Children with Developmental Language Disorder and typically developing children learn novel nouns more easily than novel verbs: An experimental comprehension and production study.

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Abstract: Previous research suggests that nouns are generally learned more easily than verbs. However, few studies have investigated this issue amongst children with Developmental Language Disorder (DLD) or presented novel verbs and nouns in comparable training contexts. The present study therefore compared noun and verb learning in 18 Children with DLD and 36 Typically developing (TD) children aged from 3;1 (years; months) to 4;10. Participants were presented with two short cartoon videos that were dubbed with an audio script containing three novel nouns and three novel verbs (six novel nouns and six novel verbs in total). Children completed a comprehension and production task both immediately post-test and in a retention follow-up three to five days later. The TD children outperformed the children with DLD on both comprehension and production (though only in the retention test session and not the immediate test session). Although a noun advantage was observed, there was no evidence that its magnitude differs between TD children and children with DLD.

Keywords: Developmental Language Disorder (DLD); Word Learning

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Introduction

Developmental Language Disorder (DLD) is a condition that affects around 7% of the population (Norbury et al., 2016) with a prevalence of 8% for boys and 6% for girls (Tomblin et al. 1997). It is a neurodevelopmental disorder that is characterised by persistent and significant language difficulties that cannot be attributed to hearing loss or neurological damage. (Leonard, 2014: 3, Bishop, 2017). DLD is not a homogeneous disorder and individuals with this condition present with varied profiles of impairment in oral language and cognitive skills (Bishop, 2006). Areas of weakness in cognitive skills can include difficulties in attention, memory, problem solving and reasoning. Areas of weakness in oral language can include difficulties with phonology, morphology, syntax, semantics, and pragmatics. However, a key impairment in DLD is a deficit in the ability to learn new words, and this is the focus of the present study.

The Word-Learning Deficit in DLD

Word learning is a primary building block for acquiring language. Amongst Typically Developing (TD) children, there is evidence that early vocabulary size is a significant predictor of later grammatical development and literacy (Lee, 2010) and research suggests a link between vocabulary and academic achievement (Castles et al., 2018).

Children with DLD have consistent deficits in learning novel lexical labels (Alt & Plante, 2006) and storing new vocabulary compared with TD children (Gray, 2004, McGregor et al., 2011). Their vocabularies tend to show less breadth and depth in comparison to those of their age-matched peers (Dollaghan, 1998; Kail & Leonard, 1986, McGregor, Oleson, Bahnsen, & Duff, 2013) and numerous novel word learning studies have found that children with DLD require more encounters with a word before learning takes place (Alt, 2011; Alt & Plante, 2006; Alt, Plante, & Creusere, 2004; Gray, 2003, 2004; Gray, Pittman, & Weinhold, 2014; McGregor, Licandro, et al., 2013).

To learn a novel word, a child must build a phonological representation, a semantic representation, and make an association between the two (Chiat, 2001). A breakdown at any of these stages may impact the child's ability to recognise and further refine their word knowledge (Gray et al., 2020). McGregor et al. (2020) describe the process of learning a new word as involving encoding, re-encoding, and retention. Through this process, a child will learn a new word and store it in their memory where the lexical entry will be further built upon and refined. For some children, though, a breakdown in this process means that word learning is particularly difficult, although the reasons for this difficulty are still unclear.

One line of research suggests that children with DLD have difficulty with word learning due to impaired encoding (McGregor et al., 2013). There is evidence that children with DLD have difficulty encoding the phonological information in words (Bishop, North, & Donlan, 1996, Edwards & Lahey, 1998). In a series of studies with adolescents and adults with DLD, McGregor et al., (2013, 2017) developed the 'encoding deficit hypothesis'. Participants were trained on novel words and their associated referents,

and it was found that children with DLD had poorer performance on the immediate post-training tasks, but retention of the word seemed intact after one week. However, the gap between TD participants and those with DLD widened over time, indicating a potential problem with the retention of phonological information. McGregor et al.'s subsequent studies controlled for confounds with retention and concluded that "encoding of word form is the primary bottleneck to word learning among people with DLD" (McGregor et al., 2020:14).

Bishop and Hsu (2015) found similar results. They compared eight-year-old children with and without DLD and found that the children with DLD showed significant difficulty with the word learning task post training, but after two weeks both groups performed at a similar level suggesting that the children with DLD may have had difficulty with encoding the information but not with retention (see also Leonard et al, 2019, for a similar finding with five-year-olds).

However, one potential problem with this conclusion is that in many studies that consider retention, the performance of both TD children and children with DLD is so poor that it is difficult to tell whether there is really no retention deficit in DLD, or just a floor effect in the data. For example, Jackson et al. (2020) looked at six-year-old TD children and those with DLD. Their study involved teaching the children eight novel words over a four-day period and considered encoding, re-encoding, and retention abilities in both groups. Their findings suggested that children with DLD have difficulty with word learning in comparison to their TD peers and were consistent with the idea that these difficulties were due to encoding rather that retention, but both groups performed so poorly on retention that it was impossible to rule out an additional retention deficit that was hidden by the floor effect in the data.

