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Research Article

Do Children With Developmental Language Disorder (DLD) Have Difficulties With Interference Control, Visuospatial Working Memory, and Selective Attention? Developmental Patterns and the Role of Severity and Persistence of DLD

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Purpose: Many children with developmental language disorder (DLD) have weaknesses in executive functioning (EF), specifically in tasks testing interference control and working memory. It is unknown how EF develops in children with DLD, if EF abilities are related to DLD severity and persistence, and if EF weaknesses expand to selective attention. This study aimed to address these gaps.
Method: Data from 78 children with DLD and 39 typically developing (TD) children were collected at three times with 1-year intervals. At Time 1, the children were 5 or 6 years old. Flanker, Dot Matrix, and Sky Search tasks tested interference control, visuospatial working memory, and selective attention, respectively. DLD severity was based on children's language ability. DLD persistence was based on stability of the DLD diagnosis.
Results: Performance on all tasks improved in both groups. TD children outperformed children with DLD on interference control. No differences were found for visuospatial working memory and selective attention. An interference control gap between the DLD and TD groups emerged between Time 1 and Time 2. Severity and persistence of DLD were related to interference control and working memory; the impact on working memory was stronger. Selective attention was unrelated to DLD severity and persistence.
Conclusions: Age and DLD severity and persistence determine whether or not children with DLD show EF weaknesses. Interference control is most clearly impaired in children with DLD who are 6 years and older. Visuospatial working memory is impaired in children with severe and persistent DLD. Selective attention is spared.

Children with a developmental language disorder (DLD) struggle with learning language without an obvious cause (Leonard, 2014). The disorder is frequent. The estimated prevalence is about 7.5% (Norbury et al., 2016; Tomblin et al., 1997), which rises to 50% if children with low-average intelligence are included (Norbury et al., 2016). In the literature, DLD has been portrayed in different ways. Some emphasize that specific aspects of language are selectively impaired in DLD and propose that DLD is a domain-specific deficit (Rice & Wexler, 1996; Van der Lely, 2005). Others highlight that language difficulties coincide with neuropsychological weaknesses (Botting & Marshall, 2017; Kapa & Plante, 2015). In line with this second approach to DLD, several studies report impairments in executive functioning (Pauls & Archibald, 2016; Vissers et al., 2015; Vugs et al., 2013). Executive functions (EFs) are domain-general cognitive functions used for purposeful goal-oriented and flexible behavior (Diamond, 2013). Not all EFs seem impaired to the same degree (Henry

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et al., 2012; Im-Bolter et al., 2006), however, and not all studies find that EF is impaired in children with DLD (Lukács et al., 2016).

The primary aim of the current study was to better understand the sources of variable outcomes in nonverbal EF tasks and identify which children with DLD between 5 and 8 years old are likely to experience EF difficulties. Specifically, we investigated whether children with DLD have difficulties with interference control, working memory, and selective attention tasks, and we wanted to know if any differences across DLD and typically developing (TD) controls change over time as the children grow older. In addition, we investigated whether EF difficulties of children with DLD are influenced by severity and persistence of DLD. Severity of DLD was measured via a language ability index based on three language measures (sentence repetition, use of inflectional morphology, receptive vocabulary). Persistence of DLD was established via measures independent of the current study and based on whether or not children were diagnosed with DLD throughout the full duration of the study. Note that it is not the case that the language problems of children who were not diagnosed with DLD anymore at later times ceased to exist. Rather, their scores were not low enough to meet the rather stringent diagnostic criteria in the Netherlands, where the current study was situated. Severity and persistence of DLD are thus closely related.

The Development of EFs

EFs are commonly viewed as a set of correlated and separable higher order cognitive processes that include inhibition (response inhibition, interference control), working memory updating, and set shifting (Miyake et al., 2000). EFs regulate our behavior through their influence on lower order processes, and in doing so, they withhold us from responding automatically, help to resist interference, enable executing complex tasks, and shift between tasks. The well-known unity and diversity framework (Miyake et al., 2000) combines a unitary and fractioned view of EF and captures both the existence of a common neural substrate that is linked to domain-general abilities and relatively low intercorrelations across individual EF tasks (Friedman & Miyake, 2017).

EF abilities are observed already at ages 3 and 4 years (Best & Miller, 2010), but consistent evidence for separable EF components and differentiation into specific functions such as inhibition, working memory, and shifting is lacking at these early ages (Brydges et al., 2014; Wiebe et al., 2011). Others report separable EF components at ages 7 years and above (Huizinga et al., 2006; Lehto et al., 2003; Shing et al., 2010). For the current study with children between ages 5 and 8 years, these previous findings imply that specific EFs are developing and becoming increasingly separable. For this reason, separate analyses were conducted for the interference control, working memory, and selective attention tests administered as part of this study.

It has been argued that EF development is supported through language development, as verbal mediation strategies such as self-talk and labeling of actions and objects may enhance children's EF performance (Marcovitch & Zelazo, 2009; Vygotski, 1962). This hypothesis is confirmed by research showing that language abilities predict children's later EF development (Bohlmann et al., 2015; Fuhs & Day, 2011; Jones et al., 2020; Kuhn et al., 2016; Slot & Suchodoletz, 2018). These findings suggest that EF in children with low language abilities, such as children with DLD, could be impaired. For the current study, we investigated whether this indeed holds for interference control, working memory, and selective attention.

Interference Control, Working Memory, and Selective Attention in DLD

Interference control is the ability to resist or resolve interference in the external environment that is irrelevant to the task at hand (Friedman & Miyake, 2004). Working memory is the small amount of information that can be held in mind and used in the execution of cognitive tasks (Cowan, 2014) and enables the manipulation and processing of temporarily stored information (Gathercole et al., 2004). Pauls and Archibald's (2016) meta-analysis shows interference control deficits in children with DLD, regardless of verbal demands, based on 34 included studies. Vugs et al. (2013) conducted a meta-analysis on visuospatial working memory based on 21 studies, seven of which included combined storage and processing tasks. Tasks that require both storing and processing of information are considered more complex and rely more on executive abilities than storage-only tasks (Gathercole et al., 2004). Vugs et al. found visuospatial working memory weaknesses in children with DLD with a relatively large effect size for the storage-and-processing tasks.

While the results of meta-analyses point to interference control and working memory deficits in DLD, the results of individual studies contradict each other. For example, Henry et al. (2012) found that children with DLD score lower than TD controls on verbal and nonverbal interference control and working memory after controlling for age and verbal and nonverbal intelligence, while Lukács et al. (2016) found hardly any negative effects of DLD on nonverbal interference control and working memory tasks. Findings on interference control and (visuospatial) working memory abilities of children with DLD are thus not always in agreement. Individual differences between children with DLD may be a source of discrepancy. For the purpose of this study, we investigated whether the presence of interference control and working memory weaknesses in children with DLD could be related to three interrelated factors: children's age, DLD severity, and DLD persistence.

