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Prosodic aspects of repetition in Swedish-speaking children with developmental language disorder

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Abstract

Purpose: To examine repetition of stress and tonal word accents in real words and non-words in Swedish-speaking children with developmental language disorder (DLD), and to investigate the relation of prosodic repetition to measures of language ability.

Method: A cross-sectional study was undertaken with 30 monolingual Swedish-speaking children with DLD, mean age 4;11 (years;months) and 29 age-matched controls, mean age 5;1, who repeated words and non-words with systematically varying prosody. Group differences for the repetition of prosodic features, and correlations between repetition and phonology, grammar, and vocabulary, were explored.

Result: Children with DLD performed below controls on repetition of prosodic features of words and non-words. Repetition of stress and tonal word accent was not correlated with phonological production or receptive vocabulary, but a significant correlation was found between stress repetition in words and expressive grammar.

Conclusion: Repetition of stress and tonal word accents is challenging for children with DLD acquiring Swedish as their first language, but may not be a good indicator of general language ability. Prosody should be taken into account when interpreting results from clinically used word repetition (WR) and non-word repetition (NWR) tasks.

Keywords: children; language disorder; word repetition; non-word repetition; prosody; Swedish

Introduction

Children with developmental language disorder (DLD)1 have persistent language impairment without a known cause (Bishop, Snowling, Thompson, Greenhalgh, & Catalise-2, 2017). Heterogeneity is substantial, with large variability in terms of affected language abilities, and severity of the impairment (Bishop, 2006). One task that has been proposed as a clinical marker for specific language impairment (SLI) is non-word repetition (NWR) (Conti-Ramsden, Botting, & Faragher, 2001). In much of the previous research on NWR, focus has been on the ability to repeat segments (e.g. consonants), while prosodic features have received less attention (Roy & Chiat, 2004). Prosody functions as a scaffolding for the detection and acquisition of lexical, syntactic and phonological elements (Arbisi-Kelm & Beckman, 2009; Jusczyk, 1997), and the development of prosodic skills important in communication continues well after the age of school entry in children with typical language development (TLD; Wells, Peppé, & Goulandris, 2004). Therefore, investigations of what role prosody plays in tasks that are indicative of language disorders (such as NWR) are motivated. The present study examined how Swedish-speaking four- to six-year-old children with DLD and age-matched controls with TLD repeat the prosodic features stress and tonal word accent in words and non-words, and how repetition of stress and tonal word accent correlated with phonological production, expressive grammar, and receptive vocabulary.

Swedish prosody

Stress placement in Swedish is variable between words. This variability enables the use of stress to distinguish meaning in a number of minimal pairs of

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words, e.g. /ˈfɔːrməl/ ‘formula’ and /ˈfɔːrˈmɛl/ ‘formal’. Simplex word forms receive one main stress. Compounds receive both main and secondary stress; the main stress is assigned to a syllable belonging to the first part of the compound, while secondary stress is assigned to a syllable in the last part (Bruce, 2012).

Swedish has a system with two lexical tones. These are referred to as tonal word accents 1 and 2, which are realised as distinct tonal contours over the word. Tonal word accent 1 is characterised by a low tone on the stressed syllable, followed by a rise. Tonal word accent 2 instead has a high tone followed by a fall on the stressed syllable (Bruce, 2012). The tonal word accents can be used distinctively, and there are about 300–400 minimal pairs in which the words are distinguished by tonal word accent alone (Elert, 2000). All stressed Swedish words have either tonal word accent 1 or 2. Monosyllabic words and words with stress on stressed Swedish words have either tonal word accent 2 instead has a high tone followed by a fall on the stressed syllable, followed by a rise. Tonal word accent 1 word

Data on the age of acquisition for the prosodic features of Swedish is quite sparse. Children with TLD prefer trochaic stress patterns in the earlier stages of phonological development (Nettelbladt, 2007). Tonal word accent 2 is typically acquired first (Peters & Strömqvist, 1996), and production of tonal word accent 2 has been observed in children aged 12–18 months (Engstrand, Williams, & Lacerda, 2003). However, correct contrastive use is likely not in place until around the age of four (Plunkett & Strömqvist, 1992).

Prosodic problems are not uncommon in Swedish-speaking children with DLD. Samuelsson, Scocco, and Nettelbladt (2003) found that deviant prosody at the word, phrase and discourse levels combined occurred in one third of their sample of four- to seven-year-olds with language impairment (LI). At the word level, children with LI have been found to perform below children with TLD on production of both stress and tonal word accents (Samuelsson & Löfqvist, 2006; Samuelsson, Reuterskiöld, Nettelbladt, & Sahlén, 2011).

**Word and non-word repetition**

In a non-word repetition task, the child is presented with an unknown word form without meaning, that is a non-word, and is asked to repeat it back immediately. NWR has proved useful in discriminating between children with and without SLI (for a review see Graf Estes, Evans, & Else-Quest, 2007), and has been suggested as a potential behavioural marker for the SLI phenotype (Bishop, North, & Donlan, 1996). Evidence that children with DLD perform below children with TLD on NWR tasks comes from studies of children acquiring a range of languages, for example, English (Dollaghan & Campbell, 1998), Spanish (Girbau, 2016), Italian (Dispaldro, Leonard, & Deevy, 2013), and Swedish (Kalnak, Peyrard-Janvid, Forssberg, & Sahlén, 2014). Word repetition (WR) has not been investigated as thoroughly as NWR, although WR accuracy has been found to be lower in English-speaking children referred for speech and language therapy assessment (Chiat & Roy, 2007), and in Italian-speaking children with SLI (Dispaldro et al., 2013), compared to children with TLD.

