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# Influences of Bilingualism and Developmental Language Disorder on How Children Learn and Process Words

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Previous studies found that bilingual children and adults with typical language development (TLD) perform better than monolinguals in novel word learning, but show lower scores on lexical retrieval tasks (e.g., naming known words). Children with developmental language disorder (DLD) lack in their abilities in both tasks compared with children with TLD. The current study tested the interplay between bilingualism and language disorder during novel word learning and lexical retrieval. Preschoolers ($N$ = 101; 50 boys and 51 girls; mothers' mean years of education = 16.35) in four groups (Hebrew monolinguals or Russian-Hebrew bilinguals with DLD or TLD) learned 12 novel real words (6 with a familiar referent and 6 with a novel referent) and performed a lexical retrieval task. Children exhibited significant learning with no effect of bilingualism, but a negative effect of language disorder. Thus, children with DLD performed worse than children with TLD, and this ability was not affected by bilingualism. In lexical retrieval, DLD groups scored lower than TLD groups, and critically also bilinguals scored lower than monolinguals. This differential effect of bilingualism in the two tasks suggests that bilingualism does not impede language learning mechanisms even among children with DLD. Instead, the findings suggest that lower performance in the lexical retrieval task is due to decreased frequency of exposure. By exploring both word learning and lexical retrieval, the study highlights the differential mechanisms at play in the effects of bilingualism and language disorder on the developing lexicon.

*Keywords:* word learning, lexical retrieval, developmental language disorder, bilingualism



To become proficient speakers of a language, children need to learn and appropriately use extensive vocabulary (e.g., Segbers & Schroeder, 2017). The ability to learn and the ability to access lexical representations constitute key prerequisites for literacy development (e.g., Perfetti, 2007), and are likely to have long-lasting effects on speakers' linguistic abilities (Nation, 2006). As such, it is important to understand how variability in children's characteristics influence novel word learning and lexical retrieval processes. In the current study we focus on two sources of variability—developmental language disorder (DLD) and bilingualism, and examine how they affect both learning of novel words and processing of known words. By comparing the two aspects of the developing lexicon in the same individuals, we aim to uncover the relevant mechanisms at play in both dimensions. To this end, four groups of children were tested, including monolingual and bilingual children, with typical language development (TLD) or DLD. All children were tested on both learning of novel words and processing (retrieval) of known words and the interaction between these two processes is examined.

## Word Learning and Lexical Retrieval

Novel word learning is a complex cognitive-linguistic task, which is crucial for children's language development, for efficient communication, and for reading development (e.g., Perfetti, 2007). It consists of at least three components that may be acquired simultaneously (see Figure 1): a new concept (or meaning), a new form (label) including phonological and morphological features (Swingley, 2007), and a mapping between the form and the meaning (Hirosh & Degani, 2018). Natural word learning clearly includes decontextualization in which knowledge about the learned word is broadened beyond a specific situation (Friend et al., 2018). Nonetheless, our focus here is on initial learning of form, meaning, and the mapping between them.

Although the process of novel word learning typically requires learning of all three components, under some conditions this is not the case. For example, when learning a second language or when learning synonymous words, there is often no need to learn a new concept, but learning a form and linking the form and the known meaning remain necessary. Notably, although word learning is a spontaneous basic process in language acquisition, children vary

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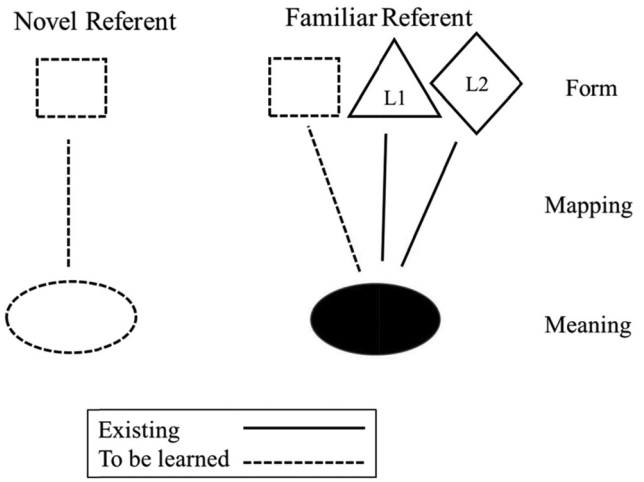
**Figure 1**
*The Three Components of Novel Word Learning as a Function of Referent Type*




in their ability to learn novel words. Of relevance, there is evidence to suggest that bilingual children are better at word learning compared to monolingual speakers (e.g., Kaushanskaya et al., 2014; for review see Hirosh & Degani, 2018), whereas children with DLD are characterized by difficulty in word learning (Bishop & Hsu, 2015; Kan & Windsor, 2010).

Once a word has been learned and integrated into the lexicon, the child needs to access the word and use it appropriately. The process by which the speaker retrieves known words is called *lexical retrieval*. It may entail retrieving the phonological form based on a provided meaning (as examined in the current study) and may also reflect retrieval of a given meaning based on a provided form. This retrieval process thus taps into the same three components, namely form, meaning, and the mapping between them. Of relevance, both bilingual children and children with DLD have been shown to exhibit difficulty in lexical retrieval tasks (Degani et al., 2019). Here, we test how DLD and bilingualism affect word learning and lexical retrieval in the same children and whether these two processes interact.

## Novel Word Learning in Bilinguals

Numerous studies found that bilingualism is beneficial for novel word learning both among adults and among children (Benitez et al., 2016, Experiment 3; Eviatar et al., 2018; Kalashnikova & Burnham, 2016; Kaushanskaya et al., 2014; Kaushanskaya & Marian, 2009b; Poepsel & Weiss, 2016; but see Diego-Lázaro et al., 2021; and Degani & Goldberg, 2019). For instance, English–Spanish bilingual adults outperformed English monolinguals in learning artificially constructed novel words that were orthographically but not phonologically similar to English (Kaushanskaya & Marian, 2009b). Comparing classroom English–Spanish bilingual children to English monolingual children on a novel word learning task, Kaushanskaya et al. (2014) observed a bilingual advantage in learning novel words in association with familiar referents, but not in association with novel (invented) referents. In contrast, Eviatar et al. (2018) observed a bilingual advantage when comparing Arabic–Hebrew bilingual children to Arabic and Hebrew monolingual children, although all words were learned in association with novel referents. Across both studies, bilingual children outperformed monolinguals in learning novel vocabulary, but the role of referent familiarity remains unclear.

To understand the importance of manipulating referent familiarity, as is done in the current study, it is relevant to consider the mechanisms underlying the beneficial effect of bilingualism to word learning. Specifically, these mechanisms are still debated, with accounts spanning direct linguistic effects as well as indirect domain general cognitive processes (for review see Hirosh & Degani, 2018). Of interest, the explanations that emphasize differences between bilinguals and monolinguals in the linguistic system itself can be viewed in light of the three components of word learning mentioned above (form, meaning, and mapping).

One account highlights the form component and suggests that bilinguals' advantage stems from their superior phonological memory (Papagno & Vallar, 1995; but see Kaushanskaya & Marian, 2009a for evidence of a bilingual advantage even with comparable phonological memories). If this is the case, then bilinguals are expected to outperform monolinguals in word learning whenever a novel form is to be learned, regardless of its meaning. Accordingly, one would expect superior bilingual learning of novel words to familiar and novel referents, alike.

A second class of explanations for bilinguals' better vocabulary learning suggests that the advantage is not due to superior form (phonological) learning, but rather stems from differences in learning and representing meanings. Bilinguals have been suggested to be more sensitive to semantic information during word learning due to higher activation in their semantic system (Kaushanskaya & Rechtzigel, 2012). Under this assumption, bilinguals are expected to outperform monolinguals when learning of a novel meaning is required. Accordingly, bilinguals should outperform monolinguals when learning of an unfamiliar (novel) referent, but not when learning a novel form to a familiar (known) referent.

