30. Experimental Methods to Study Atypical Language Development

BIBLIOGRAPHICAL NOTE

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Abstract

In this chapter we present current issues on experimental methods in the study of atypical language development with a focus on developmental language disorders (DLD). We first present a short history of terminology surrounding DLD and follow this with a discussion of critical topics related to DLD assessment including cross-linguistic research, multilingualism, persisting disorders in teenagers, age-differences (pre-school, school age, adolescence, and adults) in manifestations and domains studied, language comprehension versus production, and cognitive assessment. We also bring focus to the question of matching control groups in the study of atypical language development. We present the most common methods used in the investigation of language impairments from the behavioural and neurocognitive perspectives. We provide an overview of the issues related to establishing equivalence between groups with and without language impairments. We conclude with recommendations for practice and future directions in the study of atypical language development.

1. Introduction

1.1. Definition of DLD

The diagnostic criteria for children with language disorder in the DSM-V (American Psychiatric Association, 2013) include early onset of symptoms and persistent difficulties in language acquisition caused by comprehension or production deficits. These are characterized by a reduced vocabulary, limited sentence structures, and discourse impairments. Those language deficits are not the result of sensory, motor impairments, or global delay, and will result in functional limitations in many areas, including social participation and academic achievement. The new developmental language disorder (DLD) label suggested by Bishop and colleagues (2017) aligns with the DSM-V definition while adding that a DLD diagnostic should result in functional impairments. Both agree that language disorders diagnosed at the age of 4 or 5 years usually persist into adulthood. The DSM-V specifies that the profile of language strengths and weaknesses is likely to change over a child's development.

The previously used label "specific language impairment" (SLI), which became widely used in the 1980s (Reilly et al., 2014), was recently replaced by the label DLD (Bishop et al., 2017). SLI referred to children with language disorders whose cognitive abilities were within normal limits and for whom there was no discernible reason for the language disorder. However, causes for language disorders are multifactorial (Bishop et al., 2017), and thus nonverbal skills within normal limits are no longer included as a diagnostic criteria for DLD. Volkers (2018) noted that some consider SLI to be a subcategory of DLD, where SLI includes children without nonverbal impairments. Others have also considered that the main difference between both labels really differs in the extent to "which identification depends upon functional impacts" (McGregor et al., 2020, p.38).

1.2. Disorders with atypical language development

If the language deficits occur together with a known biomedical condition and are thus part of a more complex pattern of impairment, this condition is called a differentiating condition. In this case, the label "language disorder associated with X" is used, where X is the known biomedical condition (Bishop et al., 2017). These differentiating conditions include intellectual disability and autism spectrum disorder (ASD). While the primary

impairments expected in ASD are social deficits, this disorder is heterogeneous and is associated with a wide range in cognitive and language abilities (Georgiou & Spanoudis, 2021). As a result, performance on language tasks may sometimes be similar between participants with DLD or ASD (ibid).

Developmental dyslexia (DD), i.e., a disorder that impairs automatization of the reading and writing system (Ziegler et al., 2008) and is often comorbid with DLD. While DD includes many subtypes (ibid), phonological deficits are often part of the disorder, which can impact on oral language skills. As the causal relationship between this disorder and DLD is unclear, it is considered as a potential co-occurring condition (Bishop et al., 2017).

2. **Historical Perspectives**

The first published works on developmental language impairment date from the 1800's with Gall (1822, in Leonard, 2014). Initial reports were provided by neuroscientists or psychologists presenting case reports of children with seemingly normal cognitive abilities and concurrent language learning deficits. In the mid 1900's research on DLD focused on defining the impairment and establishing a) the existence of a language learning deficit in the absence of cognitive, neurological, or environmental causes and b) the etiology of language learning impairments (Ingram, 1959). It is now believed that around 7% of the general population presents with a language production or comprehension deficit (Tomblin et al., 1997). However, the etiology of DLD remains a debate as various genes have been suggested to be at the root cause of the impairment. Furthermore, different genetic mutations could result in similar linguistic manifestations, but also a mutation in the same gene could have different consequences depending on the speaker (Bishop & Snowling, 2004; Bishop et al., 2006).

