

# **LSCD 2014: Workshop on Late Stages in Speech and Communication Development**



**UCL, London, UK, 3-4 April 2014**

Division of Psychology and Language Sciences, Chandler House



Conference website: <https://www.ucl.ac.uk/psychlangsci/research/speech/lscd-2014>

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Book of abstracts of LSCD 2014, The 1<sup>st</sup> Workshop on Late Stages in Speech and Communication Development held at University College London (UCL), London, UK, 3–4 April 2014

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## **Foreword**

There has been much emphasis, in research on speech and communication development, on the rapid changes that occur in the first five years of life. By that age, a child is able to communicate effectively enough to enter primary education. However, less attention has been given to later stages of development. Research has shown that even when a child is judged to be consistently producing all speech sounds, production is not adult-like, with more dispersed and variable phoneme categories and motor gestures. Similarly, in speech perception, phoneme categories are less clearly defined until early teens and children are more affected by noise and reverberation. Cognitive, attentional and memory factors may also influence children's ability to use speech effectively; communicative and conversational strategies (such as repair and turn-taking) continue to develop in adolescence.

When is speech development truly complete? This question will be a focus of the workshop, along with the interplay between speech development and cognitive, perceptual and motor systems. The questions that will be addressed are relevant for clinical and educational practice, and also inform theories of language processing and levels of representations.

Speech development is often investigated either from a purely phonetic/phonological perspective, or focused on interactional/pragmatic principles but these two research areas rarely intersect. The workshop will provide an opportunity for interactions between researchers from these different areas of developmental research.

We are delighted to welcome to London participants from many different countries and would also like to thank all the invited speakers for their participation to this workshop. We hope that this workshop will lead to fruitful exchanges and hopefully even new collaborations.

Final thanks must go to members of the LSCD 2014 organising committee, to our colleagues who have helped organise this event, to the Economic and Social Research Council (ESRC) and Division of Psychology and Language Sciences who have sponsored this workshop and, of course, to all contributors.

This workshop is organised under the aegis of the ESRC-funded project on Speaker-Controlled Variability in Children's Speech in Interaction (RES-062-23-3106).

Valerie Hazan (Chair – LSCD 2014)

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## Workshop on Late Stages in Speech and Communication Development

3-4 April 2014, UCL

### PROGRAMME

#### Thursday 3 April

<b>AM</b>	
08:45 - 09:40	Registration
09:40 - 09:50	Welcome
09:50 - 10:30	<b>Keynote 1 – Valerie Hazan:</b> The development of clear speech strategies in children aged 9 to 14
<b>10:30 - 11:30</b>	<b>Oral Session 1: Development of speech production in typical populations I</b>
Tilda Neuberger & Mária Gósy	A cross-sectional study of disfluency characteristics in children's spontaneous speech
Tara McAllister Byun & Mark Tiede	Perception-production relations in later development of American English /r/
Benjamin Munson	The emergence of gendered speech styles in the first decade of life: A comparison of boys with and without gender identity disorder
<b>11:30- 11:50</b>	<b>COFFEE BREAK</b>
11:50 - 12:30	<b>Keynote 2 – Sarah-Jayne Blakemore:</b> The social brain in adolescence
<b>12:30 - 13:30</b>	<b>LUNCH</b>
13:30 - 14:10	<b>Keynote 3 – Jack Sidnell:</b> Children's peer interaction: norms, practices and emerging accountability
<b>14:10-15:10</b>	<b>Oral Session 2: Development of communicative abilities</b>
Franziska Köder	Children's struggle to shift perspective in direct speech
Ibon Manterola & Margareta Almgren	Development of oral discourse skills in Spanish L2
Aleksandr Kornev & Ingrida Balčiūnienė	Story (re-)telling and reading in children with dyslexia: Language or cognitive resource deficit?
<b>15:10 – 16:30</b>	<b>TEA &amp; POSTER SESSION</b>
16:30 – 17:10	<b>Keynote 4 – Melissa Redford:</b> Rhythm from reduction: the emergence of prosodic words in children's speech

