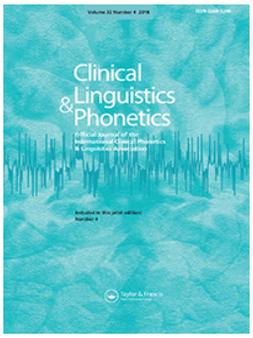

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What we can learn from naming errors of children with language impairment at preschool age

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ABSTRACT
Naming is a complex, multi-level process. It is composed of distinct semantic and phonological levels. Children with naming deficits produce different error types when failing to retrieve the target word. This study explored the error characteristics of children with language impairment compared to those with typical language development. 46 preschool children were tested on a naming test: 16 with language impairment and a naming deficit and 30 with typical language development. The analysis compared types of error in both groups. In a group level, children with language impairment produced different error patterns compared to the control group. Based on naming error analysis and performance on other language tests, two case studies of contrasting profiles suggest different sources for lexical retrieval difficulties in children. The findings reveal differences between the two groups in naming scores and naming errors, and support a qualitative impairment in early development of children with naming deficits. The differing profiles of naming deficits emphasise the importance of including error analysis in the diagnosis.

KEYWORDS
Language impairment; lexical retrieval; naming errors

Introduction

Lexical retrieval is a central language process of transforming ideas into words. A developmental language impairment (LI) often disrupts this process. This study focused on lexical retrieval (naming) deficits in preschool children with LI, exploring their naming errors.

The lexical retrieval process

Lexical retrieval models describe typical word production processes and their possible deficits. According to these models, lexical retrieval consists of two lexical stages: semantic and phonological. The *semantic lexicon* contains information about the meaning of words, such as the semantic category, function. The *phonological lexicon* includes the spoken pattern of the word: metrical information (number of syllables and stress pattern) and segmental information (its phonemes—consonants and vowels). (For elaboration on the lexical retrieval model, see Biran & Friedmann, 2005; Butterworth, 1992; Dell, 1986;

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Michal Biran and Rama Novogrodsky declare an equal contribution.

Friedmann, Biran, & Dotan, 2013; Levelt, 1992; Nickels, 1997; and others.) Support for the assumption that the lexical retrieval process consists of two distinct stages—semantic and phonological—comes from word retrieval failures: (a) slips-of-the-tongue in individuals without language impairment (e.g. Fromkin, 1971); (b) tip-of-the-tongue states (e.g. Brown & McNeill, 1966); and (c) naming errors in adults (Biran & Friedmann, 2005; Ellis & Young, 1996) and children (Best, 2005; Faust, Dimitrovsky, & Davidi, 1997; Kambanaros, Grohmann, Michaelides, & Theodorou, 2014; Novogrodsky, Kreiser, & Friedmann, 2010) with naming deficits. The current study adds to the growing literature confirming two distinct retrieval deficits, by presenting two case studies, one with a phonological deficit and one with a semantic deficit.

Naming deficits in children

Various studies examined the nature of naming deficits in children (Bragard & Schelstraete, 2007; Friedmann et al., 2013; German, 1984, 2002; Messer & Dockrell, 2006; Novogrodsky, 2015). This deficit is frequent among children with LI. Dockrell, Messer, George, and Wilson (1998) reported that 23% of the children in therapy had naming deficits.

Naming ability has a critical role in language development. Gathercole and Baddeley (1993) argued that semantic and phonological information, which enable word production, is required for language development and literacy. Other studies referred specifically to the role of phonology in vocabulary development and found that poor phonological skills, manifested mainly in poor phonological working memory, plays a crucial role in vocabulary development (e.g. Gathercole & Baddeley, 1989, 1990). German (2002) showed that school age children with a naming deficit have difficulty retrieving words from the vocabulary learned in class and sometimes perform less well on academic tasks. Hence, it is very important to diagnose and provide therapy for this deficit at young ages.

The nature of naming deficits in children

Studies found various types of errors produced by children with a naming deficit when they failed to retrieve the target word. These included semantic, phonological, 'don't know' responses and others (visual, unrelated, etc.) (Bragard & Schelstraete, 2007; Dockrell et al., 1998; Friedmann et al., 2013; German, 1984, 2002; German & Newman, 2004; Lahey & Edwards, 1999; McGregor, 1994, 1997; Novogrodsky & Kreiser, 2015). Best (2005) and German (1984) suggested that the lexical retrieval model developed for adults can also be used for children, with consideration of the child's developmental stage. This is an important point for research on retrieval difficulties in children with LI, emphasising the need to integrate between effects of typical development and impairment. The current study looked at this question by examining naming deficits in preschool children.