In addition to interference control and visuospatial working memory, we investigated selective attention. According to the integrative framework (Garon et al., 2008), EF development and children's performance on EF tasks build on selective attention, which is the basic ability to selectively process certain stimuli while ignoring others either for a short time or for a longer time; in the latter situation, children also need the ability to sustain their selective attention. Knowing whether selective attention is compromised in children with DLD is relevant, as EF difficulties of children with DLD may be rooted in attention deficits. Many children with DLD indeed have an attention deficit (Baker & Cantwell, 1987; Mueller & Tomblin, 2012; Tannock & Schachar, 1996); it is estimated to be one of the most frequent neurodevelopmental disorders in children with DLD (Redmond et al., 2015). Children with DLD who are not diagnosed with attention disorders often have difficulties sustaining their attention (Blom & Boerma, 2016; Boerma et al., 2017; Ebert & Kohnert, 2011; Finneran et al., 2009; Spaulding et al., 2008), but it is less clear whether selective attention is also compromised, independent of the ability to sustain attention. The few studies with brief tasks suggest that auditory selective attention (Noterdaeme et al., 2001) presents more problems for children with DLD than visual selective attention (Engel de Abreu et al., 2014). Whether visual selective attention is spared in DLD regardless of age or levels of DLD severity and persistence is unknown.

Investigating Variation: Development and DLD Severity and Persistence

Both children with DLD and TD children have been found to make use of verbal mediation in EF tasks (Fatzer & Roebers, 2012; Lidstone et al., 2012), but children with DLD may be less able than their TD peers to use verbal mediation, in particular, in tasks with verbal instructions (Pauls & Archibald, 2016). Such tasks have a linguistic representation of the task requirements, and due to their weak language and verbal short-term memory, children with DLD may fail to build sufficiently strong linguistic representation and retain those representations, hampering their task performance. Weak abilities to retain linguistic representations of the task would explain why Lukács et al. (2016) found that EF differences between the DLD and TD groups disappeared when differences in verbal short-term memory between the groups were statistically controlled. Botting (2005), comparing performance of children with DLD and TD children on intelligence tests over time, raises the possibility that verbal mediation becomes more important as children grow older. Botting suggests that the tasks used with older children may be different; older children have more advanced language skills, and older children may be more experienced using verbal mediation strategies. This hypothesized development could be different for children with DLD: The dependency on verbal mediation and benefits offered by it may increase less in children with DLD than in their TD peers, resulting in a growing gap; this is why differences in EF test performance between the TD and DLD groups may not be stable and could emerge and increase over time, similar to what Botting found for intelligence.

In addition to age, severity and persistence of DLD may be related to EF weaknesses. Children with more severe and persistent DLD may be less able to effectively use verbal mediation than their peers with less severe and persistent DLD. Severity and persistence of DLD could also be associated with EF weaknesses because EF is implied in successful language learning. That EF predicts children's language is confirmed in various studies (Boerma et al., 2017; Bohlmann et al., 2015; Ibbotson & Kearvell-White, 2015; Montgomery et al., 2010; Slot & Suchodoletz, 2018; Yoshida et al., 2011; but see Gooch et al., 2016), including a previous study that we conducted with children with DLD (Blom & Boerma, 2019). In this study, we investigated whether a latent EF factor (based on measures of interference control, working memory, and selective attention) predicted children's lexical and syntactic abilities 1 year later. Analyses were performed with children with DLD and same-age TD controls. In the DLD group, EF predicted lexical skills, confirming the hypothesis that the lexical development of children with DLD is supported by domain-general EF abilities. To determine directionality, we also investigated relationships in the reverse direction. These analyses demonstrated that, in the TD group, but not in the DLD group, lexical skills predicted EF, which is consistent with the idea that children with DLD are less able than their TD peers to use verbal mediation. Note that the evidence for an increasingly important role of verbal mediation was less conclusive, as the effect of lexical skills on EF only reached significance at younger ages. In summary, both the findings that EF impacts on language and language impacts on EF predict that children with severe and persistent DLD have more EF difficulties than children with less severe and persistent DLD.

Apart from the two meta-analyses discussed earlier (Pauls & Archibald, 2016; Vugs et al., 2013), hardly any research investigated the moderating effects of development (typically indexed by children's age) and DLD severity and persistence on EF skills. Vugs et al. (2013) found an effect of DLD severity for visuospatial storage, but not for more complex storage and processing working memory tasks. With regard to interference control, Pauls and Archibald (2016) found that DLD severity did not impact on the magnitude of the difference between the DLD and TD groups. Furthermore, neither of the two meta-analyses found an effect of age. Importantly, these findings have to be interpreted within the limits of meta-analyses. Pooling data may obscure subtle differences between tasks, and development was investigated cross-sectionally instead of longitudinally. Moreover, DLD severity in these meta-analyses was based on measures of vocabulary knowledge in some of the included studies. As vocabulary measures may be less sensitive to DLD than grammar measures at the word and sentence level (Leonard, 2014), this may have led to an underestimation of the likelihood of finding a true difference in EF performance between children with more or less severe DLD (Pauls & Archibald, 2016).

This Study

This study builds on our previous research in which we investigated developmental relationships between EF, on the one hand, and children's lexical and syntactic skills, on the other hand (Blom & Boerma, 2019). Whereas that study was focused on EF as a predictor of specific language outcomes in DLD, the current study aims to enhance our understanding of the variation in EF outcomes among children with DLD. The following research questions guided our study: Do children with DLD have weaknesses in nonverbal interference control, working memory, and selective attention, and to what extent are these weaknesses related to age and to DLD severity and persistence? This is the first study that investigates interference control, working memory, and selective attention across the DLD and TD groups using a longitudinal approach, thereby considering development, DLD severity, and DLD persistence as moderating variables.

DLD severity was investigated using three language ability measures to do justice to the heterogeneity of DLD (Conti-Ramsden & Botting, 1999; Leonard, 2014): inflectional morphology, sentence repetition, and lexicon. Inflectional morphology (Krok & Leonard, 2015) and sentence repetition (Conti-Ramsden et al., 2001) are typically impaired in children with DLD. Unlike inflectional morphology and lexicon, sentence repetition may not be considered to reflect (specific) language abilities. Sentence repetition taps into lexical knowledge and verbal short-term memory (Alloway & Gathercole, 2005; Klem et al., 2015), but it predominantly reflects syntactic knowledge (Frizelle & Fletcher, 2014; Polišenská et al., 2015). Lexicon seems less affected by DLD than grammar (Leonard, 2014), but in-depth investigations indicate that children with DLD have fewer words in their vocabularies than TD children and that their word knowledge is shallower (McGregor et al., 2013). In addition, the lower vocabulary outcomes of children with DLD persist over time (McGregor et al., 2013; Rice & Hoffman, 2015). The longitudinal design of the study enabled us to investigate DLD persistence by comparing those children who had a DLD diagnosis throughout the three waves of data collection to a subgroup consisting of the children who lost their DLD diagnosis because their impairment was less severe, their language had developed relatively well, or both.

Three sets of predictions were formulated. The first set of predictions concerns differences between the DLD and TD groups. We expected that the children with DLD and the TD children would improve with age on interference control, working memory (Best & Miller, 2010), and selective attention (Pozuelos et al., 2014). We also expected that the children with DLD would perform lower on the three tasks than TD controls but predicted that the effect would be nuanced in the following ways: Assuming that older children are better able to make use of verbal mediation as a support strategy to improve task performance than younger children, between-groups differences between the DLD and TD groups may emerge and increase in magnitude over time. Specifically, the TD children may show a steeper development of interference control, working memory, and selective attention than children with DLD.