<b>17:10 – 18:10</b>	<b>Oral Session 3: Development of speech perception in typical populations I</b>
Ewa Jacewicz & Robert Fox	The interaction of linguistic and indexical knowledge in the perception of typically developing 9-12 years old children
Matthew Davis, Samuel Evans, Kathleen McCarthy, Anastasia Giannakopoulou, Lindsey Evans & Joanne Taylor	Lifespan learning of speech perception in native and non-native listeners
Louise Croft, Tom Hope Ōiwi Parker-Jones, Peter Rankin , Cathy Price & Torsten Baldeweg	Age-related changes in the speech perception network from 5-16 years of age
<b>19:30 –</b>	<b>DINNER AT GALLIPOLI</b>

## Friday 4 April

<b>AM</b>	
09:20 - 10:00	<b>Keynote 5 – Bill Wells:</b> Intonation in the school years: interactional and psycholinguistic perspectives
<b>10:00 - 11:00</b>	<b>Oral Session 4: Speech development in L2/bilinguals</b>
Kathleen McCarthy, Merle Mahon, Stuart Rosen & Bronwen G. Evans	Acquiring a second language in childhood: The phonemic development of sequential bilingual children
Siobhán Nic Fhlannchadha & Tina Hickey	Understanding the later acquired aspects of the Irish language in children and adults
Bencie Woll & Joanna Atkinson	Learning a sign language as an L1 in adulthood: Implications for notions of a sensitive period in phonological development
<b>11:00 - 11:30</b>	<b>COFFEE BREAK</b>
11:30 - 12:10	<b>Keynote 6 – Lorna Halliday:</b> Development of auditory processing skills in children with mild to moderate hearing loss: Links to language?
<b>12:10 - 13:10</b>	<b>Oral Session 5: Speech development in children with SLI</b>
Victoria Knowland, Sam Evans & Stuart Rosen	Audio-visual speech perception in school-aged children with and without language impairment

Rob Zwitserlood, Marjolijn van Weerdenburg, Frank Wijnen & Ludo Verhoeven	Speech disruptions in school-age children with SLI: A developmental perspective
Iris Duinmeijer, Anne Baker, Jan de Jong & Fred Weerman	Perception and production of subject verb agreement in children and adolescents with and without Specific Language Impairment
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14:00 - 14:40	<b>Keynote 7 – Natalia Zharkova:</b> Speech motor control development in children between 5 and 13 years old: evidence from ultrasound imaging of tongue movements
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Yvonne Wren, Sharynne Mcleod, Paul White, Laura Miller & Sue Roulstone	Speech development at age 8: Findings from a longitudinal population study
Saloni Krishnan, Katherine Alcock, Daniel Carey, Lina Bergström, Annette Karmiloff-Smith & Fred Dick	Oromotor control and imitation predict novel word production in the school years
<b>15:20 - 15:50</b>	<b>TEA</b>
<b>15:50 - 16:30</b>	<b>Oral Session 7: Development of speech perception in typical populations II</b>
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Jenni Heikkilä, Eila Lonka, Sanna Kuitunen & Kaisa Tiippana	Speechreading skills in Finnish-speaking adults, typically developing children and children with specific language impairment
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17:10 - 17:20	Closing
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- [2] Anita Auszmann and Tilda Neuberger: Vowel stabilization process in Hungarian children.
- [3] Ingrida Balčiūnienė and Eglė Krivickaitė: Linguistic disfluency in 6-years olds' narrative speech.
- [4] Eleni Baldimtsi, Eleni Peristeri and Ianthi Maria Tsimpli: Mental state terms and the role of working memory in high functioning autistic children's story generation from picture-stories.
- [5] Johanna Barry and David Moore: Profiling listening difficulties with respect to developmental disorders of language, literacy, and social skills.
- [6] Adelina Castelo: The phonological awareness between Grade 5 and College in Portuguese students.
- [7] Bénédicte Grandon, Anne Vilain, Hélène Løevenbruck and Sébastien Schmerber: Vowel spaces in French children wearing cochlear implants.
- [8] Sonia Granlund, Valerie Hazan and Merle Mahon: Acoustic-phonetic adaptations to a hearing-impaired listener by normally-hearing and hearing-impaired children and adolescents.
- [9] Hélène Guiraud, Sonia Krifi-Papoz, Vania Herbillon, Aurélia Bascou, Sibylle Gonzalez-Monge, Lydie Merle and Véronique Boulenger: Processing of natural fast speech and time-compressed speech in children with speech output disorders.
- [10] Viktória Horváth: Temporal properties of 9-year-old children's spontaneous speech.
- [11] Alisa Ikonen, Arja Voutilainen, Kaisa Launonen & Anu Klippi: Specific language impairment from childhood to adolescence; diagnosis, evolution and risks of well-being.
- [12] Saloni Krishnan, Robert Leech, Evelyne Mercure, Sarah Lloyd-Fox and Fred Dick: The effects of perceptual distortion, age and proficiency on functional neural activation for sentence processing.
- [13] Saloni Krishnan, Robert Leech, Jennifer Aydelott and Fred Dick: Recognising environmental sounds in complex sound scenes: Change over the school years.
- [14] Keith Nelson and Kiren Khan: How the cognitive system supports the development of complex narrative abilities in children.