Finally, a third explanation for bilinguals' benefit in word learning focuses on the mapping of form to meaning, postulating that bilinguals have a higher efficiency in generating a link between the new form and an already existing meaning (Kaushanskaya et al., 2014). Bilinguals have practiced learning two names (first language and second language) to the same concept, and are thus more experienced than monolingual speakers in generating a connection between the novel word form and its referent (meaning). This bilingual advantage of mapping two labels to the same concept is related to differences between bilinguals and monolinguals in their reliance on the *mutual exclusivity bias* (Clark, 1987), which refers to the child's belief that an object has only one name. As a result, children prefer to link a new word to a novel referent, more than to a familiar referent, which already has a name in their mental lexicon (Clark, 1987; Kaushanskaya et al., 2014). To illustrate, in a typical paradigm testing the mutual exclusivity bias, the child is presented with a known object (e.g., a ball) and is then presented with the same object along with a novel object, and is asked to select one of the presented objects upon hearing a new form (e.g., "touch the *funnel*"). The mutual exclusivity bias refers to the child's tendency to select the novel object over the familiar one. In a recent study, Lewis et al. (2020) showed that the linguistic experience of the child affects the strength of this tendency, in that the mutual exclusivity bias was larger among 2–3-year-old monolinguals

relative to age-matched multilinguals. Similar findings were observed among children of different ages (Kalashnikova et al., 2015). Although the reliance of bilinguals on mutual exclusivity may be linked to their knowledge of the two labels in their existing languages (e.g., Nicoladis & Laurent, 2020), the general pattern suggests that bilingual speakers weight the mutual exclusivity bias differently than monolingual speakers, and this may allow them to tolerate ambiguous (two-to-one) mapping of two labels to a known referent. Such two-to-one ambiguous mapping (as illustrated in Figure 1 in the case of a familiar referent), occurs for monolingual children in the case of synonymous words, which are relatively rare, but for bilingual children this is a common linguistic situation, in which one meaning is represented by a separate word form in each of the bilinguals' languages. Accordingly, bilinguals may be better at word learning of known referents that require such ambiguous mapping. If this is the case, bilinguals should outperform monolinguals only in cases when such many (forms) to one (meaning) mapping is needed (Kaushanskaya et al., 2014; but not Eviatar et al., 2018).

Of note, in the current study children learn a novel form to either a familiar or a novel referent, but the known label is never presented, and children are not asked to select one of two objects (a familiar and a novel referent). Thus, the paradigm we employ differs from that typically used in mutual exclusivity bias studies and may provide new insights into the mechanisms at play during bilingual novel word learning. If the bilinguals' advantage in novel word learning stems from superior phonological (form) processing, then bilinguals should outperform monolinguals when learning both familiar and novel referents. If the bilinguals' advantage stems from superior processing of meaning, then bilinguals should outperform monolinguals when learning novel referents, but not familiar ones. Finally, if the bilinguals' advantage stems from their experience in mapping two forms to the same meaning (see Figure 1), we predict a bilingual advantage for familiar referents only. Critically, we tested this prediction while also measuring children's lexical retrieval of known words to explore the relationship between these two abilities.

## Bilingualism and Lexical Retrieval

In contrast to word learning and other communicative skills, where bilingual children outperform monolinguals, bilingual children often score lower than monolingual children in lexical-retrieval tasks (Bialystok et al., 2010). For instance, Gross et al. (2014) observed that simultaneous and sequential Spanish–English bilinguals scored lower than monolingual English children on standardized receptive and expressive vocabulary tests tapping lexical retrieval. Further, in the expressive vocabulary task in which children were asked to name pictures, bilingual children scored lower than monolinguals even when conceptual scoring was adopted, by which the children could retrieve the name of the picture in their other language. The difficulty of bilinguals with lexical retrieval tasks has been documented across various tasks with bilingual adults (picture naming; see, e.g., Gollan et al., 2005) and across the life span (for review see, e.g., Bialystok, 2009).

Notably, two main classes of explanations have been proposed to explain the bilingual difficulty in lexical retrieval tasks. First, because both languages of bilingual speakers appear to be activated even when bilinguals attempt to function in a single language (Kroll et al., 2006), competition between representations in the two languages (Hermans et al., 1998) may hinder bilinguals' lexical retrieval performance. Second, an additional source for bilinguals' reduced lexical retrieval performance may be rooted in their accumulated patterns of use. Specifically, the Frequency Lag Hypothesis (Gollan et al., 2011) posits that because bilinguals need to divide their language usage between two languages, they use each language less often than do monolinguals. This reduced frequency of use leads to weaker representations for bilinguals, leading to a bilingual reduced lexical retrieval performance. Whereas both accounts predict reduced performance for bilinguals in lexical retrieval tasks, they differ in their prediction for word learning. Specifically, based on the competition account, referent familiarity should modulate the effect. One option is that bilinguals would experience increased competition when learning a new form to a familiar referent, because available word forms in both the first and the second language may create competition. Alternatively, as alluded to above, bilinguals may be more experienced in negotiating competition and thus may present an advantage over monolinguals for such familiar referent learning. Based on the frequency-based account, word learning should not be affected by bilingualism, because for both bilingual and monolingual children, these novel words have no accumulated frequency. Group differences should therefore disappear. In the current study we tested these contrasting predictions in both children with TLD and with DLD.

## Novel Word Learning in DLD

Novel word learning is one of the linguistic tasks in which children with DLD have difficulties, in comparison to children with TLD (Beverly & Estis, 2003; Bishop & Hsu, 2015; Kan & Windsor, 2010). For example, Bishop and Hsu (2015) compared learning among children with DLD relative to age-matched and language (receptive grammar)-matched control children with TLD. They found that during the initial stages of learning, children with DLD performed worse than those with TLD on a verbal paired-associate learning task, but not on a comparable nonverbal version of the task. In a recent meta-analysis, children with DLD exhibited novel word learning skills that were on average more than half a standard deviation below those of children matched on chronological age (Kan & Windsor, 2010). Further, the difference between children with DLD and those with TLD was larger in recognition tasks compared with production tasks (Kan & Windsor, 2010). Accordingly, word learning was predominantly measured here using a recognition task.

The sources of difficulties for children with DLD in learning novel words can be framed by considering the components of word learning. Focusing on learning of the form component, some studies emphasize the role of explicit memory for novel phonological strings (Bishop & Hsu, 2015). In contrast, other accounts focus on the meaning component, and suggest that children with DLD are impaired in acquiring concepts. For instance, Alt et al. (2013) showed significant differences between children with DLD and TLD in rating images of animals that varied from the standard concept in parameters of color and pattern.

Finally, the disadvantage of children with DLD in word learning can be rooted in the mapping of form to meaning. Evidence for differential mapping operators for children with DLD are suggested by the finding that children with DLD rely less on the mutual exclusivity assumption. For instance, Estis and Beverly

(2015) found that preschool-age children with DLD did not prefer a novel referent over a familiar referent, in contrast to age-matched peers with TLD who showed this tendency. Children with DLD therefore appear to exhibit difficulties in learning novel words, but the source of this difficulty is yet to be determined. By manipulating referent familiarity, the current study aims to provide relevant constraining evidence to the mechanisms at play.

## DLD and Lexical Retrieval

Among the defining characteristics of children with DLD is a difficulty in word finding, or lexical retrieval tasks (Dockrell et al., 1998; Kambanaros, 2013). As alluded to earlier, children with DLD have been proposed to exhibit specific deficits in phonological representations (McGregor, 1994), in semantic representations (Alt et al., 2013; Biran et al., 2018) or in the mapping of form to meaning (Beverly & Estis, 2003), but general cognitive deficits may also be involved (for review see Leonard, 1998). Of relevance, lexical retrieval deficits of children with DLD compared to those with TLD have been observed both among monolingual children and among bilingual children (e.g., Kambanaros et al., 2013, 2015; Novogrodsky & Kreiser, 2015). For instance, in a picture naming test, Anaya et al. (2018) observed that English–Spanish bilingual children with DLD exhibited lower naming accuracy compared to bilingual children with TLD, especially when adopting conceptual scoring.

