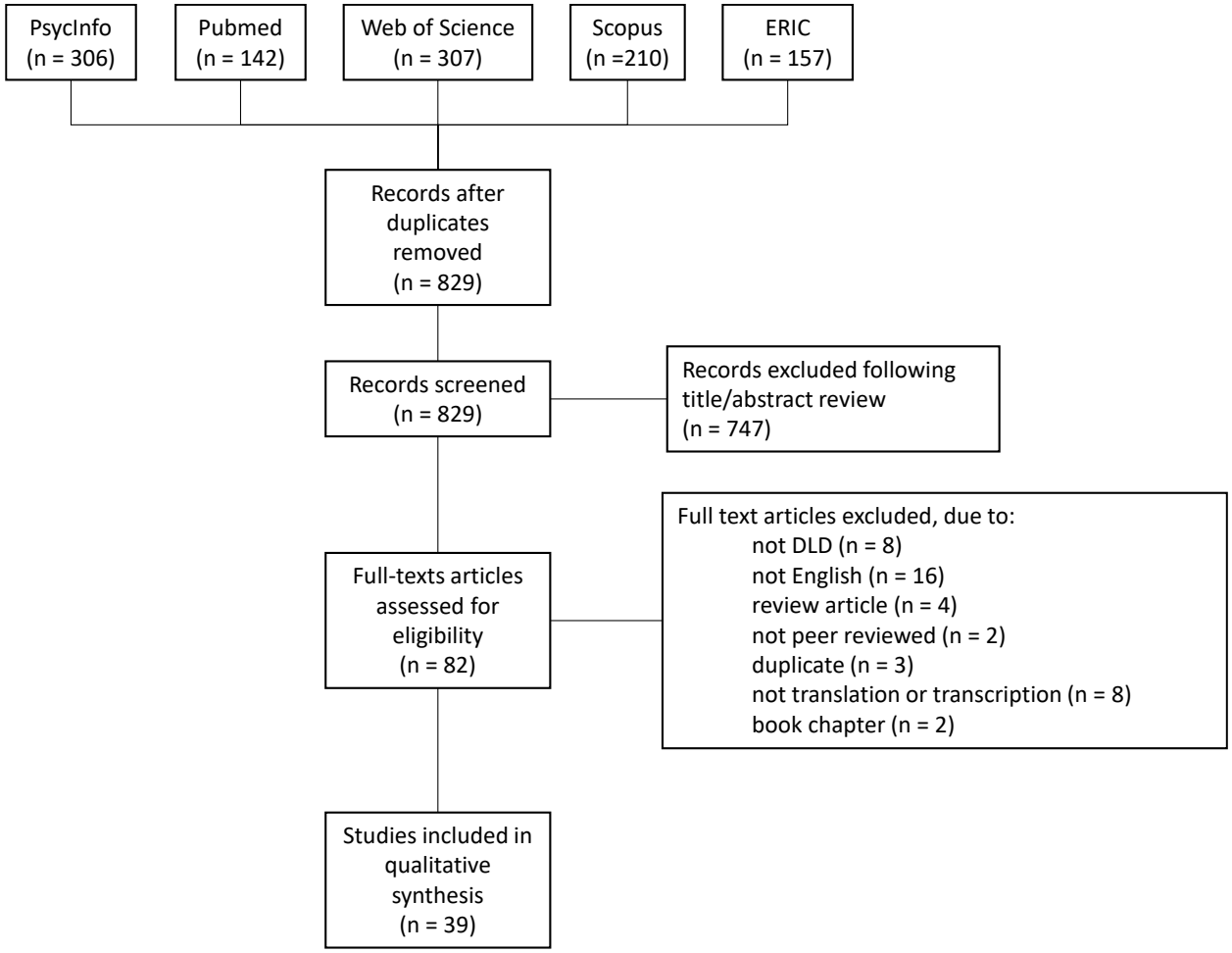

Figure 1. Study selection PRISMA flow diagram