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Word-initial /r/-clusters in Swedish speaking children with typical versus protracted
phonological development

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Key words:

Word-initial /r/-clusters, Swedish speaking children, children with protracted phonological development,
children with typical development

Abstract

The present study investigated word-initial (WI) /r/-clusters in Central Swedish-speaking children with and without protracted phonological development (PPD). Data for WI singleton /r/ and singleton and cluster /l/ served as comparisons. Participants were twelve 4-year-olds with PPD and twelve age- and gender-matched typically developing (TD) controls. Native speakers audio-recorded and transcribed 109 target single words using a Swedish phonology test (Blumenthal and Lundeborg, 2014) with 12 WI C+/r/-clusters and three WI CC+/r/-clusters. The results showed significantly higher match scores for the TD children, a lower match proportion for the /r/ targets and for singletons compared with clusters, and differences in mismatch patterns between the groups. There were no matches for /r/-cluster targets in the PPD group, with all children except two in that group showing deletions for both /r/-cluster types. The differences in mismatch proportions and types between the PPD group and controls suggests new directions for future clinical practice.

Key words:

Word-initial /r/-clusters, Swedish-speaking children, children with protracted phonological development, children with typical development

Introduction

Children with protracted phonological development (PPD) without an identifiable etiology form a relatively large and heterogeneous group. Under the umbrella designation, a division into articulation disorders, phonological delays, deviant phonological disorders and childhood apraxia of speech is sometimes made (Ball, 2016). PPD is the most common language impairment in preschool Swedish children, and phonology is the most widely investigated linguistic domain regarding Swedish children (Nettelbladt, 2007). One question is whether the phonological patterns observed in Swedish children are language-specific or reflect crosslinguistic patterns. This question is being addressed through Swedish participation in a crosslinguistic study of phonological development (Bernhardt and Stemberger, 2015). The present paper focuses on word-initial (WI) /r/-clusters in typically developing (TD) Swedish children and children with PPD. The results are compared with results from other languages in the concluding paper in this issue. A brief description of the Swedish language will first be provided, followed by an overview of previous research on phonological development in Swedish children, specifically focusing on WI /r/-clusters but providing comparisons with WI /r/ as a singleton and with the related segment /l/, both as a WI singleton and in clusters. (For additional theoretical and methodological background on the study, authors are directed to the Introduction to this issue.)

Swedish Phonology: Word Structure and Consonant Inventory

Swedish is the majority language in Sweden and is spoken natively by 8.3 million speakers, most of whom live in Sweden (Riad, 2014). The language belongs to the North Germanic language group and is closely related to the neighbouring languages, Danish and Norwegian. Swedish spoken in Sweden can be divided into six dialectal areas, based on prosodic types, but, based on the major characteristics of phonetic variation, into just two major dialects: South Swedish and Central Swedish. Central Swedish is spoken by a majority of the inhabitants of Sweden. It is relatively homogeneous, both regarding socially conditioned variation and in stylistic differentiation between contexts. It is also the dialect most frequently heard in media and is used as the pronunciation standard in the teaching of Swedish as a foreign language (Riad, 2014).

Word structure

The typical word in Swedish consists of a stem of one or two syllables, often with additional inflectional affixes. In a corpus based on written text, only 14 among the most common 200 words have more than two syllables, 7 of which are names of months¹. Swedish is rich in compounds and new words are formed by derivation and compounding (Hedlund, Pirkola and Järvelin, 2001).

The prosodic word is the domain for stress in Swedish and only one stress is permitted within the prosodic word. Stress in Swedish is not fixed and there are minimal pairs where the placement of stress is distinctive, for example in the words /'fɔrmɛl/ 'formula' and /fɔr'mɛl/ 'formal'. However, the trochaic stress pattern is more frequent and is considered the default.

¹ http://www.lexiteria.com/word_frequency/swedish_word_frequency_list.html

As in languages such as English and German, there are many words with iambic stress, most of which are of foreign origin; however, many of these are so well-integrated into modern Swedish that most speakers do not realize they were originally non-Swedish. Larger word structures like compounds tend to take two stresses, a primary stress early in the word and a secondary stress late in the word (Bruce, 2012). In addition to stress, there is a tonal word accent system: there is a phonological distinction between two tonal configurations of words, referred to as accent 1 (rising tone) and accent 2 (falling tone). Accent 1 words typically have monosyllabic stems, and accent 2 words have disyllabic stems. An example of the distinction is found between the two Swedish words and-en [ándɛn] ('the duck') and ande-n [àndɛn] ('the spirit').

Relevant to word structure is the length distinction for vowels. Swedish has nine distinctive vowel qualities, which contrast for length (long versus short) in stressed syllables (table 1); all vowels in unstressed syllables are short. In stressed syllables long vowels are either syllable-final or followed by a short consonant, and short vowels are followed by a long consonant or a consonant cluster.

Swedish has a fairly large number of consonant clusters in WI and word-final (WF) position in both monosyllabic and multisyllabic words (Eliasson, 2014). Clusters in general and specifically rhotic clusters are discussed further below.

Insert table 1 about here

Consonant inventory

The consonant system consists of 18 phonemes (table 2), with the exception of /h/, all can be realized as long or short, although this difference is not contrastive (McAllister, 1998). All consonants except /ŋ/ and the retroflexes can appear word initially. Glottal stop appears predictably in WI position, especially after a pause. The phoneme /j/ is typically referred to as an approximant, but is almost always fricated. Consonants can be short or long as noted above under word structure.