NWR has been assumed to be a measure of phonological working memory (Gathercole, Willis, Baddeley, & Emmslie, 1994). However, the ability to repeat non-words is also dependent on phonological processing (Bowey, 2006) and long-term lexical knowledge (Gathercole, 2006). WR is less reliant on phonological working memory capacity compared to NWR, since it supposedly enables the activation of already learned lexical representations in long-term memory. This is likely to explain why words are easier to repeat than non-words (Chiat & Roy, 2007).

Manipulation of the stimulus properties have been shown to affect repetition performance. Increasing non-word length typically results in decreased repetition accuracy (Dollaghan & Campbell, 1998), which is in accordance with the view of NWR as a measure of phonological working memory. Further, reduced repetition accuracy is associated with non-words that have low similarity to real words (Gathercole, 1995), low phonotactic probability of the phoneme sequences (Coady & Aslin, 2004), and high phonological complexity (Gallon, Harris, & van der Lely, 2007).

The repetition of prosodic non-word properties, such as stress patterns or tone, have received comparably limited attention (Roy & Chiat, 2004). Prosody is important in early language acquisition (Johnson & Jusczyk, 2001), and prosodic development appears to continue beyond the age of eight years (Wells et al., 2004). Thus, investigations of the role of prosody in tasks that could potentially predict language development, for example, NWR, may yield both theoretically and clinically relevant results. In the present study, Swedish-speaking children with DLD and children with TLD performed a WR and NWR task that enables analyses based on length, stress, and tonal word accent.

**Repetition of prosodic features of words and non-words: typical language development**

Roy and Chiat (2004) found that English-speaking two- and three-year-olds the children rarely omitted stressed syllables in WR and NWR, while unstressed syllables were more frequently omitted. The two-year-olds omitted twice as many syllables as the three-year-olds, suggesting improvement over time.
Further, prosodic position played an important role—three times as many pre-stressed syllables (i.e. unstressed syllables occurring before the stressed syllable) were omitted, compared to post-stressed syllables (after the stressed syllable) (Roy & Chiat, 2004), which is in line with the preference for trochaic over iambic rhythmical patterns of young children acquiring English (Echols, 1996; Gerken, 1994).

One of the few studies of tonal influences on repetition was done by Yuzawa and Saito (2006), who examined the effect of Japanese pitch accent on NWR. Japanese-speaking children aged between three and six years repeated two-syllable non-words that were either accented or unaccented. The results revealed that accented non-words were easier to repeat than unaccented, but only for the younger children (Yuzawa & Saito, 2006).

**Repetition of prosodic features of words and non-words: developmental language disorder**

Sahlén, Reuterskiöld-Wagner, Nettelbladt, and Radeborg (1999b) investigated repetition of words and non-words in Swedish-speaking children with LI aged 4;11–5;11. The words and non-words varied in length between two and four syllables, and were matched pairwise for stress and tonal word accent. Overall, there were few syllable omissions, but there was a clear effect of prosodic position on the omission of unstressed syllables in both words and non-words; only 1% of the post-stressed syllables were omitted, compared to 6% of the pre-stressed syllables, indicating a preference for trochaic over iambic stress patterns (Sahlén et al., 1999b).

Chiat and Roy (2007) studied syllable omissions in WR and NWR in English-speaking children aged 2;6–4;0 years, who had been clinically referred for speech and language therapy assessment. The clinically referred children omitted about twice as many syllables compared to children with TLD. Further, the clinically referred children were more prone to repeat syllables in real words than in non-words, while the children with TLD were not. The authors attributed this somewhat surprising finding to possible weak long-term lexical representations, arguing that the phonological constraints on real words may not apply to non-words. Pre-stressed syllables were omitted more frequently than post-stressed syllables by the clinically referred children, an effect of prosodic position that was also found for the children with TLD (Chiat & Roy, 2007).

Dispaldro (2014) analysed syllable omissions in Italian-speaking children with SLI, aged 3;11 to 5;8 years, and a group of younger language-matched children with TLD. The children with SLI omitted significantly more syllables than the children with TLD, but only in four-syllable non-words. An effect of length was found for both groups; no omissions were made in two-syllable items, and fewer syllables were omitted in three-syllable compared to four-syllable items. More pre-stressed than post-stressed syllables were omitted, indicating a preference for trochaic stress patterns similar to that previously found for Swedish- and English-speaking children (Dispaldro, 2014).

**Repetition of prosody and language ability: developmental language disorder**

Few attempts have been made to identify potential relationships between repetition of prosodic word or non-word features and language ability. A notable example is the study by Dispaldro (2014), who examined the association of syllable omissions and the use of direct-object clitic pronouns. He found that the ability to repeat pre-stressed syllables in four-syllable non-words explained 24% of the variance in clitic pronoun production, while phonological storage capacity explained no additional variance. Italian clitic pronouns typically occur in pre-stressed positions, and it may be that the ability to use this grammatical element is partly dependent on the same underlying prosodic skill as the ability to repeat pre-stressed syllables (Dispaldro, 2014). Although these results are only tentatively suggestive of a link between prosodic repetition and grammar, they fit nicely with theoretical approaches to grammatical development that assume that morphemes in prosodically disadvantageous positions are harder to acquire (Demuth, 2014; Gerken, 1994). Swedish grammatical morphemes typically comprise unstressed syllables, and they often occur in pre-stressed positions. This is especially evident for indefinite articles (e.g. ett apple [et 'eple] “an apple”), copulas (e.g. äplet är grönt [‘eplet e ‘groen] “the apple is green”), and prepositions (e.g. titta på teve ['tita pa 'teve] “watch television”), but many inflectional affixes may also occur in such positions.