The cause for lexical retrieval deficit is an open question. McGregor (1997) tested English-speaking children ages 3.3–5.11 yr on a picture-naming task. Semantic errors were the most common, and the percentage of errors decreased with age. According to McGregor, the large number of semantic errors might indicate either a semantic or a phonological deficit. A semantic deficit was supported by priming studies that showed no semantic priming effect in the language impaired group (Hennessey, Leitão, &

Mucciarone, 2010) and by intervention studies showing improvement in naming after semantic therapy (Ebbels et al., 2012). A phonological deficit was supported, for example, by Faust et al. (1997), who found that school age Hebrew-speaking children with LI could give semantic information about words they could not retrieve, suggesting that they had access to semantic information about the target word, but not to its phonological information. Thus, their findings indicate a separation between semantic and phonological information. Faust et al. (1997) argued that the children's phonological information was insufficient for word retrieval. This was also supported by intervention studies showing improvement in naming after phonological therapy (McGregor, 1994). It is important to note that whereas phonological errors support phonological deficits, semantic errors support semantic deficits, but need to be confirmed with other tests, as they may also arise from a deficit in the phonological lexicon (Caramazza & Hillis, 1990; Howard & Gatehouse, 2006; McGregor, 1997). Semantic errors can occur from deficits in the semantic representation of the word and from impaired access to its phonological representation. In case of a failure to access the phonological representation, a representation of a different word semantically related to the target word is activated, and a semantic error is produced.

To summarise, there is no agreement regarding the source of naming deficits in children. This may be due to the heterogeneity of participants, age range and characteristics of the deficits (Best, 2005; Newman & German, 2002). Best (2005) also noted that there are many group studies, rather than case studies, which makes it difficult to determine the source of each participant's deficit.

Different profiles of naming deficits in children

Studies that examined individual profiles indicated that children can have deficits at different stages of the word retrieval process (Best, 2005; Bragard & Schelstraete, 2007; Friedmann et al., 2013; German, 1984; McGregor, 1994). McGregor (1994) evaluated two children with naming deficits, ages 5.0 and 4.9 yr. They produced mostly semantic errors; however, phonological errors were also produced. Following an intervention that was based on phonological tasks, the number of naming errors decreased. The results might be taken as an evidence that these children had a phonological deficit. Bragard and Schelstraete (2007) reported on a nine-year-old child with LI and naming difficulties. Based on the dissociation he showed between low performance on semantic tasks and intact performance on phonological tasks, the authors concluded that his naming deficit resulted from a deficit in semantic representation. Friedmann et al. (2013) presented four profiles of school age children with naming deficits, integrating the characteristics of picture-naming errors and other language tasks, including nonword repetition, reading and working memory. A semantic deficit was diagnosed based on semantic errors in naming in the absence of phonological errors, in addition to poor performance on a written association test. Intact performance on nonword reading and nonword repetition tasks, indicating preserved phonological processing, were also taken as support for a semantic deficit. In contrast, a phonological deficit was diagnosed when a child exhibited poor performance on nonword repetition tasks and produced both semantic and phonological errors in naming tests, while performance on picture and written association tasks was intact, indicating preserved conceptual and semantic information. These findings

provide evidence for different profiles of naming deficits in children, and highlight the importance of integrating performance on various measures and tests as part of the diagnostic process.

The current study compared the characteristics of naming errors of preschool children with LI to those with typical language development (TLD). We predicted that: (a) children with LI and difficulties in language production will not perform as well as children with TLD on a naming task; (b) children with LI will show different error patterns compared to children with TLD; and (c) different individual error profiles will be found: A phonological deficit will manifest by phonological errors on a naming test, in addition to deficits in other phonological tests; semantic deficits will manifest by semantic errors (more than the mean of the LI group) and intact performance on phonological tests.

Method

Participants

The experimental group included 16 children with LI: 11 boys and 5 girls, ages 4.4–6.6 yr (mean age 5.3), all native Hebrew speakers, from middle-high socio-economic status. They were recruited from a child development institute in the centre of Israel. Comprehensive clinical assessment was administered according to the protocol used in the child development institute, including formal and informal language tasks. All participants met the ***exclusionary criteria*** for language impairment (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; 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.

Inclusionary criteria for participating in the study were performing below age score in one of two lexical production tasks: (a) descriptions (from the MAASE test for spoken language processing. Rom & Morag, 1999); and (b) the ITPA test (Illinois Test of Psycholinguistic Abilities. Kirk, McCarthy, & Kirk, 1967; Hebrew version, Fisher, 1975). To rule out comprehension difficulties, a comprehension subtest of the Katzenberger Hebrew Language Assessment Measure was administered (Auditory Processing Subtest, Katzenberger & Meilijson, 2014) (see Appendix A). 14 participants scored within age norm in this subtest, and two participants had marginal scores. The decision was made to include these two participants as they showed a significant clinical gap between good comprehension and impaired production. In addition, we included the scores of the participants on two phonological tasks that were administered as part of the clinical assessment: a nonword repetition task (Biran, 2010) and a phonological awareness subtest (Katzenberger & Meilijson, 2014). These tasks were used as part of the analysis of the individual's profiles.

