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ORIGINAL ARTICLE

Using a word association task to investigate semantic depth in swedish-speaking children with developmental language disorder

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ABSTRACT

We examined word associations in Swedish children with Developmental Language Disorder (DLD) compared to their typically developing (TD) peers. Furthermore, the study aimed to explore the dimensions of vocabulary knowledge (breadth, depth, and fluency) in these children. Fifty children (15 DLD and 35 TD) participated in the study, aged six to nine years. This age span is commonly associated with substantial lexical reorganisation, by some referred to as the syntagmatic-paradigmatic shift. Fifty items from the Kent-Rosanoff list were used to elicit word associations (say the first word that comes to mind). Word associations were coded as paradigmatic (lion-tiger), syntagmatic (chair-sit), phonological (moon-poon), and other/no answer (foot-hello/bed- -). A semantic depth score (paradigmatic and syntagmatic associations) was calculated and analysed. The children with DLD showed significantly lower semantic depth scores than their TD peers, in line with previous research in English-speaking children. However, the vocabulary dimensions were uniformly affected for the DLD group, contradicting previous findings of semantic depth as a particular area of weakness in this group.

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Developmental language disorder; vocabulary assessment; lexical organisation; word associations; children

Introduction

Developmental language disorder (DLD) is commonly characterised by late onset of word learning and reduced rate of vocabulary acquisition [1–3]. Vocabulary comprises the building blocks of language and literacy development and is often considered to be one of the key components in school success [4,5]. However, most assessments available to speech and language therapists focus on receptive and expressive vocabulary, leaving other areas of semantic knowledge less explored [6]. There is some evidence that children with DLD have problems in lexical organisation, i.e. the structure and amount of word knowledge, exceeding those in vocabulary breadth [7,8], in contrast to children with TD who appear to simultaneously acquire word labels, meanings and use of words. While previous models of vocabulary knowledge primarily distinguish between breadth (by some referred to as size) and depth (sometimes referred to as organisation), Treffer, Milton and Treffer-Dallers [9] have proposed a third dimension, fluency. Breadth refers to how many words are known, and is often assessed through simple comprehension or recognition of the word, while depth refers to deeper knowledge of the word, including semantic relations and abstract or metaphorical use. Lastly, fluency refers to an individual's ability to access and use words with speed and ease.

Background

Word association tasks

Word associations have a long tradition in a range of disciplines, including psychology, linguistics, and speech and language therapy. Word association tasks have been used for different purposes, such as diagnosing psychiatric disorders, tracking developmental change, and, to some extent, identifying language disorder. A number of factors have been shown to influence word associations, including word class, word frequency, language typology, and cultural differences, making interpretation of the results of word association studies difficult. Entwisle [10] showed nouns to generate paradigmatic (a semantically related word that can replace the stimulus word in a sentence) associations at an earlier point in development than other word classes for English-speaking children, whereas Namei [11] found words of low frequency to generate syntagmatic (semantically related but different word classes) and even phonological (phonological similarities between the stimulus and the response) associations also in Swedish-Persian adults. Danish [12] and Greek [13] have been shown to generate a higher proportion of syntagmatic associations than English [14], and word associations have been shown to be heavily influenced by cultural context [15]. In addition, different scoring procedures have

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been used, focusing on grammatical class or semantic links. When scored grammatically, more elaborated associations are referred to as homogeneous when stimulus and response belong to the same form class, and heterogeneous when stimulus and response come from different form classes. In addition to form class, a semantic scoring also requires a semantic link between stimulus and response. Two types of semantic associations are often described; taxonomic/paradigmatic associations, where stimulus and response are semantically related and from the same form class (e.g. table-chair), and thematic/syntagmatic associations, where stimulus and response are semantically related but from different form classes (e.g. table-eat) (see, e.g. [8,16–21]).