In Swedish-speaking children, repetition of consonants in non-words has been found to correlate with receptive syntax (Sahlén, Reuterskiöld-Wagner, Nettelbladt, & Radeborg, 1999a), and expressive phonology and grammar (Sahlén et al., 1999b). Sahlén et al. (1999a) also found a simple correlation between NWR and receptive vocabulary, but controlling for receptive grammar skills rendered this correlation nonsignificant. Potential relationships between repetition of prosodic features and language ability remain to be revealed.

In summary, prosodic factors appear to affect repetition in children with both DLD and TLD. Limited research exists of the relationship between prosodic aspects of repetition and language ability. Further investigations of what role prosody plays in repetition could potentially yield theoretically and clinically relevant insights into what NWR (and WR) tasks measure. In Swedish, grammatical morphemes often comprise syllables that occur in prosodically disadvantaged positions. Further, the Swedish tonal word accents are associated with morphology, with different tonal word accents signalling different
suffixes. Swedish-speaking children with DLD often exhibit prosodic deficits in addition to phonological, grammatical, and lexical problems. It is possible that repetition tasks that take into account stress and tonal word accent could capture prosodic deficits that underlie grammatical difficulties.

The present study

The first aim of the present study is to examine the ability of Swedish-speaking children with DLD to repeat stress and tonal word accent in words and non-words, and to relate their performance to that of children with TLD. To this end, a repetition task with systematically varying lexical prosody is used. Based on the results of Chiat and Roy (2007) and Dispaldro (2014), one hypothesis is that the children with DLD will perform below the children with TLD on the repetition of stress patterns, mainly due to a greater number of omitted unstressed syllables. Given that problems with tonal word accent use are not uncommon in Swedish-speaking children with DLD (Samuelsson et al., 2003), a further hypothesis is that performance on tonal word accent repetition will be less accurate in children with DLD.

The second aim is to explore if repetition of prosodic features of words and non-words is correlated with phonology, grammar, and vocabulary. Results of previous studies have indicated that segment repetition may be related to language ability (Sahlén et al., 1999a, 1999b), but it is not clear if these findings would extend to repetition of prosodic features of words and non-words.

The following research questions are addressed:

1. Are Swedish-speaking children with DLD as accurate as children with TLD on repetition of the prosodic features stress and tonal word accent in words and non-words?
2. Is repetition of stress and tonal word accent correlated with phonological production, expressive grammar, and receptive vocabulary in children with DLD?

Method

Participants

Thirty children with DLD and 29 controls with TLD participated. Inclusionary criteria for all children were that they should be between four and six years old, be monolingual speakers of a Central Swedish dialect, and have normal hearing. Informed written consent was obtained from caregivers, and the children received simplified spoken information about the testing. The study received ethical approval from the Regional Ethical Review Board in Linköping, Sweden (Dnr 2013/92-31).

Children with developmental language disorder

Letters with information about the study as well as consent forms were distributed to caregivers for 142 children with DLD. All children had received a diagnosis of language impairment according to ICD-10 (World Health Organization, 2010). However, selection was made based on the language symptoms described by the clinicians, rather than the ICD-10 diagnoses. Criteria for inclusion in the study was problems with expressive phonology and/or grammar, excluding pronounced lexical, semantic and pragmatic impairments. As the medical records of the children were not accessible, there are very limited background data on the speech and language characteristics of each child. Written consents were given by caregivers for 40 of the children, out of which 10 were lost due to multilingualism, inability to attend the testing session because of illness, or difficulties to find a suitable time for testing. The remaining 30 children were aged between 4;1 and 6;2 (years;months) (49–74 months, \(M = 59.3\) \(SD = 7.3\)) and consisted of 10 girls and 20 boys. All children performed within normal limits on the Nordic Orofacial Test–Screening (NOT–S) (Bakke, Bergendal, McAllister, Sjögren, & Åsten, 2007), and were reported to have normal hearing by their caregivers.

Children with typical language development

A total of 166 information letters were provided to caregivers of typically developing children. Caregivers of 34 children gave their written consent, whereof five later declined to participate prior to testing. The remaining 29 children were aged 4;1–6;4 (49–80 months, \(M = 61.3\) \(SD = 8.2\)). The group comprised 18 girls and 11 boys. All were reported to have normal hearing by their caregivers.

Procedure

All children performed a WR and NWR task, tests of phonological production, grammatical production, receptive vocabulary, and nonverbal intelligence. Testing was administered during one or two sessions, totalling about 90–120 minutes including suitable breaks, and took place in a quiet room at Linköping University hospital, at the preschool, or in the child’s home. All testing was administered by the first author.

The word and non-word repetition task

The WR and NWR task (Sundström, Samuelsson, & Lyxell, 2014) included 25 words and 25 non-words, one to five syllables in length, with systematic variation of stress patterns and tonal word accents. Some of the words and non-words included in the task were adopted from Sahlén et al. (1999b). Words were, as far as possible, selected to be familiar to children aged
four and above. However, no procedure was undertaken to assure that the children actually knew the words. Words and non-words were matched pairwise for prosody. More detailed information about the words and non-words can be found in Appendix 1.