[15] Magdalena Smoczyńska, Ewa Haman, Magdalena Kochańska and Magdalena Łuniewska: Describing complex pictures as a method of eliciting speech samples from children aged 5 to 10: Syntactic characteristics of the speech of Polish children

[16] Hannah Stewart and Sygal Amitay: Development of auditory attention: Distractibility and conflict resolution.

[17] Krisztina Zajdó: Spelling long vowels and consonants in children with learning difficulties including those with mild intellectual disability: Results from 8th and 11th grade students.

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## THURSDAY MORNING - ORAL SESSIONS

09:50 - 10:30	<b>Keynote 1 – Valerie Hazan:</b> The development of clear speech strategies in children aged 9 to 14
<b>09:50 - 11:30</b>	<b>Oral Session 1: Development of speech production in typical populations I</b>
Tilda Neuberger & Mária Gósy	A cross-sectional study of disfluency characteristics in children's spontaneous speech
Tara McAllister Byun & Mark Tiede	Perception-production relations in later development of American English /r/
Benjamin Munson	The emergence of gendered speech styles in the first decade of life: A comparison of boys with and without gender identity disorder
<b>11:30- 11:50</b>	<b>COFFEE BREAK</b>
11:50 - 12:30	<b>Keynote 2 – Sarah-Jayne Blakemore:</b> The social brain in adolescence

## **The development of clear speech strategies in children aged 9 to 14 years**

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It is often necessary for adult talkers to make adaptations to their speech in order to maintain effective communication either in difficult listening conditions, with interlocutors who do not share their language or who are still developing their speech and language skills. In the clear speaking styles produced in these situations, enhancements are typically made to several acoustic-phonetic characteristics of the speech such as articulation rate, vowel space area, fundamental frequency mean and range, mean energy, pause frequency and duration (see Smiljanic & Bradlow, 2009, for a review). Clear speaking styles are to an extent tailored to the communication barrier they are aiming to overcome (e.g. Hazan & Baker, 2011).

In our study, we hypothesised that the ability to make clear speech adaptations was likely to be a skilled aspect of speech production, acquired late in the developmental process. There is little data available on clear speech adaptations in children. A study involving 3 to 5 year olds showed that the older children in the study were making some adaptations to their speech but that these adaptations were not adult-like (Redford & Gildersleeve-Neumann, 2009), while another, with a similar age range, did find evidence of clear speech characteristics, such as vowel area expansion, increased vowel duration and fundamental frequency (Syrett & Kawahara, in press). There is therefore evidence of early stages of clear speech adaptations in preschool children but with the potential for further developments.

The aim of our study was to investigate the later stages of development in clear speech adaptations. Ninety-six young people aged between 9 and 14 years inclusive (50 F, 46 M) participated in this study: thirty 9-10 year olds (14F, 16 M), twenty-four 11-12 year olds (16F, 8M) and forty-two 13-14 year olds (20F, 22 M). Reference data for twenty adult speakers (9F, 11M) was taken from the LUCID corpus (Baker & Hazan, 2011). As in our previous study with adults (Hazan & Baker, 2011), unscripted speech was obtained by recording pairs of participants while they completed a collaborative 'spot the difference picture task' ('diapix', van Engen et al., 2010; Baker & Hazan, 2011). In the 'barrier' condition, clear speech adaptations were naturally elicited by placing a communication barrier affecting one of the talkers in the task (i.e. by passing one of the talker's speech through a three-channel noise-excited vocoder before transmitting it to the second talker). This naturally led the 'unimpaired' talker leading the interaction (the talker whose speech we analysed) to make adaptations to their speech in order to maintain effective communication. In the reference 'no barrier' condition, both talkers could hear each other normally.