The popularity of word association tasks may be attributed to easy administration and consistency in responses across trials [22]. The respondent is asked to produce, orally or in a written form, the first association that comes to mind after hearing or reading a given stimulus word. Word associations are thought to expose the underlying mental lexicon and can, thus, be used to explore interconnections between words and shed light on the organisation of the mental lexicon. In a more developed lexicon, the network of associations is larger and more hierarchically structured [23]. The interconnections in the lexicon are often depicted by a spreading activation [24]. Each word is represented as a conceptual node, connected to other nodes. When hearing a word, the conceptual node is activated, and related nodes are more easily activated. Consequently, words that are frequently heard or used together will be more strongly connected to each other.

Lexical organisation in children with TD

One of the first studies on developmental aspects of lexical organisation was conducted by Brown and Berko [16] who were interested in the connection between semantic and grammatical knowledge. They found adults to produce more homogeneous associations than children, who produced predominantly heterogeneous responses. With increasing age, the amount of homogeneous associations increased. Similarly, Entwisle et al. [10] found increased use of paradigmatic associations with age, equivalent to homogeneous associations.

Cronin [17] followed a group of typically developing children between five and six years of age. The children were assessed three times during the course of their first school year and examined for developmental changes in word associations as an effect of literacy acquisition. An increase in paradigmatic associations was found for the older children and a significant proportion of the variance was explained by word comprehension. Cronin [17] therefore suggested that the ability to associate paradigmatically is highly influenced by reading comprehension. Hashimoto, McGregor and Graham [25] put forward that even younger children can make paradigmatic associations, although this ability grows more stable and robust with age. In their study, two related experiments were performed. The first experiment was an object decision task where both taxonomic and thematic primes were used, with the assumption that differences in speed and accuracy in object decision would give insights into the child's knowledge of semantic relations. In the second experiment, participating six- and eight-year-olds were asked to describe the nature of taxonomic and thematic relations. In the first experiment, even the six-year olds showed knowledge of both taxonomic and thematic relations and there was no significant difference between the conditions. In the second experiment, however, the six-year-olds were less accurate in the taxonomic condition compared to the thematic condition, a performance gap not present for the eight-year olds. The authors' interpretation of the results was that while young children do, indeed, show knowledge of taxonomic relations the relations are more fragile and the representations are not as robust as in older children [25].

Lexical organisation in children with DLD

Previous research on children with DLD has demonstrated limitations with storage, retrieval and organisation of lexical items (for an overview, see [6]). In an earlier study by Kail and Leonard [26], children with DLD were less likely than age-matched controls to take advantage of category cues in a word recall task. The children with TD recalled more words from a categorized list (e.g. only animals) than from an uncategorized list (words from several different categories). In contrast, the children with DLD recalled the same number of words from both lists [26].

Using a repeated word association task, Sheng and McGregor [8] compared the performance of children with DLD to that of age- and vocabulary-matched peers. The children with DLD performed below both comparison groups. Sheng and McGregor [8] concluded that the children with DLD had deficits in their lexical organisation exceeding what could be expected from the breadth of their vocabularies, and the authors suggested that the problems more likely were the consequence of weaker or absent links between words in the mental lexicon. When examining individual performance in the DLD group, 57% of the children were considered poor responders. This subgroup was characterized by a wide gap between receptive and expressive vocabulary knowledge, reminiscent of the profile of children with word-finding difficulties [8]. In an ensuing study, McGregor et al. [27] compared the repeated word associations of children with DLD to those of children with autism spectrum disorder and typically developing children. Again, the group with DLD were at a disadvantage regarding lexical organisation compared to the other groups. The authors interpreted the limitations in lexical organisation of the children with DLD as resulting from incomplete representations of word meaning and immature knowledge of word-to-word relationships [27]. In addition, McGregor et al. [7] showed that the children with DLD, in comparison to the participants with TD, had reduced vocabulary breadth (knew fewer words) and depth (less detailed knowledge of the words). However, the relationship between breadth and depth differed between the two groups, and the children

Table 1. Background information on participants' age, maternal education and scores for Raven's coloured progressive matrices and nonword repetition.