Linguistic and acquisition research on DLD began in earnest in the 1980's with a specific focus on structures that proved to be difficult for children with the disorder. Generally, it has been found that children with DLD will present with delayed word learning and phonological development, as well as impoverished syntactic structures and morphosyntax as compared to their typically developing peers (Leonard, 2014). Older children with DLD will usually have good lexical semantic abilities in comparison to

their morphosyntactic abilities, and phonological difficulties resolve, at least in part, before they become teens (Courteau et al. resubmitted). As they mature, morphosyntactic abilities remain impaired, and pragmatic difficulties can emerge (Fujiki & Brinton, 2014). However, research has largely focused on morphosyntactic abilities, as these are quite prevalent in DLD across languages and ages. These include difficulties producing tense marking, number agreement on verbs, nouns and determiners, gender agreement on determiners, clitics and adjectives, case-marking and so on. Manifestation of these difficulties varies from language to language, and the initial focus on monolingual English-speaking children for the bulk of research in DLD has resulted in an Anglocentric and monolingual theoretical approach to DLD. We address multilingualism in the critical issues (section 3.1) next and return to cross-linguistic issues below in the current contributions (section 4.2).

3. Critical Issues and Topics

3.1. Multilingualism

Multilingualism, that is using several languages on a regular basis, is not to be considered as an exception but rather as the rule: it is estimated that worldwide multilinguals represent at least 50% of the population (Grosjean, 2021). The number of people with DLD who are multilingual is increasing. However, it is well established that multilingualism is not what causes such disorders (Paradis et al., 2008). The challenge for research on multilingual children lays in disentangling typical from atypical language processing, as multilingual children may also present with linguistic weaknesses such as lexical access difficulties, agreement errors, and reduced syntactic complexity.

It is thus crucial to have access to reliable tools in multiple languages to identify and study DLD in multilingual children. Research development on the comparison of multilingual children with and without DLD is also highly relevant to avoid under and over identification of DLD in clinical settings. Interestingly, studies show that longer exposure to a second language (L2) in school predicts better performance for TD bilinguals but not for bilinguals with DLD (Blom & Paradis, 2015; Altman et al., 2016). Comprehension tasks have been shown to be reliable in distinguishing children with and without DLD in multilingual settings (Elin Thordardottir & Brandeker, 2013). However,

comprehension tasks can be prone to Type 1 errors (see section 5.5 on comprehension tasks and section 6.1 on Type 1 errors).

Recent tools have been developed to characterize DLD markers in multilingual settings. The *Language Impairment Testing in Multilingual Settings* battery (LITMUS, Armon-Lotem et al., 2015) includes several tasks known to identify DLD that have been designed for multiple and diverse languages including non-Indo-European ones: Sentence repetition, multilingual assessment in narratives, crosslinguistic lexical tasks, nonword repetition and a parental bilingual questionnaire. These allow researchers not only to enhance cross-language comparisons but also to assess multilinguals in their multiple languages (see https://www.bi-sli.org/litmus-tools).

The sentence repetition task is a good tool to disentangle DLD from grammatical weaknesses that characterize multilingual speakers (see section 5.3). Non-word repetition is equally important as it usually reveals a similar performance between multilingual and monolingual speakers without language impairment as long as stimuli do not involve language-specific phonemes. Furthermore, this task identifies both monolingual and multilingual children with DLD andesearch reveals no bilingualism effects and differentiation between children with and without DLD who are bilingual. Research also supports the influence and importance of phonological complexity on language processing in children with DLD (dos Santos & Ferré, 2018).

3.2. Cognitive assessment: language and beyond

Historically, definitions of specific language impairment (SLI), for both research and clinical purposes, were predicated on observable differences between language abilities and non-verbal cognitive abilities: nonverbal scores were expected to be within normal limits. This approach however had its issues. For one, some putatively non-verbal cognitive assessment tasks are more verbal than others (Durant et al., 2019) and they can promote implicit verbal routines (Botting et al., 2013). Second, depending on the task used, children could remain in or be excluded from the SLI group (Miller & Gilbert, 2008) because they were reclassified as having low IQ, an exclusionary criterion for SLI. This has an impact not only on language rehabilitation and health services (Reilly et al., 2014) but also on how representative a body of research on that population may be,

because non-verbal cognitive abilities can be low on average or even below normal range, depending on how you measure them.

Following CATALISE (Bishop et al., 2017) cognitive assessments are no longer used to classify children as having a language impairment, as long as the language deficit is not associated with a known biomedical condition (e.g., autism spectrum disorder, or intellectual disability). They can however offer us insight into how linguistic and cognitive abilities interact. For example, declarative verbal memory impairments are specifically linked to working memory deficits in a subgroup of children with DLD (Lum et al., 2015) and bilingual children with DLD may exhibit unequal deficits in nonverbal cognitive skills across tasks, i.e., no deficits are observed on pattern recognition (a cube design task), but they are found on symbolic memory (reproducing picture in different colours in a specific order), supporting the notion that it is difficult to correlate verbal and non-verbal abilities in this population (Durant et al., 2019).