In this talk, we will present an overview of our analyses. The main set of analyses evaluated changes in the acoustic-phonetic characteristics of the speech produced in the 'no barrier' and 'barrier' conditions. Measures were made of articulation rate, pause frequency and duration, pitch mean and range, vowel formant ranges and vowel area, and intensity. We will discuss our findings regarding age and gender effects on the degree of clear speech adaptation for each of these acoustic-phonetic dimensions. As illustration, see Figures 1 and 2 for graphs representing changes in articulation rates and vowel F1 and F2 range as a function of age and condition. Clarity ratings (carried out with adult listeners) of short excerpts from the 'no barrier' and 'barrier' conditions have shown that the utterances produced by children in the 'barrier' condition were rated as significantly clearer than the utterances taken from the 'no barrier' sentences, but the difference between conditions is much smaller than those previously obtained for adult speakers in these same conditions. A number of further analyses are being carried out on the child diapix corpus. Analyses of the frequency of miscommunications in the diapix interactions and of repair strategies are

showing that the 9-10 year olds are using repetition as their most frequent strategy to deal with miscommunications whereas older children and adults are more frequently using strategies such as rephrasing and expansions (Hazan & Pettinato, 2013). Analyses of the effect of age and communicative condition on lexical diversity are also being carried out.

Overall, these analyses are suggesting that although young speakers aged between 9 and 14 years are making acoustic-phonetic adaptations in order to clarify their speech in difficult communicative conditions affecting their interlocutor, the extent of adaptations is not as great as that seen in adults, even when we consider the teenagers in this study (13-14 year olds). A plausible explanation is that the acquisition of the many strategies that may be used to clarify speech is dependent on experience and that initially children may rely on a smaller range of salient strategies such as speaking more slowly and shouting. However, we suggest that many other factors may at least partly account for our findings. Some factors are linked to linguistic-phonetic influences. First, speakers in the 9 to 14 year old age range still show a lower degree of articulatory control than adult speakers and this may affect the ability to make rapid speech adaptations (Walsh & Smith, 2002); second, children tend to show a lower degree of reduction in conversational speech (Redford & Gildersleeve, 2009) thus having a more limited range for further hyperarticulation in their clear speech; finally, children have more limited vocabularies, which may affect their conversational repair strategies. Other factors are language-external. The lack of a visual channel of communication in both the 'barrier' and 'no barrier' conditions may have led to greater overall hyperarticulation in children than adults who may be less reliant on these additional cues; children and teenagers show less empathy or understanding of difficulties experienced by their 'impaired' interlocutor (Choudhury, Blakemore & Charman, 2006) and may be less willing to adapt their speech if not directly affected by the communication barrier.