Recently, the effects of DLD on lexical retrieval were examined along with the effect of bilingualism. Degani et al. (2019) explored lexical retrieval in a four-group design (similar to the one used here) using a naming task. They found that DLD was associated with lower lexical retrieval performance, and that this was the case within the monolingual groups and the bilingual groups. Further, English–Hebrew bilingual children scored lower than Hebrew monolingual children both among children with TLD and among children with DLD. Importantly, although bilingual children with DLD performed worse than all other groups, they performed better than expected based on combining the effects of bilingualism and DLD. The authors concluded that the presence of bilingualism does not exaggerate the impact of DLD on lexical retrieval. Expanding this research, here we explore both word learning and lexical retrieval in the same children to reveal the relationship between these two processes.

## The Current Study

The current study examined novel word learning and lexical retrieval performance of monolingual and bilingual children with and without a language disorder. To the best of our knowledge, this is the first study to explore the joint effects of bilingualism and DLD on word learning. To this end, and in order to explore the particular word learning components that are affected by bilingualism and language disorder, children learned novel words in association with either familiar or novel referents. In the case of familiar referents, the child needs to learn a novel form and a novel mapping of the form to the meaning, but does not need to learn a new meaning. In contrast, in the case of novel referents, the child needs to learn all three components (form, meaning, mapping of form to meaning). Comparisons across referent type will thus reveal which components are implicated as relevant for the effects of bilingualism and language disorder. Additionally, the same children were tested on a naming task tapping lexical retrieval, allowing us to explore the joint effects of bilingualism and DLD on word learning and lexical retrieval.

In the novel word learning task, bilinguals were expected to outperform monolinguals, irrespective of DLD, such that bilingual children with TLD would outperform monolingual children with TLD, and at the same time bilingual children with DLD would outperform monolingual children with DLD. Modulations by referent type would reveal the mechanisms at play. In particular, if bilinguals' advantage stems from superior form (phonological) learning, then the bilingual advantage would surface for both familiar and novel referents, as both similarly require learning of a form component. If the effect stems from superior processing of meaning by bilinguals, then bilinguals should outperform monolinguals only when learning of meaning is required, namely for novel referents. Lastly, if the bilingual effect stems from enhanced ability to create ambiguous (two-to-one) mappings, bilinguals (both TLD and DLD) should outperform monolinguals only on familiar referents (Kaushanskaya et al., 2014; Poepsel & Weiss, 2016) where such ambiguity exists.

Further, the TLD groups were expected to outperform the DLD groups, but it was unclear whether this difference would be modulated by referent type. If the deficit for children with DLD (both monolingual and bilingual) is in terms of phonological processing (the form component), then both familiar and novel referent types should be affected by DLD, because both require learning of form. However, if the deficit is in terms of semantic representations, then learning novel referents should be especially difficult for children with DLD (both monolingual and bilingual), because familiar referents do not necessitate learning a new concept. Lastly, if the deficit is in the mapping of form to meaning, although in both types of referents there is one mapping to be learned, in the case of familiar referents, the new mapping may compete with the existing mapping between the known form and the known meaning (see Figure 1). Accordingly, children with DLD might find familiar referents especially challenging. Of note, because no prior studies tested for the joint effects of bilingualism and DLD on word learning, it was not clear whether the two factors would interact. Nonetheless, we explored whether bilingualism reduced the effects of DLD in word learning, such that the word learning difference between bilingual children with TLD and bilingual children with DLD would be reduced compared to that between monolinguals with TLD and those with DLD (as was found in lexical retrieval, Degani et al., 2019).

With respect to lexical retrieval, both children with DLD and bilingual children are expected to show difficulties in lexical retrieval. Further, based on the results of Degani et al. (2019) utilizing a similar four-group design, we expect that bilingualism would not exaggerate the difficulty in lexical retrieval stemming from DLD. Thus, main effects of bilingualism and of DLD are predicted. If the two factors interact, we expect this interaction to result in less than additive effects (as in Degani et al., 2019), such that the presence of both bilingualism and DLD result in better performance than would be expected by adding the two effects. Finally, the four-group approach, along with the within-participant component, by which the same individuals learn novel word and retrieve known words, allowed us to examine the interplay between these processes in the context of bilingualism and DLD.

## Method

### Participants

One hundred and one preschool children aged 4:04–6:08 were examined, 50 boys and 51 girls who were recruited from four groups: 25 Russian–Hebrew bilinguals with TLD (BITLD), 24 Hebrew monolinguals with TLD (MOTLD), 26 Russian–Hebrew bilinguals with DLD (BIDLD) and 26 Hebrew monolinguals with DLD (MODLD). This age range was selected to minimize the involvement of explicit schooling, as reading and writing instruction starts in Israel in the first grade. Further, based on previous literature (e.g., Moav-Scheff et al., 2015), we expected children at this age range, with and without DLD, to be able to participate in the novel word learning paradigm. The four groups were matched on age (see Table 1), but we nonetheless verified that it did not significantly modulate the observed findings (see Results section below). Bilingual participants were native Russian speakers born in Israel who were exposed to Hebrew as a second language for at least 2 years and were exposed to Russian regularly at home by at least one parent. Monolingual children were native Hebrew speakers, who were not exposed to Russian or any language other than Hebrew. The four groups largely matched on socioeconomic status (SES; although BIDLD had lower SES than BITLD). As expected, children in the BIDLD group were less proficient in Hebrew and were exposed to it less than the MOTLD children, with the MODLD and BITLD in between. Further, as expected, MOTLD received higher Hebrew oral proficiency ratings in the parental report than did MODLD ($t(48) = 2.18$, $p = .034$, but this difference did not reach significance when applying the corrections for the six multiple comparisons reported in Table 1).

We note that in a previous study with a similar four-group design (Degani et al., 2019), a sample size of 58 participants was sufficient to observe an interaction between DLD and bilingualism in lexical retrieval (Odds Ratio = 2.61). Our sample size here is almost double. We are unaware of a similar four-group design in a word learning paradigm, but previous studies comparing word learning between bilingual and monolingual children (Kaushanskaya et al., 2014; $n = 19$ participants per group with 8 items learned) or between monolingual children with DLD or TLD (Bishop & Hsu, 2015; $n = 20$–28 participants per group with 8 items) have used comparable sample sizes per group. Further, using PANGEA (Westfall, 2016), we calculated the power needed to detect a three-way interaction among bilingualism, DLD, and referent type on the word learning task, treating participants as a random factor, and taking into account six repetitions (6 items) in each condition. This analysis suggested that with a minimum of 24 participants per each of the four groups, we would have a power of .88 to detect a small interaction effect size (Cohen's $d = .3$) with an alpha of $p = .05$. In the delayed test, with three groups only, reported as supplementary materials in the Appendix, the power to detect a similar sized interaction effect drops to .61.