	DLD		TD			
	M (*SD*)	Range	*M* (*SD*)	Range	*p* Value	*d*
Age (in months)	90.87 (14.61)	71–115	91.11 (11.90)	72–111	.950	0.02
Maternal education[a]	2.33 (0.71)	1–3	2.57 (0.66)	1–3	.344	0.36
RCPM (percentiles)	50.08 (30.572)	10–95	72.57 (21.36)	25–95	.007	0.40
NWRep (raw score)	6.93 (3.27)	1–12	15.69 (1.92)	11–18	<.001	3.69

[a]1 ≤ 9 years (elementary school), 2 = 12 years (high school), 3 ≥ 12 years (university).

with DLD exhibited slower growth in depth, relative to breadth, compared to TD peers. The results indicate that children with DLD show more deficiencies with depth than breadth [7]. This developmental pattern has also recently been shown for children with hearing impairment. Using linear mixed effect models, Walker, Redfern and Oleson [28] found the gap in vocabulary breadth between children with and without hearing impairment to diminish with age. For vocabulary depth, however, children with hearing impairment showed significant and stable deficits compared to normal hearing peers over time.

Aim and research questions

The aim of the present study was to examine word associations of Swedish speaking children with developmental language disorder (DLD). The research questions were:

1. Do Swedish speaking children with DLD show deficits in word associations elicited with the Kent-Rosanoff list [20] as compared to peers with typical language development (TD), and, on an individual level, do these deficits affect all children with DLD?
2. Do children with and without DLD differ on all dimensions of vocabulary knowledge (breadth, depth, and fluency) as described by Daller et al. [9]?

We expected children with DLD as a group to perform at a lower level than the TD group. However, we expected to find individual participants performing similarly to their TD peers. In line with previous research, we expect greater differences between the TD and DLD groups on the measures of semantic depth than for breadth and fluency.

Materials and method

Participants

Fifty monolingual Swedish speaking children, between 5;11 and 9;7 years of age, participated in the study. The age span represents a period of substantial lexical reorganisation, often reported to represent a shift from predominantly syntagmatic to mainly paradigmatic associations. Participants with confirmed diagnosis of DLD were recruited from language units and speech and language practitioners. The presence of language problems at this age has long been known to be persistent in nature [29]. All children passed a 20 dB pure-tone hearing screening at 0.5, 1, 2, and 4 kHz, and according to parental interviews, no known neurological or neuropsychiatric disorders were present. A 15-item questionnaire about parental education, children's language development and school and after school activities, variables known to influence vocabulary performance, was given to parents online. The study was approved by the Regional Ethics Review Board for Southern Sweden (Approval No. 2010/717). Participant characteristics are presented in Table 1.

Materials

All children were assessed with a battery of tasks, each serving distinct purposes. The background variable Nonverbal IQ, measured with Raven's Coloured Progressive Matrices (RCPM; [30]), was included to confirm that the children had cognitive abilities within the normal range. Phonological short term memory, a well-known clinical marker of DLD [31], was used to confirm group membership. It was assessed with a nonword repetition task (NWRep) consisting of nonwords two to four syllables in length, following Swedish phonotactic rules [32]. To assess the dimensions of vocabulary knowledge in the Treffer *et al.* model [9], three subtests from the Swedish version of the Illinois Test of Psycholinguistic Abilities (ITPA; [33,34]), were administered; Auditory reception for semantic breadth, Auditory association for semantic depth and Verbal fluency for fluency. To assess the dependent variable, word associations, reflecting a more free form of assessing semantic depth, a shortened version [35] of the Kent-Rosanoff list was used. The version used consists of 50 words (35 nouns and 15 adjectives) with the same proportion of nouns and adjectives as the original list [20]. The list was shortened to better suit younger children, excluding inappropriate words (e.g. whisky) or culturally/historically biased items (e.g. Bible). No other adaptations were made. The list was translated and back-translated with good consistency, 94% [36].