Insert table 2 about here

Changes in Swedish dialects over the past 100 years has mainly concerned leveling of the vocabulary, while phonetic differences remain as in previous generations (Bruce, 2010). Swedish vowels have notable dialectal variation, whereas consonants have only modest regional variation with one major exception; /r/. Relevant to this study, the /r/ appears in two variants. In Central Swedish, the rhotic phoneme is an apical trill produced in the alveolar region, whereas

it is pronounced as a uvular trill [ʀ] or fricative [ʁ] in South Swedish. Each of these two allophones have variations regarding manner. They can both be realized as approximants without the vibrating component (transcribed as [ɹ] and [ɰ]), or as fricatives (transcribed as [ɹ̥]

and [ʁ]). The lateral phoneme /l/ is dental in WI position regardless of dialect, but can be realized with a retroflex allophone [ʁ] in non-initial positions in Central Swedish.

Swedish has a fairly large number of consonant clusters: word initially, 32 diconsonantal clusters, and 6 triconsonantal (all beginning with /s/). There are innumerable WF consonant sequences, though many of them arise from consonantal suffixes. Consonant sequences occur word medially, but are split between syllables, e.g. /'gør.ka / ('cucumber') and /'hɛst.ˌsku:/ ('horseshoe'). Clusters with rhotics and laterals account for 47% of all WI clusters in Swedish. The rhotic /r/ can occur in diconsonantal clusters with bilabial, dental and velar stops and with labiodental fricatives, while the lateral /l/ only can occur with the bilabial and velar stops, and the fricatives /f/ and /s/. There are three triconsonantal clusters with /r/ (/spr- str- skr-/) and one with /l/ (/spl-/) in WI position. (See table 3.)

Insert table 3 about here

Phonological Development

In terms of consonant inventory, by age 4 years, TD children have mastered most Swedish speech sounds, including the lateral /l/ (Blumenthal and Lundeborg, 2014). However, even by 5 years, Swedish children are still mastering the entire consonant inventory. One of the latest sounds to be established is /r/. In Central Swedish the /r/ is an apical trill produced in the alveolar region. In order to be able to produce the required series of short and rapid contacts

between the tip of the tongue and the back of the alveolar ridge, the child has to have well-developed oral-motor control. It takes time to master the close coordination between the tension of the tongue body in combination with a lax tip and the fairly strong airstream required for apical trill production (Elert, 2000). Thus, it is common for children to have no other phonological mismatches except for /r/, with substitutions for /r/ targets still common up till the age of 5 years. In Swedish children with PPD, the most common phonological pattern similarly concerns substitution of glides (usually [j]) for liquids, especially /r/ (Nettelbladt, 1983).

Relative to clusters, WI diconsonantal clusters are gradually established between ages 3 and 4 years in TD children (Blumenthal and Lundeborg, 2014). Word-initial clusters with /l/ are established between 3 and 4 years, whereas clusters with /r/ are still developing for some children even after age 6 years (Blumenthal and Jacobsson, 2014; Berlund and Hasselquist, 2015). However, they are realized is of course dependent on which sounds make up the cluster.

For example, in rhotic clusters the /r/ is often deleted at younger ages, but is generally realized as [j] later on. Deletions of WI clusters with /l/ are also reported to occur very early on, i.e. before 2 years of age in TD Swedish children, but by the age of 3 years, TD children have mastered most /l/ clusters and have a high Timing Unit Match (TUM) for both /l/- and /r/- clusters even if occasional deletions occur (Nettelbladt, 1983; Blumenthal and Jacobsson 2013). (Timing Unit Match means both elements of the cluster appear, even if substituted with non-target phones.)

In Swedish speech-language pathology practice, difficulties with /r/ and /r/-clusters are

often regarded as something that should not be targeted in treatment in children below 6 years of age, with the perspective that the difficulties are common and minor, and that they will resolve easily.

The Present Study

Within the Swedish health care system, all children are invited to a health survey at 4 years. A speech and language screening is included in this, since it is expected that all TD children will have mastered almost all speech sounds and speak in complete sentences. Children showing any signs of protracted speech and language development are referred to a speech and language therapist (SLT), thus making the age group of interest to study. No recent study has compared the phonology of TD Swedish children and those with PPD. In a planned set of ongoing comparisons, the aim of the present study was thus to investigate the use of WI /r/-clusters in age- and gender-matched TD Central-Swedish-speaking 4-year-olds and those with PPD, and to identify whether match levels and mismatch patterns differed between the two groups. Even if full mastery of the rhotic clusters is not expected at age 4 in TD children, any differences between groups might be relevant as diagnostic markers. As a developmental comparison, match data for WI /r/-clusters were compared with data for WI singleton /r/ and /l/ and WI /l/-clusters. A number of predictions were made as follows:

1. Participant groups: Differences between TD and PPD groups were expected for both

matches (accuracy) and mismatch (error) data.

2. Word structure effects:

(a) The more structurally complex clusters were expected to be less advanced than the singletons.

(b) Timing Unit Match (presence of two consonant slots) was expected to be greater than Full Segmental Match.

3. Segmental effects: The more articulatorily complex /r/ was expected to be less advanced than /l/.

Method²

Participants

The study took place in a region of Sweden where Central Swedish is spoken. The PPD group

² The study was carried out in accordance with the ethical principles for medical research of the Helsinki Declaration as revised in 2008 and was approved by the Regional Ethical Review Board in Linköping, Sweden Dnr 2012/79-31.

comprised 12 children who had been referred consecutively to a local speech-language pathology clinic for suspected PPD. The children, three girls and nine boys aged 4-5 years (mean age 52.2 months, SD 3.6), were all monolingual Swedish speakers, with normal hearing and no known cognitive deficits. After being assessed all children were diagnosed with a language disorder with primarily phonological difficulties. Twelve exactly age- and gender-matched children with typical speech and language development were recruited from preschools in the same area to serve as controls.