The second set of predictions is about DLD severity and persistence. Weak performance on interference control, working memory, and selective attention may be more prominent in children with severe DLD, that is, children with the lowest language ability in our sample, than in children with milder forms of DLD. We also expected that weak performance on the three tasks would be more prominent in the children who keep their DLD diagnosis during the 2-year period of the study than in the children who lose their DLD diagnosis, as children in the first group will have more difficulties with language than children in the second group.

The third set of predictions concerns differences between interference control, working memory, and selective attention. Between-groups differences as well as effects of DLD severity and persistence may be more probable for interference control and working memory than selective attention. The reason is twofold. Previous research suggests consistent and robust weaknesses for interference control (Pauls & Archibald, 2016), and there is also considerable evidence for weaknesses in visuospatial working memory (Vugs et al., 2013), while there is less evidence for weaknesses in selective attention measured with visual stimuli (Spaulding et al., 2008). In addition, limited effects of DLD were expected because the selective attention task was short and did not require sustained attention.

Method

Participants

Data collection took place between 2014 and 2016. Data were collected at three times, starting at the age of 5 and 6 years, and there was 1 year between each wave of data collection. All children were monolingual speakers of Dutch (only Dutch spoken at home) and had a nonverbal intelligence score of 70 or higher, measured with a short version of the Wechsler Nonverbal (Wechsler & Naglieri, 2008). TD children were recruited through mainstream education. Children with DLD were recruited through two national organizations in the Netherlands (Royal Dutch Kentalis and Royal Auris Group) that provide diagnostic, care, and educational facilities for children with communicative difficulties. In total, 139 children participated; 22 children were excluded based on their nonverbal intelligence scores, age at Time 1, or additional diagnoses (see Table 1).

Table 1. Children excluded from the study.

Criteria	*n*
Nonverbal intelligence score below 70	9
Younger than 5 years and older than 6 years at Time 1	7
Autism spectrum disorder	2
Attention disorder	3
Hearing impairment	1

This resulted in a sample of 117 children at Time 1, consisting of fifty-six 5-year-old (20 TD, 36 DLD) and sixty-one 6-year-old (19 TD, 42 DLD) children (for the sample characteristics, see Blom & Boerma, 2019; see Table 1). All children who participated at Time 1 also participated at Time 2. At Time 3, one TD child and one child with DLD dropped out. There were relatively more boys with DLD, in line with expectations based on the prevalence of DLD (Tomblin et al., 1997), but the difference with the gender distribution in the TD group was not significant, $\chi^2(1) = 3.45$, $p = .06$. Parental education, $F(1, 112) = 7.94$, $p = .006$, $\eta_p^2 = .07$, and nonverbal intelligence, $F(1, 115) = 9.0$, $p = .003$, $\eta_p^2 = .07$, were lower in the DLD than the TD sample. Lower socioeconomic status and nonverbal intelligence scores are commonly observed in children with DLD (Gallinat & Spaulding, 2015; Tomblin, 1996). The groups did not differ in age: Time 1, $F(1, 115) = 1.22$, $p = .27$; Time 2, $F(1, 115) = 0.71$, $p = .40$; Time 3, $F(1, 113) = 0.56$, $p = .46$.

All participants with DLD were diagnosed by independent professionals before the first time of testing. In accordance with the official criteria that are used in the Netherlands (Stichting Siméa, 2014), they obtained a score of at least 2 *SD*s below the mean on an overall score of a standardized language assessment test battery or a score of at least 1.5 *SD*s below the mean on two out of four subscales. Given the common diagnostic standard of −1.25 *SD*s (Tomblin et al., 1996), the criteria used in our study may have resulted in a sample with relatively severe DLD. The most commonly used test batteries include the Dutch version of the Clinical Evaluation of Language Fundamentals (Kort et al., 2008) and the Schlichting Test for Language Production and Comprehension (Schlichting & Lutje Spelberg, 2010a, 2010b). All participants with DLD included in this study met these criteria at Time 1, and a total of 52 children (67%) met these criteria at all times of testing. The remainder did not meet these criteria anymore, either at Time 2 (9%, $n = 7$) or Time 3 (23%, $n = 18$). This information was missing for one participant. Instability of diagnostic categories has been observed around this age in previous research as well (Conti-Ramsden & Botting, 1999); we decided to not exclude the children who lost their DLD diagnosis during the study period, given their history of DLD and the long-term persistence of the language problems (Scarborough & Dobrich, 1990). We used the distinction between children who kept a diagnosis and those whose scores did not meet the diagnostic criteria anymore at later times as an index of DLD persistence. As part of this study, children's language abilities—details of the measures are explained below—confirm the weak language abilities of the children in the DLD group. Mixed-design analyses of variance (ANOVAs), with Group (DLD, TD) as the between-subjects variable and Time (Time 1, Time 2, Time 3) as the within-subject variable, demonstrated solid main effects of group for inflectional morphology, $F(1, 111) = 59.22$, $p < .001$, $\eta_p^2 = .35$; sentence repetition, $F(1, 110) = 146.90$, $p < .001$, $\eta_p^2 = .57$; and receptive vocabulary, $F(1, 111) = 23.75$, $p < .001$, $\eta_p^2 = .18$. The language outcomes are in the Appendix.

Measures and Procedure

This study was approved by the Standing Ethical Assessment Committee of the Faculty of Social and Behavioral Sciences at Utrecht University. Informed consent forms were signed by parents of participants. Children were individually tested by a native speaker of Dutch in two separate sessions that each lasted approximately 1 hr. Testing took place in a quiet room at school. Similar procedures were used for each time point. Nonverbal intelligence was tested at Time 1. Interference control, working memory, and selective attention measures, as well as the language measures, were administered at all three times, using the same tasks at all three times.

Interference Control, Working Memory, and Selective Attention Measures

Interference control was measured with a Flanker task (Engel de Abreu et al., 2012) administered on a laptop using the E-Prime 2.0. A horizontal row of five equally spaced yellow fish was presented to the children. The children were asked to indicate the direction of the central fish by pressing the corresponding left or right response button (which was coded within the keyboard) as quickly as possible. On congruent trials (50%), the flanking fish were pointing in the same direction as the central target fish, and on incongruent trials (50%), the flanking distractors pointed in the opposite direction. Each trial started with a fixation cross in the middle of the screen (1,000 ms), followed by the presentation of the five fish. A response had to be made within 5,000 ms and was otherwise considered incorrect. The task started with a practice phase to ensure that children understood the instructions. Subsequently, all children completed two blocks of 20 trials in which presentation of congruent and incongruent trials was randomized.

Working memory was assessed with a backward Dot Matrix test, similar to the test from the Alloway Working Memory Assessment (Alloway, 2012). In this task, children were presented with a 4 × 4 matrix in which sequences of dots appeared. After the last dot disappeared, children were asked to point out the position of the dots in reverse order. In the first block, only one dot appeared, but the number of dots increased in subsequent blocks. Each block had six trials, and there was a maximum of six blocks. The task started with a practice phase. The Alloway Working Memory Assessment procedure was applied for scoring, which meant that one point was given for each correct trial (maximum score of 36). If the first four trials of a block were correct, children automatically continued to a subsequent block and were awarded the maximum of 6 points. The task stopped when children responded incorrectly to three trials within the same block. Trials were scored as incorrect if children recalled the position of one or more dots incorrectly, if the sequence was incorrect, or if they omitted one or more dots.