Procedure

The children were tested in a quiet room at school during the school-day. The tests were given in a fixed order. RCPM was presented in accordance with the test manual. NWRep was presented orally and the child was asked to repeat the nonwords. If the child asked for repetition or clarification, the examiner repeated the nonword, but the child was not awarded a point for the item. For the ITPA subtests, instructions were given in accordance with the test manual.

Table 2. Mean (SD) and min-max values for semantic depth and association types (raw scores) for each group separately.

	DLD		TD			
	M (SD)	Range	M (SD)	Range	*p* Value	d
Semantic depth	41.33 (20.20)	7-80	58.66 (17.496)	23-90	.004	0.95
Associations						
Paradigmatic	13.53 (10.86)	3-36	20.46 (10.93)	4-45	.046	0.63
Syntagmatic	14.27 (9.4)	1-30	17.80 (8.85)	0-31	.210	0.40
Phonological	4.47 (7.75)	0-26	1.83 (5.95)	0-35	.192	0.41
Other/no answer	17.73 (8.97)	3-39	9.91 (7.64)	0-30	.003	0.97

For auditory reception, the child was asked a series of yes/no questions, while in the auditory association, the child was asked to fill in the last word of an analogy. Finally, in the verbal fluency subtest, the examiner provided a category word (any word, outdoors, food and body parts) and the child was asked to generate words belonging to this category for one minute. In accordance with the Swedish adaptation of the Kent-Rosanoff list [35], the examiner introduced the word association task to the children by saying:

> "When you hear a word, you come to think of other words. For example, if you would say coffee to me, I would probably think of tea or black. Let's try it. Can you say a word and we will see what I come to think of?"

After a couple of trials, where the examiner responded with predominantly paradigmatic associations, and it was clear that the child understood the task, the real test started. The stimuli were given orally by the examiner who asked the child to respond with the first word that came to mind. Associations were recorded verbatim on a scoring form. The sessions lasted almost one hour, and breaks were allowed when necessary.

NWRep was scored binarily (1 point for each correct word) with a maximum score of 18. Auditory reception consists of 40 items and the test is aborted after three incorrect responses within seven items. Auditory associations consist of 35 items and testing is discontinued after three consecutive incorrect answers. For verbal fluency, each word belonging to the category yields one point and a sum for all categories was computed. RCPM was converted into percentiles and the ITPA subtests into stanine scores.

Responses from the Kent-Rosanoff list were coded into one of four categories; paradigmatic (semantic link and same word class, e.g. *music-microphone*), syntagmatic (semantic link but not from the same word class, e.g. *butterfly-flying*), phonological (rhyme or alliteration, often nonwords, no semantic link to the stimulus word, e.g. *woman-poman*) and other (repetitions, no semantic link to the stimulus word, or no answer, e.g. *foot-hello* or *beautiful-* -). Paradigmatic and syntagmatic association both have a semantic link to the stimulus word. In accordance with Sheng et al. [21], a semantic depth score was calculated, by summing paradigmatic and syntagmatic associations. Paradigmatic associations were awarded two points since these associations are viewed as more mature than syntagmatic associations, which were awarded one point. Recoding of 7% of the material was made by the third author. The point to point interrater agreement was 85%.

Statistical analyses

Group differences were explored with a series independent samples *t* tests. Effect size (Cohen's *d*) was calculated and interpreted in accordance with Cohen ([37]; small = 0.2, medium = 0.5 and large = 0.8).