Assessment Material and Procedures

All children were tested using a preliminary version of a new Swedish phonology assessment

tool, LINUS³ (Blumenthal and Lundeborg, 2014)³, either at the speech clinic or in a quiet room at the preschools (controls). The assessments were audio-recorded using a Microtrack II mobile digital recorder with an external stereo electret microphone at a distance of approximately 45 centimeters (18 inches). The assessment material was constructed to enable a nonlinear analysis of Swedish child phonology and consisted of 109 target words. Twelve words had WI C/r/ clusters, three had WI CC/r/ clusters and six had WI C/l/ clusters; there were two words each with singleton /r/ and singleton /l/ (table 4).

³ <http://liu.diva-portal.org/smash/record.jsf?searchId=1andpid=diva2:737467>

Insert table 4 about here

All 109 target words were successfully elicited from all TD participants, but from only two of the 12 children in the PPD group. All /r/ and /l/ target words were collected from the TD children, and from 10 of the 12 children in PPD group.

Analysis

The author transcribed audio-recordings using narrow transcription conventions of the International Phonetic Association (The International Phonetic Association, 1999) and a transcription conventions document created for a crosslinguistic project⁴. A random selection of the recordings of two children was transcribed independently by a colleague skilled in phonetic transcription. The percentage agreement between the transcriptions was 89% (point-to-point matches) and there was no disagreement regarding the clusters, except for one word (*frukost* 'breakfast' where the cluster was transcribed as [fr-] by one but [fj-] by the other). All transcriptions were entered into the software program PHON 1.6 (Rose, MacWhinney, Byrne, Hedlund, Maddocks, O'Brien, and Wareham, 2006; Rose and MacWhinney, 2014), with exported spreadsheets used to complete the quantitative analyses.

⁴ The transcription conventions document is available from the author.

Descriptive statistics were first used to evaluate the demographics and all global match patterns (including Whole Word Match [WWM], Word Shape Match [WSM] and Percent Consonant Match [PCM]). Specific match analyses followed for /r/ and /l/ singletons and diconsonantal consonant clusters, plus CC/r/-clusters. Timing Unit Match (TUM) versus Full Segmental Match were calculated for all clusters. Because of the small sample size and heterogeneity, the nonparametric Mann-Whitney *U*-test was used to evaluate potential differences between the PPD/TD groups and between the two phonemes. Differences between singleton /r/ and /l/ and C/r/ and C/l/ within groups were analyzed with the nonparametric Wilcoxon signed rank test. Any *p*-values less than .05 were considered statistically significant. All analyses were made using SPSS© Windows version 23 (SPSS).

Results

Global measures for all elicited data are presented first as a context for the specific questions for the study. Match data for /r/-clusters and comparison targets are presented next, ending with relevant statistical comparisons. The final section describes mismatch patterns.

Global Measures

Based on all elicited target words in the assessment material (not just the targets for this study), the PPD group had 20.4 % Whole Word Match (WWM), 50.5% Word Shape Match (WSM) and a Percent Consonant Match (PCM) of 54.9%. The corresponding results for the matched TD group was 76.2% WWM, 93.7% WSM and 91.2% PCM (figure 1), i.e. all measures were

higher in the TD control group as expected.

Insert figure 1 about here

Match Data

/r/-clusters

As expected, the TD control group showed higher match levels than the PPD group for /r/-

clusters (figure 1). The Full (Segmental) Match proportion for disconsonantal C/r/ was 4.8% in the PPD group versus 63.9% in the control group. For words with triconsonantal clusters, there were no full matches in the PPD group, whereas the proportion of Full Match among the controls was 50% (five children had Full Match on all three words and two children had one or two full matches).

The proportion of Timing Unit Match (TUM) was 36.2% in the PPD group and 95.8% in the control group, i.e. as expected, notably higher for both groups than Full Match. The proportion of TUM for the triconsonantal clusters was 19.4 % in the PPD group where one child had TUM on all three words and two children had TUM on two out of three words. In the controls, the proportion of TUM was 91.7%; nine children had TUM on all three words and the remaining three children had TUM on two out of three words.

/l/-clusters

Full Match for comparison target C/l/ clusters was 31.9% in the PPD group and 87.5% in the control group, i.e. a difference in the same direction as the /r/-clusters, but with higher match levels for the /l/-clusters in both groups. The proportion of TUM similarly was higher and in the same direction: 43% in the PPD group and 100% in the control group. Again, as seen in figure 1, the groups differed significantly as expected.

Singletons

Full Match proportions for WI singleton /r/ were 8.3% in the PPD group and 66.6% for the controls, i.e. very similar to the match proportions in the /r/-clusters; match proportions for WI singleton /l/ were 45.8% in the PPD group and 91.6% in the control group, i.e. slightly higher than for the Full Match for /l/-clusters but equivalent to the TUM.

Matches: Quantitative comparisons

Consistent with expectations for the study, the TD group scored consistently and significantly higher on all variables as expected (see *p* values in figure 1). In a comparison of /r/ and /l/ singletons respectively, for example, between-group differences were significant with moderate-

large effect sizes (Mann-Whitney $U = 30$, $p = .004$, $r = -.59$ and $U = 36.6$, $p = .013$, $r = -.51$)

In terms of word structure effects, the match proportions for singleton /r/ were not statistically significant from those with C/r/ (as the similar proportions would indicate), but the difference in the TD children was close to significance ($p=.059$). The higher match proportions for singleton /l/ were significantly different from those for C/l/, however, only for the PPD group ($p =.025$, $r = -.39$, small effect size).