We recruited the TLD participants through social-media, and the DLD participants through a university-affiliated Clinical Center that provides therapy intervention for children with DLD. All participants with DLD were diagnosed prior to the study by a certified speech and language therapist using comprehensive clinical assessment according to the protocol used in Child Development Institutes, including formal and informal language tasks. All participants met the exclusionary criteria for language impairment (*DSM–5*; American Psychiatric Association, 2013; Leonard, 1998); no hearing impairment and no recent episodes of otitis media, no abnormalities of oral structure or problems in oral function; no evidence of obvious neurological impairment or impaired neurological development (IQ within the normal range); no symptoms of impaired reciprocal social interaction or restriction of activities that are typical of autistic spectrum disorder. Their speech intelligibility was intact, with no diagnosis of developmental dyspraxia or articulation problems. Forty-six of the participants with DLD (24 BIDLD and 22 MODLD) received language intervention once a week, and the rest were about to start intervention within 1–3 months. To verify the DLD diagnosis, performance on a standardized language test of Hebrew (Goralnik, 1995) was examined against available norms for both monolingual children (Goralnik, 1995) and bilingual speaking children (Altman et al., 2021). Participants with TLD had no parental concern regarding their language development. In addition to the 101 children

**Table 1**
*Characteristics of the Final Set of Participants*

| Measure | MOTLD Average (*SD*) | MODLD Average (*SD*) | BITLD Average (*SD*) | BIDLD Average (*SD*) |
|---|---|---|---|---|
| Number of participants | 24 | 26 | 25 | 26 |
| Number of females | 11 | 11 | 14 | 15 |
| Age (months) | $67.17\ (7.02)_a$ | $63.15\ (6.53)_a$ | $67.56\ (8.25)_a$ | $67.31\ (7.53)_a$ |
| Month of exposure to Hebrew | $67.17\ (7.02)_a$ | $63.15\ (6.53)_a$ | $60.64\ (16.77)_{a,b}$ | $52.35\ (14.65)_b$ |
| Month of exposure to Russian | N/A | N/A | $67.56\ (8.25)_a$ | $67.31\ (7.53)_a$ |
| Hebrew oral proficiency | $8.98\ (1.12)_a$ | $8.25\ (1.24)_a$ | $8.38\ (2.26)_a$ | $7.06\ (1.86)_b$ |
| Russian oral proficiency | N/A | N/A | $7.32\ (2.67)_a$ | $6.42\ (2.50)_b$ |
| Socioeconomic status (Mother education years) | $16.11\ (1.99)_{a,b}$ | $16.26\ (3.89)_{a,b}$ | $18.05\ (2.60)_a$ | $15.10\ (2.11)_b$ |
| Familiarity with Hebrew labels of the tested items | $0.98\ (0.03)_a$ | $0.89\ (0.11)_b$ | $0.88\ (0.16)_b$ | $0.81\ (0.16)_c$ |
| Familiarity with Russian labels of the tested items | N/A | N/A | $0.84\ (0.12)_a$ | $0.74\ (0.14)_a$ |
| Familiarity with novel words of the tested items | 0.01 (0.01) | 0.00 (0.02) | 0.01 (0.03) | 0.00 (0.00) |

*Note*. ns = nonsignificant; MOTLD = monolinguals with typical language development (TLD); MODLD = monolinguals with developmental language disorder (DLD), BITLD = bilinguals with TLD, BIDLD = bilinguals with DLD. Values are means (standard deviation). Means in the same row that do not share a subscript letters differ at $p < .05$ in a one-way ANOVA with Bonferroni correction for multiple comparisons. Month of exposure to Hebrew/Russian are the number of months the child has been exposed to each language until today. Hebrew/Russian oral proficiency is the mean rated proficiency in speaking and comprehension of the child in Hebrew/Russian based on parental rating on a scale of 0–10, with 10 representing the highest ability. Familiarity with Hebrew/Russian/Novel labels is the extent of familiarity of each child with the Hebrew or Russian labels or the learned novel words based on parental report.

reported here, an additional 10 children were tested but excluded from analysis; two MOTLD participants because they were bilingual, two MOTLD participants because they were outside the defined age range, and three participants (one MOTLD, one BITLD, and one BIDLD) because they did not cooperate during task administration. Two additional participants were excluded because they did not meet the criteria of performance on the Goralnik test: one MOTLD participant scored too low for children with TLD, and one BIDLD scored too high to be considered with DLD. Finally, one BITLD participant was excluded because of hearing loss diagnosis. The study was approved by the Ethics Committee of the University of Haifa, Protocol Number 368/18 for project "Aluntiti & Kurnas: Influences of bilingualism and SLI on novel word learning in children." The study was not preregistered.

## Materials

All study materials are available upon request.

### *Novel Word Stimuli*

Twelve novel real words were selected from a set of rare and unfamiliar words in Hebrew, based on a list of words learned for the Israeli Psychometric Test. By choosing the novel words from existing Hebrew words, we guaranteed that the selected words adhere to the phonology of the Hebrew language. However, as these words are rare and are not used in children's or adults' daily input, children were unlikely to know them. Furthermore, children were told that this was a game where they were about to hear strange and funny words. All novel words were synonyms of frequent words in children's input (see Table 2).

**Linguistic Characteristics of the Novel Words.** Six of the novel words were marked with a feminine Hebrew morpheme and six had a masculine grammatical gender. Nine words matched the grammatical gender of the corresponding synonymous word. Further, nine words matched the grammatical gender of the corresponding Russian translation (the first-language of the bilingual speakers, see Table 2). The different novel words were relatively phonologically diverse. Their phonological structure fits phonological constraints of Russian phonology, based on judgments of three native Russian speakers.

**Referents of Novel Words.** The novel words were presented during the learning phase along with 12 pictures: six pictures of existing daily familiar objects (familiar nouns in children's everyday life, e.g., a boat, from the Shemesh Test, Biran & Friedmann, 2005, or freely available pictures from Google images), and six pictures of invented novel objects (made up objects by Gonzalez-Gomez et al., 2013). Two lists were created, such that in each list, half of the novel words were paired with existing and familiar referents and the other half were paired with the invented novel objects. The two lists were counterbalanced across two versions of the word learning computer game. Each participant played in one of the two versions, such that all participants learned six of the words in association with a familiar referent and the other six in association with a novel referent, but across participants each item was paired with both familiar and novel referents. Presentation order was initially randomized, and then kept constant in both versions.

**Analysis of Item Familiarity.** Based on parental report, the 12 novel words used in the current study were indeed novel to the children (see Table 1). We excluded from analysis specific cases in which parents indicated in the parental questionnaire some knowledge of these words by the children (less than 1% of the cases). Further, a familiar referent is one that has a known label in at least one of the languages (Hebrew or Russian) or both, creating two-to-one ambiguous mapping to the novel word. To verify this, we examined whether the children were familiar with the Hebrew and Russian names (labels) of the objects. We found that in 89% of the cases children were familiar with the labels in Hebrew. There was a group effect, ($F_{(1.77,\ 19.45)}$ = 9.61, $MSE$ = .01, $p$ = .002, $\eta_p^2$ = .47), such that MOTLD children knew more words than the BITLD and MODLD children who did not differ from each other, and in turn knew more Hebrew words than the BIDLD group (see Table 1). We excluded from the analysis (5.8%) specific cases in which the Hebrew word was not familiar to the child, unless he or she was familiar with the Russian word for that same referent.

### *Goralnik Test: A Lexical Retrieval Task*

This is a standardized language test in Hebrew (Goralnik, 1995) for children ages 3–7, including five subtests: (a) vocabulary naming subtest; (b) comprehension subtest in which the child is asked

**Table 2**
*The Final Set of 12 Novel Word Stimuli*

| Novelword | Hebrew synonym | Russian translation | Word meaning | Gender novel word | Gender Hebrew synonym | Gender Russian translation | Number syllables novel word |
|---|---|---|---|---|---|---|---|
| *Ilpa* | *Sira* | *Lodka* | Boat | F | F | F | 2 |
| *Kurnas* | *Patish* | *Molotok* | Hammer | M | M | M | 2 |
| *Keilaf* | *Garzen* | *Topor* | Axe | M | M | M | 2 |
| *Marxeshet* | *Maxvat* | *Skovoroda* | Skillet | F | F | F | 2 |
| *Puzmak* | *Gerev* | *Nosok* | Sock | M | M | M | 2 |
| *Layish* | *Arye* | *Lyev* | Lion | M | M | M | 2 |
| *Shalxofa* | *Tsav* | *Cherepaxa* | Turtle | F | M | F | 2 |
| *Orlogin* | *Shaon* | *Chasi* | Clock | M | M | N/A (plural) | 2 |
| *Xarit* | *Arnak* | *Koshelyok* | Wallet | M | M | M | 2 |
| *Afifit* | *Vafel* | *Vaflya* | Waffle | F | M | F | 2 |
| *Aluntit* | *Magevet* | *Polotentse* | Towel | F | F | Neutral | 2 |
| *Isplanit* | *Plaster* | *Plastir* | Bandage | F | M | M | 2 |

*Note*. F refers to a feminine grammatical gender; M refers to a masculine grammatical gender. Italic terms refer to the phonological transliteration of the Hebrew and Russian words; orthographic forms were never presented.

to follow instructions and answer questions related to images; (c) imitation subtest in which the child is asked to repeat five sentences; (d) production subtest in which the child is asked to answer five questions and describe five simple pictures; (e) narrative subtest based on a picture book. The test allows scores per subtest as well as a total score, and serves as a common language test in the clinic and in research (Novogrodsky & Kreiser, 2019). The correlations between each subtest score and the total score are .57–.82, and the test correlates with the Peabody Picture Vocabulary T (PPVT, Duhn, 1965) at .82. To verify assignment to DLD groups, we used the tests' norms for monolingual children (Goralnik, 1995) and for bilingual Russian–Hebrew children (Altman et al., 2021). For the purposes of the lexical retrieval task, we used the vocabulary subtest only. The 15 items of this subtest differ from those of the novel word learning task.

