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Forming new words: compounding in children with developmental language disorders

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Compounding is a common word-formation strategy in Germanic languages such as English and German. This study focuses on German compounding, which is highly productive and frequently used to create new words. The ability to form new words through compounding has been observed in German-speaking children from the early stages of language acquisition. There is evidence suggesting that children with Developmental Language Disorder (DLD) may struggle with understanding and producing compounds compared to their peers with typical development (TD). These difficulties include challenges with the correct order of compound components. The present study examined compounding competence, specifically focusing on the correct ordering of compound components, in children with DLD and TD aged 4 to 5 years. Two elicitation tasks were conducted. In experiment 1, we compared the word-formations of 28 children with TD and 28 children with DLD when naming low-frequency everyday objects with those of an adult control group ($n = 10$) from a pilot-study. Across all three groups, compounds were the predominant word-formation strategy, with no difference between the three groups. Experiment 2 involved a production and a reception task using novel compound nouns. It was applied to 31 children with TD and 30 children with DLD. Furthermore, we compared the results of the production task with an adult control group from a pilot-study ($n = 23$). Both child groups produced compounds with word-order errors (inversions). In the production task, inversion rates did not differ significantly between the two child groups, but both inverted compound components significantly more often than the adult control group. However, in contrast to expectations, children with TD showed more inversions than children with DLD in the reception task ($U = 296.5$, $Z = -2.4$, $p = 0.014$). Taking into account methodological issues, we concluded that compounding might serve as a linguistic resource for children with DLD, as they may rely on it to fill lexical gaps, especially when receiving and comprehending language. Further research is needed to deepen our understanding of processing and acquisition of compounds in children with DLD and TD, taking into account the high inversion rates of the children aged 4 to 5 years.

KEYWORDS

DLD, compounding, word-formation, language processing, language acquisition

1 Introduction

Developmental Language Disorder (DLD) is one of the most prevalent neurodevelopmental conditions with a prevalence of ~0.10% worldwide (Norbury et al., 2016; Neumann et al., 2022) leading to disadvantages in education, social life and mental health, which often persist into adulthood (Clegg et al., 2005; Wilmot et al., 2024). Despite its high prevalence and long-term impact, DLD remains severely underfunded and one of the least researched neurodevelopmental conditions (Bishop, 2010; McGregor, 2020).

Taking into account the recent discussion about terminology (Bishop et al., 2017; Lüke et al., 2023), in this paper, DLD is understood as a significant deviation from typical language development measured with a standardized language test as a minimum of 1.5 standard deviations below the mean compared to children of the same age. DLD can affect all speech modalities and linguistic levels individually, rendering this disorder highly heterogeneous (Nudel et al., 2023). There is evidence for symptoms and treatment effectiveness in the areas of phonology, lexicon-semantics and syntax, while the role of morphology, especially compounding remains under-researched (cf. Neumann et al., 2022). This is highly unexpected, considering the role of the ability to form and understand new words for the expansion and structuring of the mental lexicon. Research on morphological abilities of children with DLD could lead to a better understanding of its influence on vocabulary size, language comprehension and language processing within DLD. Taking into account the role of compounds in the German language, especially in academic language (Feilke, 2012; Fuhrhop and Olthoff, 2019), a disadvantage for children with DLD in understanding and forming new words can be assumed, eventually leading to the need for more focused support in forming and understanding new compound words.

Following these research gaps, the aim of the present paper is to investigate the word formation strategies, especially compounding competences, of children with DLD. The remainder of this article is structured as follows: First, an overview of the classification of compounds relevant to the present study will be given, followed by a presentation of the current research on compound acquisition and what is known for children with DLD. Afterwards, the research questions and hypotheses are explained, followed by the description of the methodological approach. We will then present our results and conclude with a discussion.

1.1 Definition of compounds

Compounding is the most widespread word-formation strategy in languages worldwide, while English and German, as representatives of the Germanic languages, have a high preference for the use of compounds (Dressler, 2006). A compound is the result of a word-formation, where two or more words are combined (Hentschel, 2020). Besides compounding, a further word-formation strategy is the derivation, where a suffix is attached to a free morpheme (Schlücker, 2012) as seen in *Les-er* "read-er" or *Les-ung* "read-ing". German compounding is highly productive, mostly leading to a combination of two or more words. According to Wellmann (1991), approximately 75% of the German noun vocabulary consists of compound-nouns. Some words are combined with linking elements of which the *-s* like in *Wissenslücke* "knowledge gap" is the most common in German (Hentschel, 2020). However, these elements will not be the focus of this paper. German compounds are mostly composed of two constituents and often appear without a linking element, as in Obstbaum "fruit tree" (Schlücker, 2012, p. 5). The right constituent, *Baum* "tree" in this example, functions as the head, determining the overall meaning of the compound. The first constituent, *Obst* "fruit", provides additional specification and is referred to as the modifier. This example is known as an endocentric or determinative compound and accounts for 99.9% of German compounds (Hentschel, 2020). German and English endocentric compounds are realized right-headed, as illustrated in the example *Obstbaum* "fruit tree". In other languages, like Romance languages, compounds are mostly realized left-headed. Contrary to endocentric compounds, there are exocentric compounds, which are unusual in German, but more common in languages like Italian and English (Schlücker, 2012). An exocentric compound noun does not have a clear head, because the word as a whole does not belong to the same word class or category as one of its components. The meaning goes beyond the individual components, as illustrates in *Spaßbremse* "killjoy" (Schlücker, 2012, p. 6). A further classification is the distinction between root and synthetic compounds. The head of a synthetic compound is always derived from a verb, like in *Buchleser* "book reader", which describes the relation of meaning. For root compounds, like "fruit tree", the semantic relation of the constituents is not obvious and has to be interpreted situationally (Müller et al., 2015). While this can cause challenges and misunderstandings due to unfamiliar words, it also enables the creation of new and unfamiliar terms through novel compounds, which is a key factor in the high productivity of German compounding. Additionally, the right-headedness has to be considered during the interpretation of a compound, because a change of the modifier and head can lead to a change of meaning, as illustrated by the example *Orangensaft* "orange juice", and *Saftorange* "juice orange", which are both lexicalized German words. German compounding is also characterized by its complexity. While most German compounds consist of two constituents, 10% include three elements, and 1.5% are made up of four constituents (Ortner and Müller-Bollhagen, 1991, cited in Schlücker, 2012). Compounds that contain particles like in *überfließen* "overflow" (Marchand, 1969 cited in Schlotthauer and Zifonun, 2008, p. 274) illustrate, that a distinction between syntactic and morphological units is somehow controversial.

In contrast to derivational morphology, which is a comparably clear rule-based operation, "compounding is governed by more malleable principles" (Leminen et al., 2019, p. 28). Compound word creation offers a certain degree of freedom in the placement of a particular constituent morpheme within a compound. Therefore, there are different possibilities for word constructions and two or more elements can be differently combined to create a novel compound (e.g., the constituent *man* can be the first or the last constituent, like in *milkman* or *manpower*, Leminen et al., 2019, p. 28). This freedom could represent a difficulty in acquisition.