3.3. Control group matching

3.3.1. Age and language matching

Research in DLD often relies on group comparisons, most often with children who have typical development (TD) but occasionally with other groups, such as those with DD (Rispens & Been, 2007) or those with ASD (Tuller, 2017). However even within TD groups there are often two matches: a first on age and a second on some language measure. Language-matching follows the following logic: given that children with DLD present with a language development delay, comparing them to age-matched individuals will always result in group differences. Comparing them to language-matched peers can highlight differences in linguistic abilities that are beyond language delay, i.e., indicative of acquisition patterns that deviate from typical language development.

Language matching can be done on various measures. Often, receptive vocabulary tests are used as a proxy for linguistic development, but this is sub-optimal. Sentence repetition tasks are robust indicators of language impairment (Courteau et al. resubmitted ; Elin Thordardottir & Brandeker, 2013) and are often used to confirm language impairment or to match groups. Fuller measures such as mean length of utterance (MLU), a quasi-syntactic measure of development, are sometimes used.

However, when using these richer measures, matching often becomes difficult as control participants can be quite young and not yet have developed the ability to respond to task demands (Royle & Elin Thordardottir, 2008).

Note that even when comparing children with DLD to age-matched peers, one can observe interesting qualitative differences between groups. This is especially salient with error patterns. TD children produce errors commensurate with the grammar (e.g., overregularization in English, Ullman & Gopnik, 1999; Paradis et al., 2008) or with automatization (e.g., attraction effects in French, Franck et al., 2004), while participants with DLD will elicit atypical error patterns (e.g., overuse of the non-default feminine gender in French, Royle & Reising, 2019, or non-application of morpho-phonological processes , Royle & Stine, 2013).

3.3.2. Group matching in neurolinguistic experiments

Language matching is especially problematic if one is comparing neurolinguistic processing between groups, since we know that brain changes, such as myelination, are ongoing during childhood and up to young adulthood (Segalowitz et al., 2010). The available data on brain maturation show important changes in neurotypical children's event related brain potential (ERP) through grade school and beyond. It is therefore unwise to use only language-matched controls in ERP experiments, as differences observed between impaired and unimpaired groups could simply be linked to maturation effects on brain organization and specialization. Recently we have observed that if we matched our participants in an ERP on sentence repetition, our DLD group of fourteen-year-olds would be compared to 7- or 8-year-olds, which is sub-optimal for a neuroimaging study.

4. Current Contribution and Research

4.1. Neuroimaging

This points however to an exciting new avenue of research: neuroimaging of language processing in DLD. Using electroencephalograms (EEG), one can obtain millisecond by millisecond recordings of online processing as language unfolds. From the EEG one extracts ERPs to establish whether participants are sensitive to grammatical errors

(Cantiani et al., 2015) or incongruencies (Courteau et al., under review). However few languages or structures have been studied using this method, and still too few studies have focused on morphosyntactic and syntactic processing in typical language development (see Royle & Courteau, 2014 for a review). Open questions about the cognitive underpinnings of DLD that can be addressed using this method range from timing or auditory processing deficits (Kail, 1994; Tallal et al., 1981), to dissociations between domains within language and between language processing models (e.g., Hickock & Poeppel, 2007; Ullman & Pierpont, 2005).

An important caveat about neurolinguistic studies of language processing is that multidisciplinary teams are necessary for this type of research. Issues common in classic psycholinguistic research (inappropriate stimuli for participants with DLD, inappropriate questions for linguistic research, experimental designs that do not directly address the question asked) are also present in ERP and other neuroimaging research. Furthermore, difficulties understanding brain imaging methods and data analyses can also result in uninterpretable data. In ERP research, ungrammatical sentences are often used to tap into language processing. However, contrary to psycholinguistics experiments (excepting eye-tracking) ungrammaticality effects are measured during stimulus presentation and not simply at the end of a sentence. In ERPs, effects are expected to be observed directly on the error when the ERP is analysed: if the sentence is not in fact ungrammatical *at that point*, analyses are difficult to interpret (see Royle & Courteau, 2014, for examples).