Noun and Verb Learning

The above research provides clear evidence for a word learning deficit in children with DLD. However, much of the current research on word learning has focussed on noun learning to the exclusion of other kinds of word learning (e.g., Kan & Windsor, 2010). Studies with TD children have shown that nouns tend to be easier to learn than verbs (e.g., Bornstein, 2005; Gentner, 1982). While there is some debate concerning the cross-linguistic data, (e.g., Choi & Gopnik, 1995; Tardif, Gelman, & Xu, 1999), the majority of research supports the idea that the noun advantage is a universal trend across languages (Au, Dapretto & Song, 1994; Bird, Franklin & Howard, 2001; Bornstein et al., 2004; Gentner & Boroditsky, 2008; Gillette, Gleitman, Gleitman & Lederer, 1999; Kauschke, Lee & Pae, 2007; Kim, McGregor & Thompson, 2000; Snedeker & Gleitman, 2004). Several theories as to the source of the noun advantage in early acquisition have been proposed. Some researchers have suggested that parental input and frequency play an important role (Barrett, Harris & Chasin,1991). Chan, Brandone and Tardif (2009) demonstrated that parents speaking a noun-privileged language such as English produced more nouns than verbs when speaking to their children. Goodman, Dale, and Li (2008) also suggested that frequency may play an important role in early acquisition. However, other research has shown that noun

dominance cannot be attributed solely to frequency as nouns are learned more easily than verbs even when input frequency is controlled (Imai, Haryu, & Okada, 2005; Leonard, Schwartz, Morris, & Chapman, 1981; Merriman, Marazita, & Jarvis, 1993; Rice & Woodsmall, 1988). McDonough et al. (2011) found that English-speaking parents tend to request that their children repeat noun labels but act out verb meanings (Goldfield, 2000; Tardif et al., 2005), and that children prefer to attend to objects and map new names to objects rather than to actions. Some researchers have argued that nouns are more readily learned because the concepts to which they refer are more available to young learners than the concepts to which verbs refer (e.g., Byrnes & Gelman, 1991; Gentner, 1978; Gopnik & Meltzoff, 1986; Smiley & Huttenlocher,1995). Another possible explanation for the noun advantage is that, while objects are generally stable, actions are often fleeting (Gentner, 1982); thus, nouns tend to be more concrete, imageable, and more easily identifiable than verbs (McDonough et al., 2011). Salience and iconicity have also been shown to play a role (Hills, Maouene, Maouene, Sheya, & Smith, 2009; Perry, Perlman, & Lupyan, 2015; Roy, Frank, DeCamp, Miller, & Roy, 2015; Swingley & Humphrey, 2018). Other researchers have pointed out that the meaning of a concrete noun can often be inferred from the context in which it is uttered; however, the meaning of a verb depends more heavily on syntactic information and other linguistic cues. For example, in the study of Gillette et al., (1999), participants watched a mother-child interaction where both nouns and verbs were 'bleeped out' and were asked to guess the missing word. Participants were more able to guess the nouns than the verbs, which suggests that imageability played a significant role in the outcome.

A potential confounding factor when testing children's knowledge of noun and verb acquisition is that the way in which test items are typically presented may favour nouns over verbs. Nouns are typically presented in their stable state in both the testing session and the preceding training session, whereas in many word learning studies, verbs are presented in a stable state (i.e., using still pictures) in the testing session, but dynamically during training. In the present study, we address this potential confound by presenting the verbs as dynamic rather than static, using animations at test. This ensures that the actions to which the verbs refer are presented in the same way during testing and training.

The fact that children with DLD have been shown to have difficulties with word learning in general, combined with the general difficulty of verb learning, raises the question of whether children with DLD may find verb learning particularly challenging. Children with DLD may finding verb learning even more challenging than their TD peers because verb learning may require stronger abilities in phonology and semantics, and greater awareness of the links between these for effective learning, which is a known area of difficulty for these children (Wright, Pring & Ebbels, 2018). As Wright et al. point out, there are two possible reasons why phonology may impact on verb learning. First, in continuous speech, verbs are less stressed than nouns, making the phonological sequence more difficult to identify and store. Secondly, as verbs have more complex morphology, the phonological form of the verbs a child hears will be more variable than the phonological form of the nouns, which increases the

complexity of the extraction process. In terms of verb semantics, as verbs only appear in particular sentence structures, a child can use the sentence structure a verb appears in to aid their hypotheses regarding the meaning of a new verb. However, Van der Lely (1994) argues that children with DLD may have more difficulties than TD children in using this kind of information. Other research has suggested that children with DLD may have difficulty with verb learning because the child's current verb lexicon, which tends to be reduced in comparison to their TD peers, will have less learned examples of 'verb types' and this will impact the ability to learn novel verbs (Windfuhr, Faragher & Conti-Ramsden, 2002).

In fact, there is already some evidence that verb learning may be a particular problem for children with DLD. For example, children with DLD have been shown to use a narrower range of verbs in their speech, and to overuse a small set of general all-purpose (GAP) verbs such as *go* and *do* (Rice & Bode, 1993) in comparison to TD children. However, the results of studies of novel noun and verb learning with this population have been mixed, with some studies finding that children with DLD had particular difficulty learning verbs (e.g., Oetting et al., 1995), while others have not (Rice et al. 1994, Rice, Buhr, & Nemeth, 1990; Rice & Woodsmall, 1988). Determining whether children with DLD have a particular problem with verb learning may thus have clinical implications for how these children are assessed and treated. For example, a greater difficult with verb than noun learning is likely to impact on the ease with which children with DLD master verb morphology which is often an area addressed in assessment and treatment in the clinic.