Selective attention was tested with the Visual Sky Search, a subtest of the Test of Everyday Attention for Children (Manly et al., 1999). The Visual Sky Search subtest requires a child to selectively pay attention. It is a brief pencil-and-paper test that does not require children to sustain attention. Children were familiarized with the procedure during a practice phase. In the first part of the test, children had to encircle identical pairs of spaceships on an A3 (11.69 × 16.53 in.) sheet of paper. Twenty identical pairs were the targets, and there were 108 nonidentical pairs that were not targeted. Children were instructed to encircle the targets as fast as possible. Following the standardized administration procedure, we controlled for drawing speed and children's motor abilities. To this end, a second A3 sheet of paper was given to the children after they had completed the first part of the task. On this motor control sheet, only the 20 identical spaceships were displayed, and children were again asked to encircle them as fast as possible. Children's selective attention score was calculated by subtracting the mean time per target of the motor control sheet from the mean time per target of the sheet on which both targets and distractors were displayed.

Language Ability Measures

Inflectional morphology was measured with the Word Formation subtest of the Dutch Language Proficiency Test for All Children (*Taaltoets Alle Kinderen*; Verhoeven & Vermeer, 2001). The Word Formation task tests plural formation with nouns and past participle formation with verbs. Accuracy was scored off-line by a native speaker of Dutch. The maximum score that can be obtained is 24 (12 plurals and 12 participles).

Children's ability to repeat sentences was measured with the Sentence Formation subtest of the Dutch Language Proficiency Test for All Children (*Taaltoets Alle Kinderen*; Verhoeven & Vermeer, 2001). The task includes 20 sentences and, within each sentence, one function word (e.g., *Onze* [*Our*]) and one sentence pattern that reflects a specific word order property of Dutch (e.g., the absence of Verb Second in embedded clauses as in *dat ze ons een verhaal gaat voorlezen* [*that she would read us a story*]) is targeted. Accuracy was scored off-line by a native speaker of Dutch. The maximum score that can be obtained is 40 (20 function words and 20 sentence patterns).

Receptive vocabulary was measured with the Peabody Picture Vocabulary Test–III (Schlichting, 2005). In this test, children heard a target word and had to pick the correct referent out of four pictures. The test is divided in 17 sets, which increase in difficulty, with 12 target words in each set. We administered the Peabody Picture Vocabulary Test–III according to the official guidelines and thus determined the starting set based on a child's age. The task was terminated when a child picked the incorrect referent picture 9 times or more in a set. Raw scores were used in the analyses.

Data Analysis

For interference control (Flanker), both accuracy and reaction times (RTs) were documented, but we focused on RTs, as mean accuracy scores were high (accuracy Time 1: TD = 93%, DLD = 80%; Time 2: TD = 98%, DLD = 93%; Time 3: TD = 98%, DLD = 98%). In addition to the mean RTs in the congruent and incongruent condition, we calculated the Flanker effect (i.e., mean RTs incongruent minus mean RTs congruent). Both the mean RTs and the Flanker effect deviated from normality, as indicated by a *p* value of the Shapiro–Wilk test that is smaller than .05. The RT data and most of the Flanker effect data are right-skewed. The Flanker effect distributions are, in addition, leptokurtic. After a log transformation, the distributions of the mean RTs were acceptable, unlike the distribution of the Flanker effect. We decided to focus on the mean RTs in the incongruent condition. In this condition, the children also had to ignore distractors and resist interference. Mean RTs in the incongruent condition showed moderate to strong correlations with the Flanker effect (Time 1: $r_s(117) = .65$, $p < .001$; Time 2: $r_s(117) = .52$, $p < .001$; Time 3 $r_s(115) = .65$, $p < .001$), in contrast with the mean RTs in the congruent condition (Time 1: $r_s(117) = -.11$, $p = .26$; Time 2: $r_s(69) = .11$, $p = .25$; Time 3: $r_s(115) = .21$, $p = .03$). Following Engel de Abreu et al. (2014), mean RTs were calculated excluding incorrect responses, RTs below 200 ms, and RTs above 3 *SD*s of children's individual means (approximately 10% of all incongruent trials). The dependent variables of working memory and selective attention were accuracy (Dot Matrix) and the selective attention score (Visual Sky Search), respectively. The distribution of the selective attention score deviated from normality. After log transformations and removal of one outlier at Time 1 and two outliers at Time 2, an acceptable distribution was obtained.

Mixed-design analyses of covariance were run for interference control, working memory, and selective attention with group (DLD, TD) as the between-subjects variable, time (Time 1, Time 2, Time 3) as the within-subjects variable, and nonverbal intelligence and parental education as covariates to determine if children with DLD have weaknesses and to investigate if differences between the DLD and TD groups emerge and increase in magnitude as a function of development. The effect of DLD severity on EF outcomes was investigated by using a continuous approach by examining if language ability predicts interference control, working memory, and selective attention in the DLD sample. To derive a language ability index, principal components analyses were run on the three language measures for Time 1, Time 2, and Time 3. The saved factor scores were entered into regression analyses. Factor (or component) scores are numerical scores that show a child's relative standing on the latent language ability component. The effect of DLD persistence was investigated by comparing a subgroup of children who had a DLD diagnosis throughout the project duration to a subgroup consisting of children who lost their DLD diagnosis, again using mixed-design analyses of covariance. We did not assume that the children with nonpersistent DLD had lost their language problems but, instead, assumed that their scores at later ages were not low enough anymore to meet the (rather stringent) diagnostic criteria in the Netherlands. DLD severity and persistence are thus closely related. We verified the relation between DLD severity and persistence by comparing the DLD-persistent and DLD-nonpersistent subgroups on the three language ability measures. We also verified the assumption that the DLD-nonpersistent subgroup still had language issues, despite having no DLD diagnose anymore, by comparing them to the TD controls on the three language measures.

Results

Interference Control, Working Memory, and Selective Attention: Group and Time

Figures 1–3 illustrate the covariate-adjusted means of the three tasks at Time 1, Time 2, and Time 3 for the TD versus DLD group. Children's performance on all tasks improved (interference control: $F(1, 108) = 7.79$, $p = .01$, $\eta_p^2 = .07$; working memory: $F(1, 105) = 15.19$, $p < .001$, $\eta_p^2 = .13$; selective attention: $F(1, 105) = 17.13$, $p < .001$, $\eta_p^2 = .14$), from Time 1 to Time 2 and from Time 2 to Time 3 (all tasks: $p < .001$, with Bonferroni correction because of multiple comparisons). For interference control, both the main effect of Group and the interaction effect between Time × Group reached significance: main, $F(1, 108) = 5.79$, $p = .02$, $\eta_p^2 = .05$; linear interaction, $F(1, 108) = 4.27$, $p = .04$, $\eta_p^2 = .04$. The TD group outperformed the DLD group at Time 2, $F(1, 110) = 5.88$, $p = .02$, $\eta_p^2 = .05$, and Time 3, $F(1, 108) = 9.99$, $p = .002$, $\eta_p^2 = .09$, but not at Time 1, $F(1, 110) = 0.60$, $p = .44$, $\eta_p^2 = .01$. Nonverbal intelligence was a significant covariate, $F(1, 108) = 11.23$, $p = .001$, $\eta_p^2 = .09$. No significant main or interaction effects emerged for working memory (main: $F(1, 105) = 1.34$, $p = .25$; linear interaction: $F(1, 105) = 2.31$, $p = .13$) and selective attention (main: $F(1, 105) = 0.26$, $p = .61$; linear interaction: $F(1, 105) = 0.06$, $p = .81$).