Another issue is presentation modality. Because children with DLD can also present with reading or writing impairments and writing limits the lower ages at which we can test children, auditory stimuli should be preferred. However, auditory sentences contain subtle cues (sentence-initial vowel lengthening, intonation accent on errors, or even abrupt changes in the intonation phrase due to splicing). These cues are known to affect ERP patterns and might even be the direct cause for some components (Steinhauer & Drury, 2012).

Another advantage in using ERPs in establishing a defining characteristic of DLD is that we can compare neurocognitive patterns in children with DLD to those of other groups with neurodevelopmental disorders. For example, while ERPs in response to lexical-semantic mismatches appear typical in children and adolescents with DLD, there is

mixed evidence regarding children with autism spectrum disorder (ASD) (e.g., Manfredi et al., 2020).

4.2. Cross-linguistic studies of DLD

In DLD the main combinatorial linguistic components such as phonology, morphosyntax and syntax are problematic. Since these components manifest differently from language to language, one might expect that DLD symptomatology to be highly variable across languages. Indeed, DLD manifestations are constrained by language-specific parameters. Language family related symptoms have been reported, such as difficulties in processing object pronoun clitics in Romance languages, difficulties in processing verb 2nd movement in Germanic languages, and underuse of aspect markers in Chinese languages (Leonard, 2013).

Cross-language comparisons of DLD symptoms are necessary to identify common patterns or universals for this disorder. For instance, clitic omission in French might be explained by phonological or morphosyntactic hypotheses. Given that clitics are phonologically weak elements, they can be considered as phonologically non salient and thus easily omittable. In French, both determiners and clitics are impaired in children with DLD. As these function words are phonologically similar (e.g., *le* in *le livre* 'the book' and *Il le prend* 'he takes it') both phonological and morphosyntactic hypotheses could explain their omission. However, the fact that object pronouns are also impaired in other languages in which determiners and pronouns are not phonologically similar as in English ("the" and "it"), lead us to interpret such deficits as resulting from an underlying morphosyntactic deficit and not a phonological one.

A cross-linguistic perspective requires a sound experimental approach based on typological diversity. Comparing typologically close languages is useful to examine whether DLD symptomatology replicates across languages. This is in fact the case for French, Spanish and Italian preverbal clitics. In the same vein, comparing typologically distant languages is useful to determine whether DLD symptomatology replicates across languages despite heterogeneous grammatical mechanisms.

Moreover, task demands vary across languages, and it is not the case that grammatical morphology is systematically problematic in children with DLD. For instance, in

Icelandic which has richer morphology than English, grammatical morphology appears to be less taxing than in English (Elin Thordadottir, 2008; 2016). Furthermore, in many Romance languages such as Spanish and Italian, verbs quite regularly and transparently inflect for tense and agreement. Spanish or Italian-speaking Children with DLD do not exhibit the glaring deficits in tense and agreement inflections that are seen in English (Leonard, 2014). However cross-linguistic studies do not support the view that languages with a rich inflectional morphology offer learning advantages for children with DLD, as suggested by Leonard et al (1992) and Dromi et al (1993), since children with DLD have difficulty learning complex verb inflection paradigms in Finnish, a language with rich morphology (Kunnari et al., 2011). Thus, cross-linguistic perspectives are necessary to understand universal vs. language specific properties of DLD.

5. Research Methods for the Study of DLD

5.1. Spontaneous speech

As in most child language research, a common approach to investigating atypical language development is the use of spontaneous speech corpora, one of the most ecological ways to assess language impairment. This approach is used in labs, clinical settings, schools or at home. Spontaneous speech can be generated during an activity such as playing with toys, and storytelling (with or without visual support). Visual supports can help both the child and experimenter: they are mnemonic devices for the child, allowing them to focus on their message, and they allow researchers to understand the message being conveyed by participants. These supports often have no linguistic or written cues to avoid priming effects. Because some children with DLD have concurrent articulation difficulties (childhood apraxia of speech), controlled lab settings or quiet rooms are often used. However, more artificial settings can be uncomfortable for the child and often a parent or a puppet is present to make the child more comfortable.
From the spontaneous speech corpus, one can extract multiple measures that are useful for research, for example vocabulary breadth, phonological inventories, morphological productivity, syntactic development and discourse and pragmatic abilities (e.g., turn-taking, responses to questions and prompts, etc.). Spontaneous speech samples can be compared to samples from typically developing children, already collected and available

in repositories such as CHILDES and TalkBank (https://childes.talkbank.org, MacWhinney, 2000; Rose & MacWhinney, 2014).