The Present Study

In view of the considerations discussed above, the aim of the present study is to compare noun and verb learning in children with DLD and age-matched controls in an ecologically valid word learning task. The study investigates the impact of encoding and retention difficulties on the word learning deficit by testing comprehension and production both immediately after presentation and three to five days later.

We use a design adapted from Rice et al. (1990), in which novel (i.e., non-word) nouns and verbs are embedded in the narrative script of a short video. Children are shown a short video with a dubbed audio script. Children are then tested in a format similar to the Peabody Picture Vocabulary Test- Revised (PPVT-R), in which they are asked to select the correct response from a choice of four pictures/animations (comprehension test) and to produce the word when shown the appropriate picture/animation (production test). This allowed us to investigate the extent to which both encoding and retention vary as a function of group (DLD/TD) and word class (noun/verb). We predicted: (1) that the children with DLD would perform significantly worse than the control group; (2) that both groups would perform significantly better on Nouns than Verbs: and (3) that the size of the noun advantage would be larger for the children with DLD than the TD children.

Methods

Participants

Participants were recruited from a range of nurseries across Northern Ireland. Children were identified by teachers and parents as appropriate for the study, in that they were monolingual English speakers of the relevant age group. The children did not have an existing diagnosis of DLD but were assigned to a group (DLD/TD) on the basis of the standardised tests conducted as part of the study. A power analysis was carried out (using GPower) prior to recruiting participants, assuming 0.8 power and an effect size of 0.6, on the basis of the following studies: Gray (2003, 2004 and 2006) and Rice, M. L., Buhr, J. C., and Nemeth, M. (1990). This resulted in us aiming to test ninety children: (forty-five children in the DLD group and forty-five children in the TD control group). Due to the difficulties identifying and recruiting children with DLD, in total, seventy-six children were tested, but five were excluded as they did not complete all the tasks. A further seventeen children were excluded because they had been identified by their class teachers as suitable for the study, but after assessment had been completed, did not meet the strict criteria for either the DLD or the control group.

The Groups were defined as follows:

1. The children with DLD scored 1.5 or more standard deviations below the mean on the Core Language score (CLS) of the Pre-School Clinical Evaluations of Language Fundamentals 2 (PS-CELF2); a composite of three sub-tests looking at Comprehension and Production of Language; Expressive Vocabulary, Word Structure and Understanding of Sentence Structure. For assignment to the DLD group, children were required to score within 1 Standard Deviation on a cognitive assessment: the Non-Verbal Index of the Kaufman Assessment Battery for Children II (K-ABC II)
2. The TD children were defined as scoring within 1 SD of the mean on the CLS and the Non-verbal assessment of the KABCII.
3. Children in both groups passed a hearing screening administered by the researcher, and parents reported no neurological or genetic conditions, or issues with the children's motor skills.

Application of these criteria resulted in a sample size of N=54, 36 TD children (control group), 18 children with DLD (experimental group). The children's ages ranged from 3;0 (years; months) to 4;8. Table 1 below provides more detailed descriptive data on the ages of the children.

Children were deemed by the researcher, a qualified Speech and Language Therapist, to have adequate phonology to participate in the study (i.e., to not have a disordered phonological profile). Children were accepted into the study if they presented with no phonological errors or if the errors that they made were developmentally appropriate as specified by Grunwell's (1987) Common phonological processes and their

approximate ages of elimination in typical acquisition. In practice, no errors that would have made it difficult to determine the accuracy of responses were observed, with children either producing the target form or failing to respond.

Table 1. ***Details of age range***

	Age Range	**Mean**	**SD**	**No. of children aged 3:0yrs-3:5yrs**	**No. of children aged 3:6yrs-3:11yrs**	**No. of children aged 4:0yrs-4:5yrs**	**No. of children aged 4:6yrs-4:11yrs**
Combined TD and DLD	3yrs 0mths-4yrs 8mths 20 months	3yrs 9mths 45.93mths	5.63				
TD	3yrs 0mths-4yrs 8mths 20 Months	3yrs 10mths 46.03mths	5.82	11	8	12	5
DLD	3yrs 0mths-4yrs 5mths 17 Months	3yrs 9mths 45.72mths	5.24	5	3	9	1

Design and Procedure

The novel words were presented within two short Pixar cartoon videos which children watched on a laptop computer. Each cartoon was dubbed with an audio script (Appendix 1 and 2) containing three novel nouns and three novel verbs, meaning that each child heard a total of six novel nouns and six novel verbs. (See Figure 1 for details).

Six of the non-words were one syllable long and six were two syllables long. Each word was heard a total of four times.

Novel words were based on real nouns and verbs that would be familiar to children of this age group, according to the UK Communicative Development Inventory (UK-CDI). The words were manipulated to create non-words by altering the initial phoneme to a labial or alveolar sound (i.e., /p/, /b/, /m/, /n/, /t/ and /d/), which are sounds that children of the age group that was tested are typically able to produce.

The novel words were embedded in a relatively syntactically complex script as there is evidence that children use syntax to guide verb learning in a process known as syntactic bootstrapping (Fisher et al., 1991; Levin & Rappaport-Hovav, 2005; Pinker, 1989).