The control group included 30 children, ages 4.0–5.7 yr (mean 4.10) with TLD, based on preschool teachers' questionnaires, all native Hebrew speakers, from middle-high socio-economic status. No significant difference was found between the mean ages of children with LI and the control group ($p > .05$).

Parental permission was obtained for study participation for both groups.

Materials

SHEMESH naming test (Biran & Friedmann, 2004). The test includes 100 colour pictures of concrete nouns from different semantic categories. This test is used in the clinic for assessment of naming deficits in adults with brain damage (Biran & Friedmann, 2005) and school age children (Novogrodsky & Kreiser, 2015). The words in the test are controlled for length (one to four syllables, three to ten phonemes), phonological characteristics of the opening sounds (representing the different phonemes in Hebrew), and prosodic characteristics of and stress patterns (ultimate and penultimate). The items include both masculine and feminine nouns (with regular and irregular gender morphology), which is an important characteristic of Hebrew. The frequency of the nouns ranges from 2.4 to 6.84 on a scale of 1 to 7 (M = 4.9, SD = 1.09) (For more details see Biran & Friedmann, 2005.)

Procedure and error analysis

The children with LI were tested individually in a quiet room at the child development institute. The children with TLD were tested in their homes. The instruction for the children was: 'I will show you pictures of objects. Please tell me, in one word, what you see in the picture'. During the test, children were given general, positive feedback regardless of performance. Pictures for naming were presented with no time limit.

All responses were transcribed and correct responses and errors were counted.

Word familiarity

To rule out familiarity effects on naming, when a child responded, 'I don't know', the word was presented to her auditorily at the end of the test. For example, a child who responded 'I don't know' to the target word 'anchor' was asked at the end of the test, 'What is an anchor?' This allowed testing the child's familiarity with the target word. If the child said she did not know the word, it was eliminated from the total number of words and was not counted as a naming error (the total number of target words for calculating percentage correct then became 99 instead of 100). If the child's response indicated semantic knowledge of the word (e.g. 'part of a boat', 'it's in the sea'), it was counted as a 'don't know' naming error. The number of words that were excluded for each child because they were unfamiliar to him was small and varied from 0 to 8 (M = 1.75. See Appendix B).

Error type analysis

Using the SHEMESH test criteria, errors were classified into the following types: (1) semantic, (2) description, (3) definition, (4) phonological, (5) gesture, (6) 'don't know' response, (7) hesitation or (8) other (Table 1). Developmental phonological errors typical for the child's age were not coded as phonological errors (e.g. cluster reduction: *psanter (piano)-santer (chin), cfardea (frog)-cardea*) (Ben-David, 2015).

In the analysis of error types, all responses for each target noun were analysed. For example, for the target word '*GAFRUR' (match)*, one of the participants responded sequentially: *(1) 'ET' (pen)*—a visual error, *(2) 'MAFUR'*[1]—a phonological error, *(3) 'MASOR' (saw)*—an unrelated

Table 1. Types of naming errors.

Type of error	Explanation and example
Semantic	(a) Substitution of the target word with another word from the same semantic category (*bus-truck*); (b) Association—Substitution of the target word with another semantically related word, but from a different category (*umbrella-rain*); (c) Category—Naming the category that the item belongs to (*necklace-jewellery*).
Description	Trying to provide semantic information about the target word. Sometimes the information is correct and hints at the target word and sometimes not (*anchor-'boat rope'; fork-'used for preparing food'; scarf-'for winter'; piano-'to play'*).
Definition	Providing semantic information about the target word that includes its function and/or semantic category and/or description, so that it is possible to identify the target word (*anchor-'stops the boat'; glove-'you wear it on your hand when it's cold'; hedgehog-'an animal with spines'*).
Phonological	(a) Phonemic—Substitution, omission or addition of one or more phonemes in the word, creating a nonword, which includes at least half the phonemes of the target word (*vilon (curtain)-gilon; tarnegolet (hen)-tagolet; xacocra (trumpet)-xacocriya*); (b) Formal—Substitution of the target word with another phonologically related word (*xalon-balon* (window-balloon)); (c) Approximations—Searching for the phonemes without producing a word (*maftex - maf…maft…ma…*).
Gesture	Performing a hand movement that represents the function or motor act associated with the target word (*key-demonstrating the turning of a key*).
'Don't know'	*'I don't know',' I am not familiar with', 'I don't remember'*.
Hesitation	Searching for the target word (*'hmm…er…come on, I know this one…'*), for more than five seconds.
Others	(a) Unrelated—Substitution of the target word with another semantically or phonologically unrelated word (*glasses-bed*); (b) Visual—Substitution of the target item with another visually similar item (*match-pencil*); (c) Unanalysed—A description that does not match the item (*iron-'what you make for a cake'*).

error and *(4)* '*to light candles on the Sabbath'*—a description. Error types were coded by the first two authors, reliability exceeded 95%, and the few disagreements were resolved by consensus. Errors were calculated as total errors per type among total errors by each participant.