Finally, as expected, match differences between /r/ and /l/ as singletons were significant in the PPD group, with /r/ being less advanced than /l/ (Wilcoxon, $p =.034$, $r = -.43$). However, the control group data missed significance for the singleton liquids ($p = .08$, $r = -.35$); in other words, both singletons were near mastery (a ceiling effect).

Mismatches

Mismatches for /r/ in di- and triconsonantal clusters

The mismatches of diconsonantal /r/-clusters differed between the PPD group and the TD controls, not only in proportions, but also in mismatch types. The mean proportion of mismatches in the PPD group was 93% versus 36% in the controls. In the PPD group, 66% of all mismatches were deletions, i.e. word structure mismatches; all but two of the children had deletions. Among the controls, only 11% of mismatches were deletions (in total, only five deletions from four children). An overview of the deletions is seen in figure 2.

Insert figure 2 about here

The proportion of deletions of C2 (/r/) in the clusters was 61% in the PPD group and 2% in the controls (over total targets). One child with PPD deleted both C1 and C2 in the same word but no TD child showed this pattern. Epenthesis, another structural mismatch pattern, did not appear in either group.

The proportion of substitutions for C1 in the clusters was 21.7% in the PPD group but no C1 substitution was found in the control group. The proportion for substitutions of C2 (i.e. of /r/) was 31.5% in the PPD group and 31.2% in the control group.

The C2 substitutions for /r/ were either [j], [l] or [ɹ] and the distribution of the three types was different in the two groups (see figure 3). Examples of the target words realized with the three different substitutions were ['fjəkɔst] (for /'frəkɔst/, 'breakfast'), ['dlɑ:tɛ] (for /'dra:kɛ/ 'dragon'), and [pɹɪn'sɛsə] (for /prɪn'sɛsə/, 'princess'). Although the stops [d] and [g] substituted for singleton /r/ (see below), they never substituted for /r/ in clusters, possibly because clusters such as *[pd] are phonotactically illegal in adult Swedish. Some substitutions for /r/ led to phonotactically 'illegal' clusters in the adult phonology of Swedish where others did not: e.g., [fj] occurs in adult words such as /'ɸfjɛdɛr/ ('feather'), but WI *[dl] does not. Illegal clusters resulted from 38% of the substitution mismatches in the study group, and from 72% in the TD children.

Insert figure 3 about here

For the triconsonantal clusters, mismatches in the PPD group included a mixture of deletions and substitutions. Deletions occurred in the data for all but one child, i.e. for a total of 28 target words (80%). Seven showed deletions of both C1 (/s/) and C3 (/r/) in 17 words (49%). Three children maintained the syllable structure (Timing Unit Match) in a total of five targets (19.4%). These three children were consistent in their substitutions; two of them substituted [l] for /r/ and one substituted [j]. The proportion of Full Match in the control group was 52.8%, 5/12 children having full matches for all targeted words. All children in the control group had 100% Timing Unit Match, but two children in the PPD group showed deletion of a single target (one deleted C1 (/s/) in one target and the other deleted C3 (/r/) in one target). C3 underwent substitution to [j] in 12 target words (by five children). C1, /s/ underwent substitution in five words, all to [θ].

Mismatches for comparison targets

Similar to the /r-clusters, for disconsonantal /l/-clusters, all children in the PPD group had mismatches, but to a different extent and with different mismatch types. Eight of them had deletions of C2 (/l/) in 79% of the target words, and one had a single deletion of C1. Only one child had a single substitution of C2 (to [j]). Deletions of C1 occurred for one word in one child. Among the controls no child showed C2 deletion, and two children had C2 substitutions ([j] only), one child for one target word and one child for all six words.

For singletons, children in both groups showed consistent mismatch types (described below) and substitutions for /r/. However, the substitutions differed between the PPD group and

the controls. The PPD group had three types of substitutions (figure 4: 73% of which were [j], 18% [l] and 9%, other segments) whereas the four children among the controls who had mismatches for singleton /r/ all substituted [j]. Other occurring substitutions in the PPD group were the voiced stops [g] and [d] for /r/ and the fricative [ç] for /l/.

Insert figure 4 about here

Discussion

The aim of the present study was to compare match levels and mismatch patterns of WI /r/-clusters in 4-year-old Swedish children with and without PPD. A comparison of the data for the WI /r/-clusters was made with data for WI singleton /r/ and /l/ and for WI /l/-clusters. As predicted, the TD and PPD groups differed in terms of match proportions for the liquid singletons and clusters and also in mismatch patterns. In the PPD group, all children except two had deletions in both cluster types whereas in the TD controls only single deletions occurred and only in two of twelve children.

Substitution patterns overlapped between the groups, but there was also more variety in the PPD group in substitution types. All children in the PPD group substituted either singleton [j] for singleton /r/ or [l] and [j], whereas the few children among the controls that had substitutions for singleton /r/ all showed [j] as a substitution. Singleton /r/ can undergo substitution to [l] in younger children with typical development, but this is not

reported to be common in children aged 4 (Nettelbladt, 2007). For example, in data from 27 TD children aged 3;0-3;5, a majority (14 children) substituted [j] for /r/ (Blumenthal and Jacobsson, 2013).