Novel Noun Words	**Object**	**Novel Verb Words**	**Action**	**Video**
Nall	Tin toy's hat	Diting	Tin toy walking and playing music	Tin Toy
Mot	Drum Type Toy	Tuddling	Baby waving their arms and legs	Tin Toy
Poffee	Beads	Bickling	Spinning in circles	Tin Toy
Dut	Small alien	Miping	Ship warping	Lifted
Bettle	Driving handlebars	Nuving	Man levitating	Lifted
Tellon	Big Alien	Povering	Big alien moving fingers	Lifted

Figure 1. ***Novel Nouns and Verbs Details***

The videos were divided into an A and a B group, where nouns and verbs in the testing were presented in a different alternating order (i.e., noun-verb-noun or verb-noun-verb). The order in which each condition was presented to the children was randomized.

The comprehension and production tasks were administered immediately after viewing and again (for the retention test) three to five days later. The comprehension task involved showing the child a choice of four pictures representing each noun or four short video clips (less than 2 seconds) for each verb (see Figure 2). The experimenter's probe was as follows:

Inv: *'Where's the Dut?'*
Child*: (points)*

Responses were recorded manually by the researcher; 1 as correct, 0 as incorrect/no response. The production task involved showing the child a picture of the novel noun or a short video clip of the novel verb and prompting the child as follows:

Inv: *'What's he doing?*
Child*: povering*

Verbs were presented in present progressive and past tense forms in the video as this is the most natural way to describe ongoing and completed actions. Responses were considered correct if the child produced the verb in the present (e.g., povers), progressive (e.g., povering), past tense (e.g., povered) or bare stem (e.g., pover) form.

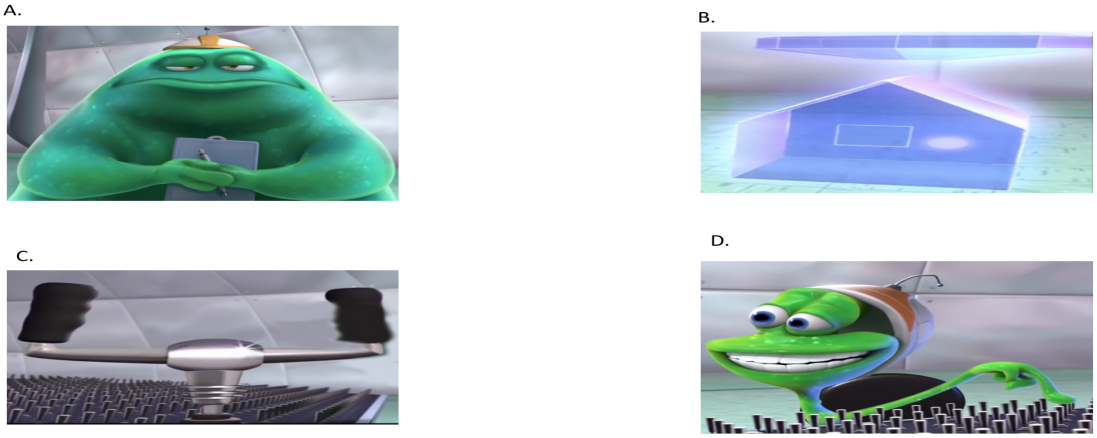

Figure 2 ***Comprehension Task Example***

Word Learning Task

Each child was tested individually in a quiet setting, with each session lasting approximately 30 to 45 minutes. Testing was divided into three sessions on three different days. The first two sessions were completed within 24 hours of each other, and the child was shown one video and completed the tasks on each day. The third session tested retention and was administered three to five days later.

On Day 1, children completed the sentence-structure and word-structure tests from the PS-CELF 2, the first two subtests from the K-ABC-II and twelve trials from the main study. On Day 2, children completed the expressive vocabulary test from the PS-CELF 2, the remaining two subtests from the K-ABC-II and a further 12 trials from the main study. On Day 3, Children were asked to complete all 24 retention trials without watching the previously seen videos. All responses were manually recorded by the researcher.

Analyses

The data were analysed using 'R' (version 1.4.1717; R version 4.1.0, R Core Team, 2018), with the packages lme4 (v1. 1-26; Bates et al., 2015) and yarr (v0.1.5; Philips., 2022). Mixed-effects models were used because the data had more than one source of random variability: participants and items. The dependent variable – for both the production and comprehension analyses - was whether the trial was completed correctly (1) or not (0). Predictor variables were Group (DLD/TD), sum coded as -0.5 and 0.5 respectively, and Part of Speech (Noun/Verb), sum coded as -0.5 and 0.5 respectively. Note that sum coding is crucial here in order to ensure that any effects of Group and Part of Speech can be interpreted as "ANOVA style" main effects.