Repetition stimuli were recorded by a female speaker, and were presented to the children via loudspeakers at approximately 70 dB SPL. Each child started with either the words or the non-words, and the presentation order of the stimuli was randomised using a computer programme. The children were told that they were going to hear some real words or words that were made up, and that they should imitate them as well as they could. Stimuli that the child did not attempt to repeat were excluded from the analyses. The children’s productions were audio recorded and transcribed phonetically. For the scoring of stress and tonal word accents, the transcriptions of the children’s production were compared to a transcription of the stimuli as pronounced by the recorded female speaker. Ten percent of the recordings from the repetition task were transcribed by an experienced speech-language pathologist (author 3) to assess inter-rater reliability. The formula used was the number of agreements divided by the total number of agreements + disagreements. Agreement for tonal word accents was 98.7% in words and 98.6% in non-words. For stress, agreement was 93.3% in words and 85.1% in non-words.

Productions of stress patterns were scored as incorrect if stress was placed on the wrong syllable, if more than one syllable was stressed, or if any syllables were added or omitted. A syllable was counted as omitted if the vowel was lost. Tonal word accent was scored as incorrect if it was the wrong variant (e.g. 1 instead of 2), if it could not be classified as either 1 or 2, or if there were more than one tonal word accent. For the stress patterns and tonal word accents, the total percentage of correct productions in words and non-words was calculated. Percentages were also calculated for each length condition with several syllables (2–5 syllables).

**Background measures**

**Linguistic abilities**

Phonological production was tested with picture naming using the Phoneme Test short version (Hellqvist, 1995). The pictures correspond to words selected to give an overview of the child’s speech sound inventory. Percentages of phonemes correct (PPC), stress patterns and tonal word accents were calculated to give a measure that was comparable across groups.

Expressive grammar was assessed with Gramba (Hansson & Nettelbladt, 2004). Noun morphology, verb morphology and syntax are elicited through sentence completion. The responses were audio recorded and transcribed prior to scoring. The maximum score is 44.

The Peabody Picture Vocabulary Test, Third Edition (PPVT–III) (Dunn & Dunn, 1997), adapted to Swedish, was used to measure receptive vocabulary. Answers are given by the child by pointing to the one picture out of four which best matches the word spoken by the examiner. As the norms for Swedish children aged four to six are lacking, only raw scores are used in the present study.

**Nonverbal intelligence**

The block design subtest from the Swedish version of Wechsler Preschool and Primary Scale of Intelligence, Third Edition (WPPSI–III) (Wechsler, 2005), was used to assess nonverbal intelligence. No verbal responses are required, and the task is to replicate a pattern of one- or two-coloured blocks within a given time limit. The patterns are presented either as models constructed by the examiner, or as pictures.

**Data analysis**

Descriptive statistics were calculated for repetition, language, nonverbal intelligence, and background measures. The Outlier Labelling Rule (Hoaglin & Iglewicz, 1987) was used to detect potential outliers. One participant in the DLD group was identified as an outlier for the variables WR accent, WR stress, and NWR stress, and was subsequently excluded from further analyses. Differences between the groups were explored with independent samples t-tests. Performance on the repetition task was further analysed with mixed repeated measures analysis of variance (ANOVA) with stimulus type (2 levels: word or non-word) and length (4 levels: 2, 3, 4, or 5 syllables) as within-group factors, and group (2 levels: typical language development or developmental language disorder) as between-groups factor. Mauchly’s test was used to assess sphericity, and violations of the assumption of sphericity were corrected with Greenhouse–Geisser correction in cases where $\epsilon < 0.75$, and Hyun–Feldt correction in cases of $\epsilon > 0.75$. For comparisons of stress error type frequencies, Mann–Whitney U test was used for between-group analyses, and Wilcoxon signed-rank test for within-group analyses, as near ceiling effects (i.e. a low number of errors) were evident for the control group. Pearson product-moment correlations were calculated for each of the repetition measures and phonological production, grammatical production, receptive vocabulary, nonverbal intelligence, maternal education, and age. The false discovery rate was corrected using the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995).

**Result**

No differences between the groups were found for age or nonverbal intelligence, while a significant
difference was found for maternal education. The children with DLD scored significantly below their TLD peers on receptive vocabulary, and expressive grammar. The DLD group also scored below on phonological production of phonemes (percentage phonemes correct; PPC), and stress, but not tonal word accents. Overall, the DLD group performed below the TLD group on grammatical production. In the DLD group, 13 out of 29 children (45%) performed more than 1.25 SD below the mean on the Gramba grammar test. According to the test manual, children who score below this cut-off are at risk of grammatical impairment (Hansson & Nettelbladt, 2004). Descriptive statistics and group comparisons (t-tests) for background and language measures are reported in Appendix 2.

How do children with developmental language disorder repeat prosody in words and non-words compared to children with typical language development?

In order to address the first research question, the children with DLD and TLD were compared on the prosodic outcome measures stress repetition and tonal word accent repetition using mixed repeated measures ANOVAs, with stimulus type (word or non-word) and length (2–5 syllables) as within-group factors. Figure 1 shows the performance for each of the repetition variables (total percentages) in both groups.