Compounds are particularly fascinating from a linguistic perspective. On the one hand, they function as morphological units that can often be expressed through syntactic structures. On the other hand, they consist of two or more lexical elements that combine to form a single word, whose meaning may sometimes only be inferred from context. Additionally, phonological aspects are important when combining words, for example through changes of prosodical patterns (Grimm, 2010). Compounds therefore can be described as a linguistic interface phenomenon.

1.2 Acquisition of compounds

To date, studies on German-speaking children remain limited. Dressler et al. (2010) analyzed spontaneous speech data from two Austrian children and found that compounds first emerged at 1;8 for the boy and 1;10 for the girl. Initially, the boy produced lexical compounds such as *Müllauto* "garbage car" and *Segelschiff* "sailing boat" before creating novel compounds like *Lasterwagen* "truck car". The girl, in contrast, began forming novel compounds such as *Leniomi* "Lenigranny" to refer to her grandmother. By 2;4, she was producing lexical compounds like *Käsebrot* "cheese bread" (Dressler et al., 2010, p. 326–327). The emergence of novel compounds is considered a sign of linguistic productivity. No instances of word order reversal were reported for the two children. However, the author describes such an error made by his daughter (2;6), who produced *Berg-häferl* instead of *Häferl-berg* for the name of a mountain, that looks like a cup (Dressler et al., 2010, p. 340).

In a longitudinal study, Schipke and Kauschke (2011) examined spontaneous speech from 39 mother-child interactions with monolingual German-speaking children aged 1;1 to 3;0. Their findings revealed both an absolute and relative increase in word formations within the second and third years of life, with compounding and derivation appearing simultaneously at around 1;9. Additionally, 10% of the observed word formations were lexical innovations, including compound nouns such as *Automensch* "car man" to describe a robot (Schipke and Kauschke, 2011, p. 75). Further observational research suggests that German-speaking children tend to create novel compounds to compensate for lexical gaps, particularly by using compound nouns. For instance, they might coin *Brennlicht* "burning light" to refer to stars (Stern and Stern, 1968, cited in Elsen and Schlipphak, 2015). The ability to form new words has been observed at a very early stage in German language acquisition

So far, further studies investigating the acquisition of compounds focused on semantic, phonological and morphological aspects. Lexical-semantic aspects of compounds are observed in studies focusing on the ability of understanding compounds (Krott and Nicoladis, 2005) and forming novel words with regard to the semantic relations that are conventional in their language (Clark et al., 1985; Nicoladis, 2003). Phonological abilities like prosodic word structure were investigated amongst others for Swedish (Mellenius, 1994) and German (Grimm, 2010). Morphological aspects such as the use of linking elements and inflection (Rosenberg and Mellenius, 2018) as well as plural use of the modifier (Nicoladis, 2005) were investigated for Germanic and Romance languages as well.

In this study, we will focus on the structural or morphosyntactic constraints of the formation of compound-nouns: the order of the head and the modifier. For the acquisition in English, there is evidence, that children understand the relation of the head and modifier at the age of two (Clark et al., 1985). This was investigated by applying a word-picture matching task with 60 children aged 2;0 to 6;0. In each trial, the child was presented with four pictures: one depicting the target word (e.g., mouse hat, a hat on a mouse), one showing only the modifier (mouse), one showing only the head (hat), and one acting as a distractor that included the correct head but a different modifier (fish hat, a hat on a fish). The authors interpret their findings as evidence that in English-speaking children a taxonomic category organization is already present in the mental lexicon by the age of two. However, it remains unclear whether children at 2;4 had already acquired the modifier head order in English, as it is uncertain how they would have interpreted reversed constructions such as hat mouse in this context (Clark et al., 1985). Clark et al. (1986) also investigated the production of novel compounds. Their findings suggest that 3- and 4-year-old children tend to produce more inverted, ungrammatical forms, such as *puller wagon* to describe someone who pulls a wagon, whereas 5- and 6-year-olds more frequently generate grammatical forms like *wagon puller*. This indicates a developmental phase in compound acquisition, during which English-speaking children initially invert the order of compound components. In a subsequent study, Clark and Barron (1988) asked children aged three to six to evaluate grammatical forms like *wagon puller* and ungrammatical forms like *puller wagon* and to correct them. Results showed a positive influence of age on the detection of ungrammatical forms. However, many of the children's corrections remained ungrammatical, which Clark and Barron (1988) interpreted as evidence that comprehension develops ahead of production.

However, there are indications from observational studies, that German-speaking children disobey the right-headedness and show inversions of the compound elements as well at a very young age around 2 years. Elsen and Schlipphak (2015) report about observed inversions produced spontaneously by a 1;9 years old German-speaking girl referring to *Fingernägel* "fingernails" and *Fußnägel* "toenails" as *Nagelfinger* "nailfinger" and *Nagelfuß* "nailtoe". Rainer (2010, cited in Elsen and Schlipphak, 2015, p. 2123) reports about a stage from 3 to 4 years, where children seem to have difficulties placing the constituents in the correct order. However, Dressler et al. (2010) found inversions to be rare in their study and Schipke and Kauschke (2011) do not mention any inversions at all. Nevertheless, Dressler et al. (2010) emphasize the relevance of investigating morpheme order in typologically different languages.

The studies mentioned above investigated exclusively monolingual children. Evidence for bilingual children on morphological acquisition is rare, but there are studies investigating cross-linguistic influence of English and French (Nicoladis, 2002), English and Persian (Foroodi-Nejad and Paradis, 2009) and Spanish and Japanese (Kutsuki, 2019) on production and reception of novel compound nouns with respect to the head modifier order. The studies revealed that bilingual children are more likely to invert compound components than their monolingual peers. This is interpreted as cross-linguistic influence, due to different word-formation strategies of the languages compared. The method of these three studies was applied to the German context by this research group (Scherger et al., 2024). They investigated 16 monolingual German-speaking children and 19 bilingual German-speaking children with 7 different first languages. The results support the previous findings that bilingual children might display cross-linguistic influence in applying the left-headedness when producing and understanding novel compounds. A higher inversion rate for production was also found for bilingual children compared to monolingual peers in another study by these author group (Scherger and Kliemke, 2021). They asked nine monolingual and nine bilingual children aged 7 to 8 years to name low frequent complex objects and analyzed their used word-formation strategies. The word-formation strategies observed did not differ in use and extent between bilingual and monolingual children.

Regarding the present investigation, the focus lies on DLD exclusively in monolingual acquisition in order to avoid a confounding of effects of DLD with effects that bilingualism might have. Because of this, bilingualism will be an exclusion criterion in this study, but investigated further in another study (Giesselbach and Scherger, submitted).

1.3 Compounding in language disorders

Developmental Language Disorders can affect semantic-lexical abilities, phonological abilities, morphological-syntactical and/or communicative abilities of children to an individual extent.