Results

Comprehension

The data from the Immediate and Retention comprehension sessions were analysed using mixed-effects models where the dependent variable was response (1=correct, 0=incorrect) and the predictor variables were Group (DLD=-0.5, TD=0.5) and Part of Speech (Noun=-.05, Verb=0.5), both sum-coded. Age in months (raw, not scaled or centred) was included as a control predictor. Following Matuschek et al. (2017), we built models with all possible random effects structures that were justified given the data and chose the model with the lowest BIC value.
For the Immediate test session, the model with the following effects structure had the lowest BIC value and so was selected as the final model (note that this model does not include correlated random effects):

glmer(Response ~ Part_of_Speech*Group + Age + (1|Participant) + (1|Lexical_Item), data=subset(First, Test_Type=="Comprehension"), family=binomial, glmerControl(optimizer = "bobyqa"))

A summary of this model is shown in Table 2 (see the accompanying OSF site for the full model output, including estimated random effect variances). This analysis revealed a significant effect of Part of Speech, reflecting better overall performance for Nouns than Verbs (recall from the analysis section that, because sum coding was used, inferences regarding main effects can be made based directly from these fixed effect terms). However, the effect of Group (DLD/TD) was not significant. Nor was the interaction of Part of Speech x Group. We thus have no evidence that the Noun advantage is greater in children with DLD. A significant positive effect of age was observed, indicating that performance improves with age.

Table 2. ***Mixed-effects model for the Immediate comprehension session.***

	Estimate	**Std. Error**	**z value**	**P Value**
Intercept	-2.58	0.98	-2.64	0.008 **
Part of Speech	-0.47	0.21	-2.20	0.028 *
Group1	0.40	0.23	1.77	0.078
Age	0.50	0.24	2.10	0.036 *
Part_of_Speech1:Group1	-0.21	0.362	-0.58	0.565

For the Retention comprehension test, the final, best fitting model had the same random effects structure as for the Immediate test session. A summary of this model is shown in Table 3 (again see the accompanying OSF site for the full model output). This time, the effect of Part of Speech was not significant, but a significant effect of Group indicated that the TD children outperformed the children with DLD. Crucially, the interaction of Part of Speech x Group was again not significant. We thus have no evidence to suggest that any Noun advantage (though none was observed in the Retention session) is greater for the children with DLD.

Table 3. ***Mixed-effects model for the Retention comprehension session.***

	Estimate	**Std. Error**	**z value**	**P Value**
Intercept	0.36	1.21	0.30	0.766
Part of Speech	-0.38	0.30	-1.27	0.203
Group1	0.98	0.29	3.42	0.001 ***
Age	-0.30	0.30	-1.00	0.317
Part_of_Speech1:Group1	0.30	0.39	0.77	0.441

These results are plotted in Figures 3 and 4. Figure 3 summarizes the proportion of correct comprehension responses for the children with and without DLD in the immediate test. Figure 4 summarizes the same data for the retention session (3-5 days later).

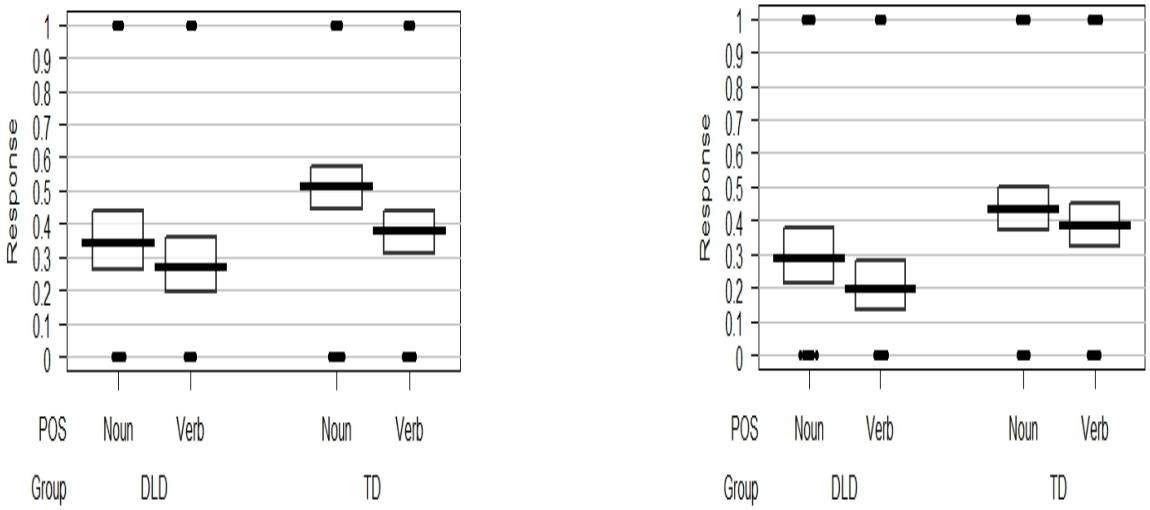

Figure 3: ***Proportion of correct choices by Part of Speech (Noun/Verb) and Group (DLD/TD) in the Immediate comprehension session***
Figure 4*: Proportion of correct choices by Part of Speech (Noun/Verb) and Group (DLD/TD) in the Retention comprehension session*

Consistent with the results of the mixed-effect analyses, these figures suggest a general advantage for Nouns over Verbs, which is greater in the immediate recall session and a general advantage for the TD children, which is greater in the retention session. They also provide no evidence of an interaction between Group and Part of Speech, though there is some suggestion that the difference in Verb learning between the two groups is greater in the retention than the immediate recall session.

Production

For the production data, mixed-effects models were run in the same way as for the comprehension data, though with the dependent variable as correct versus incorrect productions, and the same model structure was again optimal by BIC (see Tables 4-5). In this case, significant effects of Group (TD>DLD) were observed for the Retention production session (Table 5), though not the Immediate production session (Table 4). However, there was no effect of Part of Speech in either case. For both datasets, a significant positive effect of age was observed, indicating that performance improves with age. Crucially, though – just as for the comprehension data – the interaction of Part of Speech x Group was not significant in any analysis. We thus have no evidence to suggest that any Noun advantage is greater for the children with DLD.