Tonal word accents

There was a main effect of group for the repetition of tonal word accents. The children with DLD performed below the TLD children, $F(1, 56) = 11.141$, $p = 0.002$, $\eta^2_p = 0.17$. A main effect of stimulus type indicated that tonal word accents in words were easier to repeat than in non-words, $F(1, 56) = 12.732$, $p = 0.001$, $\eta^2_p = 0.19$. The main effect of length, $F(3, 168) = 11.479$, $p < 0.001$, $\eta^2_p = 0.17$, showed that tonal word accents were repeated with decreasing accuracy with increasing stimulus length. Five-syllable stimuli were significantly harder to repeat than stimuli with two ($p < 0.001$), three ($p < 0.001$), and four ($p < 0.001$) syllables. No differences between two-, three-, and four-syllable stimuli were found. There were no significant interaction effects.

Comparisons of tonal word accent 1 and 2 within each group revealed that children with DLD repeated tonal word accent 1 more accurately than 2 in non-words, $t(28) = 3.395$, $p = 0.002$, $d = 0.86$, but not in words, $t(28) = 0.115$, $p = 0.909$, $d = 0.03$. In the TLD group, no such difference between the tonal word accents was found for either words or non-words.

Stress patterns

The children with DLD performed below the TLD children on repetition of stress patterns, $F(1, 56) = 23.195$, $p < 0.001$, $\eta^2_p = 0.29$. Main effects of
Table I. Syllable omission percentages per group.

<table>
<thead>
<tr>
<th></th>
<th>TLD (n = 29)</th>
<th>DLD (n = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD) 95% CI</td>
<td>M (SD) 95% CI</td>
</tr>
<tr>
<td>WR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stressed</td>
<td>0.0 (0.0)</td>
<td>0.0–0.0</td>
</tr>
<tr>
<td>Unstressed total</td>
<td>3.2 (3.0)</td>
<td>2.0–4.3</td>
</tr>
<tr>
<td>Pre-stressed</td>
<td>3.3 (3.9)</td>
<td>1.9–4.8</td>
</tr>
<tr>
<td>Post-stressed</td>
<td>3.1 (3.1)</td>
<td>1.9–4.3</td>
</tr>
<tr>
<td>NWR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stressed</td>
<td>0.0 (0.0)</td>
<td>0.0–0.0</td>
</tr>
<tr>
<td>Unstressed total</td>
<td>2.9 (2.3)</td>
<td>2.0–3.8</td>
</tr>
<tr>
<td>Pre-stressed</td>
<td>4.0 (4.3)</td>
<td>2.4–5.7</td>
</tr>
<tr>
<td>Post-stressed</td>
<td>2.1 (2.2)</td>
<td>1.2–2.9</td>
</tr>
</tbody>
</table>

DLD: developmental language disorder; M: mean; NWR: non-word repetition; SD: standard deviation; TLD: typical language development; WR: word repetition. 95% CI: 95% confidence interval; r: effect size. Mann–Whitney U test was used for group comparisons.

Table II. Correlations of prosodic repetition to language measures in the children with DLD.

<table>
<thead>
<tr>
<th></th>
<th>Pearson correlation coefficients (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WR Accent</td>
</tr>
<tr>
<td>Phonological production</td>
<td>0.065</td>
</tr>
<tr>
<td>PPC</td>
<td></td>
</tr>
<tr>
<td>Expressive grammar</td>
<td>0.186</td>
</tr>
<tr>
<td>Receptive vocabulary</td>
<td>0.344</td>
</tr>
</tbody>
</table>

*p < 0.05, **p ≤ 0.01. DLD = developmental language disorder. WR: non-word repetition; PPC: percentage phonemes correct; WR: word repetition.

stimulus type, $F(1, 57) = 5.090$, $p = 0.028$, $\eta_p^2 = 0.08$, and length, $F(2.686, 134.282) = 95.930$, $p < 0.001$, $\eta_p^2 = 0.63$, indicate that stress errors were more frequent in non-words than in words, and that stress was harder to repeat in longer stimuli. There was also a significant two-way interaction between length and group, $F(3, 168) = 15.074$, $p < 0.001$, $\eta_p^2 = 0.21$. The children with DLD repeated stress less accurately in stimuli with four ($p < 0.001$) and five ($p < 0.001$) syllables, but not in two- and three-syllable stimuli. Further, there was a significant length x stimulus type interaction, $F(3, 168) = 5.656$, $p = 0.001$, $\eta_p^2 = 0.09$. Stress patterns were easier to repeat in words than in non-words, but only in stimuli with three ($p < 0.001$) and four ($p = 0.013$) syllables. No difference between words and non-words was found for two- and five-syllable stimuli. The assumption of sphericity was not satisfied for the length effect, as shown by Mauchly’s test, $\chi^2(5) = 19.059$, $p = 0.002$, and the degrees of freedom were adjusted with Greenhouse–Geisser correction.

Out of all stress pattern error types (stress on the wrong syllable, stress on multiple syllables, syllable omission, syllable addition), syllable omission was the most frequent. It was also the only error type that was significantly more frequent in the children with DLD in both WR, $z = 2.885$, $p < 0.003$, $r = 0.38$, and NWR, $z = 2.285$, $p < 0.001$, $r = 0.61$, and NWR, $z = 2.885$, $p < 0.003$, $r = 0.38$. The children with DLD omitted 6.1% of all syllables in words, and 4.6% in non-words. The corresponding results were 2.2% in words and 2.0% in non-words respectively for the TLD group.