No epenthesis was observed, which was surprising since epenthesis was observed in other clusters in the children studied. An acoustic analysis might have revealed a short vowel-like element in some clusters (as occurs in adult speech in /r/-clusters, and thus not counted as a mismatch here). The most common substitution for /r/ was [j], especially in the TD group. This resulted in five (of eight) /r/-clusters that are phonotactically illegal in Swedish (e.g. /dr/ as *[dj]). In the PPD group, five children substituted [j] for /r/ in clusters, but only resulting in phonotactically legal clusters (e.g. [pj]). Further data would be needed to know whether these were individual differences or some particular difference between developmental groups.

Limitations of the Study and Directions for Future Research

This study was unique in its focus and comparative samples for Swedish. However, the sample size is small and limited to one age group (4-year-olds). More data from a larger group of children across a wider age range is needed. In addition, the data were from a larger study of phonological development, and thus the number of tokens concerning /r/ was relatively low per child. For example, it would have been interesting to analyze the impact of word stress on output, but there were too few target words to allow a division into differently stressed syllables. Further studies with a greater number of /r/ and /r/-cluster tokens are needed.

Conclusion and Clinical Implications

The results in this study clearly show a distinction between the type of difficulties in /r/ production in TD children and children diagnosed with PPD, showing that the nature of the /r/ difficulties should be taken into consideration when making decisions about treatment as well as any global measures. When word and syllable structures are affected, treatment should be provided much earlier than what is commonly done in phonological treatment in Swedish speech-language pathology service. For children with PPD, specific contexts may facilitate production of a new speech sound, and others may present additional challenges. The current study underlines the importance of looking not just at the speech sounds themselves, but also their context in terms of other phonemes and word structures.

Declaration of Interest

The author has no conflict of interest regarding the study.

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Table 1. The Swedish vowel inventory.

	Front	Central	Back
High	i: y: ɪ ɤ	ʊ:	u: ɔ
Mid-high	e: ø:	ø	o:
Mid	ɛ œ ɛ:		ɔ
Low		a	ɑ:

Table 2. The Swedish consonant inventory.

		Place of articulation										
		Labial		Coronal		Dorsal		Laryngeal				
		Labial	Labiodental	Dental	Post-alveolar ^a	Palatal	Velar	Glottal				
Manner of articulation	Stop	p	b		t	d	ʈ	ɖ		k	g	
	Nasal		m			n		ɳ				ŋ
	Trill							r				
	Fricative		f	v	s		ʃ		ç	j	ħ	h
	Lateral					l		ɭ				

^aThe retroflexes, /ʈ ɖ ɳ ʃ ɭ/ are often the result of assimilations between /r/ and a coronal in Central Swedish, but are generally regarded as separate consonant phonemes because they are used contrastively in word-medial and word-final positions.

Table 3. Word-initial /r/- and /l/-clusters in Swedish

	r		l	
Labial[-labiodental]	pr	br	pl	bl
Labial [+labiodental]	fr	vr	fl	
Coronal [+anterior]	tr	dr	sl	
Dorsal	kr	gr	kl	gl
CC+	spr	str skr	spl	

Table 4. Targets with word-initial /r/ and /l/ singletons and clusters in the speech sample.

Context	/r/			/l/		
	Orthography	Adult	English	Orthography	Adult	English
Singletons	Regnbåge	ʁrɛŋ(n)bo: gɛ	Rainbow	Lamm	'lam	Lamb
	Röd	ʁrœ:d	Red	Lejon	'lɛjɔn	Lion
CC	Brandbil	'brɔn(d)bi:l	Fire engine	Blomma	'blɔma	Flower
	Dragkedja	ʁdra:ɡ,çɛdʒɔ	Zipper			
	Drake	ʁdra:kɛ	Dragon			
	Frukost	ʁfrøkɔst	Breakfast	Flygplan	'fly:(g),plɑ: n	Airplane
	Gris	ʁgri:s	Pig	Glasögon	'glɑ:s,ø:ɡɔn	Glasses
	Gräsklippare	ʁgrɛs,klɪpɑrɛ	Lawnmower(s)			
	Gräver	ʁgrɛ:vɛr	Digs			
	Krokodil	krøkɔʁdi:l	crocodile	Klocka	'klɔkɑ	Watch
	Prinsessa	pri:n'sɛsɑ	Princess	Plåster	'plɔstɛr	Band-aid
				Slott	'slɔt	Castle
CCC	Skruv	ʁskrʉ:v	Screw			
	Spruta	ʁsprʉ:ta	Syringe/needle			
	Strumpor	ʁstrɔmpɔr	Socks			

Note. Parentheses denote elements that are optional in adult pronunciations.