## Procedure

The researcher tested each participant individually during one meeting of approximately 30 minutes in a quiet room at the child's home or in the Clinical Center. The researcher first explained to the child that the meeting is dedicated for playing together and learning new words. The order of the tasks was fixed. Participants first completed the novel word learning task by playing a computer game, which included a learning phase, incorporating production attempts, and an immediate recognition test phase. Then, participants were tested in the Goralnik test (Goralnik, 1995) providing data on lexical retrieval performance and a general language score. Finally, a subset of the participants were tested with a second recognition test of the novel word learning task (delayed test), identical to the first one. Notably, the MOTLD group were the first to participate, and did not complete the delayed test, because it was added to the protocol only after their data collection has ended. Therefore, these analyses are reported only in the Appendix. In addition, prior to the meeting, participants' parents filled out a consent form and a parental questionnaire detailing the child's language history. It included a word list of the familiar objects presented in the game, and parents were asked to mark whether the child was familiar with the novel words, the Hebrew synonyms, and the Russian translations (for bilinguals) of the critical novel words.

### *Novel Word Learning*

The task included an 8-minute computer game consisting of learning and testing phases. To standardize the involvement of the experimenter, a computerized paradigm was used (see Moav-Scheff et al., 2015). Specifically, a recorded narrator explained that during the game the child should listen carefully in order to help the boy in the game (a character named Yotam) find his objects, and that at the end of the game the child would be asked some questions. In every phase of the game, there was an option to pause and resume from the same point. During the learning phase, the participants heard a story, which presented each novel word with a picture of a familiar or a novel object, in a predetermined order. The story included the following part: "Yotam remembered he left all his objects in the park and decided to go look for them. Let's help him find them. We'll try to find. . . */puzmak/*" (a sock)." Participants heard every novel word four times (following previous studies, see Kan & Windsor, 2010), while watching the corresponding pictured object in the middle of the computer screen. During each of the first three presentations, the pictured object remained on the screen for 3 seconds. During the fourth exposure, the pictured object was presented on the screen for 5 seconds, and the child was prompted to name the object before the correct word was auditorily presented. Children were expected to name the objects with the novel learned word (i.e., in Hebrew), and none attempted to name the objects in Russian. Note, that across the entire protocol, novel words were presented with a single pictured object, with no additional information regarding function, characteristics or other meaning-related features.

### *Testing Phase*

During the testing phase, which followed the learning phase, children were tested on the novel words using a recognition task consisting of 12 trials including all 12 learned novel words. On each trial an array of four objects was presented (2 familiar objects and 2 novel objects, all of which were used as stimuli in the game). The novel word was auditorily presented, inserted in a question form (e.g., "Where is *ilpa* (a boat)?") and participants were instructed to select the pictured object that corresponded to the heard novel word, by pointing to it. The display including the four alternative pictured objects remained on the screen for a maximum of 10 seconds. Across trials, the target picture to be selected appeared three times (for a maximum of twice in a row) in each of the four possible positions on the screen. This order was kept constant for all participants (Kaushanskaya et al., 2014). If the child lingered, asked "what?," asked to repeat the question, or did not cooperate, the researcher pressed a hidden button on the screen leading to one more repetition of the question. No time limit was imposed on children's responses. All auditory stimuli, questions, and instructions were prerecorded and presented in a computerized form to reduce bias. Participants' performance during the game was audio-recorded and documented by the researcher on a dedicated form including only the selected object's location, so as not to affect children's motivation. When children chose one picture and then corrected themselves (occurred only 22/1,212 (2%) of the trials), the final choice counted. The Goralnik Language Test was administered at the end of the computer game, following the guidelines of this standardized test (Goralnik, 1995). All relevant materials are available upon request.

# Results

## Learning Effects

Proportion of production attempts during the fourth presentation of the novel word, as well as correct responses in the recognition test administered immediately following learning are presented in Table 3 as a function of group and referent type. Production attempts were generally infrequent and did not differ across groups as determined by a one-way ANOVA with Bonferroni corrections for multiple comparisons ($F < 1$). Further, successful attempts were rare; only five of the 101 children tested were able to correctly retrieve the learned words when prompted during the fourth presentation of the word. This finding is in line with previous studies showing that production tasks in novel word learning are difficult for both children with TLD and DLD (Kan & Windsor, 2010). Therefore, the main dependent measure of interest from the learning task is the recognition

task. Based on this measure, participants in each group learned the novel words above chance level (.25; all one-sample $t$s $> 4$, $p$s $< .001$).

To examine effects of bilingualism, language disorder, and referent type, results from the recognition test were analyzed using logistic linear mixed effect models, as these models allow one to simultaneously account for variance related to participants and to items. The model included deviation coded fixed effects of bilingualism, language disorder, referent type, and their interactions, and by-participant and by-item random intercepts, as well as by-participant random slope for referent type and by-item random slopes for bilingualism, language disorder, and their interaction. Because the model including this maximal random structure failed to converge, we used the buildmer function in the *buildmer* package (v. 1.3; Voeten, 2019) in R (Version 3.6.1; R Core Team, 2019), which uses the glmer function from the lme4 package (v 1.1.-21; Bates et al., 2015) to select the random structure using backward stepwise elimination, while keeping all theoretically relevant fixed effects in the model (using the "include" subcommand).

Results showed a significant effect of language disorder ($F$ = 14.49, $b$ = −.69, $SE$ = .32, 95% CI [−1.32, −.06], $z$ = −2.14, $p$ = .032). Children with TLD performed significantly more accurately than children with DLD (see Figure 2). Critically, the effects of bilingualism, referent type, or their interactions were not significant (see Table 4).

Due to our theoretical interest, we further tested whether the presence of bilingualism or of DLD affects learning performance to the same extent. We thus directly compared the BITLD and MODLD groups, regardless of referent type, revealing a significant difference, ($F$ = 5.82, $b$ = −.63, $SE$ = .26, 95% CI [−1.14, −.11], $z$ = −2.37, $p$ = .018), such that learning performance was higher in the BITLD group ($M$ = .58) than in the MODLD group ($M$ = .42).

We further examined whether age affected performance, by including age as a normalized predictor in the model. Within the range tested here, there was no significant effect of age on performance ($F < 1$, $b$ = .02, $SE$ = .10, 95% CI [−.17, .20], $z$ = −.16, $p$ = .876).

## Lexical Retrieval Effects—Standardized Vocabulary Test

In contrast to the word learning test in which participants and items were randomly selected, the lexical retrieval task is based on a standardized object naming test. In this test items were purposefully selected, and thus results were analyzed by averaging performance across participants, without including items as a random factor. We thus tested the performance in the Goralnik vocabulary subtest using a univariate ANOVA, with language disorder and bilingualism as between participant factors. Results showed a main effect of bilingualism, ($F$(1, 97) = 15.98, $MSE$ = 31.08, $p < .001$, $\eta_p^2$ = .14), such that bilinguals scored lower ($M$ = 14.95, $SE$ = .78) than monolinguals ($M$ = 19.38, $SE$ = .79). In addition, there was a main effect of language disorder, ($F$(1, 97) = 18.01, $MSE$ = 31.08, $p < .001$, $\eta_p^2$ = .16), such that children with DLD scored lower ($M$ = 14.81, $SE$ = .77) than children with TLD ($M$ = 19.52, $SE$ = .80). Critically, there was no interaction between bilingualism and language disorder, ($F < 1$). Further, contrary to the word learning task (where BITLD scored higher than MODLD), an independent samples $t$-test showed that BITLD and MODLD did not differ on the Goralnik vocabulary subtest ($t < 1$, Figure 3).