Search measure

In addition to error analysis, a **'search measure'** was calculated for each participant, which was the mean number of incorrect responses retrieved for each incorrectly named target word (Novogrodsky & Kreiser, 2015). For example, a participant who named three target words incorrectly and produced one error for the first target word, three for the second target word and two for the third target word had a total of six errors and thus, a 'search measure' of 6/3 = 2.

Statistical analysis

Because we could not assume that the data of the group of children with LI were normally distributed, conservative nonparametric tests were used. For planned orthogonal comparisons, we applied Dunn's procedure. In this procedure, the level of significance is divided by the number of comparisons performed (Kirk, 2009, p. 497). For each Dunn's

[1]Here and throughout the paper, translations of the error examples will be given only when the error forms an existing word, to illustrate the semantic relation between the target word and the error. When the error is a phonological error that forms a nonword, only a transcription of the phonotactic nonword is given, without translation.

procedure, p was divided by the number of comparisons, as described in the Results section. The Mann–Whitney Test was used for comparisons between groups.

Results

The results indicate differences between the two groups in naming scores and naming errors. In addition, two case studies of children with LI are presented, each with varying performance on the naming task and on other language tests.

Performance on the SHEMESH naming test

The group of children with LI scored significantly lower than the children in the control group ($z = 5.12$, $p < .0001$). In addition, the performance of each child was significantly lower than the average score of a group of age-matched children with TLD, using the Crawford and Howell's (1998) t-test (Crawford & Garthwaite, 2012). This showed that each child in the experimental group had significant naming deficit as part of his language impairment. Naming performance improved with age, both in the language-impaired group ($r = 0.57$, t (14) = 2.61, $p = .02$) and in the control group ($r = 0.5$, t (28) = 3.08, $p < .01$), showing that the test is a sensitive measure for assessing naming performance at preschool age.

Naming error analysis

In this comparison, all incorrect responses for each target word were calculated (see Method section). The LI group produced significantly more errors than the TLD group ($M = 45$, SD = 14 vs. $M = 15$, SD = 8, respectively), $z = 5.35$, $p < .0001$. This finding is compatible with the LI group's low score on the naming task. To examine the differences in error characteristics between the two groups, the ratio of each error type was calculated from the total errors of each participant. Eight comparisons were performed. Thus, for a significant difference of $p \leq .05$, p was expected to be $\leq .05/8 = p \leq .006$, (Dunn's procedure, Kirk, 2009, p. 497). As can be seen in Table 2, the two groups show different error patterns: Percentage of semantic errors was significantly higher in the control group as compared to the children with LI. In contrast, the percentage of phonological errors (a mean of 18% of total errors) was significantly higher in the children with LI as compared

Table 2. Ratio of error types (%) of the children with LI and TLD[a].

Error type	LI (*SD*)	TLD (*SD*)	Mann–Whitney test
Semantic	35 (9)	54 (15)[b]	$z = 4.01$, $p < .0001$
Description	22 (9)	12 (10)	$z = 3.21$, $p = .001$
Definition	3 (3)	1 (3)	$z = 1.28$, $p = .2$
Phonological	18 (11)	1 (3)	$z = 5.07$, $p < .0001$
Gesture	3 (3)	0 (1)	$z = 3.87$, $p < .001$
'Don't know'	6 (6)	14 (13)	$z = 1.79$, $p = .07$
Hesitation	5 (6)	4 (10)	$z = 1.72$, $p = .09$
Other	8 (5)	14 (11)	$z = 1.71$, $p = .09$

[a]The ratio of each error type was calculated as an number of errors per type out of the total number of errors produced by the children in each group, thus, for each group, errors' types sum to 100%.
[b]Shaded cells indicate a significant difference between groups.