Figure 1. Performance of the typically developing (TD; dotted lines) and developmental language disorder (DLD; continuous lines) groups on interference control, over time; results are covariate-adjusted. Lower scores reflect better performance.

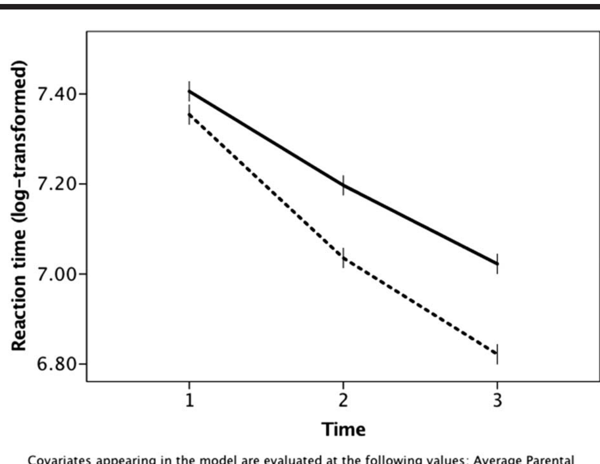
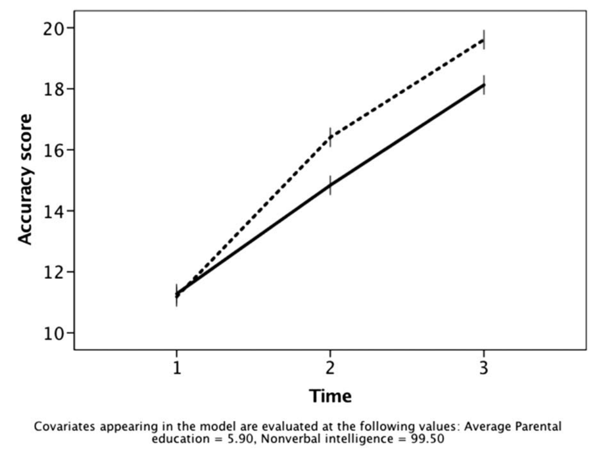


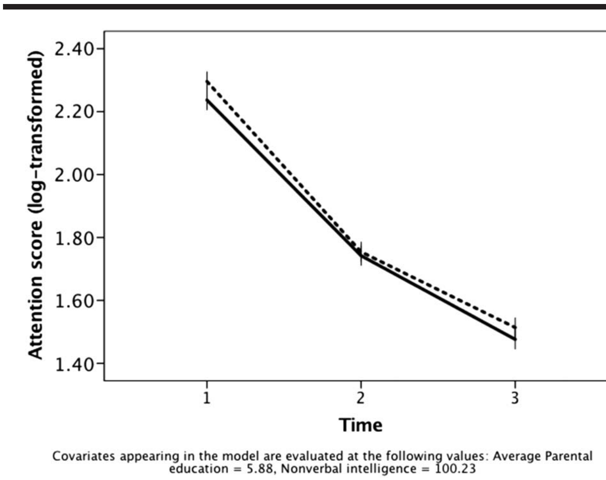
Figure 2. Performance of the typically developing (TD; dotted lines) and developmental language disorder (DLD; continuous lines) groups on working memory over time; results are covariate-adjusted. Higher scores reflect better performance.



DLD Severity

The results of the principal components analysis showed that the factorability of the three language measures was good: The correlations between the measures were significant, the anti-image correlation matrix diagonals were all above .50 (ranging between .61 and .75), the value of the Kaiser–Meyer–Olkin measure of sampling adequacy was above .60 at Time 1 (.68), Time 2 (.69), and Time 3

Figure 3. Performance of the typically developing (TD; dotted lines) and developmental language disorder (DLD; continuous lines) groups on selective attention over time; results are covariate-adjusted. Lower scores reflect better performance.



(.65), and Bartlett's test of sphericity was significant at all three times. The saved factor scores indicate a child's relative standing on the latent language ability component and were used as an index of language ability. Correlations between language ability, and background (parental education, nonverbal intelligence, age) and measures of selective attention, interference control, and working memory in the DLD sample are in Table 2. All correlations are significant, except those with parental education and nonverbal intelligence and interference control at Time 1.

Nine multiple regression analyses were run with nonverbal intelligence and age in Model 1 and language ability added in Model 2 as predictors of interference control, working memory, and selective attention in the DLD sample (see Tables 3–5). Parental education was not included because correlations with interference control, working memory, and selective attention were low, and excluding parental education enabled us to include three children for whom information on their parents' education was missing. Results revealed that language ability predicted working memory at all three times (see Table 4), over and above the effects of nonverbal intelligence and age. Language ability did not predict interference control at Time 1 (p = .53). At Time 2, a significant effect of language ability on interference control emerged (p = .04). At Time 3, a trend was found (p = .07; see Table 3). Language ability did not predict any additional variation in selective attention over and above the variation explained by nonverbal intelligence and age (see Table 5).

DLD Persistence

The children with DLD with a more persistent form of DLD (DLD-persistent; n = 52) were compared with the children within the DLD sample who had no diagnosis anymore at Time 3 and had a less persistent form of the impairment (DLD-nonpersistent; n = 25). The groups did not differ in age (Time 1: $F(1, 74) = 2.67$, p = .11; Time 2: $F(1, 74) = 1.55$, p = .22; Time 3: $F(1, 74) = 1.56$, p = .22) and nonverbal intelligence, $F(1, 74) = 0.40$, p = .53, but the parental education was on average somewhat lower in the DLD-persistent than in the DLD-nonpersistent subsample, $F(1, 71) = 5.33$, p = .02, η_p^2 = .07. Mixed-design ANOVAs indicated that the DLD-persistent group scored lower than the DLD-nonpersistent group on inflectional morphology, $F(1, 72) = 17.05$, $p < .001$, η_p^2 = .19; sentence repetition, $F(1, 71) = 24.71$, $p < .001$, η_p^2 = .26; and receptive vocabulary, $F(1, 73) = 9.36$, p = .003, η_p^2 = .11. This confirms that the children who kept their diagnosis have, on average, lower language abilities and a more severe form of DLD than the children who lost their diagnosis. Mixed-design ANOVAs indicated that the DLD-nonpersistent group scored lower than TD controls on inflectional morphology, $F(1, 60) = 12.05$, p = .001, η_p^2 = .17, and sentence repetition, $F(1, 59) = 49.81$, $p < .001$, η_p^2 = .46, showing that not meeting the diagnostic criteria anymore does not imply that the children's language issues have ceased to exist. On receptive vocabulary, the two groups did not differ, $F(1, 59) = 3.37$, p = .07, η_p^2 = .05. Results on the three language measures are in the Appendix.

Figures 4–6 illustrate the covariate-adjusted means of the results on the interference control, working memory, and selective attention tasks in the DLD-persistent and DLD-nonpersistent subgroups. The raw data are shown in Table 6.