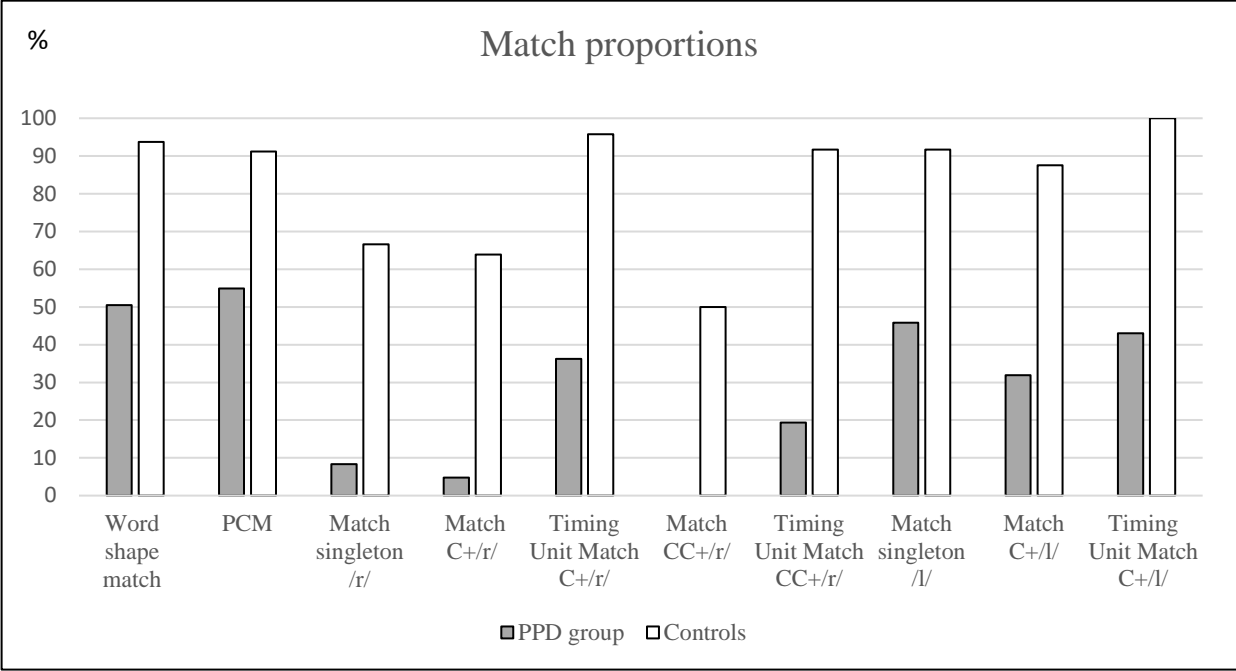
Figure Captions

Figure 1. Match proportions (%) for word shape, all consonants (Percent Consonant Match) and /r/ and /l/ (both singletons and clusters) in word-initial position for Swedish 4-year-olds. Comparisons between the control group children and those with protracted phonological development (PPD) were significant at the $p = .001$ level except for match level for singleton /r/ ($p < .01$) and singleton /l/ ($p < 0.05$, Mann-Whitney U test).

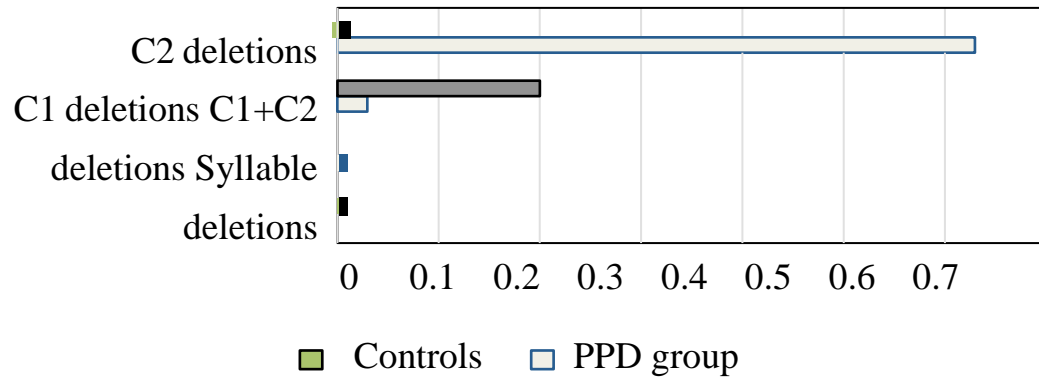
Figure 2. Proportions of deletions for Swedish mismatch patterns divided into different sub-types.

Figure 3. Distribution of different C2 substitutions (percentage of total elicited targets) in the Swedish PPD group and the controls.

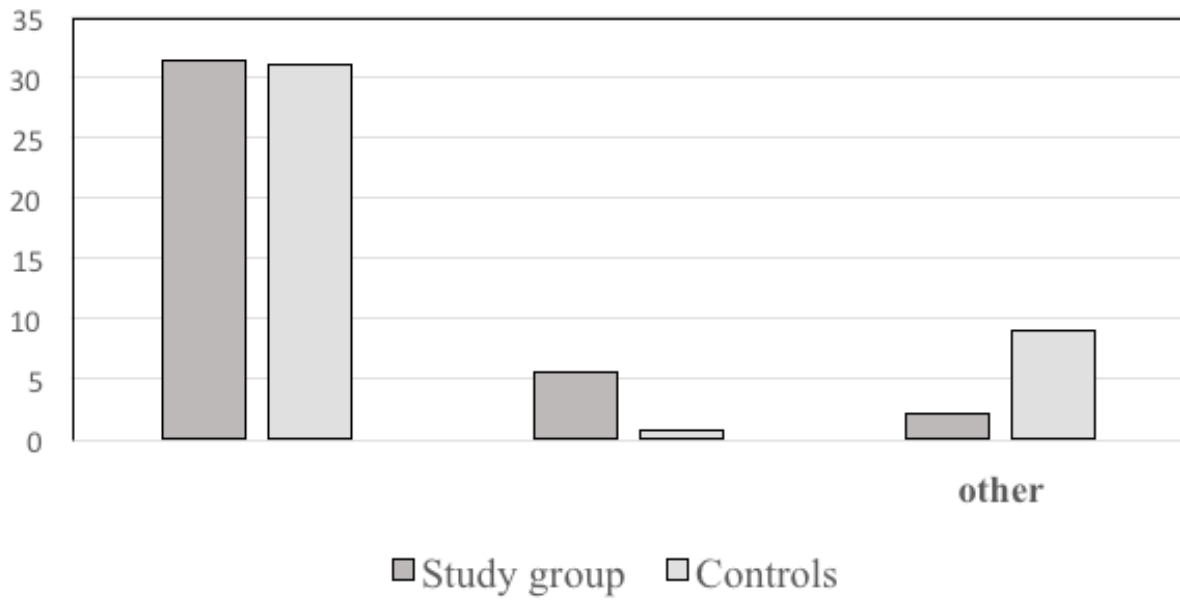
Figure 4. Overview of the different types of substitutions for /r/ in the Swedish PPD group.