## Relation Between Novel Word Learning and Lexical Retrieval Score

Finally, to examine the degree to which lexical retrieval of known vocabulary affects novel word learning, we repeated the analysis of the novel word learning test including participant's lexical retrieval score from the Goralnik vocabulary subtest (normalized prior to analysis) and allowing it to interact with the effects of interest (bilingualism, language disorder, referent type). The results revealed in addition to the significant language disorder effect, a significant three-way interaction among language disorder, referent type, and lexical retrieval score (see Table 5 for the ANOVA model summary). To unpack this three-way interaction, we examined performance separately for DLD and TLD groups.

In the DLD group, there were no effects of bilingualism ($F < 1$), lexical retrieval score ($F < 1$), referent type ($F < 1$), or any interaction (all $F$s $< 1$, with the exception of retrieval score by referent type $F$ = 1.33, $p$ = .25). Interestingly, in the TLD group, there was a significant interaction between lexical retrieval score and referent type ($F$ = 6.98, $p$ = .008), with no main effects for bilingualism ($F < 1$), lexical retrieval score ($F < 1$) or referent type ($F$ = 2.43, $p$ = .12) or other interactions (all $F$s $< 1$). Follow up tests using the *testInteractions* function from the *phia* package (v. .2-1; De Rosario-Martinez, 2015) with Bonferroni adjustments, showed that higher lexical retrieval score was linked to more

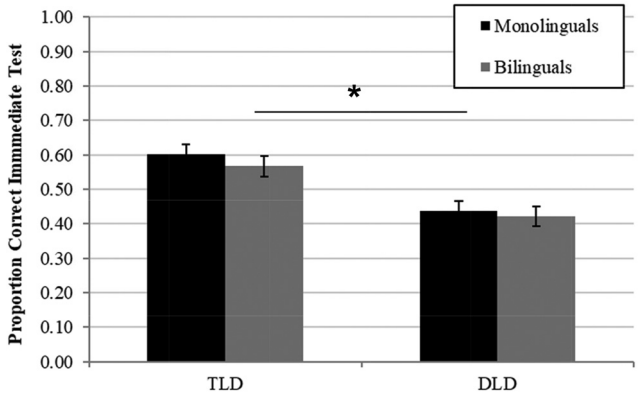
**Table 3**

*Proportion of Production Attempts and Correct Recognition in the Learning Task as a Function of Group and Referent Type (Ref). SE in Parenthesis*

| | Production attempts | | Recognition test | |
|---|---|---|---|---|
| Group | % attempted | % correct | Familiar ref | Novel ref |
| MOTLD | 25.35 (6.76) | 0.69 (0.69) | 0.62 (0.05) | 0.58 (0.05) |
| BITLD | 32.33 (6.33) | 1.33 (0.79) | 0.60 (0.05) | 0.53 (0.05) |
| MODLD | 34.62 (5.82) | 0.00 (0.00) | 0.45 (0.06) | 0.43 (0.05) |
| BIDLD | 25.64 (5.12) | 2.24 (2.24) | 0.42 (0.05) | 0.42 (0.05) |

*Note*. MOTLD = monolingual typical language development (TLD), BITLD = bilingual TDL, MODLD = monolingual developmental language disorder (DLD), BIDLD = bilingual DLD. % attempted refers to the average percent of attempts (out of the possible 12 words learned) to produce the novel word upon its fourth presentation during the learning phase. % correct refers to the average percent of correctly produced novel words upon this fourth presentation (out of the possible 12 words learned).

**Figure 2**
*Performance on the Recognition Test Following Novel Word Learning as a Function of Language Disorder and Bilingualism (Observed Means and Standard Errors)*




*Note*. $*p < .05$.

accurate learning of novel referents ($b = .41$, $\chi^2 = 1.61$, $p = .41$), but less accurate learning of familiar referents ($b = -.37$, $\chi^2 = 1.30$, $p = .41$), but none of these effects reached significance.

## Discussion

The current study explored the effects of bilingualism and DLD on learning of novel words and retrieval of known words. Four groups of children, spanning monolingual and bilingual children with and without DLD, completed a novel word learning paradigm and a lexical retrieval task. Although the word learning paradigm comprised a short session, including only four repetitions of each novel word all children learned the novel words to be able to recognize them above chance level. More importantly, the findings reveal a significant effect of language disorder, such that children with TLD learned the words better than children with DLD. Interestingly, bilingual children did not differ from monolingual children in novel word learning, and the effects of language disorder did not vary with bilingualism, or with referent type. In contrast to these word learning results, the findings from a lexical retrieval task revealed a different pattern. Here, both bilingualism and language disorder significantly affected children's performance. Children in the MOTLD group performed better than the BITLD and MODLD children, who did not differ from each other. Children in the BIDLD group exhibited the lowest scores on the task. Finally, our findings show only minor contribution of lexical retrieval scores to the explained variance in novel word learning, pointing to nonoverlapping processes tapped by each task.

### Effect of DLD on Novel Word Learning

Children with DLD exhibited reduced learning of novel words in comparison to children with TLD, and this effect did not interact with bilingualism or with referent type. This finding is in line with previous research on DLD showing that monolingual preschool children with DLD learned fewer words during a novel word learning task compared to children with TLD (Kalashnikova & Burnham, 2016; Kan & Windsor, 2010). Previous studies explained the lower scores of children with DLD as resulting from difficulty in learning the phonological form of novel words (Bishop & Hsu, 2015), difficulty in learning new concepts (Alt et al., 2013), or in associating phonological and semantic representations (Beverly & Estis, 2003). Viewed in the framework presented here (see Figure 1), all three learning components (form, meaning, and mapping) have been suggested in past research as potential sources for the effect of reduced learning.

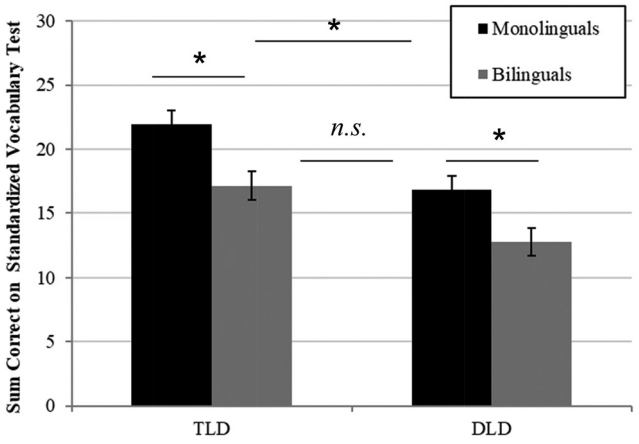
To address these explanations, the current study employed a design in which children either learned novel words in association with a familiar referent, or in association with a novel one. Critically, in the familiar referent condition, children were required to learn two components: the phonological form of the word and its mapping to meaning, but the meaning itself was known to the child. Conversely, in the novel referent condition, children were required to learn the form, the mapping of form to meaning, and also a new concept. Our results showed that children with DLD learned both types of referents (familiar and novel referent) equally less well than children with TLD. Thus, even when meaning was familiar to the child, children with DLD experienced