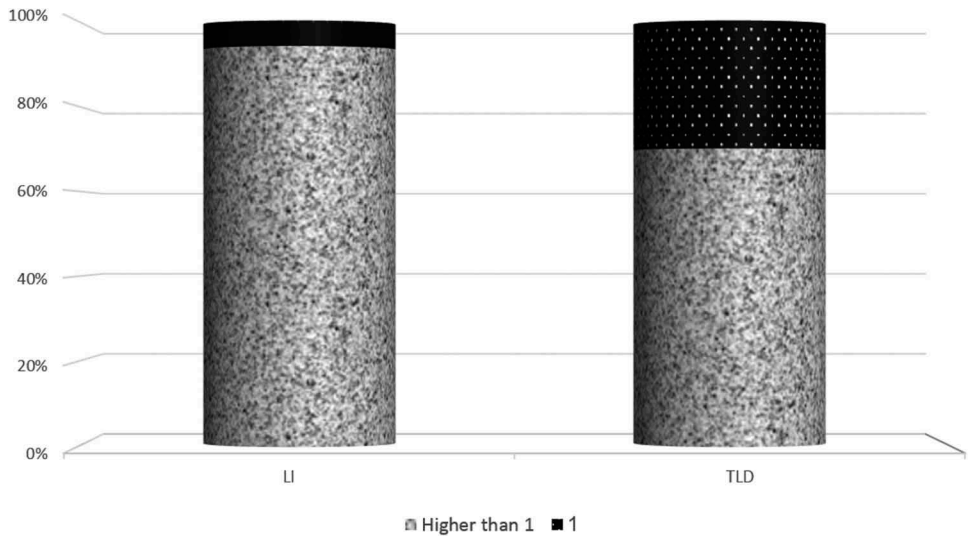

Figure 1. Percentage of children who scored '1' and 'higher than 1' on the 'search measure' in the two groups.

to the children with TLD, who produced very few phonological errors (two children produced one phonological error each). Furthermore, the two groups differed in distribution of descriptions, phonological errors and gestures; these errors were more frequent in children with LI as compared to their peers with TLD. The definition errors were low for both groups, which is compatible with their ages. At preschool age children's definition is still immature (Benelli, Arcuri, & Marchesini, 1988), and thus it is less available as a strategy when the naming process fails.

The 'search measure' was aimed to test the differences in the number of words the children retrieved for the target words they failed to name. For each child, the number of incorrect error responses produced was counted and divided by the number of target words named incorrectly. As can be seen in Figure 1, more children with LI had a 'search measure' higher than 1 (only one child with LI had 'search measure' of 1). Namely, on average they produced more than one word when the word retrieval process failed. In the control group, only about 2/3 of the children showed this pattern. On a Mann–Whitney test, the 'search measure' of the group of children with LI was significantly higher than the control groups ($z = 2.2$, $p = .03$). That is, in addition to the higher mean number of errors among the children with LI, this measure emphasises that their search process for each target word involved more errors when they tried to retrieve a target word.

Different profiles of naming deficits

The naming errors of children with LI and impairment in additional tests can manifest in different profiles. The two case studies presented here suggest dissociation between phonological and semantic deficits.

Case 1: MK, 5.6 yr old

MK's naming performance was 47% correct. As can be seen in Figure 2, 39% of his total errors were phonological (*gamal-gaman* (camel)), whereas the mean rate of phonological errors in the group with LI was 18%. Four of these errors were formal errors (phonological errors creating real words), and three of these words were semantically unrelated to the target word (*ramzor-masor* (traffic light-saw)). Thus, even the errors creating real words indicated a phonological rather than a semantic deficit; although they were real words not related semantically to the target word. Semantic errors constituted 27% of his total errors, whereas the mean rate of semantic errors in the group with LI was 35%. These errors suggest the possibility of a phonological deficit as the source of his retrieval difficulties. In addition, when he failed to retrieve the target word, 12% of his responses were descriptions (including partial and sometimes inaccurate semantic information). A phonological task that was administered as part of the clinical assessment also supports a phonological deficit. On a nonword repetition task, his performance was poor and lower than that of his age peers (only 50% correct). In summary, the lower performance on the nonword repetition task and a high percentage of phonological errors is indicative of a phonological deficit as the dominant source of MK's retrieval deficit.

Case 2: EH, 4.10 yr old

EH scored 67% on the naming test. As Figure 2 shows, 29% of his total errors were semantic (camel-donkey; cherry-grape). His phonological errors (3%) included one formal error, which was also semantically related to the target word (*xacil-bacal* (eggplant-onion)), and two approximations. In addition, 47% of his responses when failing to retrieve the target word were descriptions (lock-'you open it and then it opens'; needle-'sharp, popping a balloon'). This error profile of semantic errors with only two phonological errors may indicate a semantic deficit as the source of his retrieval difficulties. His intact performance on two phonological tasks administered as part of the clinical