Table 4. ***Mixed-effects model for the Immediate production session.***

	Estimate	**Std. Error**	**z value**	**P Value**
Intercept	-13.98	3.75	3.73	0.000 ***
Part of Speech	0.19	0.82	0.23	0.815
Group1	1.08	0.88	1.24	0.215
Age	2.34	0.87	2.70	0.007 **
Part of Speech: Group1	0.25	1.49	0.17	0.865

Table 5. ***Mixed-effects model for the Retention production session***

	Estimate	**Std. Error**	**z value**	**P Value**
Intercept	-7.15	2.72	-2.63	0.009 **
Part of Speech	0.59	0.89	0.66	0.509
Group1	1.63	0.75	2.17	0.030 *
Age	0.74	0.64	1.16	0.247
Part of Speech: Group1	-1.11	1.31	0.85	0.396

These results are plotted in Figures 5 and 6. Figure 5 summarizes the proportion of correct production responses for the children with and without DLD in the immediate test session. Figure 6 plots the same data for the Retention production session.

Consistent with the results of the mixed-effects analyses, these figures provide no evidence of a Noun advantage in either group, but they also show that both groups were essentially at floor in both production sessions. The absence of such an effect is therefore unsurprising.

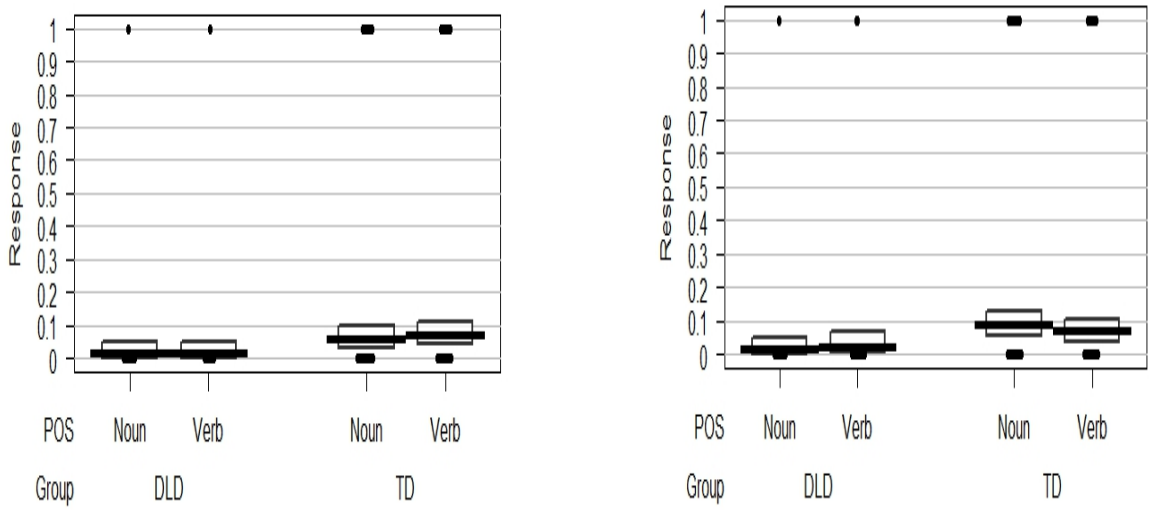

Figure 5: ***Proportion of correct production responses by Part of Speech (Noun/Verb) and Group (DLD/TD) in the Immediate comprehension session***

Figure 6*: Proportion of correct production responses by Part of Speech (Noun/Verb) and Group (DLD/TD) in the Retention comprehension session*

Summary

Generally, as expected, the TD children outperformed the children with DLD in both comprehension and production; though, somewhat surprisingly, only in the Retention test session and not the Immediate test session. A (narrowly) significant Noun > Verb advantage (p=0.03) was seen in only one analysis: the Immediate comprehension session. Importantly, in no analysis was the Part of Speech x Group interaction significant. Thus, we have no evidence to suggest that any Noun advantage is greater for the children with DLD, in either production or comprehension, whether tested immediately, or in a later retention session.

Discussion

In this study we compared noun and verb learning in children with DLD and age-matched controls in an ecologically valid word learning task. We also investigated the impact of encoding and retention difficulties on the word learning deficit by testing comprehension and production both immediately after presentation and three to five days later. We predicted that the children with DLD would perform significantly worse than the TD children; that both groups would perform significantly better on

nouns than verbs, and that the size of the noun advantage would be larger for children with than without DLD.

Our results showed that, as predicted, the children with DLD performed significantly worse than the TD children in the comprehension task and in the production task, though only in the retention session. This is in line with previous studies that have demonstrated that children with DLD have difficulty with word learning in comparison to their peers without DLD, though previous studies have tended to find differences in encoding rather than retention. The results of our study also confirmed our prediction that a noun advantage would be evident across both groups, though this was significant only in the immediate comprehension task. The study thus demonstrated that, other than lower overall performance, the children with DLD performed similarly to the TD children with respect to their comprehension of novel words. That is, despite the small sample size, both groups appear to show better comprehension of novel nouns than novel verbs, which adds to the existing body of literature suggesting a noun advantage.