DLD-nonpersistent outperformed DLD-persistent on interference control, $F(1, 69) = 8.30$, p = .005, η_p^2 = .11, and working memory, $F(1, 66) = 7.64$, p = .007, η_p^2 = .10, at all time points. In both cases, nonverbal intelligence was a significant covariate (interference control: $F(1, 69) = 5.68$, p = .02, η_p^2 = .08; working memory: $F(1, 66) = 13.02$, p = .001, η_p^2 = .17). Selective attention did not differ across the DLD-persistent and DLD-nonpersistent groups; the results suggested a trend indicating lower performance in DLD-persistent group, $F(1, 66) = 3.68$, p = .06. Working memory, $F(1, 57) = 6.87$, p = .013, η_p^2 = .09, and selective attention, $F(1, 66) = 12.51$, p = .001, η_p^2 = .16, improved over time, but interference control did not, $F(1, 69) = 2.47$, p = .12.

Discussion

For the purpose of this study, we investigated whether or not children with DLD have weaknesses in interference control, working memory, and selective attention. Moreover, we examined if differences between the DLD and TD groups develop as the children grow older, and if DLD severity and persistence moderate the effect of

Table 2. Correlations between language ability and background measures (parental education, nonverbal intelligence, age), as well as concurrent relations between language ability and interference control, working memory, and selective attention at Time 1, Time 2, and Time 3 in the developmental language disorder sample.

Variable	PE Time 1	NVIQ Time 1	Age Time 1, 2, 3	IC Time 1, 2, 3	WM Time 1, 2, 3	SA Time 1, 2, 3
Language ability Time 1	.12	.22	.52***	−.10	.42***	−.35**
Language ability Time 2	.12	.35**	.43***	−.38***	.45***	−.34**
Language ability Time 3	.05	.41***	.38**	−.37**	.39***	−.29*

Note. PE = parental education; NVIQ = nonverbal intelligence (quotient score); IC = interference control (reaction times in milliseconds; lower score = better performance); WM = working memory (number correct; higher score = better performance); SA = selective attention (combined score based on reaction time and number correct; lower score = better performance).

*p < .05. **p < .01. ***p < .001.

Table 3. Summary of the hierarchical regression analyses of language ability predicting interference control (Time 1, Time 2, and Time 3).

Time	Model	*B*	*t*	*R*	Adj. R^2	ΔR^2
Time 1	Model 1			.10	.08	.10*
	NVIQ	−.18	−1.57			
	Age T1	−.23	−1.99			
	Model 2			.11	.07	.01
	NVIQ	−.19	−1.63			
	Age T1	−.27	−2.04			
	LA T1	.08	0.64			
Time 2	Model 1			.17	.15	.17**
	NVIQ	−.29	−2.63*			
	Age T2	−.22	−1.97			
	Model 2			.22	.18	.05*
	NVIQ	−.23	−2.05			
	Age T2	−.13	−1.11			
	LA T2	−.25	−2.10*			
Time 3	Model 1			.16	.13	.16**
	NVIQ	−.23	−2.08*			
	Age T3	−.26	−2.38*			
	Model 2			.19	.16	.04
	NVIQ	−.16	−1.34			
	Age T3	−.20	−1.74			
	LA T3	−.23	−1.87			

Note. NVIQ = nonverbal intelligence quotient score; T = time; LA = language ability.

$^*p < .05$. $^{**}p < .01$.

Table 5. Summary of the hierarchical regression analyses of language ability predicting selective attention (Time 1, Time 2, and Time 3).

Time	Model	*B*	*t*	*R*	Adj. R^2	ΔR^2
Time 1	Model 1			.40	.38	.40***
	NVIQ	−.41	−4.36***			
	Age T1	−.40	−4.28***			
	Model 2			.41	.38	.01
	NVIQ	−.40	−4.21***			
	Age T1	−.36	−3.35**			
	LA T1	−.10	−0.92			
Time 2	Model 1			.25	.23	.25***
	NVIQ	−.30	−2.90**			
	Age T2	−.32	−3.07**			
	Model 2			.26	.23	.01
	NVIQ	−.27	−2.52*			
	Age T2	−.28	−2.47*			
	LA T2	−.13	−1.09			
Time 3	Model 1			.24	.22	.24***
	NVIQ	−.18	−1.71			
	Age T3	−.42	−3.96***			
	Model 2			.25	.22	.01
	NVIQ	−.15	−1.37			
	Age T3	−.39	−3.55**			
	LA T3	−.08	−0.66			

Note. NVIQ = nonverbal intelligence quotient score; T = time; LA = language ability.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

DLD on interference control, working memory, and selective attention. The results present a nuanced picture: Not all three tasks are equally problematic, and not all children diagnosed with DLD have weaknesses to the same degree. Below, we summarize and discuss the main results.

Table 4. Summary of the hierarchical regression analyses of language ability predicting working memory (Time 1, Time 2, and Time 3).

Time	Model	*B*	*t*	*R*	Adj. R^2	ΔR^2
Time 1	Model 1			.25	.23	.25***
	NVIQ	.34	3.18**			
	Age T1	.29	2.74**			
	Model 2			.30	.27	.05*
	NVIQ	.31	3.00**			
	Age T1	.16	1.30			
	LA T1	.27	2.25*			
Time 2	Model 1			.17	.15	.18**
	NVIQ	.26	2.34*			
	Age T2	.26	2.39*			
	Model 2			.25	.22	.08**
	NVIQ	.18	1.63			
	Age T2	.15	1.32			
	LA T2	.32	2.77**			
Time 3	Model 1			.19	.17	.19**
	NVIQ	.33	3.03**			
	Age T3	.21	1.90			
	Model 2			.23	.20	.04*
	NVIQ	.25	2.20*			
	Age T3	.14	1.23			
	LA T3	.24	2.02*			

Note. NVIQ = nonverbal intelligence quotient score; T = time; LA = language ability.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Interference Control, Working Memory, and Selective Attention

Interference control, working memory, and selective attention improved in the children with DLD and the TD

Figure 4. Performance of the DLD-nonpersistent ("no diagnosis Time 3"; dotted lines) and DLD-persistent ("diagnosis Times 1–3"; continuous lines) groups on interference control over time; results are covariate-adjusted. DLD = developmental language disorder. Lower scores reflect better performance.

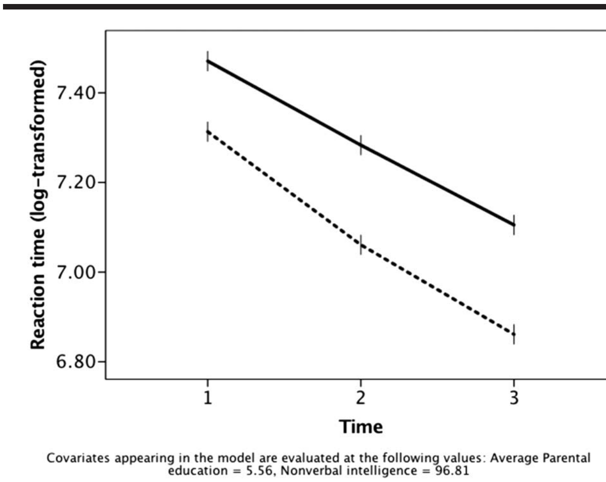


Figure 5. Performance of the DLD-nonpersistent ("no diagnosis Time 3"; dotted lines) and DLD-persistent ("diagnosis Times 1–3"; continuous lines) groups on working memory, over time; results are covariate-adjusted. DLD = developmental language disorder. Higher scores reflect better performance.