Overview of proportion of deletions



C2 substitutions by type (% of total elicited targets)



Substitutions for singleton /r/ in the PPD group

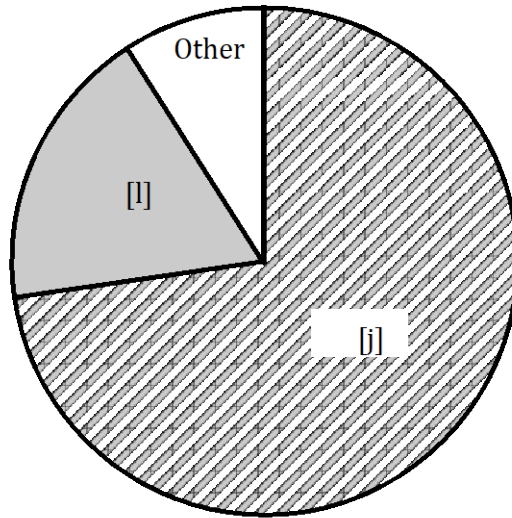


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Overview of proportion of deletions

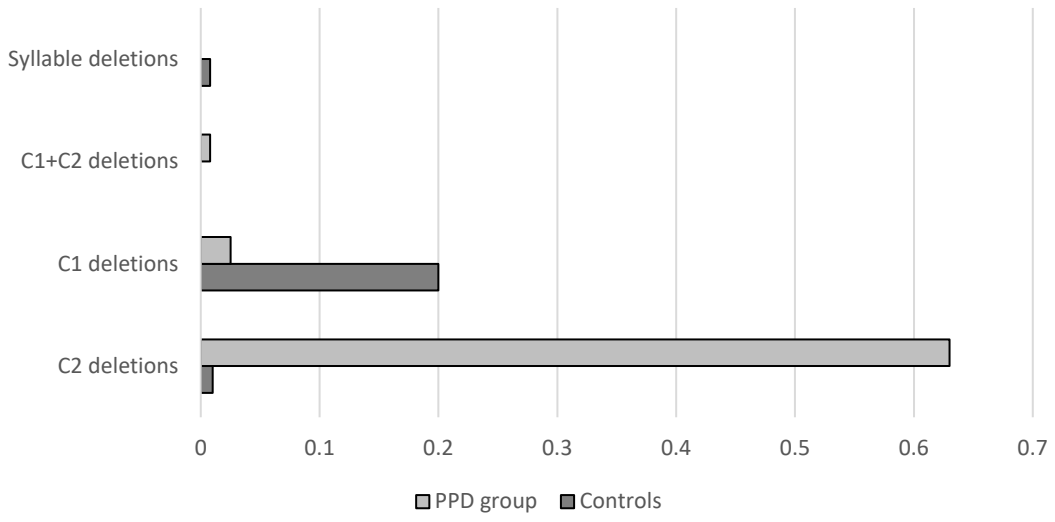


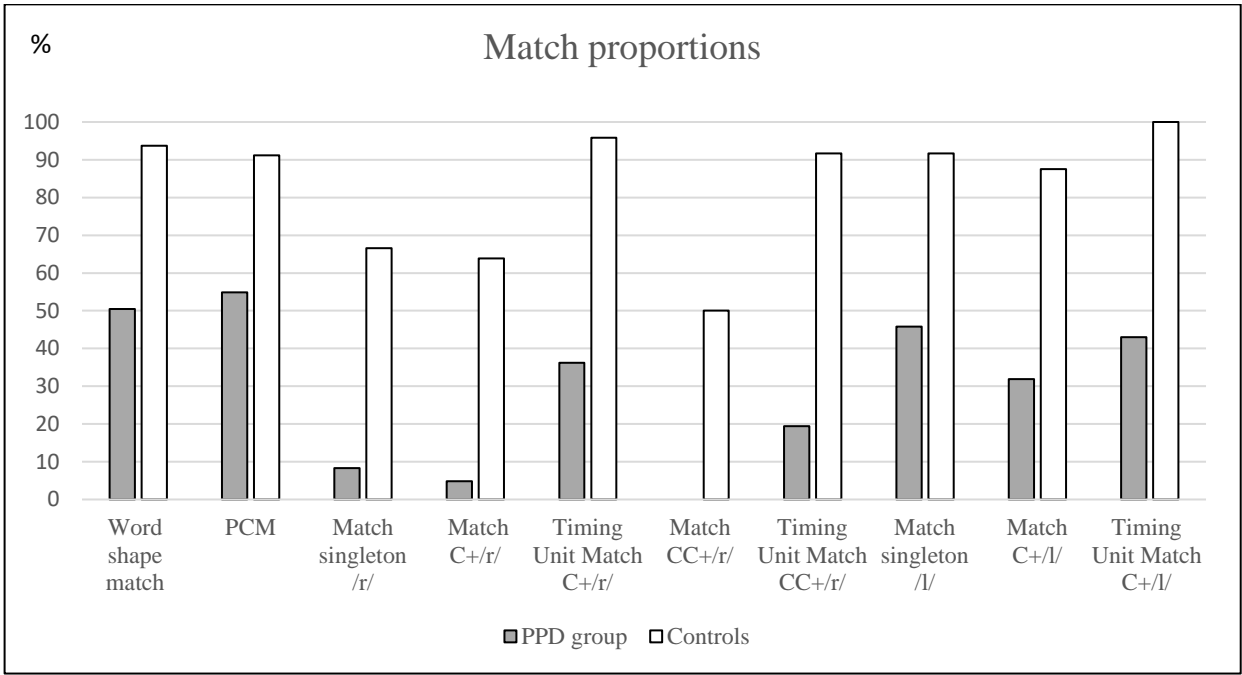
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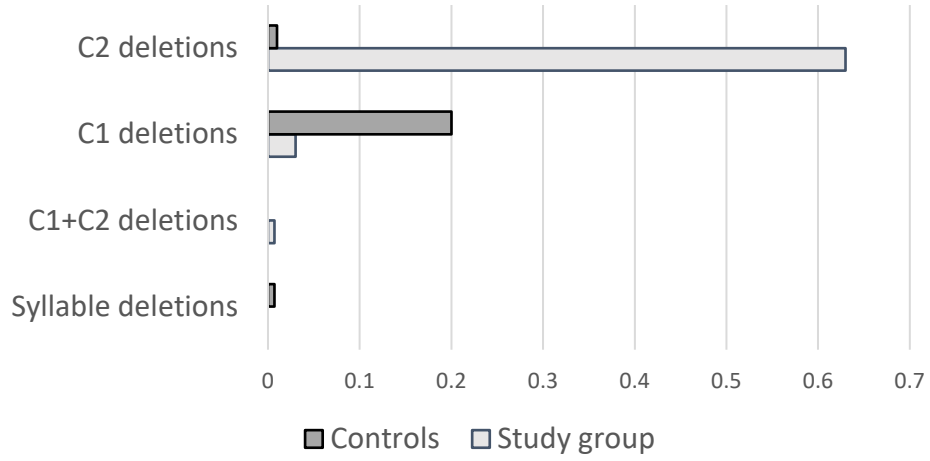
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	Drake	ʀdra:kɛ	Dragon			
	Frukost	ʀfrøkɔst	Breakfast	Flygplan	'fly:(g),plɑ: n	Airplane