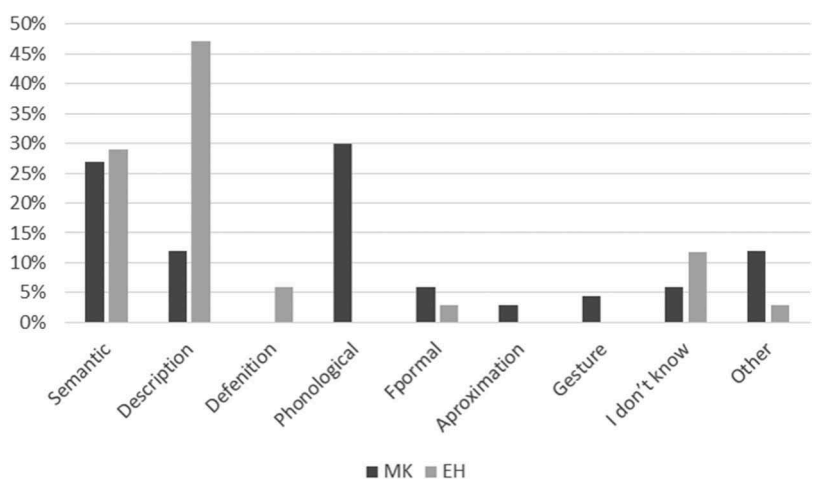

Figure 2. Different error types (%) for MK and EH.

assessment supports the semantic deficit. EH's performance was similar to that of his age peers, on a nonword repetition task (95% correct) and on a phonological awareness task (in which he performed as expected for his age). In summary, EH's intact performance on the phonological tasks and the high percentage of semantic errors, almost without phonological errors, suggest a semantic deficit as the dominant source of his retrieval deficit.

These two case studies demonstrated different profiles of naming deficits. The profiles are not reflected in the percentage of correct naming. Only when analysing the types of errors in combination with performance on other language tasks, is a picture of the child's profile revealed.

Discussion

The current study examined the characteristics of naming deficits in preschool children. The findings indicate differences between children with LI and those with TLD in naming performance, in the types of errors produced and in 'search measure'. Previous studies showed that naming difficulties characterise a sub-group of children with LI (Dockrell et al., 1998; Faust et al., 1997; Friedmann & Novogrodsky, 2011; Lahey & Edwards, 1999; McGregor, 1994; McGregor & Appel, 2002; Novogrodsky & Kreiser, 2015; Sheng & McGregor, 2010). In the current study, we further examined naming error characteristics of children with LI, focusing on the different naming profiles that can be diagnosed among them.

Naming performance

The findings revealed that naming performance on the SHEMESH test was significantly lower for children with LI than for children with TLD. In addition, both groups showed improvement in naming with age. These findings demonstrate that the SHEMESH naming test is sensitive for detecting naming deficits in preschool children; thus, it can be used in the clinic as part of the language assessment of young children.

Error characteristics

Three major characteristic error types were produced by the children with LI: a large number of ***descriptions, phonological*** errors and ***gestures***. In contrast, the control participants produced more ***semantic*** errors.

The children with LI had a higher rate of ***description*** errors. These descriptions were general and did not allow identification of the target word when it was unknown to the addressee (e.g. *'to play/playing'* for *musical instruments*, without specific details; *'taking leaves'* for *'rake'; 'cutting'* for *'pineapple'*). In previous studies, no difference was found in description errors between school age children with LI and chronologically younger controls (Kambanaros & Grohmann, 2010; Novogrodsky & Kreiser, 2015). Comparing the findings of the current and previous studies suggests that with age, children with LI learn how to use the strategy of description, which could also be an effect of therapy. An important finding of the current study is that when preschool children with LI and naming deficit are compared to TLD peers, the former show more attempts at

description, and their descriptions indicate partial semantic knowledge. These findings can be used as a qualitative measure in the differential diagnosis of naming deficits in preschool children. It also suggests that intervention with young children should include description tasks in order to advance their communication abilities in everyday life and in an academic learning environment. Definition errors were low in both groups, which is consistent with their language acquisition stage. At preschool age, definition ability is still immature (Benelli et al., 1988; Friedmann, Aram, & Novogrodsky, 2011) and thus, cannot be a sensitive measure for distinguishing typical from impaired language development.

Phonological errors were salient in the LI group and consistent with previous findings indicating that these types of errors distinguish typical from impaired language development (Faust et al., 1997; German & Newman, 2004; Messer & Dockrell, 2006; Novogrodsky & Kreiser, 2015). While children with LI might produce many phonological errors, children with TLD almost do not produce such errors (Kambanaros, Grohmann, & Michaelides, 2013; Messer & Dockrell, 2006; Novogrodsky & Kreiser, 2015). It is important to note that developmental phonological errors that are common at preschool age were not included in the error analysis. Phonological errors were significantly higher in the LI group compared with the TDL group. This finding supports the assumption of partial, yet insufficient phonological knowledge in the group with LI (Faust et al., 1997). Kraizer and Novogrodsky (2012) showed that school age children with LI had 3% phonological errors on a naming task. Comparing the current findings to those of Kraizer and Novogrodsky (2012) suggests that age and/or language intervention can have a positive effect on reducing the rate of phonological errors. To further explore the effect of age on error characteristics, longitudinal studies that follow the same children over time are needed.