**Syllable omissions**

The syllable omissions made in the different prosodic positions are shown in Table I. Omissions of stressed syllables were rare in both groups. The children with DLD omitted more unstressed syllables in both pre-stressed and post-stressed position compared to the children with TLD.

Looking at syllable omissions in each group separately, the children with DLD omitted more unstressed syllables in words than in non-words, $Z = 2.562$, $p = 0.009$, $r = 0.34$, while no difference was found in the group with TLD. Comparisons of pre-stressed vs. post-stressed syllables demonstrated that the children with DLD omitted significantly more pre-stressed syllables in both words, $Z = 3.135$, $p = 0.001$, $r = 0.41$, and non-words, $Z = 2.023$, $p = 0.042$, $r = 0.27$. The children with TLD omitted more pre-stressed syllables only in non-words, $Z = 1.023$, $p = 0.047$, $r = 0.26$.

**Is repetition of prosodic word and non-word features correlated with language ability?**

The second aim of the study was to explore the possibility of prosodic repetition as an indicator of language ability in children with DLD. Table II displays correlations between stress and tonal word accent repetition measures and phonological production PPC, expressive grammar, and receptive vocabulary. Overall, the ability to repeat prosodic features of words and non-words was weakly correlated with the language measures. However, there was significant correlation between the ability to repeat stress patterns in words and expressive grammar. Individual scores on stress in WR and expressive grammar for both children with DLD and TLD are presented in Figure 2.

Given the strong effect of length on stress pattern repetition in words, it was of interest to examine if the correlation with expressive grammar changes with an
increasing number of syllables in the DLD group. The results revealed significant correlations with expressive grammar only for stress repetition in words with four syllables \( r = 0.470, p = 0.010 \) and five syllables \( r = 0.399, p = 0.032 \).

Discussion

The first aim of the present study was to describe the ability to repeat prosody in Swedish-speaking children with DLD in comparison with controls with TLD. As predicted, the children with DLD displayed a lower ability to repeat both tonal word accents and stress patterns compared to the children with TLD. For tonal word accents, this group difference was independent of stimulus length. So, while repetition accuracy for tonal word accents in both children with DLD and TLD decreased in longer stimuli, the effect of length was similar in both groups. With regard to repetition of stress patterns, children with DLD performed below the children with TLD only in the longer four- and five-syllable stimuli. This suggests that the ability to repeat stress is more adversely affected by increased stimulus length in children with DLD, regardless of whether the stimuli are words or non-words.

To the best of our knowledge, this is the first study providing evidence that repetition of tonal word accents pose a difficulty for children with DLD compared to children with TLD. This finding would appear to be in line with previous findings that tonal word accents are problematic for Swedish-speaking children with LI (Nettelbladt, 1983; Samuelsson & Löfqvist, 2006). The difference between the groups was found in both WR and NWR. There was also an effect of familiarity, reflected by the finding that tonal word accents were produced with higher accuracy in words than in non-words. Familiarity effects may be related to both higher phonological working memory demands, and to a decreased stability of articulatory movements required in the coordination of prosodic and segmental features, in NWR compared to WR (Reuterskiöld & Grigos, 2015).

There was no difference in repetition accuracy between the two tonal word accents, except for tonal word accent 1 being easier to repeat than tonal word accent 2 in non-words for children with DLD. This latter finding could mean that tonal word accent 1 is easier to use for children with DLD when there is no support from lexical representations, which lends some support to the view that tonal word accent 1 is the default, unmarked variant (Riad, 2014).
Tonal word accents were assessed perceptually, and most errors were judged as substitutions. As the development of tonal word accent use is not complete until the age of four for typically developing children (Plunkett & Strömqvist, 1992), differentiation between the tonal word accents is likely still under way for some of the children with DLD. It is entirely possible that emergent, covert tonal word accent contrasts are used, but not perceived by an adult listener (Samuelsson & Löfqvist, 2006). Acoustic analyses of the f0 patterns would shed more light on this issue.

The finding that the children with DLD had a lower ability to repeat stress patterns of words and non-words is consistent with previous studies (Chiat & Roy, 2007; Dispaldro, 2014). This difference was, however, only found for four- and five-syllable stimuli, which is also consistent with previous studies. Sahlén and colleagues (1999b) found that more unstressed syllable omissions were made by Swedish-speaking children with DLD as word and non-word stimuli increased in length. Similarly, the Italian-speaking children with DLD in Dispaldro (2014) omitted more syllables than younger typically developing children in four-syllable non-words, but not when the non-words were two or three syllables in length. The fact that the group difference in the present study was dependent on length could indicate that part of the difficulties with stress pattern repetition in children with DLD is caused by limitations in phonological working memory capacity (Gathercole & Baddeley, 1990).

The majority of stress repetition errors were due to omissions of unstressed syllables, which was also the only stress error type that differed significantly between the groups. In line with the findings of Chiat and Roy (2007), the children with DLD, but not the children with TLD, in the present study omitted more unstressed syllables in words than in non-words. Chiat and Roy suggested that the stress repetition in non-words may have been less constrained than in real words by deficient long-term representations in their sample of two- to four-year-olds with DLD. This explanation could apply also to the slightly older children in the present study.