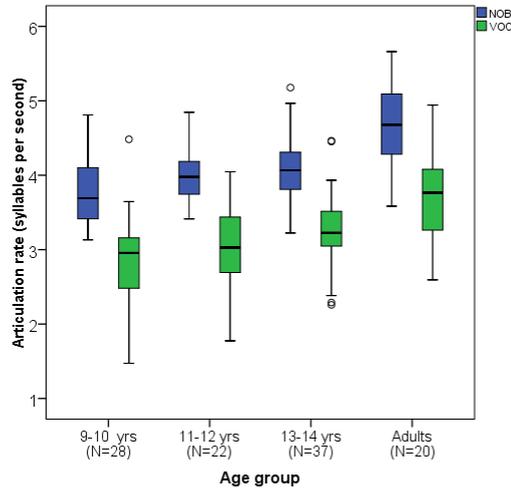
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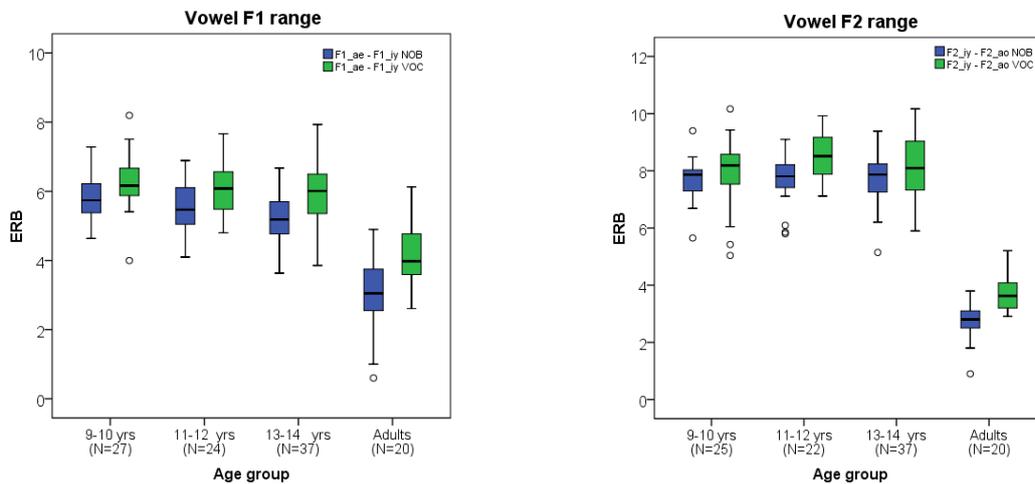
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**Figure 1:** Articulation rate (in syllables/second) for the four age groups as a function of test condition: 'no barrier' (labelled NOB) and 'barrier' (labelled VOC).



**Figure 2:** Vowel F1 range (difference between mean F1 in /i/ and mean F1 in /ae/) and vowel F2 range (difference between mean F2 in /i/ and /O/) for the four age groups as a function of test condition: 'no barrier' (labelled NOB) and 'barrier' (labelled VOC). Formant measurements were made on vowels contained in content words produced in the diapiix recordings by the 'unimpaired' talker. Formant values greater than 2 SD of the mean per talker were excluded from the calculation of the means.



## A cross-sectional study of disfluency characteristics in children's spontaneous speech

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**Introduction.** Speech development is rapid until the age of 6, therefore a great number of investigations concentrate on this period. Later stages of language acquisition have been sporadically investigated. The present study addresses the analysis of age-specific patterns of Hungarian-speaking children's disfluencies and repair strategies from the age of 6 until the age of 13. Children are supposed to acquire the forms and functions of disfluencies from the adults' spontaneous utterances together with the acquisition of the semantic, syntactical, phonological, etc. rules of their first language (MacLachlan & Chapman, 1988). Although children's spontaneous utterances differ from that of adults' in many respects, particularly in complexity and fluency, their disruptions and disfluent episodes show a lot of similarities to those of adults' (e.g. Hudson Kam & Edwards, 2008). Several studies in the area of children's speech fluency have been primarily motivated by the necessity for interventions for children with language disorders (e.g. Yaruss et al., 1999; Guo et al., 2008). The typically-developing children's utterances were also investigated in order to provide an adequate normative reference.

Adults' speech disfluencies tend to occur when speakers encounter difficulties in forming concepts, activating syntactic frames, or retrieving the syntactic and semantic information of lexical items (Levelt, 1989). The question arises whether similar phenomena in children's speech show the same patterns or, on the contrary, children's disfluencies have their own specific characteristics in relation to language acquisition. The processes of monitoring and repair must be of a high relevance already during the early stages of speech development. Since both the erroneous and the well-formed, norm-following utterances are produced by the same rules of production, the analysis of disharmonic phenomena can help the researcher to look into the hidden operation of speech planning processes (Fromkin, 1974). During the early stages of language development (generally between the ages of 2 and 3), a lot of children undergo a period of typical disfluency (e.g. Ambrose & Yairi, 1999). Previous studies demonstrated that complexity of utterances would increase with age and would appear to be correlated with occurrences of disfluency (e.g. Evans, 1985). Our hypotheses are that (i) the occurrence of disfluencies would increase with age, (ii) the ratio of self-repair would significantly differ across age groups, (iii) the durations of editing phases would decrease with age.