Results

Preliminary analyses

The groups did not differ significantly on age, t (48) = 0.06, p = .95, d = 0.02, or maternal education, t (42) = 0.96, p = .344, d = 0.36). As expected, and confirming the diagnosis of DLD, a significant group difference was found for NWRep, with the TD group outperforming the children with DLD; NWRep, t (16.7) = 9.40, $p < .001$, d = 3.69. The TD group also outperformed the DLD group in nonverbal IQ (RCPM), t (45) = 2.81, p = .007, d = 0.62. In order to ensure that the difference in nonverbal IQ did not influence the dependent variable, a regression analysis was performed. All assumptions were met. Nonverbal IQ did not influence the dependent variable significantly and only accounted for 0.4% of the total variance. Nonverbal IQ was therefore not included as a covariate in further analyses. See Table 1 for descriptive statistics.

Group comparisons

Mean values for the association types and the semantic depth score (i.e. paradigmatic and syntagmatic associations) are reported in Table 2. An independent samples *t* test was performed with group (DLD, TD) as the independent variable and semantic depth as the dependent variable. A statistically significant difference was found between the DLD and TD groups for the semantic depth score, t (48) = 3.06, p = .004, Cohen's d = 0.95. The participants with DLD exhibited lower semantic depth scores than the TD group. Comparisons for each type of association were also made (paradigmatic; t (48) = 2.05, syntagmatic; t (48) = 1.27, phonological; t (21.42) = 1.32, other/no answer; t (48) = 3.14). See Table 2 for p and d values.

To investigate individual performances, a cut-off was calculated on the dependent variable semantic depth defined as

Table 3. Mean (SD) and min-max values for the raw scores of semantic breadth, depth, and fluency.

	DLD		TD			
	M (*SD*)	Range	*M* (*SD*)	Range	*p* Value	*d*
Auditory reception (breadth)	1.53 (1.06)	1–4	4.60 (2.31)	1–9	<.001	1.52
Auditory association (depth)	1.33 (1.05)	1–5	4.17 (2.18)	1–9	<.001	1.48
Verbal fluency (fluency)	2.53 (1.64)	1–7	5.03 (1.45)	3–8	<.001	1.66

the TD mean minus 1 *SD* (58.66-17.499 = 41.164). All participants were compared to this value. For semantic depth, 60% (9 participants) of the children in the DLD group performed below the cut-off (range 7–40, $M = 28.67$, SD = 11.37) while 17% (6 participants) of the children in the TD group performed below the cut-off (range 23–32, $M = 29.50$, SD = 3.39).

Vocabulary dimensions

Three independent samples *t* tests were performed with the same independent variable (group) and the measures of semantic breadth, depth, and fluency as the dependent variables. Statistically significant differences were found for all measures with the TD group outperforming the DLD group. Effect sizes (*d* values) were similar for all vocabulary dimensions. Table 3 presents all values.

Discussion

Differences between children with and without DLD

In this study, the participants with DLD showed lower semantic depth scores than their TD peers. This is in line with previous research on word association behaviour in children with DLD [7,8,27]. Whereas previous studies have all been conducted on English speaking children, our study examines Swedish children, extending the validity of lexical organisation as a relevant measure in the assessment of children with DLD across languages. Similarly, comparable results have been found for bilingual children with DLD [21,38,39] further confirming lexical organisation, and particularly paradigmatic associations, to be an area of difficulty for children with DLD. In contrast to grammatical ability, for which different aspects have been shown to be affected for speakers of different languages (for a summary, see [40]), lexical organisation is more uniformly affected regardless of language background. When examining the individual performance of the participants with DLD, 60% of the children were found to be low performers, i.e. scoring below the cut-off. Similar percentages have been found in earlier studies by Sheng and colleagues [8,21]. The results indicate that some, but not all, children with DLD have deficits in their lexical organisation, as measured by word associations. This is not surprising since lexical development repeatedly has been shown to be largely variable in children with TD (for an overview, see [41]) as well as for children with DLD [42].