More unstressed syllables were omitted in pre-stressed compared to post-stressed positions in both WR and NWR by the children with DLD, indicating a preference for trochaic stress typically found in in younger Swedish-speaking children with TLD (Nettelbladt, 2007). This finding corroborates the results for Swedish-speaking children with DLD obtained by Sahlén et al. (1999b), and comparable effects of prosodic position in repetition have also been established in clinically referred English-speaking children (Chiat & Roy, 2007) and Italian-speaking children with SLI (Dispaldro, 2014). A possible interpretation is that children with DLD attempt to conform their output to the more frequent trochaic stress pattern (Gerken, 1994). The children with TLD in the present study also omitted more pre-stressed than post-stressed syllables in non-words, but not in words. It may be that they have more stable and diversified prosodic representations for real words, but that there is still a trochaic bias effect for unknown word forms. Future studies will have to determine if the ability of Swedish-speaking children with DLD to repeat unstressed syllables is similar to that of children with TLD, but delayed.

The second aim of this study was to examine if repetition of prosodic word and non-word features correlates with phonological production, expressive grammar and receptive vocabulary. No correlation could be found between the ability to repeat tonal word accent or stress, and phonological production (measured as the percentage of correct phonemes) or receptive vocabulary. Expressive grammar was significantly correlated with the total score for stress repetition in words, but not in non-words. A closer look at this association of stress repetition to grammar further revealed that the correlation only held for words that were four or five syllables long, indicating that phonological complexity (Gallon et al., 2007) or limitations in working memory (Gathercole & Baddeley, 1990) could be mediating factors. The cross-sectional design of the present study does not permit conclusions to be drawn about the nature of the relationship between stress repetition and grammar. However, the existing research literature provides some intriguing grounds for speculation. An association of pre-stressed syllable omissions to grammar is in line with accounts stating that grammatical morphemes occurring in such prosodic positions—such as Swedish articles, prepositions or copulas—are more vulnerable than others (Demuth, 2014; Gerken, 1994). For the present analyses, only the total expressive grammar score was used. Future investigations into the possible link between stress repetition and grammar should include detailed analyses of which types of grammatical morphemes that are problematic, and in what prosodic positions they occur. To summarise, prosodic problems as part of an explanation for grammatical deficits is theoretically feasible, and might be reflected in the ability to repeat stress patterns in words, at least if they are long enough.

Limitations

The WR and NWR task employed in the present study was designed to include all possible combinations of stress placement and tonal word accent (see appendix), but each combination occurred in just one word–non-word pair. As a result, the number of items differed between the length conditions, with, for instance, three two-syllable words/non-words and nine five-syllable words/non-words. A weakness of the design used is that less data was collected in the shorter length conditions, and also that there was less opportunity for scores to vary. The comparably low number of items in the two- and three-syllable WR/
NWR conditions may have influenced the correlational analyses, and may partly explain the weaker, non-significant correlation between WR and expressive grammar in the two- to three-syllable compared to the four- to five-syllable conditions. It may further have affected pairwise comparisons based on stimulus length, both within and between groups. Consequently, interpretations of these analyses need to be made with caution.

Although the results of the correlational analyses suggest an association between prosody in WR and grammar, the cross-sectional design of the present study does not allow for inferences about the direction of this supposed relationship. Longitudinal studies, preferably with larger sample sizes, could enable investigations of whether the ability to repeat prosody at earlier ages is predictive of later grammatical development. Future research should also include a wider range of prosodic measures, based on both experimental and, for example, conversational data, as well as detailed assessments of expressive and receptive grammar.

The DLD and TLD samples were equal in terms of age and nonverbal intelligence. There was a significant but small difference in maternal education length, which could potentially have affected the results to some degree. That being said, the average maternal education—used here as a proxy for socioeconomic status—was quite high in both groups. Another issue that ought to be addressed is the gender distribution in the groups, which may have influenced the group differences (Bornstein, Hahn, & Haynes, 2004).

Conclusion

The repetition of prosodic features in words and nonwords is challenging for Swedish-speaking children with DLD compared to children with TLD. Group differences were quantitative as well as qualitative. Not only did the children with DLD make more errors when repeating stress patterns and tonal word accents, but they also displayed a greater sensitivity to prosodic position regarding the repetition of unstressed syllables. The results of the present study adds to the body of research that shows differences between children with language disorders and typically developing children for repetition of stress patterns and segmental features. An implication of these findings is that prosody should be considered as detailed assessments of expressive and receptive grammar.

The DLD and TLD samples were equal in terms of age and nonverbal intelligence. There was a significant but small difference in maternal education length, which could potentially have affected the results to some degree. That being said, the average maternal education—used here as a proxy for socioeconomic status—was quite high in both groups. Another issue that ought to be addressed is the gender distribution in the groups, which may have influenced the group differences (Bornstein, Hahn, & Haynes, 2004).

Note

1. We have used the term developmental language disorder (DLD) to describe our participating children. Several other labels for children with unexplained language deficits are in use, such as specific language impairment (SLI) or just language impairment (LI). In the sections to follow, terminology has been kept in accordance with the articles referred to.

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Declaration of interest

The authors report no conflict of interest. The authors alone are responsible for the writing and content of this paper.

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References


Appendix 1. Features of the words and non-words in the repetition task (Sundström, Samuelsson & Lyxell, 2014). Some items have been adopted from Sahlén et al. (1999b).