Spontaneous speech can however have drawbacks. Data can be time-consuming to transcribe and analyse, although there are programs for semi-automatic morphological coding in CHAT/CLAN (MacWhinney, 2000). Spontaneous speech data can also underestimate or overestimate linguistic abilities. For example, it has been shown that complex syntactic structures are better studied in elicitation tasks than spontaneous speech (Steel et al., 2013), and fewer errors on morphosyntactic agreement can be found in spontaneous speech compared to elicitation (Royle & Riesing, 2019). Furthermore, the communicative context may not demand or encourage targeted structures.

5.2. Elicitation tasks

A solution is to use elicitation tasks. These probe linguistic structures that are potential domains of weakness in children with language impairment. In this way, one can assess mastery levels and upper limits in children. Elicitation can take many forms. Participants can name pictures, describe events, complete sentences, and respond to questions that are structured to elicit targeted structures (e.g., "What did Kermit do yesterday?" to elicit the past tense, or "This is a wug, these are two __" to elicit plural agreement). Story retell resembles spontaneous speech but is more constrained, and is usually categorized as an elicitation task, as there is a significant amount of priming for all aspects of language, and constraints are much higher on what the child is expected to say than in spontaneous speech.

A method often used in research and clinical settings is word naming or elicitation tasks. In addition to evaluating breadth or depth of lexical knowledge, these are often used to match participant groups or to categorize children as being language disordered or not, and are sometimes used as proxies for global linguistic knowledge. Breadth of lexical knowledge is assessed using, e.g., picture-naming tasks. Short videos or animations are occasionally used for verb naming. Depth of knowledge can be evaluated using oral categorization tasks (e.g., "Which words go together?") or card sorting. Further semantic and grammatical information (i.e., part of speech, Verb, Noun, etc.) can be gathered by asking children for word definitions or how they would use them in a sentence.

Elicitation tasks do however does not providing a global picture of language development. Using only elicitation, it would take too much time to obtain a full portrait of a child's development. This is important because children with language impairment might have relative strengths and weaknesses that are not highlighted by specific tasks. This issue is valid for all the methods we present in the following sections.

5.3. Sentence repetition

A specific subcategory of elicitation tasks is sentence repetition. Leclercq et al. (2014) suggest that the ability to repeat sentences accurately is subserved by two factors: a (morpho-)syntactic factor and a lexical one. They found that both factors contributed almost equally to scores on a sentence recall task: 52.56% of the variance was explained by morphosyntax, and 43.92% was explained by the lexicon. Sentence repetition tasks have been shown to discriminate between children and teenagers with typical development and DLD in many languages including English (Conti-Ramsden et al., 2001) and French (Leclercq et al., 2014; Elin Thordardottir et al., 2011). This task can also discriminate between different types of atypical language development (e.g., DLD and ASD, Sukenik & Friedmann, 2018, however, see Silleresi et al., 2018 for conflicting results).

In a study on Palestinian Arabic (Taha et al., 2021) observed that most grammatical errors made by children with DLD resemble those made by TD children, but that they are more frequent. Also, despite large similarities in error types between the two groups, some atypical errors were exclusively produced by the DLD group. For example, verb omission, or substitution of the singular verb for the plural form (e.g., [ʃirbib], drink-PAST-3MS 'he drank' for [ʃirbu], drink-PAST-3PL, 'they drank'), and passive prefix *in-* omission which results in changing the sentence to active voice, and finally production of fragmented syntax due to multiple omissions. Such observations are highly important as they provide qualitative benchmarks for the study of DLD.

5.4. Grammaticality judgment

The grammaticality judgment task is another device used to probe language abilities. Although some might think that grammaticality judgments are hard to elicit in young

children, this is not always the case. For example, Crain and Thornton (2000) have shown one can use truth-value judgment tasks (TVJT) to tap into grammatical knowledge by evaluating what meaning a child assigns to a given sentence. In this approach, the child will hear a sentence produced by a puppet. For example, if Kermit says "*Only Peter Rabbit will eat a carrot or a pepper*", and Peter Rabbit eats a carrot, an English-speaking child aged 3;06 will accept this sentence as true. The child will reject this as false if Cookie Monster eats a carrot, showing understanding of both the disjunctive reading of "or" and the scope of "only" (Crain & Thornton, 2006). Some advantages to this approach are that the child does not feel tested, ambiguous sentences can be probed, and many types of structures and levels of complexity can be studied. Although most studies have used TVJT for semantics and syntax, they can be used for other linguistic domains, such as phoneme perception (Rvachew et al., 2017).