Hashimoto et al. [25] found that children as young as six years exhibited taxonomic organisation. However, with increasing task demands, these links were found to be less robust than thematic links. Similarly, our results indicate that the children with DLD perform like younger children, showing both paradigmatic and syntagmatic relations, but with greater access to syntagmatic associations. However, in their comparison between children with DLD and vocabulary matched younger children with TD, Sheng and McGregor [8] found that children with DLD had limitations in their word associations exceeding those expected from their vocabulary breadth. McGregor et al. [7] also found problems with semantic depth to exceed those in semantic breadth in children with DLD compared to TD peers. Taken together, these findings suggest that children with DLD have an unusually prolonged development of lexical organisation and that differences between children with and without DLD may increase with age.

Our results fail to replicate those of McGregor et al. [7] and Sheng & McGregor [8]. When inspecting the effect sizes for the individual vocabulary dimensions, semantic depth does not stand out as more affected for the DLD group, in comparison to the TD group, relative to semantic breadth and fluency, as would have been expected from the previous studies. Thus, the vocabulary dimensions appear more uniformly affected for the participants with DLD in the present study. Instead, verbal fluency is the measure for which the values of the DLD and TD groups are farthest apart, despite being the vocabulary dimension where the participants with DLD perform best. Differences in the assessment and scoring procedures used in the present study and the studies by McGregor et al. [7] and Sheng and McGregor [8] may offer an explanation to the differing results. For diagnostic purposes, binary tasks with right or wrong answers, sometimes referred to as convergent tasks [41], facilitate administration. On such tasks, children with DLD often underperform. In order better to capture the true competence of children with DLD divergent tasks [41] should be used. Divergent tasks offer a more flexible assessment, awarding points also to early signs of emergent ability, e.g. the first correct occurrences of a target structure. As such, divergent tasks are better able to capture the true potential under optimal circumstances [41]. Indeed, in this study, the effect size for semantic depth as measured with the Kent-Rosanoff list ($d = 0.95$) indicates that children with DLD perform better, and more in line with peers with typical language development, on divergent than convergent tasks. Somewhat surprisingly, therefore, in our data set, verbal fluency, a divergent task, yields the greatest effect. One possible explanation is that one of the tasks in the ITPA word association composite is to produce any word that comes to mind, without being restricted to any predetermined category. This, arguably, constitutes a measure of semantic

breadth. In addition, children with DLD are not helped by semantic cues [26], which adds a dimension of semantic depth to the task, by McGregor et al. [7] and Sheng and McGregor [8] previously shown to be impacted by DLD. As such, verbal fluency in the present study captures all vocabulary dimensions specified by the Daller et al. (2007) model.

Methodological considerations

A number of methodological concerns can be raised. Although the use of the Kent-Rosanoff list allows easier comparisons with several previous studies, the list was not developed for the purpose of studying children with DLD and creating a new list, specifically adapted for the age group, might be warranted. 35 of the 50 words in the list are nouns, and there is a risk that the proportion of nouns may have skewed the results, in favour of the children with DLD. As noted by Entwisle et al. [10], young children tend to respond with a noun, regardless of the stimulus word class, resulting in possible paradigmatic responses not reflecting actual advancement in semantic organisation but merely shared word class. This might have influenced our results with, as discussed earlier, the children with DLD responding more similarly to younger children. Emerson and Gekoski [43] further investigated paradigmatic associations to nouns and divided the paradigmatic associations into interactive and categorical associations. Interactive associations are characterized by parts, for example *car-tire*, or an action sequence, for example *train-tracks* (the train runs on tracks) whereas categorical associations are based on shared characteristics, such as *car-truck* or *crib-bed*, representing words within the same semantic category/hierarchy. With this division, Emerson and Gekoski [43] found younger children to respond predominantly with interactive associations while the older children gave mostly categorical associations. For clinical use, this kind of more fine-grained division might be more useful in separating children with and without DLD. In addition, for an assessment tool to be of use in speech and language therapy decision-making it must also be easy to administer and score. The word association task used in the present study should be further developed in both regards to be of clinical value.

Disclosure statement

The authors declare no conflicting interests.

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