Previous studies have identified deficits in word form encoding, but not retention. The opposite was found here. This may suggest that children with DLD have more difficulty with the retention than the encoding aspect of the task, but another explanation may be that in previous studies, the retention difficulties have simply been hidden by floor effects in the data. It is also possible that the immediate effect found in previous studies made it difficult to find an additional effect on retention, and hence that the absence of an immediate effect in the present study made the effect at retention easier to detect.

A further consideration is that in comparison to previous studies, the design of our study meant that there was a delay with the encoding assessment and so the study may be more accurately described as a study of short- and long-term retention in TD children and children with DLD, rather than as a study of encoding and retention. If this is the case, then it is possible that the greater differences between the TD children and the children with DLD in the delayed than the immediate recall task may actually reflect differences in encoding which only impacted retention over the longer term.

The present study provided further evidence for the noun advantage in English, but it did not show that the noun advantage is significantly greater in children with DLD than in TD children. Although the noun bias appeared to disappear in the retention session, this is likely a consequence of lower overall performance and the encoding versus retention issues outlined above; future studies should investigate whether it is still found when performance levels are higher. One way to increase performance might be to change the schedule according to which children are exposed to the novel words. For example, Childers and Tomasello (2002) found that production of novel words improved when training was spread over multiple days (see also Ambridge, Theakston, Lieven and Tomasello, 2006, for a similar finding for construction learning). A further factor that may have impacted the ability of both groups to learn novel words, may have been the syntactic complexity of the narrative. As previously

discussed, the decision was made to present the words in this way, as research has shown that children can learn information about the meaning of verbs because the structure in which the verb participates provides information via a process called 'Syntactic bootstrapping'. Some studies have shown that children with language impairment may have syntactic bootstrapping difficulties and presenting the words in this way will have made the task more complex in terms of what the children had to hold in working memory and this may account for why both groups performed poorly on the task. Studies have also shown that working memory (Jackson et al., 2020) and syntactic bootstrapping (Johnson & de Villiers,2009, Rice et al., 2000) may be particular areas of difficulty for children with DLD. While these factors may have differentially affected the performance of the children with DLD, they do not appear to have interacted with the type of word being presented as there was no evidence in this study for a greater noun advantage in the DLD children than in the TD controls.

A similar point can be made about the verbs used in the study, which varied both in syllable length in comparison to the nouns, due to the addition of inflection, and in the fact that they were presented in different tenses. Research has shown that children with language difficulties are prone to phonological and semantic impairments which may contribute to their word learning difficulties, including their difficulties with learning verbs (Black & Chiat, 2003). This may have contributed to the difficulty of the verb-learning task. It might therefore be advisable in future studies, to explicitly control for these factors in the design of the novel word stimuli. However, these factors do not appear to have differentially affected the performance of the children with DLD as they did not show a greater noun advantage than the TD controls. Verb learning in both groups may also have been impacted because nouns are always presented in the same state whereas verbs are presented with a range of endings depending on the context of the sentence. This at times may have increased the length of the word that the child had to hold in working memory and, may also have made it harder to learn the words as they were being heard in a range of different contexts.

An obvious limitation of the present study is that it suffers from lack of power due to difficulties recruiting children with DLD, which is common in this literature. A more definitive test of our predictions must therefore await future studies, which could use the effect size observed in the present study as the basis for a power calculation that would ensure a well-powered design. Our view, on the basis of the present results, is that – counter to our initial prediction – the noun advantage is probably *not* greater for children with than without DLD. Testing this prediction of a null effect would therefore require either a Bayes Factor analysis or frequentist equivalence testing, as well as a very large sample.

However, it is possible that a greater noun advantage could be detected using a different approach to that used in the present study. Recall from the Introduction that novel word learning studies have shown that children with DLD require more exposures to a word before it is learned (Alt, 2011; Alt and Plante, 2006; Gray, 2003,2004). It is therefore possible that the number of exposures needed to learn a word is a more sensitive measure than rates of correct comprehension and production per se, and hence that

using this measure might reveal the kind of interaction between group and part of speech that was predicted, but not found, in the present study.

In summary, the main conclusion that can be drawn from the present study, is that TD children tend to show better overall performance in novel word learning tasks than children with DLD, and that a noun advantage can be seen in both groups, even with improved verb imageability, as compared to previous studies, though this effect was only found in the immediate recall condition. There is, however, no evidence in the present study that children with DLD show a greater noun bias in learning than age-matched TD children.

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Data, code and materials availability statement

The data that support the findings of this study and a pre-print of the manuscript are available from OSF. https://osf.io/3eqtk/files/osfstorage

Ethics statement

This study was approved by the University of Liverpool Ethics Committee. Informed written consent was obtained from the schools and caregivers, and the children also gave verbal assent.