**Table 4**
*Model Summary Predicting Proportion Correct in the Word Learning Test*

| Fixed effects | *b* | *SE* | 95% CI | *z* | *p* |
|---|---|---|---|---|---|
| (Intercept) | 0.35 | 0.26 | [−0.16, 0.86] | 1.35 | .177 |
| Bilingualism (*bilinguals*) | −0.20 | 0.32 | [−0.83, 0.43] | −0.62 | .537 |
| Language Disorder (*DLD*) | **−0.69** | **0.32** | **[−1.32, −0.06]** | **−2.14** | **.032** |
| Referent Type (*novel*) | 0.19 | 0.26 | [−0.32, 0.70] | 0.72 | .474 |
| Bilingualism (*bilinguals*) × Language Disorder (*DLD*) | 0.17 | 0.45 | [−0.72,1.06] | 0.38 | .708 |
| Bilingualism (*bilinguals*) × Referent Type (novel) | 0.16 | 0.37 | [−0.56,0.88] | 0.44 | .661 |
| Language Disorder (*DLD*) × Referent Type (*novel*) | −0.05 | 0.37 | [−0.77,0.67] | −0.13 | .898 |
| Bilingualism (*bilinguals*) × Language Disorder (*DLD*) × Referent Type (*novel*) | −0.30 | 0.52 | [−1.31,0.71] | −0.58 | .562 |
| Random effects | | | | | |
| σ2 | 3.29 | | | | |
| τ00 Participant | 0.46 | | | | |
| τ00 Item | 0.17 | | | | |
| ICC | 0.16 | | | | |
| *N* Participant | 101 | | | | |
| *N* Item | 12 | | | | |
| $R^2_{marginal} = .03$; $R^2_{conditionnal} = .19$ | | | | | |

*Note*. Bold terms refer to significant effects at the $p < .05$. Italic terms denote the level of the fixed effect.

**Figure 3**
*Performance on the Lexical Retrieval Task (Standardized Goralnik Vocabulary Subtest) as a Function of Language Disorder and Bilingualism (Observed Means and Standard Errors)*




*Note*. *n.s.* = nonsignificant.
*$p < .05$.

more difficulty in learning a new phonological form and associating it with that meaning, compared to children with TLD. These findings are less consistent with the explanations placing the emphasis on learning of meaning, because if the locus of the DLD difficulty was in learning of meaning, learning of novel referents would have been affected more than familiar referent learning. The fact that no interaction was observed between the effect of DLD and that of referent type supports an impairment in one or both of the shared components in the two referent conditions, namely in learning the phonological form and/or the mapping of form to meaning.

## Effect of Bilingualism on the Novel Word Learning Task

In the current study, bilingualism had no significant effect on performance in the novel word learning task. This finding is in contrast with previous literature showing a bilingual advantage in novel word learning (Eviatar et al., 2018; Hirosh & Degani, 2018; Kaushanskaya et al., 2014). The lack of a bilingualism advantage in the current study may be related to the fact that the children learned the novel words through Hebrew (their second language), as the narration during the computer game, in both the learning and testing phases, was delivered in Hebrew. This suggestion is consistent with the proposal of Bogulski et al. (2019), who examined adult monolingual English, Spanish–English and Chinese–English bilinguals in a Dutch word learning task, and showed no bilingual advantage when bilinguals learned the words via English (their second language). In that same study, a group of English–Spanish bilinguals who learned through their first language (English), did exhibit a learning advantage over the monolinguals. The authors concluded that the bilingual advantage in novel word learning is present only when the novel language is acquired via the first, or dominant language (see also Degani & Goldberg, 2019). Consistent with this proposal, in the current study children learned the novel words through their less dominant language Hebrew (proficiency profile was verified by parental report, see Table 1). The current findings add to the growing literature suggesting that the language through which learning takes place affects bilingual learning (Hirosh & Degani, 2021), in that bilingual children, with and without DLD, performed similarly to their monolingual peers when learning novel words through their second language. In addition, there was no interaction between bilingualism and referent type. Thus, although familiar referents necessitate an ambiguous two-to-one mapping of form to meaning, whereas no such ambiguity and competition are present for novel referents, bilinguals learned each referent type like monolinguals.

## Lexical Retrieval

Although bilingual children performed similarly to the monolingual children in the novel word learning task, these same children exhibited reduced performance in lexical retrieval of known words as measured by a standardized naming task. The difference between bilingual and monolingual children was evident in children with TLD, in that the MOTLD scored higher than BITLD. The same performance gap was observed among children with

**Table 5**
*ANOVA of Model Predicting Proportion Correct in the Word Learning Test Including Lexical Retrieval Score*

| Fixed effects | *df* | *F*-value | *p*-value |
|---|---|---|---|
| Bilingualism | 1 | 0.30 | .582 |
| Language disorder | **1** | **14.23** | **<.001** |
| Referent type | 1 | 1.68 | .195 |
| Lexical retrieval score | 1 | 0.66 | .417 |
| Bilingualism × Language Disorder | 1 | 0.00 | .994 |
| Bilingualism × Referent Type | 1 | 0.00 | .969 |
| Language Disorder × Referent Type | 1 | 0.57 | .451 |
| Bilingualism × Lexical Retrieval Score | 1 | 0.65 | .421 |
| Language Disorder × Lexical Retrieval Score | 1 | 0.00 | .999 |
| Referent Type × Lexical Retrieval Score | 1 | 1.30 | .254 |
| Bilingualism × Language Disorder × Referent Type | 1 | 0.28 | .595 |
| Bilingualism × Language Disorder × Lexical Retrieval Score | 1 | 0.04 | .843 |
| Bilingualism × Language Disorder × Referent Type × Lexical Retrieval Score | 1 | 0.09 | .763 |
| Bilingualism × Language Disorder × Referent Type | **1** | **7.78** | **.005** |
| Bilingualism × Language Disorder × Lexical Retrieval Score | 1 | 0.06 | .815 |

*Note*. Bold terms refer to significant effects at the $p < .05$.

DLD, in that the MODLD scored higher than BIDLD. We further observed no difference in lexical retrieval of known words between monolingual children with DLD and bilingual children with TLD. These patterns were similarly reflected in parental reports of children's familiarity with the Hebrew labels that were synonyms of the 12 novel words (see Table 1). The fact that children with DLD performed worse than children with TLD in the lexical retrieval task is consistent with the literature (e.g., Biran et al., 2018; Dockrell et al., 1998; Novogrodsky & Kreiser, 2015). Moreover, the particular pattern of differences among the four groups observed here is in line with a recent lexical retrieval study testing older children (aged 9–14) in a similar four-group design (Degani et al., 2019), whereby MODLD and BITLD did not differ from each other in naming 90 pictures.

The results of the current study are also informative with respect to the effects of bilingualism on lexical retrieval. Previous studies observed reduced lexical retrieval performance for bilingual children relative to monolingual children (e.g., Bialystok et al., 2010 in receptive vocabulary; Gross et al., 2014 in picture naming), as is typically found for adults (for review see, e.g., Bialystok, 2009). The observed difficulty for bilinguals in lexical retrieval tasks has been suggested to be due to simultaneous activation of representations from both languages leading to competition from existing representations (Hermans et al., 1998), and to reduced frequency of use, in that bilinguals divide their time between the two languages to which they are exposed, such that representations are less available in both languages (Gollan et al., 2005, 2011). Under this latter frequency account, bilinguals were expected to perform worse than monolinguals only in tasks that reflect differences in frequency of exposure and not when frequency is controlled for. In the novel word learning paradigm, all children alike had no prior exposure to the novel words. In contrast, the lexical retrieval task taps knowledge of known words (Hebrew words), for which bilingual children may have had reduced frequency of use compared to monolingual children. The results of the current study provide support for the frequency explanation in two ways. First, bilinguals performed worse than monolinguals only on the lexical retrieval task but not in the novel word learning task, when frequency of exposure was controlled for (kept at zero) and bilinguals did not differ from monolinguals. Second, the fact that there was no interaction between referent type and bilingualism in the novel word learning task provides additional support for the frequency interpretation. Familiar referents and novel referents differ in the competition they create for the learner. For familiar referents bilinguals may suffer from competition from labels in both their first and second languages, whereas for novel referents no such competition exists. If increased competition for bilinguals was to hinder performance, bilinguals should have learned novel referents better than familiar referents, but this was not the case. Together, this pattern supports the role of frequency of exposure in explaining differences between bilinguals and monolinguals in lexical processing (Gollan et al., 2005).