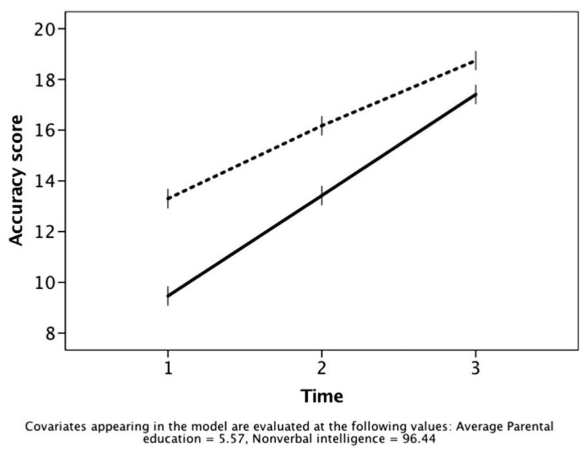


Table 6. Descriptives interference control, working memory, and selective attention in DLD-nonpersistent (children who were not diagnosed anymore with DLD at Time 3; np) and DLD-persistent (children who were diagnosed with DLD at Time 1, Time 2, and Time 3; p), raw data.

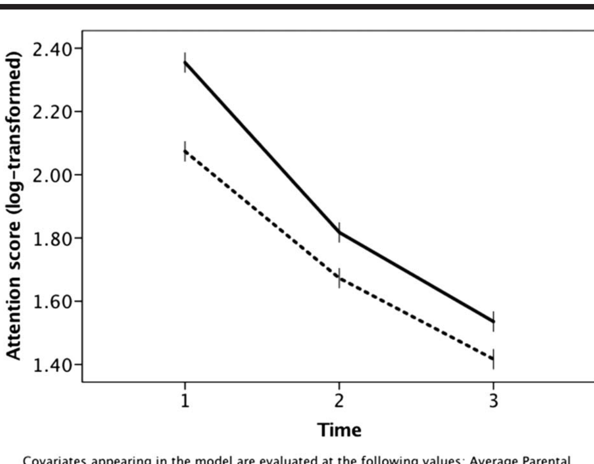
Variable	Time 1 *M* (*SD*)	Time 2 *M* (*SD*)	Time 3 *M* (*SD*)
Interference control DLD-np	1,638 (636)	1,359 (704)	1,074 (453)
Interference control DLD-p	1,905 (638)	1,539 (503)	1,266 (370)
Working memory DLD-np	14.00 (5.53)	16.33 (8.22)	18.67 (6.44)
Working memory DLD-p	9.24 (3.81)	13.02 (5.35)	17.23 (4.86)
Selective attention DLD-np	9.87 (6.60)	**9.11 (13.98)**	4.58 (2.07)
Selective attention DLD-p	14.71 (15.15)	7.36 (5.17)	5.17 (2.03)

Note. The boldfaced value indicates that the relatively poor performance of DLD-np on selective attention Time 2 is due to one extreme outlier, which was removed in the log-transformed data used for the statistical analyses. DLD = developmental language disorder; Interference control = reaction times in milliseconds (lower score = better performance); Working memory = number correct (higher score = better performance); Selective attention = combined score based on reaction time and number correct; lower score = better performance).

children between Time 1 and Time 2 and between Time 2 and Time 3, covering the age range between 5 and 8 years, as expected (Best & Miller, 2010; Pozuelos et al., 2014). The current study demonstrates that the overall growth pattern is similar for the TD and DLD groups, except for the development of interference control. Interference control showed an interaction effect that reflected a somewhat steeper development for TD children compared to children with DLD, especially between Time 1 and Time 2. We turn to this observation below.

The results show that interference control is impaired in children with DLD, confirming the findings reported in previous research (Pauls & Archibald, 2016). The measure we used—mean RTs in the incongruent condition of the Flanker task—did not control for general speed. Although it is possible that weak motor skills (Noterdaeme et al., 2002) contributed to the lower performance of the DLD group, it is unlikely that motor differences explain the full effect as RTs in the incongruent condition correlated moderately to strongly with the Flanker effect, which is a measure that does control for general speed. Pauls and Archibald (2016, p. 1082) suggest that weak abilities to retain linguistic representations of the task may affect performance on EF tasks. Such linguistic representations may indeed exist for the Flanker task. In order to perform well on this task, children need to remember the (verbally given) task instructions, that is, the task rule to indicate the direction of the central fish by pressing the corresponding left or right response button as quickly as possible. If children have difficulties retaining and refreshing this rule in working memory, their performance will be hampered, which may explain the lower performance of children with DLD. In line with this idea, we found that the children with DLD with better language abilities had better interference control. Longitudinal analyses revealed that the interference control gap between the DLD and TD groups emerged at Time 2 and was still present at Time 3. Botting (2005), who found a similar growing gap between the DLD and TD groups for performance on nonverbal intelligence tests, raises the possibility that verbal mediation may become more important as children grow older. This hypothesis is consistent with the observation that language ability predicted interference control at Time 2, but not at Time 1. At Time 3, this relationship was not significant, but it was clearly stronger than at Time 1 and showed a trend.

Figure 6. Performance of the DLD-nonpersistent ("no diagnosis Time 3"; dotted lines) and DLD-persistent ("diagnosis Times 1–3"; continuous lines) groups on selective attention over time; results are covariate-adjusted. DLD = developmental language disorder. Lower scores reflect better performance.



With regard to working memory, a Dot Matrix task was used in which children need to indicate the location of a series of dots in the reverse order. The children with DLD performed similar to TD controls on this task. At first sight, this seems to conflict with the outcomes of a meta-analysis, which concludes that visuospatial working memory is impaired in children with DLD (Vugs et al., 2013). However, whereas previous research shows robust evidence for verbal working memory deficits in DLD, findings of individual studies are more mixed for visuospatial working memory (Montgomery et al., 2010). For example, Alloway and Archibald (2008) and Lukács et al. (2016) do not observe significant differences between the DLD and TD groups. The results of our study may shed light on variable findings across studies. First, language ability in the DLD group consistently predicted variation in working memory, showing that children with less severe DLD do not experience working memory problems. Second, the group with less persistent DLD performed better on working memory than the group with more persistent DLD. Thus, children who have more severe and persistent DLD experience limitations in visuospatial working memory, whereas children with milder and less persistent language impairments do not. Consequently, one sample of children with DLD may show, on average, lower visuospatial working memory performance than TD controls, whereas this pattern is not necessarily replicated in another sample.

The children with DLD performed on par with their TD peers on the Visual Sky Search task, which tests selective attention, confirming the outcomes of Engel de Abreu et al. (2014). There were no indications that severity and persistence of DLD impact on selective attention: Language ability did not predict selective attention within the DLD sample, and the children with persistent DLD did not differ in their performance from the children who had less persistent DLD and were not diagnosed with DLD anymore at Time 2 or Time 3. Previous research found that DLD is associated with deficits in sustained selective attention (Blom & Boerma, 2016; Boerma et al., 2017; Ebert & Kohnert, 2011; Finneran et al., 2009; Noterdaeme et al., 2001; Spaulding et al., 2008). It is relevant to note that, for the purpose of a previous study, we analyzed sustained attention data from the same sample of children with DLD at Time 1 (Blom & Boerma, 2016). These showed "sustained" selective attention difficulties, in line with the other studies. Our past and present research thus suggests that the inability to sustain attention is more likely to contribute to children with DLD's lower EF performance than the inability to pay attention selectively.