<table>
<thead>
<tr>
<th>No. of syllables</th>
<th>Stress pattern</th>
<th>Tonal word accent</th>
<th>Word (translation)</th>
<th>Non-word</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td>1</td>
<td>jätin (male name Jan)</td>
<td>jüb</td>
</tr>
<tr>
<td>2</td>
<td>WS</td>
<td>1</td>
<td>kanin (rabbit)</td>
<td>rägn</td>
</tr>
<tr>
<td>1</td>
<td>SW</td>
<td>1</td>
<td>järne (heat)</td>
<td>mirven</td>
</tr>
<tr>
<td>2</td>
<td>WWS</td>
<td>1</td>
<td>spezial (special)</td>
<td>rövel</td>
</tr>
<tr>
<td>1</td>
<td>WSW</td>
<td>1</td>
<td>kristst (male name Kristoffer)</td>
<td>kratjkel</td>
</tr>
<tr>
<td>1</td>
<td>SWW</td>
<td>1</td>
<td>minmum (minimum)</td>
<td>kösismen</td>
</tr>
<tr>
<td>2</td>
<td>WSW</td>
<td>2</td>
<td>sosana (female name Susanna)</td>
<td>pelasma</td>
</tr>
<tr>
<td>2</td>
<td>WWWS</td>
<td>1</td>
<td>eventöld (possible)</td>
<td>getomnafel</td>
</tr>
<tr>
<td>3</td>
<td>WSWW</td>
<td>1</td>
<td>histurdia (story)</td>
<td>hydorra</td>
</tr>
<tr>
<td>1</td>
<td>WWWWW</td>
<td>1</td>
<td>karanizet (bombs)</td>
<td>draelatb</td>
</tr>
<tr>
<td>1</td>
<td>SWWW</td>
<td>1</td>
<td>kömpisana (friends)</td>
<td>knättagav</td>
</tr>
<tr>
<td>2</td>
<td>SWWWW</td>
<td>2</td>
<td>inebandy (floorball)</td>
<td>ätrfnwv</td>
</tr>
<tr>
<td>2</td>
<td>WWWWW</td>
<td>2</td>
<td>jomnastikst (gymnasi)</td>
<td>tibfrime</td>
</tr>
<tr>
<td>2</td>
<td>WWWWW</td>
<td>2</td>
<td>kaninlühel (cinnamon bun)</td>
<td>ganünlülte</td>
</tr>
<tr>
<td>2</td>
<td>WWWSWW</td>
<td>1</td>
<td>tyranosåros (tyrannosaurus)</td>
<td>lartbsübns</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>1</td>
<td>tälttabisar (telebobbies)</td>
<td>dëlatemsear</td>
</tr>
<tr>
<td>1</td>
<td>WSWWWW</td>
<td>1</td>
<td>trömgn (tram)</td>
<td>clygmagta</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>1</td>
<td>dinosårre (dinosaur)</td>
<td>tsödödërro</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>1</td>
<td>elektrostët (electricity)</td>
<td>amitrosukil</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>2</td>
<td>berjodilbürna (roller coaster)</td>
<td>bæerkatypudina</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>2</td>
<td>ishshvööba (ice hockey stick)</td>
<td>igstekldona</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>2</td>
<td>fjärfljötor (giraffe)</td>
<td>fillatjoflar</td>
</tr>
<tr>
<td>1</td>
<td>WWWSWW</td>
<td>2</td>
<td>pramperpja (a witch from a fairy tale)</td>
<td>bämpermula</td>
</tr>
</tbody>
</table>

S: strong, stressed syllable; W: weak, unstressed syllable.

Appendix 2. Descriptives and group comparisons for background and language variables.

<table>
<thead>
<tr>
<th></th>
<th>TLD (n = 29)</th>
<th>DLD (n = 30)</th>
<th>t(57)</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in months</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>t(57)</td>
<td>p</td>
<td>d</td>
</tr>
<tr>
<td>Maternal education in years</td>
<td>16.0 (2.3)</td>
<td>14.8 (2.3)</td>
<td>2.07</td>
<td>0.043</td>
<td>0.53</td>
</tr>
<tr>
<td>Nonverbal intelligence</td>
<td>25.8 (3.7)</td>
<td>24.4 (6.0)</td>
<td>1.03</td>
<td>0.303</td>
<td>0.28</td>
</tr>
<tr>
<td>Receptive vocabulary</td>
<td>90.6 (21.1)</td>
<td>76.8 (19.1)</td>
<td>2.64</td>
<td>0.011</td>
<td>0.70</td>
</tr>
<tr>
<td>Expressive grammar</td>
<td>34.2 (4.8)</td>
<td>27.9 (6.3)</td>
<td>4.26</td>
<td>&lt;0.001</td>
<td>1.14</td>
</tr>
<tr>
<td>Phonological production: PPC</td>
<td>94.2 (4.6)</td>
<td>77.4 (8.2)</td>
<td>9.74</td>
<td>&lt;0.001</td>
<td>2.56</td>
</tr>
<tr>
<td>Phonological production: Tonal word accents</td>
<td>96.1 (5.7)</td>
<td>93.5 (4.9)</td>
<td>1.87</td>
<td>0.067</td>
<td>0.50</td>
</tr>
<tr>
<td>Phonological production: Stress</td>
<td>98.2 (1.9)</td>
<td>94.7 (3.8)</td>
<td>4.44</td>
<td>&lt;0.001</td>
<td>1.18</td>
</tr>
</tbody>
</table>

TLD: typical language development; DLD: developmental language disorder; M: mean; SD: standard deviation; t(df) = t-statistic(degrees of freedom); d = Cohen's d effect size; PPC: percentage of phonemes correct. Independent t-tests were used for group comparisons.