Other approaches, such as the alien-learner paradigm, have been used to probe sentence or agreement processing in typically developing and language-impaired children. The child can "feed" the alien with "food" when they produce a grammatical sentence, providing positive reinforcement, and avoiding negative responses (Labelle & Valois, 2003). Another way to elicit positive responses for wrong answers is to ask if the sentence sounds "weird" (Courteau et al., 2013). In this approach it is also possible to probe children with follow-up questions such as "Why?", "How would you say it?" etc., thus ensuring that the reason why a child has responded in a certain way is explicit (or, if the child cannot explain why, they might be able to model the correct sentence).

However, one must pay attention to task design as grammaticality judgments are highly prone to Type 1 errors, that is measuring something else than what was supposed to be measured and leading to the conclusion that the initial hypothesis is true. For example, comprehension difficulties might lead children to interpret a sentence as wrong for the wrong reasons. An example of this is a case where the sentence "The cat eats mouse" was judged to be wrong by a child with DLD because of its semantic content. She responded that "Cats eat little balls" i.e., cat food (Rose & Royle, 1999). Type 1 errors are also the bane of comprehension tasks, to which we now turn.

5.5. Language comprehension versus production tasks

The use of both production and comprehension tasks to study and assess DLD is highly relevant as this may help us better comprehend what the underlying linguistic deficits are and differentiate between language profiles of bilinguals and children with DLD. Indeed, while the former groups show difficulties in language production despite good comprehension and grammatical judgement, the latter exhibit production difficulties and impaired comprehension and grammatical judgment. Chondrogianni and colleagues (2015) claim that L2 learners' problems with grammatical morphology are output related and do not reflect impaired underlying grammatical representations. Production difficulties in bilinguals could be caused by lexical access and retrieval difficulties (Bialystok et al., 2008), prosodic differences between languages (Goad & White, 2006), lack of automaticity, or a combination of these. This then creates an expressive-receptive "gap", that is an asymmetry between low production and higher comprehension skills in bilingual children. This gap varies according to the amount of exposure, irrespective to the language family: lexical gaps have been reported in many studies (Gibson et al., 2014).

A "grammatical gap"–better performance in morphosyntactic comprehension than production–has also been reported in bilingual children (Anderson et al., 2019; Pourquié et al., 2019) and bilinguals perform on par with the monolinguals in comprehension but not production tasks (Pratt et al., 2020). This is a good testing ground to disentangle DLD from bilinguals' impaired grammatical production because, in children with DLD, comprehension seems to be more problematic than in typically developing bilinguals. The importance of evaluating comprehension skills in children with DLD cannot be overstated: on-line comprehension studies can provide us with a window into the underlying representations and processing routines of language learners (Chondrogianni et al., 2015). One can employ various techniques to assess comprehension using "on-line" methods such as eye-tracking, and ERPs, or with the aid of off-line tasks such as sentence comprehension, sentence-picture matching, or TVJTs. Whatever the technique used it is essential to use adequate stimuli. Since comprehension involves cognitive skills that go beyond linguistic processing, such as vision and audition. Targeting linguistic comprehension requires controlling the linguistic features of stimuli, such as for instance sentence complexity. More importantly, comprehension tasks targeting specific features

must avoid extra linguistic cues beyond the ones being tested. For instance, the fLEX sentence comprehension task assesses both lexical and morphosyntatic verb processing while avoiding external cues that could be triggered by subject pronouns or phonological liaison between the subject and the verb that exists in French (Pourquié, 2017).
It can be the case that a task developed to test comprehension does not *in fact* test the feature it was designed to probe. For example, Roulet-Amiot and Jakubowicz (2006) probed sensitivity to gender agreement by asking children to make semantic categorisations (e.g., "something you can wear") and presented them nouns with appropriate and inappropriate gendered determiners or adjectives. Children with DLD showed difficulties on the task but were not affected by gender errors. The authors concluded that children with DLD did not have any difficulties processing gender. However, one could argue that the comprehension task could easily be carried out without agreement checking, and that the ability to process and check gender features would have in fact slowed down processing. Thus, is it hard to interpret results from this task as data for (or against) a gender-processing deficits in French-speaking children with DLD. These types of situations can give rise to Type 1 errors, which return to below in section 6.1.