The combined results lead us to conclude that (visual) selective attention is not impaired in children with DLD. Interference control is impaired in children with DLD from the age of 6 or 7 years. From this age onward, both children with milder and more severe forms of DLD are outperformed by TD controls on interference control, although the difference is larger for children with severe DLD. Visuospatial working memory presents an area of difficulties only for children with DLD with a relatively severe and persistent language impairment.

Theoretical Implications

EFs do not develop in isolation but build on and are supported by other cognitive abilities. It is unlikely that the EF impairments in DLD that emerged in our study are rooted in a lack of selective attention, as selective attention itself was not impaired in the children with DLD we studied. Intelligence may have contributed to some extent to the low interference control outcomes of the children with DLD as the intelligence cutoff was relatively low (−2 *SD*s), the children with DLD had on average lower intelligence scores than the TD controls, and intelligence predicted performance on EF tasks. However, even when intelligence scores were covaried, the children with DLD performed lower on interference control. Weaker sustained selective attention may have contributed to the children with DLD's lower interference control, as the Flanker task required the children to keep focused for a longer time.

There is an ongoing theoretical debate on how EF and language are related developmentally. The current study did not directly address this debate, in contrast to our previous research in which we performed cross-lagged analyses to identify the directionality of relationships between language and EF skills (Blom & Boerma, 2019). Yet, the current study did produce a few results that are potentially relevant. The growing gap in interference control between the TD and DLD groups may provide indirect support for the role of verbal mediation. We further observed that children with less persistent DLD also have relatively well-developed interference control and working memory. Previous research, including our own aforementioned study, has shown that children may make use of these cognitive functions for learning and using language (Ibbotson & Kearvell-White, 2015; Montgomery et al., 2010; Yoshida et al., 2011). If this is indeed the case, their relatively well-developed EF may have contributed to the language development of children with less persistent DLD, resulting in language performance above clinical levels.

In our sample, many children diagnosed with DLD did not only have language weaknesses but also weaknesses in interference control and working memory. This finding contributes to the mounting body of research showing that children with DLD have difficulties to resist interference from environmental distractors and keep information active for further manipulation (Kapa & Plante, 2015; Pauls & Archibald, 2016; Vugs et al., 2013). As such, our results are another illustration of the fact children with DLD with only linguistic weaknesses are relatively rare. Yet, it remains to be seen if language and weaknesses in executive functioning are causally linked or related indirectly through third variables (Gooch et al., 2016; Kapa & Plante, 2015) and if the linguistic weaknesses of children with DLD are caused by deficient domain-specific learning mechanisms or stem from impaired domain-general information-processing mechanisms (Botting & Marshall, 2017).

Clinical Implications

Language assessment methods, including standardized instruments and conversational assessments, that are used to diagnose DLD may be impacted by weak EF (Redmond et al., 2011). Low outcomes on language assessments may therefore not always reflect low language abilities but could, in part, also reflect domain-general EF weaknesses. Consequently, children with relatively weak EF may be more likely to be diagnosed with DLD (Wittke & Spaulding, 2018). Our results also underscore the conclusion that EF tests cannot be reliably used to support the identification of DLD (Laloi et al., 2017), as the performance of children with DLD is too variable and dependent on factors such as task complexity, age, and DLD severity and persistence. Another clinical implication is that treatments for children with DLD should reckon with limitations in interference control and working memory and language interventions should be tailored to the needs of children with these limitations, as distracting information and many visual stimuli that involve working memory could reduce any treatment effects.

Limitations and Future Directions

As captured in the unity and diversity framework (Miyake et al., 2000), a task in the domain of executive functioning is not necessarily tapping solely the component it intends to measure. To deal with task impurity and measure separate components more reliably, it is recommended to use multiple measures per component and extract latent variables (Friedman & Miyake, 2017). For the current study, including multiple measures per component was not possible as the children already participated in a large number of different tasks. The three tasks we used tested interference control, working memory, and selective attention. We were unable to include measures of sustained attention and set shifting in this three-wave longitudinal study; data on sustained attention were only available for Time 1 (Blom & Boerma, 2016), and data on set shifting were available for Time 2 and Time 3. Previous research suggests that effects of DLD on set shifting are small (Pauls & Archibald, 2016) or nonexistent (Henry et al., 2012; Im-Bolter et al., 2006). Given the findings of our research, it is worthwhile to investigate whether this also holds for children with severe DLD.

Lower performance of children with DLD on interference control, as well as effects of DLD severity and persistence on interference control and working memory, suggest that language and executive functioning are developmentally related but also underline the conclusion that more research is needed to understand the nature of the relationships (Gooch et al., 2016). An area for future research is children's use of verbal strategies as a mediator variable (Pauls & Archibald, 2016). Fatzer and Roebers (2012) suggest that the maintenance of information in working memory by using linguistic representations becomes more important as the task demands increase. Botting (2005) argues that verbal mediation may become more important as children grow older. Future research could compare executive functioning in children with DLD and TD children at different ages manipulating articulatory suppression to establish if verbal strategies can explain weaker performance of children with DLD and determine which tasks benefit from verbal mediation and pinpoint who benefits from it.

Author Contributions

Elma Blom: Conceptualization (Lead), Formal analysis (Lead), Funding acquisition (Lead), Investigation (Equal), Methodology (Equal), Writing–Original Draft (Lead), Writing–Review & Editing (Lead). **Tessel Boerma:** Conceptualization (Supporting), Investigation (Equal), Methodology (Equal), Writing–Review & Editing (Supporting).

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Appendix

Language Measures

Table A1. Language measures in the DLD and TD groups.

Variable	Time 1 *M* (*SD*)	Time 2 *M* (*SD*)	Time 3 *M* (*SD*)
Inflectional morphology DLD	11 (4)	13 (5)	17 (4)
Inflectional morphology TD	16 (4)	19 (4)	21 (3)
Sentence repetition DLD	12 (7)	17 (8)	22 (8)
Sentence repetition TD	29 (6)	32 (6)	35 (4)
Receptive vocabulary DLD	77 (11)	89 (12)	98 (11)
Receptive vocabulary TD	88 (12)	99 (11)	106 (11)

Note. DLD = developmental language disorder; TD = typically developing.

Table A2. Language measures in the DLD-nonpersistent and DLD-persistent groups.

Variable	Time 1 *M* (*SD*)	Time 2 *M* (*SD*)	Time 3 *M* (*SD*)
Inflectional morphology DLD-np	13 (4)	15 (5)	19 (4)
Inflectional morphology DLD-p	10 (4)	12 (4)	16 (6)
Sentence repetition DLD-np	17 (8)	22 (7)	27 (6)
Sentence repetition DLD-p	10 (6)	14 (6)	20 (8)
Receptive vocabulary DLD-np	82 (11)	95 (11)	102 (12)
Receptive vocabulary DLD-p	75 (10)	87 (12)	95 (10)

Note. DLD-p = developmental language disorder with diagnosis at all three times (persistent); DLD-np = developmental language disorder no diagnosis anymore at Time 2 or Time 3 (nonpersistent).