A delayed onset of vocabulary acquisition is often one of the first signs of DLD (Sansavini et al., 2021). As their development progresses, children with DLD typically fail to catch up with the vocabulary of their peers with typical development (TD). Research suggests that deficits in lexical-semantic organization may be a contributing factor (Sheng and McGregor, 2010). The constituents of compound words are often semantically related either through a part-whole relationship (meronymy) or a category-subtype connection (hyponymy), as illustrated by the example *fruit tree*. The hypernym *tree* functions as the head, while the modifier *fruit* provides further specification. Together, they form the compound noun *fruit tree*, which is a hyponym of tree. Deficits in lexical organization may therefore result in difficulties with both the comprehension and production of compounds. Additionally, compounding can result in complex word-formations, particularly in German, which, according to Motsch et al. (2022), may contribute to difficulties in word storage and retrieval. However, research has shown that children with lexical deficits create novel compounds to compensate for gaps in their vocabulary. In an intervention study by Ulrich (2012, cited in Motsch et al., 2022, p. 36), children referred to a *Bügeleisen* "iron" as *Glattmacher* "smooth maker". This demonstrates the formation of a synthetic compound that describes the function of the object as a reaction of a lexical gap. Grimm (2010) investigated the interaction between phonological and lexical abilities in German compounding as part of her dissertation. She describes that an increase in lexical knowledge drives the phonetic differentiation of words, which in turn enhances the phonological precision of target word production. Words are stored in connection with phonologically similar words, known as phonological neighbors (a. o. Yates, 2004). To differentiate phonological neighbors from one another, additional storage of phonetic details is required, which supports the computation of phonotactic probabilities. In German, certain phoneme sequences, such as /nt/ in *Hand* ("hand"), are more common, so called phonotactically legal, whereas sequences like /sk/ in *Skat* aren't common or phonotactically illegal. Compounding often leads to phontactically illegal phoneme sequences, such as /tb/ in *Luftballon* ("air balloon"; Grimm, 2010). Because of this, Grimm argues that the constituents of compounds are stored separately, which could lead to inversions of word order. How these acquisition processes manifest in children with DLD remains unclear and is therefore identified by Grimm (2012) as a research desideratum and has not been researched since.

As compounding is defined as a linguistic interface phenomenon, compounding could be affected by children with DLD on different linguistic levels.

To date, relatively few studies have examined compounding in children with DLD. Most of the studies are from English speaking surroundings, mostly focusing on morphological aspects, like inflection and plural formation in synthetic compounds (van der Lely and Christian, 2000; Clahsen and Almazan, 2001), indicating that children with DLD have more difficulties than their peers with TD. Three studies focused on phonological aspects of compounding, reporting difficulties for children with DLD who speak Greek (Dalalakis, 1999; Kehayia, 1997) and Japanese (Fukuda and Fukuda, 1999). Padrik (2005) investigated 40 Estonian children with and without DLD. They were asked to name people who carried out different activities, like *the man catches fish*. In Estonian, this can be realized as a conversion *fisher*, a compound-noun *fishman* or a synthetic compound *fish-catcher*. Results showed that children with DLD were more likely to produce phrases and simple words like *man* to describe the people, compared to the children with TD, who produced mostly conversions, which is according to Padrik (2005) the preferred word-formation in Estonian for personal descriptions. A disorder that frequently co-occurs with DLD is autism spectrum disorder (ASD). The comprehension of conventional compounds was examined by Riches et al. (2012) in four groups: adolescents with TD, adolescents with ASD with and without Language Impairment (LI), and adolescents with DLD. Adolescents with ASD-LI and DLD exhibit similar difficulties in explaining the meaning of compounds, which has been attributed to semantic-lexical deficits. Additionally, Kambanaros et al. (2019) found that children with ASD had more difficulty explaining the meaning of novel compounds compared to their TD peers. In line with the research focus of the present study, Grela et al. (2005) and McGregor et al. (2010) found more inversions in children with DLD than in children with TD. Grela et al. (2005) asked ten English-speaking children aged 4;8 to 7;0 to invent new names for example for animals living in a certain place or objects that are made of a certain material. All children formed compounds, but only 65% of the children with DLD formed right-headed compounds. Children with TD followed the principle of right-headedness in 97% of the utterances, which indicates a difficulty for children with DLD compared to children with TD applying the right-headedness when producing novel compounds. Following the methodical approach by Grela et al. (2005), McGregor et al. (2010) found comparable results, as children with DLD (aged 5;0 to 8;6) showed more word error mistakes when producing novel root compounds (e.g., umbrella horse for an umbrella with horses on it). However, children of both groups produced novel compound-nouns. Additionally, they asked children with

DLD to explain conventional English compound-nouns (e.g., "Why do we say car door?"), like Krott and Nicoladis (2005) did. The children with TD outperformed children with DLD at explaining the meaningful relationship between the modifier and head. The authors attributed this difficulty to faulty lexical-semantic processing abilities in children with DLD related to reduced knowledge of the relationships between words in their semantic lexicons.

According to Libben et al. (2020), compounds provide valuable insights into the organization of the mental lexicon due to their dual nature as both integrated structures and combinations of recognizable sub-elements. Thereby the question arises, whether compounds are processed holistically or decomposed. There is evidence for multiple routes from EEG, MEG- and fMRI research (MacGregor and Shtyrov, 2013; Holle et al., 2010; Leminen et al., 2019). The psychocentric view suggests that both whole-word representation and representations of constituent lexemes are necessary to process compounds (Libben, 2014). The argument of efficiency can be used in favor for both processing ways: representing only single constituents of compounds in the mental lexicon would result in considerable storage efficiency, while representing all multimorphemic compounds in their full forms would increase the size of the mental lexicon but result in less computational parsing mechanism needed (computational efficiency, see Libben, 1998). Leminen et al. (2019, p. 31) point out, that "research on compounding is somewhat scarce" and that further research is needed. Semenza and Mondini (2015) emphasize, that word-formation investigations in language disorders reveal interesting information about processing of complex words. To the best of our knowledge, no studies have investigated language processing in relation to compounding in children with DLD.

To summarize, German-speaking children begin using compounds before the age of two, primarily relying on lexicalized words but also creating novel compounds already (Dressler et al., 2010; Schipke and Kauschke, 2011). Early in language acquisition, difficulties in applying right-headedness can lead to the production of inverted compounds (Elsen and Schlipphak, 2015). Research on English-speaking children with DLD suggests that they struggle more with right-headedness when producing and understanding conventional and novel compounds compared to their peers with TD (Grela et al., 2005; McGregor et al., 2010). However, there is limited evidence on the compounding competencies of German-speaking children with DLD and the implications for their processing of complex words. This study addresses this gap by focusing on German-speaking children aged 4 to 5 years. At this age, children with TD have typically mastered the principle of right-headedness, whereas English-and Estonian-speaking children with DLD show persistent difficulties (Padrik, 2005; Grela et al., 2005; McGregor et al., 2010).

2 Research questions and hypotheses

The aim of this study is to investigate the competencies of monolingual German children with DLD to produce and understand novel compounds. Therefore, two elicitation procedures were applied to children with and without DLD aged 4 to 5 years.

The performance of the two groups will be analyzed and compared to answer the following research questions:

RQ1. Which word-formation strategies (compounding or derivation) do children with DLD show compared to peers with TD and adults when naming low-frequency everyday objects?
RQ2. Do children with DLD invert compound components more often in the comprehension and production respectively of novel compounds compared to peers with TD and adults?
RQ3. How do therapy focus (phonology, morphology-syntax or lexicon-semantics) and therapy duration influence the inversion rates of children with DLD in their production and comprehension of novel compounds?
RQ4. How do age and gender influence the inversion rates of children with DLD and TD in their production and comprehension of novel compounds?