**Participants, material and method.** Seventy typically developing, Hungarian-speaking children participated in this study. Thirty-three of them were boys and 37 of them were girls. None of the children had any hearing disorders and their intelligence fell within the normal range. The analysis was cross-sectional including five age groups: (i) 6-year-old preschool children, (ii) 7-year-old first-graders, (iii) 9-year-old third-graders, (iv) 11-year-old fifth-graders, and (v) 13-year-old seventh-graders were from the same elementary school of Budapest.

Spontaneous speech samples were recorded at children's school and were digitized at a 44.1 kHz sampling rate and a 16-bit resolution. Participants were recorded individually. The task of the children was to talk about their free-time activities, hobbies and everyday life. Speaking time was not limited. The total duration of the corpus was 371.2 minutes. The recordings were labeled using Praat 5.2 software (Boersma & Weenink, 2011).

Seven types of disfluency were categorized and analyzed by the two authors separately (Table 1). In case of very rare disagreement, the phenomenon was excluded. Filled pauses refer to nonlexical one-syllable vocalizations (e.g. *um*, *uh*, *ah*), whereas filler words refer to conventional words or phrases conveying various meanings and functioning as discourse markers (e.g. *I mean*, *well*, *you know*). Repetitions denote repeated linguistic units (e.g. segment, syllable, or word) that do not

signal emphatic meaning. Although grammatical errors are questionable during language acquisition we analyzed all those forms that did not follow the morphological and syntactical rules and norms of the language (e.g. *I were was ill*). False starts are word fragments, where the speaker realizes, before articulating a complete word, that it does not correspond with the intended target word (e.g. *I have a do- cat*). False words are completely articulated words that were not intended to produce (e.g. *I have a dog cat*). The category of sequential errors contains anticipatory and perseveratory substitutions (e.g. *blocks of flowers* instead of *box of flowers*). The frequency of occurrences, the ratio of repaired and unrepaired disfluencies, and the duration of editing phases (which is the interval between the interruption point and the onset of the repair) were measured. Statistical analysis was conducted using SPSS 13.0 software (One-way ANOVA, Tukey post hoc test, Kruskal–Wallis test, as appropriate). The confidence level was set at the conventional 95%.

**Results.** Disfluency phenomena occurred less frequently in the 7-year-old children’s speech samples, and were most frequent in the thirteen-year-olds’ speech samples. One-way ANOVA revealed significant main effect of ‘age’:  $F(4, 69)=2.724$ ;  $p=.037$  (Table 1).

**Table 1.** Occurrences of disfluencies per minute across ages

Age groups (years)	Mean (item/minute)	SD	Minimum (item/minute)	Maximum (item/minute)
6	14.3	4.81	7.6	25.8
7	10.8	4.87	3.1	18.4
9	14.9	4.08	8.9	22.0
11	14.0	5.49	3.3	21.9
13	16.4	4.23	9.4	23.5

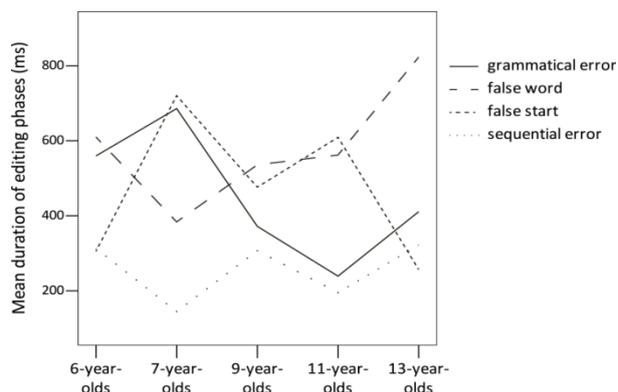
Data showed that the frequency of each type of disfluency phenomena depended on age. Repetition was more frequent in preschool children as opposed to school-age children. School-age children preferred filled pauses when they were assumed to need more time to overcome their speech production difficulties. Significant differences were shown in three types of disfluency depending on age: filled pauses ( $F(4, 69)=5.052$ ;  $p=.001$ ), filler words ( $F(4, 69)=3.512$ ;  $p=.012$ ), and repetitions ( $F(4, 69)=10.175$ ;  $p<.001$ ). As expected, grammatical planning and execution seemed to be more difficult for the younger speakers (6- and 7-year-olds) than for the older speakers. In addition, self-repairs of grammatical errors were sparser in preschool children than in school-age children.