The third characteristic error type in the group of children with LI was ***gestures***. The children produced iconic gestures that represent the meaning of the target word (Hadar, Wenkert-Olenik, Krauss, & Soroker, 1998); for example, turning a key or cutting with a knife. Similarly, German (1984) found that children with word finding difficulties produced significantly more gestures compared to those with TLD. In most studies that analysed naming errors in children, gestures were classified under 'other types of errors' (e.g. Kraizer & Novogrodsky, 2012) or were not analysed at all (e.g. Dockrell, Messer, & George, 2001; Kambanaros, 2013). The low percentage of gestures in the current study can explain why this error type was ignored in many previous studies. The small number of gestures produced by children struggling to retrieve a word is consistent with findings showing that children with LI have difficulties with gesture production (Wray, Norbury, & Alcock, 2016) and comprehension (Botting, Riches, Gaynor, & Morgan, 2010; Wray et al., 2016). However, German (1984) referred to gestures produced by children with word finding difficulties in naming tasks and indicated that they 'may indicate that a child knows the word but is having difficulty retrieving it' (p. 354). German (1984) also suggested that gestures can help distinguish between receptive and expressive deficits, and thus should be included in error analysis. It is thus suggested to include gesture analysis as part of the general picture of error characteristics of children with LI and naming deficits.

The control group presented a different pattern of errors, producing more ***semantic*** errors than the group with LI did. The most common error type in children is semantic

(McGregor, Friedman, Reilly, & Newman, 2002) and this characterises children with TLD and those with LI (Dockrell et al., 2001; Kambanaros, 2013; Kapalková & Slančová, 2017). Most of the semantic errors in the two groups included words from the same category (*'pot'* for *'kettle'; 'apple', 'pineapple'* or *'strawberry'* for *'cherry'*). This finding is consistent with those of McGregor et al. (2002), who showed that most errors produced by English-speaking children with TLD, ages 5–7 yr were semantic within-category errors. The current findings suggest that semantic errors that constitute up to half of the total errors still fall within the normal range for preschool children.

'Don't know' responses were similar across the two groups, in line with previous studies[2] of monolingual children (Dockrell et al., 2001; Kraizer & Novogrodsky, 2012) and multilingual children (Kambanaros, Grohmann, Michaelides, & Theodorou, 2013). However, German (1984) found that children with word finding difficulties produced significantly more 'don't know' responses compared to those with TLD. This response was sometimes produced with another error (*'don't know', 'saxophone'* for *'piano'*). It is important to note that the 'don't know' responses were re-examined using a familiarity task at the end of the test and were counted only for items found to be familiar to the child (see Method section). That is, when participants produced 'don't know' responses to words they were familiar with. Dockrell et al. (2001) assumed that a 'don't know' response is a delay strategy in the naming process. Does this response characterise an impaired, compared to an intact process? Future studies exploring various naming tasks among different ages can further explore the implicit and explicit knowledge children have when producing a 'don't know' response.

Word search measure

In addition to the different types of errors, differences between children with LI and children with TLD were found for *word search* processes. For each target word where retrieval failed, children with LI provided significantly more erroneous responses. For example, for the target word *'flashlight'*, one child produced *'binoculars'* and then *'if it's dark you need to see where something is broken'*—a semantic error followed by a description error. Our findings are in line with previous studies indicating several naming attempts for each target word among children with LI, which indicates naming deficit (Dockrell et al., 2001; Novogrodsky & Kreiser, 2015). For preschool children, this finding is important as a quantitative measure, in addition to the test score. 'Search measure' may be a complementary score to correct test performance, specifically in populations with diverse vocabulary knowledge. For example, young children have significant differences in vocabulary, which are strongly influenced by the environment (Bialystok, Luk, Peets, & Yang, 2010). The 'search measure' could differentiate between children who do not know the target item (Bialystok et al., 2010) and children with lexical retrieval difficulties. Moreover, vocabulary measures are not valid for children who are exposed to more than one language (Kambanaros, Michaelides, & Grohmann, 2016; Khoury Aouad Saliby, dos Santos, Kouba Hreich, & Messarra, 2017), for children in immigrant populations (Armon-Lotem, Altman, Burstein-Feldman, & Walters, 2013) and for children from different cultures (Miller, Webster, Knight, & Comino, 2014), due to differences in

[2]These responses are also called 'blocking responses' (Dockrell et al., 2001).

language experience (de Villiers, 2004). The vocabulary of participants from these populations is an intervening variable on performance in naming tests. Longitudinal studies and cross population studies should examine whether the 'search measure' is sensitive among children with LI, to detect naming deficits in diverse populations.