Based on findings from the literature, we hypothesize that children with DLD will produce fewer compounds when naming low-frequency everyday objects and generating novel compounds compared to TD children and adults. Instead, they are expected to respond more frequently with simplizia, descriptions or provide no response, similar to findings in Estonian children with DLD (Padrik, 2005). Given the indications from Grela et al. (2005), McGregor et al. (2010), and the broader scientific consensus that children with DLD show more linguistic difficulties than their TD peers (Bishop et al., 2017; Lüke et al., 2023), we further hypothesize that children with DLD will invert compound components more frequently than children with TD in both experiments of the present study. Considering the heterogeneity of DLD, we will examine whether the focus of therapy influences inversion rates. However, we hypothesize no such effect, as successful word-formation requires an interplay of semantic-lexical, phonological, and morphological competencies, as outlined in the background. Based on evidence supporting the effectiveness of speech and language therapy (Neumann et al., 2022), we expect that a longer therapy duration will reduce inversion rates in children with DLD. Furthermore, since previous research indicates that children with TD in an early acquisition phase also invert compound components (Clark et al., 1986; Clark and Barron, 1988; Dressler et al., 2010; Elsen and Schlipphak, 2015), we predict a negative influence of age on inversion rates.

3 Materials and methods

3.1 Participants and data collection

To compare the word-formation strategies in TD and DLD, 61 monolingual children with DLD ($n = 30$) and TD ($n = 31$) aged 4 to 5 years were recruited from speech therapy practices and kindergartens in North-Rhine Westphalia, Germany. The presence of typical language development was verified using the *Sprachentwicklungstest für 3-5-jährige Kinder* (SETK 3-5, Grimm, 2015). None of the TD children were receiving speech or language therapy at the time of the study. The results of the SETK 3-5 confirmed no need for therapy. Furthermore, children with

TABLE 1 Participant characteristics.

	Children with DLD ($n = 30$)	Children with TD ($n = 31$)	Adults ($n = 33$)
Age	$M = 60.9$, $SD = 6.9$ *range* = 48–71 months	$M = 59.4$, $SD = 5.9$ *range* = 50–71 months	$M = 37.7$ years, SD=16.3 *range* = 18–73 years
Gender	m = 56.7%, f = 43.3%	m = 41.9%, f = 58.1%	m = 53.1%, f = 46.9%

other disorders, likely to co-cause a DLD, were excluded from the study. Therefore, parents confirmed that their children were not suspected or diagnosed with the following conditions, which are according to Bishop et al. (2017) and Lüke et al. (2023) considered to be other contributory causes of DLD: intellectual disabilities (IQ below 70), genetic syndromes, hearing disorders, childhood aphasia, childhood brain damage, neurodegenerative diseases, disorders from the autistic spectrum, and motor disorders. All children with DLD were already receiving speech and language therapy on average for 13.7 months ($SD = 6.0$, *range* = 3–28 months). The therapy duration for eight of these children is unknown. Information regarding therapy duration, therapeutic focus and diagnostic assessments was obtained from the treating speech-language therapists with a written questionnaire. According to the overarching nature of the phenomenon compounding as outlined above, the children's therapy focus had to include at least one of the following structural linguistic domains: lexical-semantics, morphology-syntax, or phonology. Children with isolated phonetic disorders, fluency disorders, or voice disorders were excluded from the study. For 12 children, therapy focus was on lexicon-semantics and for 16 children it was on phonology, while only two children received therapy due to deficits in the morphosyntactic domain. According to the therapists, the diagnoses were made using the following standardized, normed language tests from German: SETK3-5 (Grimm, 2015), PDSS (Kauschke et al., 2022), TROG-D (Fox-Boyer, 2023) or AWST-R (Kiese-Himmel, 2005). For 19 children, no information is available on the assessment tests used for the diagnosis. A total of 31 children with TD was assessed twice in their kindergarten setting: first, for the exclusion of DLD, and on a separate session for the experimental tasks. Testing took place in a quiet room, where the experimenter presented visual stimuli on a laptop. The same experimental tasks were applied to 30 children with DLD within their speech therapy practices. However, due to advantages in terms of practicability, 13 assessments were conducted remotely via Zoom, with the experimenter connecting to the speech therapy practice online and receiving on-site support from the speech therapist. As Table 1 shows, the age ranges are comparable between groups (Mann-Whitney $U = 300.00$, $p = 0.340$).

Additionally, we analyzed adult data from two pilot studies (Scherger and Kliemke, 2021; Scherger et al., 2024), including 33 adults aged 18 to 73 years. The adults were asked to name the low-frequency objects (experiment 1) or novel compounds (experiment 2) in a paper-pencil study. Table 1 provides an overview of the participant characteristics.

To explore the word formation strategies of the two groups, two different experimental procedures were applied.

FIGURE 1
Item 1 of Experiment 1 (Scherger and Kliemke, 2021, appendix).

3.2 Experiment 1

3.2.1 Material & Procedure

Experiment 1 is a picture-naming task using 15 images depicting low-frequency real objects or object components. Based on a pilot study with ten adult German speakers and a study with mono- and bilingual children, we anticipated conventional lexical gaps in children with TD and DLD, as well as for adults (Scherger and Kliemke, 2021). A complete list of items is provided in the study by Scherger and Kliemke (2021, Appendix).

Figure 1 illustrates Item 1 from the elicitation procedure. Participants were instructed to create a single-word name for the depicted item, which was typically circled. If they named or described the entire picture instead, they were asked again pointing to the circled object part. Since the experiment did not assess lexical knowledge, unknown objects were explained to the children before they were asked to name them.

This experiment was conducted with 28 children with TD and 28 children with DLD of the child groups from Table 1. Additionally, data from a pre-study were analyzed, in which ten monolingual German-speaking adults aged 18–57 years ($M = 27.1$) were asked to write down names for 13 of the 15 items (Scherger and Kliemke, 2021).

3.2.2 Analysis

The children's performance was video-recorded. Afterwards the reactions of the children were transcribed and analyzed on the basis of the definitions given in Table 2.

To compare the reactions across the three groups, the average number of each reaction type (see Table 2) for each participant was calculated. Afterwards, mean values were compared between groups. Additionally, we analyzed all compounds in terms of their right- and left-headedness and their complexity, defined by the number of components. This also included combinations with verb particles, such as "on," "out," "over," etc. These were classified as compound constituents (Schlotthauer and Zifonun, 2008). For example, the reaction *Rausreindrücker* "out in pusher" was interpreted as a compound with three components. Furthermore,

TABLE 2 Definitions and examples for reaction types.

Reaction type	Definition	Example (Figure 1)
Compounds	A combination of two or more words or particles.	*Seifenblasenstab* ("Soap bubble wand")
Simplizia	A word that consists of a single morpheme.	*Stiel* ("handle")
Derivations	A combination of words and confixes with word-formation affixes like *-er* or *-ung*.	*Puster* ("Blower")
Phrases	Description of the appearance or function of the item.	*long yellow circle*
Zero reactions	No reaction even after a second request and explanation of the item's function.	*I don't know*/no answer given

Rausreindrücker was analyzed as a synthetic compound, which was analyzed as a subcategory of compounds. In addition to reaction types, we also analyzed whether the reactions were novel words or existing German lexical words.