The mean ratios of self-repairs were 45.86%, 65.88%, 56.48%, 78.43%, and 65.71% (respectively) of all repairable speech errors across ages. The repairs of false starts were the most frequent ones in most of the age groups while repairing grammatical errors was the least frequent in our material. There was an increasing tendency to repair false words across ages while sequential errors were repaired in larger extent by 6- and 7-year-olds than by school-age children older than 9 years.

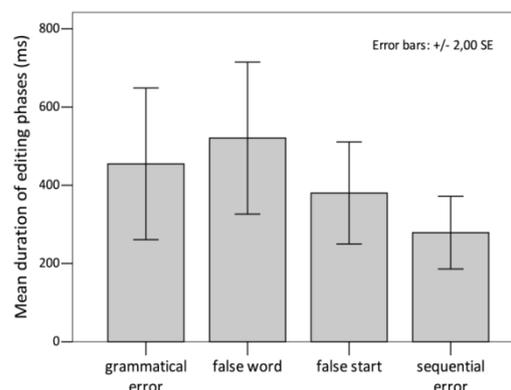
The durations of editing phases were the shortest in sequential errors (mean: 276 ms) and the longest in the case of false words (mean: 571 ms). They had an average duration of 489 ms in false starts while 455 ms in grammatical errors. According to the Kruskal–Wallis test, ‘age’ had no significant main effect on the duration of editing phases of either disfluency type (Figure 1). However, durations of editing phases significantly differed in terms of the type of disfluency:  $\chi^2=8.074$ ;  $p=.045$  (Figure 2).

**Conclusions.** Our study focused on occurrences and self-repair characteristics of children’s narratives. Results seem to confirm the assumption that various types of disfluency phenomena can be related to speech planning processes underlying the speaker’s speech production. The changes of speech fluency may be associated with the developing language usage.

**Figure 1.** Mean duration of editing phases of the repairable disfluencies across ages



**Figure 2.** Mean durations of editing phases of the repairable disfluencies



Our first hypothesis was slightly confirmed, occurrences of disfluency phenomena showed some increase with age. Slight differences refer to a more or less constant quantity of disfluent episodes in children's speech samples regardless the age. This might suggest a relatively stable interrelation between speech production and disfluencies. The tendency of occurrence of self-repairs shows a decrease of unrepaired speech errors as the age increases. The ratios of self-repairs may be affected by individual characteristics, and the age-dependent frequency of the disfluency types. The third hypothesis has not been confirmed. The duration of the editing phases depended primarily on the type of the disfluency and not on the children's age. This can be explained by a very similar repairing strategy of children from the age of 6 onwards.

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## Perception-production relations in later development of American English /r/

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**Background.** It is well-established that children's performance on perceptual tasks changes over the course of development, with refinement continuing until at least 12 years of age (e.g. Hazan & Barrett, 2000). Other research has established that children who show deficits in the production of some speech sound contrasts tend to perform more poorly on perceptual tasks involving that specific sound contrast than their peers with typical production (see summary in Shiller, Rvachew & Brosseau-Lapr e, 2010). These findings of links between perceptual sensitivity and production accuracy can be related to studies showing that typical adult listeners vary in the sharpness of their perceptual categories, and listeners who have the most precise auditory targets are also more precise in their production of speech sound contrasts (e.g. Newman, 2003; Ghosh et al., 2010).