	Gris	ʀgri:s	Pig	Glasögon	'glɑ:s,ø:gɔn	Glasses
	Gräsklippare	ʀgrɛs,klɪpɑrɛ	Lawnmower(s)			
	Gräver	ʀgrɛ:vɛr	Digs			
	Krokodil	krɔkɔʀdi:l	crocodile	Klocka	'klɔka	Watch
	Prinsessa	pri:n'sɛsa	Princess	Plåster	'plɔstɛr	Band-aid
				Slott	'slɔt	Castle
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	Strumpor	ʀstrɛmpɔr	Socks			

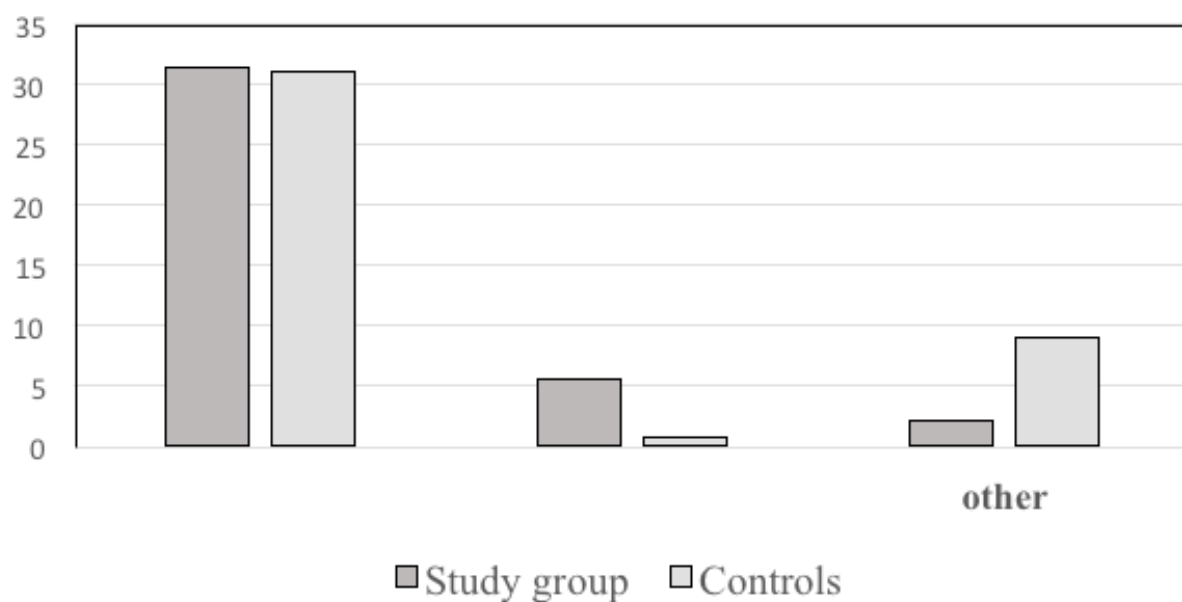
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Overview of proportion of deletions



C2 substitutions by type (% of total elicited targets)



Substitutions for singleton /r/ in the PPD group