3.3 Experiment 2

3.3.1 Material

To investigate the comprehension and production of novel compound nouns, an elicitation procedure was administered to 31 children with TD and 30 children with DLD, of which 28 participated in experiment 1. The procedure was developed based on international studies examining word-formation strategies in monolingual and bilingual children (Nicoladis, 2002; Foroodi-Nejad and Paradis, 2009; Kutsuki, 2019;). It has previously been applied to mono- and bilingual children aged 2;7 to 8;11 years (Scherger et al., 2024). Before, the suitability of the selected items for forming novel compounds was tested with 23 German-speaking adults and one monolingual German-speaking 5-year-old child (ibid.). The elicitation procedure consists of a production and a comprehension task, each including 16 test items and two practice items. Novel compound nouns were specifically chosen to avoid disadvantaging children with DLD due to lexical gaps and to assess their ability to generate new words. The compound components are real nouns, selected to represent familiar, child-oriented concepts (e.g., pear and frog), resulting in novel compounds such as frogpear (see Figure 2).

3.3.2 Procedure production task

To eliminate lexical gaps in naming the individual components of the compound, children were first asked to name each constituent separately in both the production and reception tasks. If a child provided no response or an incorrect one, the target word for the constituent was supplied. To prevent priming effects, the components were presented in a randomized order. In the production task, after naming the constituents, children were then asked to form a novel compound noun by combining the two given components to label the new item. The task was introduced with an example and a practice item, which was corrected to ensure comprehension. The following reactions have not been corrected.

3.3.3 Procedure comprehension task

After naming the constituents in the comprehension task, the children were asked to select the picture that matched the target item (e.g., mousebook). The target item was presented without an article to avoid priming effects. As shown in Figure 3, the options available for selection included the target item (mousebook = 3), the inversion (bookmouse = 4), and the two individual components (book = 1 and mouse = 2) as distractors in a randomized order. The first two items were an example and practice item as well.

For a child-friendly approach, the test was integrated into a frame story in which the children were asked to help a professor and his assistant by thinking of names for new inventions (production task) and showing suitable pictures for names of new inventions (comprehension task). To prevent priming effects, the production task was placed before the comprehension task.

3.3.4 Analysis

The experimental task was video-recorded and children's reactions were transcribed and analyzed afterwards. For the production task we analyzed whether they produced compound nouns or described the picture (e.g., *"pear with frogs on it"*). When they produced a compound noun, we analyzed the order of the components and if they inverted them by naming it pear frog, which would be a frog with pears on it. The pointing reactions of the children in the comprehension task were documented and analyzed as well.

The analysis for the production and reception task included calculating the inversion rates for each participant. Then, we compared the mean values of the production task between the two groups of children and the control group with adults. The inversion rates of the reception task were compared between the two groups of children, because the reception task was not applied to the adults during the pre-test. The inversion rates of participants who described or did not respond to at least half of the items in the production section were excluded from the mean calculation to avoid distortion.

3.4 Data analysis

The aim of the **first research question** was to investigate the word-formation strategies when naming low frequency objects of children with DLD compared to peers with TD and adults. In order to answer the first research question, we compared the percentages of the analyzed responses, with a particular focus on compounds, including their inversions and complexity. Due to the unequal distribution of data across the three groups, we applied the non-parametric Kruskal-Wallis test.

Addressing the **second research question**, the inversion rates were compared in the production task between the three groups. Due to non-equally distributed data, we calculated the rank sum Kruskal-Wallis test as well. For the reception task, we compared the

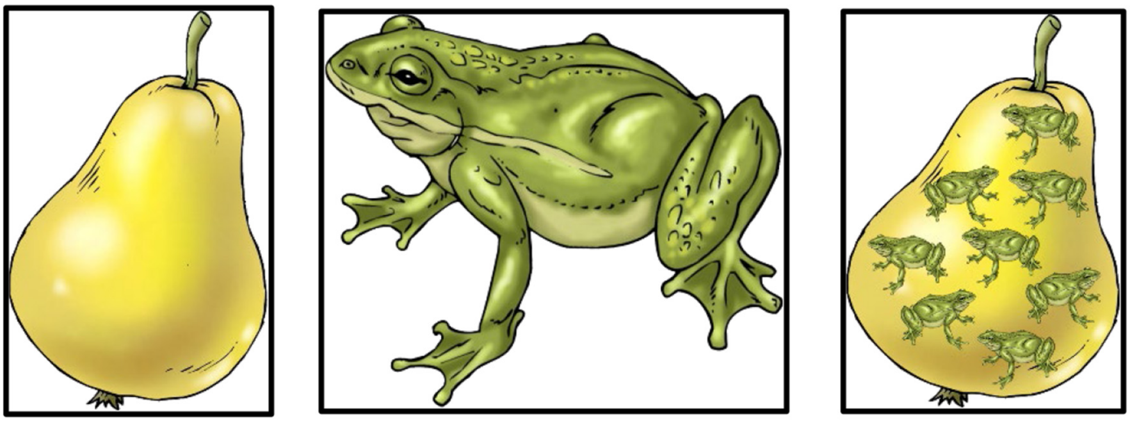

FIGURE 2
Example for the production task: Pear + Frog = Frogpear.

FIGURE 3
Example for the comprehension task: Book + Mouse = Mousebook (3).

inversion rates between the two child groups. Since the data were not normally distributed, we applied the Mann-Whitney U test.

With regard to the **third research question**, the influence of therapy focus and duration on the performance of the children with DLD in the production and reception task of experiment 2 was analyzed calculating two multiple linear regression models.

In order to answer the **fourth research question**, multiple linear regressions were carried out to investigate the influence of age, gender and DLD on the inversion rate in the production and reception task of experiment 2.

To account for multiple comparisons, we applied the Bonferroni correction to control the family-wise error rate. Given that four hypotheses were tested simultaneously, the conventional significance level of $\alpha = 0.05$ was divided by the number of tests (4), resulting in a corrected alpha level of $\alpha = 0.0125$ for each individual test.

The calculations were carried out with SPSS (IBM).

4 Results

4.1 Experiment 1

In total, 786 responses were analyzed across the three groups. Three children with DLD and one child with TD were excluded from the analysis as they did not respond to at least half of the items. Among the remaining participants (TD: $n = 27$, DLD: $n = 25$, adults: $n = 10$), 10.9% of responses were zero reactions. Figure 4 provides an overview of the analyzed responses from the children with TD and DLD and the adult control group. Across all groups, compounds were the most frequently used strategy for naming the low-frequency objects (TD: $M = 55.96$, $SD = 24.84$; DLD: $M = 59.52$, $SD = 21.72$; adults: $M = 69.63$, $SD = 15.05$). On a group level, 43.0% of the produced compounds were synthetic compounds. The second most common response type was classified as simplizia (TD: $M = 22.45$, $SD = 18.53$; DLD: $M = 20.14$, $SD = 14.04$; adults: $M = 18.54$, $SD = 12.92$) while derivation was the least frequent word-formation strategy (TD: $M = 4.59$, $SD = 8.02$; DLD: $M = 5.84$, $SD = 9.04$; adults: $M = 0.76$, $SD = 2.30$). On average, 13.4% of the items were described in a phrase.