Authorship and Contributorship Statement

Paula Stinson and Julian Pine conceived and designed the study and Paula Stinson collected the data and wrote the first draft of the manuscript. Both authors analysed the data, approved the final version of the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Appendix A

Appendix 1- 'Tin Toy' Script

Object/ Action	**Non- word**
Noun 1- Beads	Poffee
Noun 2- Tin toy's hat	Nall
Noun 3- Drum	Mot
Verb 1- Baby waving their arms and legs	Tuddle
Verb 2- Tin toy walking and playing music	Dite
Verb 3- Spinning in circles	Bickle

Tin Toy

Visual	**Narration**
1. Camera spans over box and shows the room with toys.	1. Let's meet our new friend Tin Toy. He has just come out of his box! He's not the only toy there. There are some stacking rings and some Poffee (coloured beads).
2. Close up of Tin toy as he looks around the room.	2. Tin toy is wearing his special hat today. It's called a Nall (Tin toy hat). His Nall is his favourite thing to wear. He's having a look around the room. He can see the stacking rings and Poffee too!
3. Tin toy watches as baby enters the room. Baby sits by the toys and begins to move.	3. There's someone coming. It's a baby! Tin toy is happy to see the baby. Oh, look the baby is tuddling (waving legs and arms). Did you see him Tuddle? Tin toy was so surprised at that, it's made his Nall shake. The baby is fling again with the blue ring.
4. Baby lifts the beads from the floor.	4. Look what the baby is getting now. He's lifted the Poffee. Oh no, the baby Tuddled and the Poffee have broke.
5. Tin toy starts to move away from the baby.	5. Tin toy's not sure what to do. He stepped back and his Mot (drum) just banged. Look what Tin toy's doing, he's Diting (moving while paying music).
6. Tin toy moves around the room as the baby follows him	6. The baby is following him and watching him Dite. I hope his Nall stays on his

	head!
7. Tin toy spins around and continues to run away from the baby.	7. He's in such a hurry he's started to Bickle (spin in circles). Did you see how fast he Bickled? He's Diting as fast as he can now away from baby. Look at his Mot banging.
8. Tin toy heads towards the box and gets stuck.	8. Where will he Dite to? He's stuck in the box now. How will he get out? He's Bickled and got out of the box! The baby was surprised to see him Bickle.
9. Tin toy goes under the sofa and sees the other toys	9. He's safe under the sofa now. He's nice and quiet now that his Mot isn't banging. Look, there are other toys under the sofa with Tin toy.
10. The baby falls over and begins to cry.	10. Oh no. Now the baby's fallen over and he's crying. Tin toy goes to see if he's okay.
11. Tin toy goes out to the baby and the baby shakes him and throws him.	11. oh the baby's thrown Tin toy! I hope he hasn't broken his Mot.
12. The baby shakes inside the bag and Tin toy follows him as he leaves the room.	12. The baby's looking in Tin toy's box and what is he doing now? The baby is stuck! Oh dear, I hope he can get the bag off.

Appendix 2- 'Lifted' Script

Object/ Action	**Non- word**
Noun 1- Small alien	Dut
Noun 2- Big Alien	Tellon
Noun 3- Driving handlebars	Bettle
Verb 1- Man levitating	Nuve
Verb 2- Big alien moving fingers	Pover
Verb 3- Ship warping	Mipe

Lifted

Visual	**Narration**
1. Camera spans over a house at night. A man is sleeping inside, and a light is seen from the window	1. It's the middle of the night and everything is very quiet. There's a man sleeping soundly in his bed. Look there's a bright light and it's coming from a spaceship!
2. The man floats above his bed and moves around the room.	2. Watch, the man is starting to Nuve (levitate). He's nuved all the way out of his bed! Oh dear, he's nuved right into the wall … again!
3. Inside the spaceship a small alien is working the control panel as a larger alien watches. The small alien chooses switches as the man is moved around inside his bedroom.	3. Look here's a Dut (small alien). It was him that was making the man Nuve. There's a Tellon (big alien) watching him. He doesn't look very happy. He's trying to find the right switch. Oh no! The man is moving all around the room.
4. The small alien tries other switches as the big alien watches.	4. The Dut is trying a different switch. That one wasn't right!
5. The small alien is frustrated as he tries many different buttons	5. Oh no. I don't think the Dut is doing very well. There are a lot of switches and he doesn't know which one to choose.

	6. I don't think the Tellon thinks he's picking the right one, do you?
6. The big alien watches as the small alien consistently chooses the wrong switch. The man is moved around the room.	Oh dear, that wasn't the right one, either. This must be very tricky. The man is going everywhere!
	7. Maybe the book will help him find the right one.
7. The man is transported outside his house and into a tree.	The man is stuck in the window now, oh no! He's gone straight into a tree.
8. The man travels from the tree up into the spaceship.	8 The man is going all the way up to the ship. Can you see?
	9. Uhoh! He's fallen back down again. The Tellon won't like that. Phew, they caught him before he hit the ground. Well done, Tellon!
9. The man falls from the spaceship towards the ground.	
	10. What's he going to do now? Maybe he'll pover. Look he's povering! He can pover very fast. Because he povered , now everything is going back the way it was.
10. Big alien takes the controls and returns the man to bed while restoring his room.	
	11. He's using the Bettle (Handlebars) now to drive them home. Oh dear, the Dut is very sad. But look, he's giving him the Bettle so he can drive. He's so happy he can use the Bettle. He'll use the Bettle to drive them all the way home.
11. The big alien begins to drive and when the smaller alien looks sad, he offers him the steering wheel.	
	12. The spaceship is getting ready to Mipe (warping) so they can go home. Uhoh, looks like they've fallen back to earth. Look the spaceship is Miping. They've Miped back into space They didn't even wake the man when they Miped!
12. The spaceship is about to fly but falls back to earth and then flies into space. The man's house is destroyed but he is still sleeping in his bed.	

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