Profiles of naming deficits

In addition to group-level comparisons, we presented individual profiles of two children with LI and naming deficits. MK showed a dominant phonological deficit and EH showed a dominant semantic deficit. These two profiles agree with previous studies suggesting that specific naming deficits of children with LI can be shown (Best, 2005; Bragard & Schelstraete, 2007; Friedmann et al., 2013; McGregor, 1994; Novogrodsky et al., 2010). As was shown, the integration of naming errors and performance on other language tests can distinguish between two sources of difficulties: phonological and semantic. This distinct pattern was not found for all children in the current study, which can be explained by the low prevalence of specific profiles at young ages, meaning that more children show mixed profiles. Characterising the specific naming deficit is important for planning successful interventions for each child, according to her deficit. Various intervention methods for children with naming deficits are presented in the literature (e.g. German, 2002; German, Schwanke, & Ravid, 2012; Kambanaros et al., 2016; McGregor, 1994); however, further research is needed to explore the relationship between various profiles and intervention methods.

In summary, the current study found differences between the performance of preschool children with LI and those with TLD, in naming scores, types of errors and 'search measure'. Based on integration of error characteristics and performance on other language tests, the two case studies of different linguistic profiles suggest differing sources of naming deficits. This differential diagnosis has both theoretical and clinical significance. Theoretically, it supports the word retrieval model from the perspective of developmental language impairments. Clinically, these findings support the need for individualised diagnosis and specific intervention plans for children according to the dominant profile of their deficit.

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Declaration of interest

The authors report no conflicts of interest.

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Appendix A. Performance on the language tests of the children with LI

		Inclusionary Criteria		Phonological tasks	
Participant	Age	Descriptions[a]	ITPA[b]	Nonword Repetition[c]	Phonological Awareness[d]
DS	4.4	2	4.1	72	8
YY	4.4	1.25	–4	72	
DB	4.6	0.75	–4	83	2
RN	4.7	0.25	4.8	94	0
YV	4.7	2.5	4.5	89	2
EH	4.10	1	4.10	94	9
AZ	5.0	1	5	72	0
AD	5.2	0.5	4.5	89	4
ST	5.2	0.75	4.1	78	0
EK	5.3	0.5	5.3	56	3
MK	5.6	1.75	4.10	50	
RH	5.6	1.25	5.1	89	8
AK	6.0	2.5	6	83	6
AA	6.1	1	–4	72	10
YL	6.3	2	5.8	89	28
AB	6.6	2.25	5.3	94	8

Shaded cells indicate performance lower than control group's performance in at least 1 SD—for Descriptions, ITPA and Phonological Awareness. For the Nonword Repetition task, we used Crawford and Howell (1998) comparison.
Empty cells indicate that the test was not administered to the child.
[a]Rom and Morag (1999). M = 2.64, SD = 0.8 (Children aged 6 yr and older were compared with M = 3.73, SD = 1.18).
[b]Kirk et al. (1967). Language age.
[c]Biran (2010). M = 94%, SD = 6.3.
[d]Katzenberger and Meilijson (2014). For 4–5 yr old: M = 9.9, SD = 8.6, for 5–6 yr old: M = 20.9, SD = 9.6.

Appendix B. Correct performance on the naming task, total number of errors and ratio of error types of the children with LI

Participant	Age	Sex	Correct %	Unfam. words	Total errors[a]	Sem. %	Desc. %	Def. %	Phono. %	Gesture %	Don't know %	Hes. %	Other %
DS	4.4	M	70	2	35	37	17	0	23	3	11	3	6
YY	4.4	M	43	3	67	46	19	0	4	1	10	2	18
DB	4.6	M	48	0	60	35	25	0	8	3	14	0	15
RN	4.7	F	43	8	61	52	23	5	8	2	2	0	8
YV	4.7	M	58	0	48	40	29	0	10	4	2	5	10
EH	4.10	M	67	0	34	29	47	6	3	0	12	0	3
AZ	5.0	M	65	3	43	33	16	0	40	9	2	0	0
AD	5.2	M	66	1	42	40	7	0	12	7	21	11	2
ST	5.2	M	53	2	54	29	26	0	19	0	2	6	18
EK	5.3	M	74	0	27	22	22	7	26	11	0	0	12
MK	5.6	M	47	2	67	27	12	0	39	4	6	0	12
RH	5.6	M	63	0	48	38	15	6	27	2	0	2	10
AK	6.0	F	67	0	33	27	30	3	18	3	6	7	6
AA	6.1	F	67	4	35	29	20	6	14	0	6	19	6
YL	6.3	F	74	2	28	32	18	7	21	0	4	14	4
AB	6.6	F	76	1	32	50	25	0	9	3	3	6	4

Unfam. words = Number of unfamiliar words (these words were excluded from the total number of words for calculation of % correct performance); Sem. = Semantic; Desc. = description; Def. = Definition; Phono. = Phonological; Hes. = Hesitation.

[a]Error analysis sums the total number of responses a child produced per target word on the naming test. Thus, participants' total number of errors can be higher than the number of target words they named incorrectly.

Notice that in the 'Total errors' and 'Number of unfamiliar words' columns, the numbers are *not* percentages.