After Bonferroni correction, there was no significant difference for zero reactions between the three groups (Kruskal-Wallis-$H = 6.5$, $p = 0.038$). For the other reaction types, no significant differences were observed across the three groups (Kruskal-Wallis-test: compounds: $H = 2.7$, $p = 0.175$; simplizia: $H = 0.0$, $p = 0.957$; derivations: $H = 2.9$, $p = 0.223$; phrases: $H = 1.1$, $p = 0.564$).

In their compound production, five children with DLD, four children with TD, and one adult inverted compound components. The overall inversion rates were 3.8% for children with TD, 3.2%

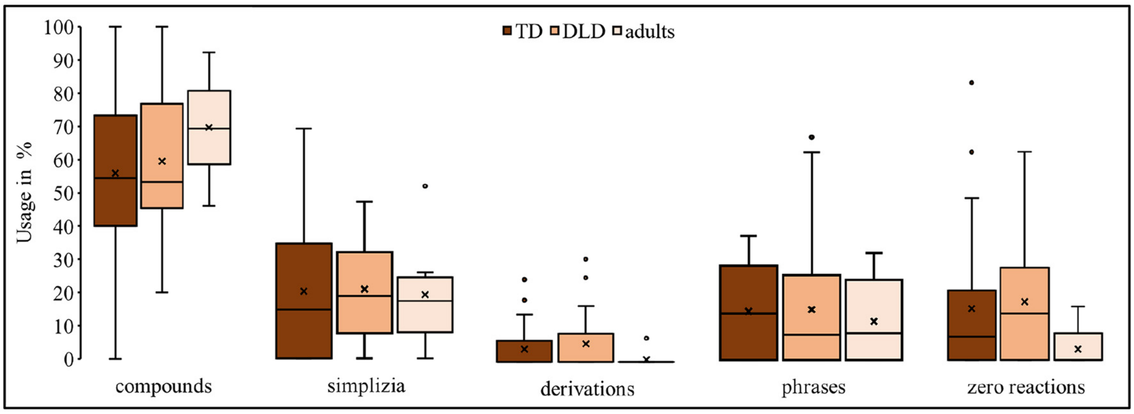

FIGURE 4
Percentage of reaction types observed for experiment 1.

for children with DLD, and 1.0% for the adult control group. A Kruskal-Wallis test showed no significant difference between the three groups ($H = 0.4$, $p = 0.780$). Across all groups, the majority of compounds consisted of two components (TD: 72.1%, DLD: 77.8%, adults: 55.3%) like *Blasenstab* "bubble wand". Compounds consisting of three elements, such as *Seifenblasenstiel* "soap bubble stick", were produced in 25.9% of cases by children with TD and in 20.4% of cases by children with DLD, whereas adults formed 32.7% of their compounds with three components. More complex compositions with four or more components were rare in both child groups (TD: 2.0%, DLD: 1.8%) but occurred descriptively more frequently in adults (11.4%). However, children in both groups also formed complex compounds. Examples include *Drunterhertauchband* "underneath diving band", produced by a child with TD for Item 6, and *Kugelschreibereinfahrer* "ball point pen retractor" produced by a child with DLD for Item 5. A Kruskal-Wallis test confirmed no significant differences between the three groups in terms of compound complexity (two components: $H = 3.4$, $p = 0.174$, three components: $H = 2.0$, $p = 0.366$, four components: $H = 2.4$, $p = 0.299$).

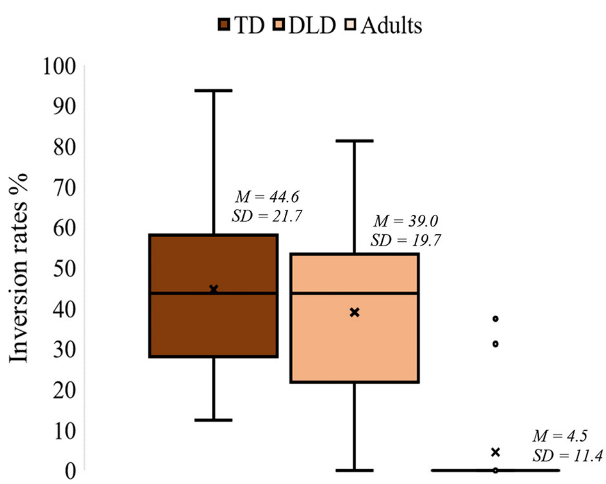

FIGURE 5
Inversion rates in the production task of experiment 2.

4.2 Experiment 2

4.2.1 Production task

The responses from one child with DLD and two children with TD were excluded from analysis, as they produced compound nouns for fewer than half of the items. After exclusion, 1.286 responses remained, produced by 81 participants ($n = 29$ with TD, $n = 29$ with DLD, $n = 23$ adult controls). Across all three groups, the majority of responses were compound nouns (TD: 93.1%, DLD: 94.3%, adults: 100%). As shown in Figure 5, children with DLD inverted an average of 39.0% of the items, while children with TD had an average inversion rate of 44.6%. In the adult control group, by contrast, an inversion rate of 4.5% was shown (where inversions occurred in three participants). A Kruskal-Wallis test revealed a significant difference in inversion rates between the groups ($H = 37.4$, $p < 0.001$). *Post-hoc* pairwise comparisons showed significant differences between adults and children with DLD ($U = 50.5$, $Z = -5.2$, $p < 0.001$) as well as between adults and children with TD ($U = 30.5$, $Z = -5.7$, $p < 0.001$). However, no significant difference was found between the inversion rates of children with DLD and TD ($U = 446.5$, $Z = -0.044$, $p = 0.965$).

4.2.2 Reception task

For the reception task, a total of 976 responses from children with TD ($n = 31$) and children with DLD ($n = 30$) were analyzed. In 99.9% of the cases, the children selected either the target item or its inversion, while 0.1% showed the modifier or head of the compound noun. Both groups exhibited uncertainties in identifying the target item, as reflected in the inversion rates of 50.8% for children with TD and 39.7% for children with DLD (see Figure 6). This difference is statistically significant (Mann-Whitney $U = 296.5$, $Z = -2.4$, $p = 0.014$).

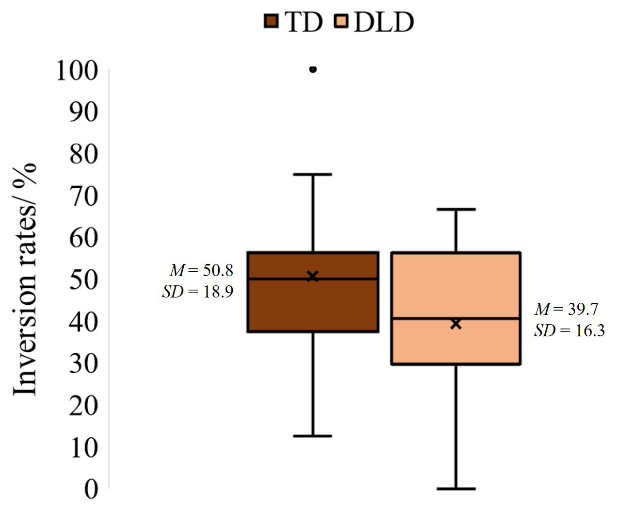

FIGURE 6
Inversion rates in the reception task of experiment 2.