5.6. Language assessment within subdomains

One must not forget that language has multiple subdomains i.e., it is multidimensional (Lonigan & Milburn, 2017). Subdomains are often evaluated separately, to the extent that it is possible. Tomblin and Zhang (2006) give an example of how language is assessed through commercially available batteries: domains such as grammar and vocabulary will be evaluated by different tasks in the receptive and expressive modalities, assuming that subdomains can be impaired or preserved in any individual domain (e.g., preserved receptive syntax versus impaired expressive vocabulary). Recently, challenging the assumption of language's multidimensionality, language acquisition has been studied through linguistic assessment tasks with confirmatory factor analyses, that allow researchers to confirm if the studied constructs are distinct, and to validate if they have empirical foundations (ibid). In children with and without DLD, there is evidence that language's multidimensionality increases with age. Tomblin and Zhang's (2006)

longitudinal study of 1929 children with and without DLD showed that it is valid to consider vocabulary–assessed with word-level tasks–and grammar–reflected by sentence-level tasks–as two separate dimensions starting in second grade. Lonigan and Milburn (2017) also found that vocabulary and syntax were two dimensions starting in preschool, but that they nonetheless shared a lot of variance. Interestingly, both these studies failed to find evidence supporting the idea that language comprehension and production skills are different dimensions.

While grammatical (morpho-)syntactic deficits have been widely investigated in DLD with a variety of experimental methods, less attention has been paid to lexico-semantic deficits. For instance, although Conti-Ramsden et al. (2001) administered vocabulary tasks to their participants, results on these were not included in their diagnostic accuracy analyses. However, studies show impairments on lexical tasks. McGregor et al. (2013) assessed children and teenagers with DLD on their vocabulary breadth and depth. Children with DLD showed deficits on both measures throughout all age groups. Impairments were also found on receptive vocabulary. Using a picture-word matching test in a longitudinal study from ages 2;6 to 21 years, Rice and Hoffman (2015) found lower performance for participants with DLD compared to TL across the study. In a recent study, lexico-semantic relationship tests had an outstanding diagnostic accuracy to discriminate between French-speaking teenagers with and without DLD (Courteau et al. resubmitted).

Impairments in phonological working memory–in the sense of "a limited capacity system allowing the temporary storage and manipulation of information" as defined by Baddeley (2000: 418)–have been observed in teenagers with DLD. Using forward and backward digit span tasks, Arslan et al. (2020) found impaired phonological working memory skills in French-speaking DLD children and teenagers when compared to age-matched controls. Interestingly, there wasn't any difference between the teen groups on visuospatial working memory skills, but the younger DLD group showed significantly lower performance than their aged-matched TL peers on one visuospatial test, suggesting that visuospatial skills can normalize with age.

6. Recommendation for Future Studies

6.1. Avoid developing experiments that result in false positive results

When designing linguistic experiments, one must take care that we are in fact clearly testing our hypothesis. It could be that the results obtained give us the erroneous impression that we have proved our hypothesis whereas in fact the null hypothesis is true. Crain and Thornton (2000) recommend that one should stack the cards in experiments against the null hypothesis to avoid children's responses being right for the wrong reason. In some cases, it might be impossible to test a given feature without "stacking the deck" because of the linguistic properties under investigation. In this case, extreme caution should be taken in data interpretation. One solution to this problem is to develop more than one type of experiment addressing the question at hand. Another solution is to use an interdisciplinary approach to address multiple parameters (linguistic, psycholinguistic, sociological, and clinical) that may come into play.

6.2. Use multiple sources of information

We reviewed several methods with their advantages and disadvantages, typically used to study language acquisition and processing in participants with DLD. A common-sense approach to circumventing many issues is to use multiple tasks, for example combining comprehension and production tasks, or using spontaneous speech and elicitation probes, to obtain richer information sources on linguistic abilities in participants. This approach allows for more nuanced interpretation and a better understanding of linguistic deficits and strengths in participants. The choice of tasks to be used is obviously constrained by research questions and hypotheses, but also by time. Younger children typically need breaks every 30 minutes and might not be willing to stay in the lab for more than 2 hours. A specific, if time-consuming task that can provide complementary information to more classic behavioural tasks is neuroimaging.

Neurocognitive investigations using ERPs have the distinct advantage of allowing us to compare language processing abilities in people with DLD across lexical-semantic and morphosyntactic processing. Children and teenagers with DLD consistently exhibit the N400 component–a component typically linked to lexico-semantic processing, as expected, when processing lexico-semantics (see Royle & Courteau, 2014, for a review,

and Courteau et al. under review). However, ERPs for morphosyntactic processing tend to be different from their peers (ibid), suggesting impairments in this domain. To date, very few aspects and languages have been studied using this technique. For example, at the word level, lexico-sematic incongruency paradigms dominate the field, often in the form word-picture presentation. Furthermore, ERPs have not yet been used to investigate linguistic maturation in DLD, as has been done in second language learning research (see Steinhauer, 2014, for a review).