## The Effect of Lexical Retrieval of Known Vocabulary on Novel Word Learning

Comparisons within the same children revealed differential effects of DLD and bilingualism on the two types of tasks. Whereas DLD hindered performance in both learning of novel words and lexical retrieval of known words, bilingualism affected only lexical retrieval processes. This differential pattern emphasizes the different nature of the two aspects of the developing lexicon. The novel learning task taps the beginning stages of representing new knowledge into the lexicon, because children had no prior familiarity with the novel word forms. In contrast, the lexical retrieval task taps extraction of already existing representations from the lexicon, whereby these representations have been shaped by previous encounters and frequency of use. To further explore the degree to which these different tasks tap similar mechanisms, we examined whether children's lexical retrieval ability predicted their novel word learning score. We found that for children with TLD, increased lexical retrieval abilities of known words was associated with numerically better learning of novel referents (but not of familiar referents). With the exception of this association (evident in a significant interaction but not in follow-up tests), with a large group of children, lexical retrieval of known words was not predictive of novel word learning. This is not to say that the two processes are completely independent in natural language use, as there is ample evidence to suggest that prior word knowledge is associated with better word learning (Degani & Goldberg, 2019). Instead, our findings show that once DLD, bilingualism, and referent type are controlled for, there is only a minor contribution of children's lexical retrieval ability to novel word learning. This finding highlights the nonoverlapping aspects measured by these two tasks. Note that in the current study learning processes were measured predominantly using a recognition test, whereas lexical retrieval was measured using a production test. Kan and Windsor (2010) observed stronger effects of DLD in learning when measured through recognition tests compared to production tests, and other research shows that the two modalities may differ in their reliance on different mechanisms (e.g., frequency, Gollan et al., 2011). Nonetheless, the clear dissociation in the observed pattern, especially with respect to the effect of bilingualism, implies that lexical retrieval tasks should not be taken as a proxy for word learning in bilingual populations.

## Bilingualism and DLD

In both the novel word learning and the lexical retrieval tasks, no interaction was observed between DLD and bilingualism, suggesting that the two variables exert independent effects. Bilingualism and DLD both decreased the performance in the standardized task tapping lexical retrieval of known words, consistent with previous effects observed separately for DLD (Dockrell et al., 1998), and for bilingualism (Gross et al., 2014), and for both types of variables (Degani et al., 2019). At the same time, in the learning paradigm, DLD impaired performance (see also Alt et al., 2013) but bilingualism did not. The results show that in tasks tapping the learning mechanism itself, rather than lexical retrieval of known words, the presence of DLD impairs performance but the presence of bilingualism does not. Relatedly, whereas in the word learning task BITLD outperformed MODLD, in the lexical retrieval task there was no significant difference between the two groups (see also Degani et al., 2019). This finding is of great importance for clinical purposes, as it suggests that retrieval of known lexical items may be misleading in the diagnosis of DLD in bilingual populations (for an overview of this issue see Novogrodsky & Meir, 2020). Because bilingualism did not exert an influence on novel

word learning, we suggest that such a paradigm may be a more sensitive tool for distinguishing between TLD and DLD in the case of bilingual children compared to standardized lexical retrieval tasks.

One additional aspect of the current study should be emphasized. In the current paradigm, learning a novel word in association with a familiar referent did not significantly differ from learning it in association with a novel referent, but a numerical advantage was observed for familiar referents. Further, this pattern reached significance in a delayed test (reported in the Appendix). Although the familiar referent advantage seems at odds with the literature on the mutual exclusivity bias, by which children prefer to associate a novel word with a novel referent, it is important to keep in mind that in the current paradigm children were not required to dissociate the two referents. Thus, our results imply that learning difficulty within the current paradigm is driven by the number of different representations that need to be established more than the potential competition between linked form representations, as familiar referents require learning of form and mapping, whereas novel referents require learning of all three components (form, meaning and mapping). Notably, the difficulty associated with learning the additional meaning component in the case of the novel referents may have been exaggerated by the particular instantiation of the manipulation. Specifically, the novel referents in the current study were depicted by invented novel objects (Gonzalez-Gomez et al., 2013), that may have recruited memory for a visual pattern, rather than an emphasis on meaning per se. At the same time, our study did not require children to recall semantic features of the learned objects, such that even superficial encoding of the new referent could have been sufficient. Requiring more emphasis on meaning, for instance by asking learners to recognize semantic features of the novel objects (Alt et al., 2019), may require children to resolve potential competition from existing representations, hindering learning of familiar referents. It remains to be tested whether a novel word learning task that necessitate stronger reliance on meaning would similarly reveal a familiar referent advantage.

To summarize, the present findings demonstrate that although children with DLD learned less well than children with TLD, they were nonetheless able to learn novel vocabulary in a short, computerized paradigm accompanied by an experimenter who is a speech-language pathologist by profession. Bilingual children did not differ from monolingual children in novel word learning, as this paradigm eliminates frequency of exposure differences between bilingual and monolingual children. In contrast, bilinguals' lexical retrieval performance which is affected by prior frequency of exposure with the known words, showed lower scores compared with monolinguals. Together, the study highlights the differential effects of two sources of variability in the emerging lexicon, namely effects of bilingualism and language disorder on learning of novel words compared to lexical retrieval of known words.

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# Appendix

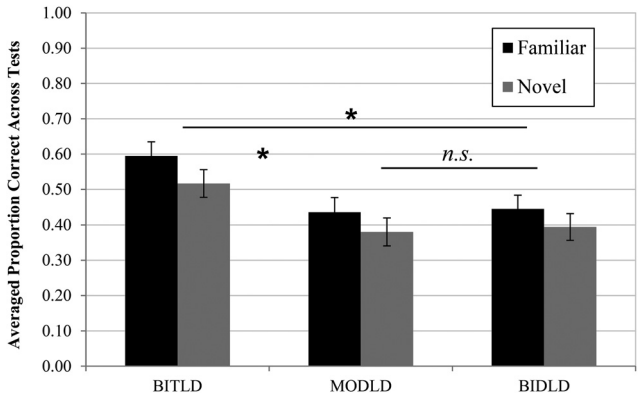
## Delayed Test

### Delayed Test: Learning Performance Across Time

For the three groups that performed both the immediate and the delayed tests (BIDLD, MODLD, BITLD), we examined whether performance changed over time. Specifically, because children in the MOTLD did not complete the delayed test, we included group as a three-level factor. In addition, we included referent type (familiar vs. novel) and test (1 vs. 2) as fixed effects and allowed the three factors to interact. As in the main analyses, logistic linear mixed effect models were used. The *buildmer* function (Version 1.3; Voeten, 2019) in R (Version 3.6.1; R Core Team, 2019) was used to identify the best fit random structure. As seen in Figure A1, the analysis revealed a significant effect of referent type ($F = 7.85$, $p = .005$), with familiar referents ($M = .49$, $SE = .04$) being responded to significantly more accurately than novel referents ($M = .42$, $SE = .04$). There was also a significant group effect ($F = 6.07$, $p = .002$), and pairwise comparisons with Bonferroni corrections revealed that BITLD performed significantly more accurately than both BIDLD ($b = .34$, $\chi^2 = 8.84$, $p = .009$) and MODLD groups ($b = .67$, $\chi^2 = 9.60$, $p = .006$), which did not differ from each other ($b = .51$, $\chi^2 = .02$, $p = 1.0$). There was no interaction between group and referent type ($F < 1$). Further, the effect of test ($F = 1.09$, $p = .30$) or its interactions with group ($F < 1$), referent type ($F = 2.04$, $p = .15$), or both ($F < 1$) were not significant, suggesting performance did not significantly change following the delay.

**Figure A1**

*Performance for Each Group Averaged Across the Immediate and the Delayed Tests, as a Function of Referent Type (Observed Means and Standard Errors)*




*Note*. *n.s.* = nonsignificant.
*$p < .05$.

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