TABLE 3 Overview of predictors related to therapy in production and reception in DLD (RQ 3).

Predictor	Inversion rates production task experiment 2	Inversion rates reception task experiment 2
Therapy duration (months)	$\beta = -0.894$, $p = 0.251$, SE $= 0.755$	$\beta = 0.363$, $p = 0.543$, SE $= 0.587$
Therapy focus	$\beta = 1.239$, $p = 0.799$, SE $= 4.796$	$\beta = -3.531$, $p = 0.356$, SE $= 3.731$
	$R^2 = 0.070$	$R^2 = 0.059$

4.3 Influencing factors

The two multiple linear regression models assessing the effects of therapy focus and duration on inversion rates in the production and reception tasks of experiment 2 for children with DLD revealed no significant predictors, as shown in Table 3.

Two multiple linear regression models were calculated to investigate the influence of age, gender and DLD on inversion rates in the production and reception task of experiment 2 for all children.

As you can see in Table 4, there were no significant influences of gender and age on inversion rates in the production and reception task for both groups. However, DLD is a statistically significant predictor in the reception task.

5 Discussion

The aim of this study was to investigate the word-formation strategies of monolingual children with DLD aged 4 to 5 years and compare their performance in compounding to their peers with TD and to an adult monolingual control group. The children who were investigated with two different experimental procedures produced mainly compounds when naming low-frequency objects and novel words. These findings are consistent with previous findings, indicating that monolingual German-speaking children are able to form novel compounds to name new words from early on Schipke and Kauschke (2011). The high dominance of compounds in contrast to, e.g., derivational strategies in the responses of the two experiments can be explained by the experimental approach, where compounding was forced. In experiment 2, which focused on the investigation of compounds, the high proportion of compounds confirms that the test procedure was valid for examining compounding. Due to our choice of the objects in experiment 1 (whole objects and parts of objects), a context was given in which it was highly likely to use compounding as has been confirmed by the adult data. Therefore, it can be concluded that the task forces participants to produce compounds. However, unexpectedly and contrary to our hypothesis, children with and without DLD responded comparably in experiment 1 regarding the proportion of the different word-formation strategies. These results are not in line with the findings for Estonian reported by Padrik (2005). According to the results of Padrik (2005), it was supposed that children with DLD would have shown more difficulties with the complex word-formation process of compounding also in German. It could be the case that lower use of compounding strategies by children with DLD can be seen only in spontaneous speech situations where children avoid the use of compounds. What children with DLD are able to do in experiments could be an expression of their underlying competence. What they deliberately choose to do in spontaneous speech situations in the sense of their performance could be very different. In order to check for this variability between competence and performance, studies will be needed that explicitly contrast frequency of compound usage in spontaneous speech and in elicited speech data in children with DLD. When forcing children to produce compounds (by an experimental setting), it would also be of interest to check for latency in children with TD and DLD. There could be a difference in processing time between DLD and TD that was not the focus of the present study.

Overall, the word-formation strategies of the children aged 4 to 5 years with and without DLD were comparable with the word-formations that were produced in the adult control group.

With respect to inversion rates in experiment 2, the results of our study are unexpected as children in contrast to adults inverted a much higher proportion of compounds—in production and in reception. This could mirror a developmental stage which

TABLE 4 Overview of predictors for production and reception in TD and DLD (RQ 4).

Predictor	Inversion rates production task experiment 2	Inversion rates reception task experiment 2
Age (months)	$\beta = 0.015$, $p = 0.970$, SE $= 0.409$	$\beta = 0.293$, $p = 0.376$, SE $= 0.328$
Gender	$\beta = 3.897$, $p = 0.464$, SE $= 5.283$	$\beta = -2.396$, $p = 0.575$, SE $= 4.254$
DLD	$\beta = -1.410$, $p = 0.792$, SE $= 5.325$	$\beta = -11.696$, $p = 0.007$, SE $= 4.278$
	$R^2 = 0.013$	$R^2 = 0.125$

in older children will disappear. It is up to future studies to investigate older children to verify this interpretation. However, although the precise relationship between comprehension and production is still a matter of debate (Azpiroz et al., 2019), in most cases comprehension precedes production in general language acquisition (Stokes et al., 2019; Scherger et al., 2023) and in compound acquisition (Clark and Barron, 1988). In order to reflect typical developmental steps, the reception data in the present study should show less inversions than the production data. However, this is not the case in the present study. Furthermore, given the well-known influence from DLD on language acquisition paths (Bishop et al., 2017), children with DLD should show more difficulties than children with TD. This, again, is not the case in the present data. It remains unclear whether this difference between DLD and TD reflects genuine linguistic processing differences or whether the results are due to task effects. With respect to task design effects, we have deliberately decided not to compare the results of the two experiments, as they differ in terms of their methodology. However, for the interpretation of the high inversion rates in experiment 2, it seems useful to compare the methodological approaches. One possible explanation for the different inversion rates between experiment 1 and 2 is a missing semantic relation between the two compound components in experiment 2. This could have led to challenges in applying the right-headedness. Another possible explanation could be the approach in experiment 1. The aim of the experiment was to investigate the word-formation strategies when naming low-frequency objects. Thereby on average 37.0% of the responses consisted of lexicalized items in both children groups. For example, when a child names the item 1 (s. Figure 1) *Seifenblase* "soap bubble", the child's attention is drawn to the fact that a word is being searched for the circled object during the survey. If the child shows no other reaction, the answer *Seifenblase* is evaluated as a compound, regardless of the fact that this word-formation only names the hypernym rather than the circled object (which was in fact a hyponym). When a lexicalized compound is formed, the demand on the child is much lower compared to the task in experiment 2, which could possibly explain the lower inversion rate in experiment 1. However, in experiment 1 children with and without DLD formed complex words in a comparably amount as adults. The inversion rates in the production task of experiment 2 were significantly higher for children compared to adults. This could lead to the interpretation that inversion is a general developmental phenomenon of German-speaking children aged 4 to 5 years. This indication is supported by the performance of two children with DLD, who were excluded from the study, because of their age. One child, aged 3;3 did not react in experiment 1 and only produced two novel compound nouns in the production task of experiment 2. For the other items, it named the head or modifier of the compound. Another 7;0 years old participant with DLD was an outlier producing and understood the novel compounds in experiment 2 to 100% in the correct order. However, the results of this study are limited with regard to interpretations of developmental phases, because the age range is kept relatively small for methodological reasons and data is based on a cross-sectional sample. The small age range is also a possible explanation, that age was not an influencing factor on inversion rates in experiment 2 (RQ 4).

Returning to the observed outperformance of children with DLD compared to typically developing children in the reception task, a third possible explanation—beyond task design effects—may involve the influence of uncontrolled variables. Although experiments 1 and 2 were designed to account for several confounding factors (e.g., word frequency), certain variables such as the semantic transparency of the novel compounds or the general processing load could not be fully controlled. These factors may have differentially affected the two groups, potentially placing greater demands on TD children than on children with DLD.