6.3. Explore the language learning continuum: Go beyond the school years.

In fact, there are relatively few language development studies of people with DLD after grade school. There is a sizable amount of work on educational and social outcomes in teens and adults with DLD (e.g., Durkin & Conti-Ramsden, 2010; Conti-Ramsden et al., 2018), but much less on linguistic attainment, and the majority, if not all, focus on monolingual English speakers. One could ask, what the target grammar is for a person with DLD? This is not a trite question, as it is intimately linked to theories and our understanding of DLD.

However, one challenge in interpreting these results is that for most of the studies, child and adolescent control groups do not present the expected adult patterns associated with mature morphosyntactic processing. This is especially important for ERP research where, again, data on native adult speakers are not available outside a few, mostly Indo-European, languages. Future studies should test adults with DLD to determine whether typical morphosyntactic processing patterns are present, thus providing evidence for maintenance or impairment as a defining feature of DLD.

6.4. Align research with needs

As we just mentioned, some research on DLD focuses on outcomes and attainment. This type of research is not only important for educators and policymakers but also for people with DLD, who do not always feel that research reflects their needs. A growing trend in medicine is the “patient partner” concept where patients actively participate in experiment design, not only as “subjects”. In anthropological linguistics and language revitalization work similar partnerships are becoming the norm, and in some cases

obligatory. With this in mind, researchers in the domain DLD should expect to integrate the needs of the DLD community and persons with DLD as partners in their future research. A recent paper outlines research that persons with DLD would actually like to be investigated (Kulkarni et al., 2022) with the caveat that respondents in this study were from Great-Britain and might not represent the full array of needs of all people with DLD. Some of these can and should be pursued by language specialists. For example, suggestions outline needs for teacher training and interventions focusing on speech, language, and communication-related goals, as well as receptive language skills. Psycholinguists should be invested in this type of research to avoid Type 1 errors discussed above.

7. **Future Directions**

Breaking out of the tradition of working on monolingual and mostly Indo-European languages will not only allow us to better understand DLD but also to account for the varieties of linguistic experiences that are prevalent in our multilingual and increasingly immigrant-rich cultures. Furthermore, as language is learned under diverse conditions, one can question whether monolinguals provide the appropriate benchmark for all learners, be they with or without DLD. One approach that considers diversity in learning conditions uses multi-group comparisons, and groups other than typically developing monolinguals, that include diverse learners and learning contexts, placing immigration, integration and adaptation front and centre.

As mentioned, despite more than 40 years of research, few studies focus on language attainment in adults with DLD. Future studies should explore this area. Domains that could be evaluated are pragmatics, reading and writing and use of language in work settings, in addition to higher level syntax and logic, domains that are rarely investigated in young children but that are important for adults. This work will help us better understand language learning as a lifelong process in DLD, but also allow for better linguistic and social integration in persons with DLD.

As researchers, we often justify our studies simply by stating that science is intrinsically interesting, valuable, and important (and cite the habitual example of how GPS would not exist without Einstein's ideas). But an important issue regarding research on DLD is that it is an almost invisible domain of inquiry, if you compare it to other developmental disorders such as ADHD or ASD (Bishop, 2010). As Bishop notes "when prevalence is taken into account, the number of publications on rare conditions is greatly in excess of that for common conditions" and this is linked to less funding being awarded to less severe conditions, of which DLD is a member, even though social impacts of DLD are significant. Furthermore, research disciplines (medicine, genetics, psychology, linguistics, and speech-language pathology) have different funding opportunities that greatly affect the amount of research in their respective domains. It is thus not an easy task for researchers interested in DLD to convince decision makers to fund their research. We can suggest two approaches that might help resolve this issue. First, working in interdisciplinary teams to obtain funding for research that is grounded in clear linguistic descriptions and informed testing of language abilities, while expanding linguistics' imprint on health and other sciences interested in DLD (e.g., genetics and neuroimaging). Second, working with the DLD community to promote research that not only helps us better understand what DLD is, but also has a positive impact on their lives.

8. Further Reading

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9. **Related Topics**

autistic spectrum disorder, dyslexia, bilingualism, multilingualism

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