Children with DLD are used to process words they do not have stored in their mental lexicon to a much higher degree than children with TD. Due to the fact that children with DLD often have larger lexical gaps due to word learning difficulties (Nation, 2014; Leonard et al., 2024) and the situation in the reception task, therefore, is more common to them, the task could have caused a higher processing load for children with TD compared to children with DLD. As the tasks used in this study are not designed to measure processing load, this conclusion remains a matter of interpretation that needs further investigation. On the other hand, filling lexical gaps in their lexicon by combining the meaning of two elements should be a typical acquisition task also for children with TD by this age. It, therefore, should not have led to these differences. Theoretically, it could be the case that children with TD and DLD by this age process multimorphemic words in different ways. The advantage of children with DLD over children with TD seen in the reception task of the present study could be a hint to a processing way that relies less on storage than on computation (computational efficiency, see Libben, 1998). As the task is designed by including only novel, non-existing compounds, the strategy of using the storage of lexical items and therefore simultaneous processing of a whole-word item is not available for this task. Children are forced to use computational parsing mechanisms and process single constituents of the compounds sequentially in order to succeed in this task. Additionally, differences in processing speed may have played a role. Prior research suggests that children with DLD tend to process linguistic information more slowly (Miller et al., 2001; Witherstone, 2024). This slower processing may have reduced the likelihood of premature or misleading interpretations of the novel compounds. In contrast, the relatively faster processing speed of TD children may have led to premature activation of the initial compound element, potentially resulting in incorrect, inverted interpretations.

Another explanation could be that children with DLD have learned to process novel words more explicitly through therapeutic intervention, whereas children with TD may have processed them more implicitly. However, in this case we would have expected an influence of therapy duration on the ability to form and understand compounds (RQ3). The absence of the predictive influence of therapy duration shown in Table 3 could be due to small sample size (see limitations). Additionally, to investigate the comprehension of modifier-head relations in more detail, it would have been informative to assess the explicit interpretation of novel compounds by children, following the approach of Krott and Nicoladis (2005). However, the RQ1 and RQ2 can be answered by means of the data of the present study stating no differences in word-formation production between children with and without

DLD in our sample and a higher competence in interpreting novel compounds by children with DLD compared to children with TD. Taking into account possible influence of uncontrolled variables, as discussed above, this suggests that children with DLD could possess a resource in word formation, especially compounding and understanding of unknown words. This may be because they rely more frequently on various word formation strategies to compensate for gaps in their vocabulary compared to children with TD, as it was already reported by Ulrich (2010, cited in Motsch et al., 2022). However, this interpretation should be treated with caution, especially given the unequal testing conditions between the two groups (see limitation section), which may have influenced the observed performance as well.

Research on compound acquisition in German is limited and our findings on inversions should therefore be investigated further with a wider age group in a longitudinal design. A longitudinal study is currently being carried out with monolingual and bilingual children between the ages of two and seven years (Giesselbach and Scherger, submitted). In the longitudinal approach, we took the high inversion rates from experiment 2 into account and added a task in which animals and objects with a semantic relation had to be named in line with the methodological procedure by Grela et al. (2005). Concerning the ongoing debate in psycholinguistic research about whether compounds are processed holistically or decomposed, the high rate of inversions observed during the formation and comprehension of novel compounds supports the view that compounds are processed in a decomposed manner. Our findings suggest that children process novel compounds differently from adults. This could be also due to language-independent cognitive maturational processes involved in understanding the methodology of our experiments. Further psycholinguistic investigations in children with and without DLD could contribute to a deeper understanding of language processing.

6 Limitations

To our knowledge, this is the first study to investigate the compounding skills of German-speaking children with DLD, providing important insights into their language competencies. However, some methodical limitations will be discussed in the following. First, the sample size and the constriction to the age range is relatively low. Given the small group sizes, the results of the multivariate analyses should be interpreted with caution. In particular, conclusions regarding the influence of therapy focus and duration are limited due to missing data ($n = 19$) and very small subsample sizes, especially for the morpho-syntactic therapy focus group ($n = 2$). The fact that we found no influence of therapy focus on the inversion rates in experiment 2 can be discussed by the small group of children with therapy focus on grammar ($n = 2$), the little information about language abilities and missing data ($n = 19$) for therapy duration. However, the range of 28 months for the therapy duration is wide spread and its influence is unclear, as we predicted that therapy would have a positive influence on compounding. We could also assume that children who have been in therapy for longer have a greater need for treatment. For interpreting the influence of therapy on compounding in a more informed way, an investigation of the role of compounding in speech and language therapy is needed. If compounding is a resource for children with DLD in their language reception, as we have interpreted the results of our study, this resource should be used to expand and structure the mental lexicon of children with DLD. The development and evaluation of a therapy concept could lead to a better understanding of compounding skills of children with DLD and the influence of other language abilities.

In addition, the language abilities of the children with DLD should have been assessed, as we have no information of the assessments used for diagnosis for 19 children with DLD. However, a DLD diagnosis is not in doubt for the children, as all children with DLD were undergoing speech therapy at the time of the survey and the focus of therapy was confirmed by the speech therapist treating them. Taking into account that DLD is a highly heterogenous disorder, information about the language abilities of the children would have led to a better understanding of the observed word formation strategies. Lastly, it was not possible to control for socio-economic status and general cognitive abilities. As this could have an influence on language acquisition phenomena (Rowe, 2018; Niu et al., 2024), future studies need to assess this important potential influencing factor, for example by applying parental questionnaires and intelligence tests. Furthermore, the not fully comparable data collection of the children with DLD and TD may have influenced the results. The children with DLD were tested with a familiar person, their speech- and language therapist, while the children with TD were tested by an unknown person. This discrepancy in examiner familiarity could have introduced differences in comfort level, task engagement, and overall performance that may confound the group comparisons. Particularly, this could be one of several reasons for the outperformance of children with DLD over children with TD in the comprehension task (see Discussion).

The methodological approach of experiment 2 was already discussed above. The instructions in experiment 1 ("name a new word") may have influenced the naturalness of the responses. However, adult data confirmed that German monolingual speakers would also mostly rely on compounding when following the task instructions. In addition, reactions categorized as descriptions and simplizia were not analyzed further, as the focus was on the word formations. A more differentiated, qualitative analysis of reactions other than compounding and the calculation of the naming latency could lead to new insights on language abilities of children with DLD. This data would be available due to video-recording of the tests and could be analyzed as part of a secondary analysis. In addition, we have decided to interpret synthetic compounds as a compound. This word formation includes a derivation as well, which is not represented by this interpretation.

Overall, our findings revealed no differences in word-formation production between children with and without DLD. Interestingly, children with DLD demonstrated greater competence in interpreting novel compounds than their TD peers. Future research that addresses the methodological limitations discussed above would provide valuable insights into compounding in typical and impaired child language acquisition.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by ethics committee of the TU Dortmund University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

LG: Data curation, Investigation, Visualization, Conceptualization, Writing – original draft, Methodology, Writing – review & editing, Formal analysis. A-LS: Conceptualization, Methodology, Writing – original draft, Supervision, Writing – review & editing.

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Conflict of interest

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

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