The refinement of perceptual categories in later stages of childhood has particular relevance for North American English /r/, one of the latest-emerging and most frequently misarticulated sounds in the dialect. Among children with a history of speech sound disorder, an estimated 30% continue to exhibit residual errors affecting sibilant and rhotic sounds at 9 years of age, and roughly 9% show these errors from 12-18 years (Lewis & Shriberg, 1994). It has been suggested that children with residual errors affecting /r/ have a poorly-specified auditory target that encompasses both correct and misarticulated /r/. Previous studies have reported deficits in /r/ perception in children who misproduce /r/ (Shuster, 1998). However, perceptual deficits in older children with persistent /r/ misarticulation seem to be subtle, if they exist at all. There is a need for precise data about /r/ perception in this age range that can serve as a basis for comparison in clinical studies.

The present study was conducted with the goal of examining the relationship between perception and production of American English /r/ in typically-developing children aged 9-14. American English /r/ is distinguished by the low height of the third formant, F3 (e.g. Delattre & Freeman, 1968) and the small distance between F3 and F2 (Boyce & Espy-Wilson, 1997). Previous work has shown that children's /r/ becomes acoustically more differentiated in the age range 9-15 (Flipsen et al., 2001). We hypothesized that this result would be replicated in our participants aged 9-14. We also predicted that a perceptual measure, the slope of a logistic function fitted over responses in a /r/-/w/ identification task, would increase with age. Finally, we predicted a significant correlation across participants between acoustic and perceptual measures of precision for /r/.

**Methods.** *Participants:* Participants were 23 native English speakers aged 9;0-14;0 (mean = 11.7 years; SD = 1.4 years). All participants passed a pure-tone hearing screening at 20dB and had no history of major neurobehavioral, speech-language or hearing impairment, per parent report. Results from four participants were discarded due to incomplete or extreme outlier data, yielding a final *n* of 19.

*Perceptual identification task:* Two 10-step acoustic continua from /r/ ('rake') to /w/ ('wake') were synthesized using naturally produced tokens of *rake* elicited from one 10-year-old female and one 8-year-old male speaker. Continua were generated by modifying the LPC spectra in successive equal steps while holding the residual (pitch and release noise) constant. Items from the continuum were presented in isolation over headphones. Participants were trained to indicate which word they heard by pressing a button labeled with a picture and a written word. After passing a practice block, participants heard each of the 10 steps of the female speaker continuum 8 times each in random order, with a break halfway through. This process was repeated for the male speaker continuum.

**Production task:** Participants were recorded producing the target words ‘rake’-‘wake’ and ‘bud’-‘bird’ in the carrier phrase “Say X for me.” Words were elicited 10 times each in both clear and casual speech conditions, modeled at the start of each block; only careful speech data will be reported here. Productions were blocked by word and speaking condition, with order counterbalanced across participants. Trained students used Praat software to select the /r/ interval in each target word and identify the point representing the lowest height of F3. The heights of the first three formants were then extracted using automatic LPC tracking, with the number of coefficients determined on an individual basis for each speaker.

**Analyses:** Perceptual sensitivity was evaluated with a logistic function fitted over the number of ‘rake’ responses at each step in the continuum, calculated separately for male and female speaker continua. The metric we term “acuity” represents the distance in continuum steps between the 25% and 75% points on the fitted logistic function, with a smaller distance reflecting a steeper slope and thus a more refined perceptual response. The measure of “bias” represents the location on the continuum of the 50% point of the logistic function. We examined correlations between age in months and acuity and bias for both male and female continua. In the acoustic domain, we measured rhoticity using an adjusted measure in which F3 in /r/ was divided by F3 in /ʌ/ in ‘bud’ to scale for differences in vocal tract size. We examined the correlation between age in months and adjusted F3. Finally, we examined correlations between measures of /r/ perception and production.

**Results. Perceptual identification:** Responses to the male and female speaker continua differed significantly in bias, with the male speaker continuum skewed in the direction of “wake” ( $t = -3.6$ ,  $df = 37.7$ ,  $p < .001$ ). There was no difference in average acuity ( $t = -.44$ ,  $df = 37.9$ ,  $p = .6$ ). There was no significant correlation between age in months and either acuity or bias for either continuum. (Male: bias  $\rho = .07$ ,  $p = .78$ ; acuity  $\rho = -.19$ ,  $p = .42$ ; female: bias  $\rho = -.32$ ,  $p = .17$ ; acuity  $\rho = -.24$ ,  $p = .3$ ).

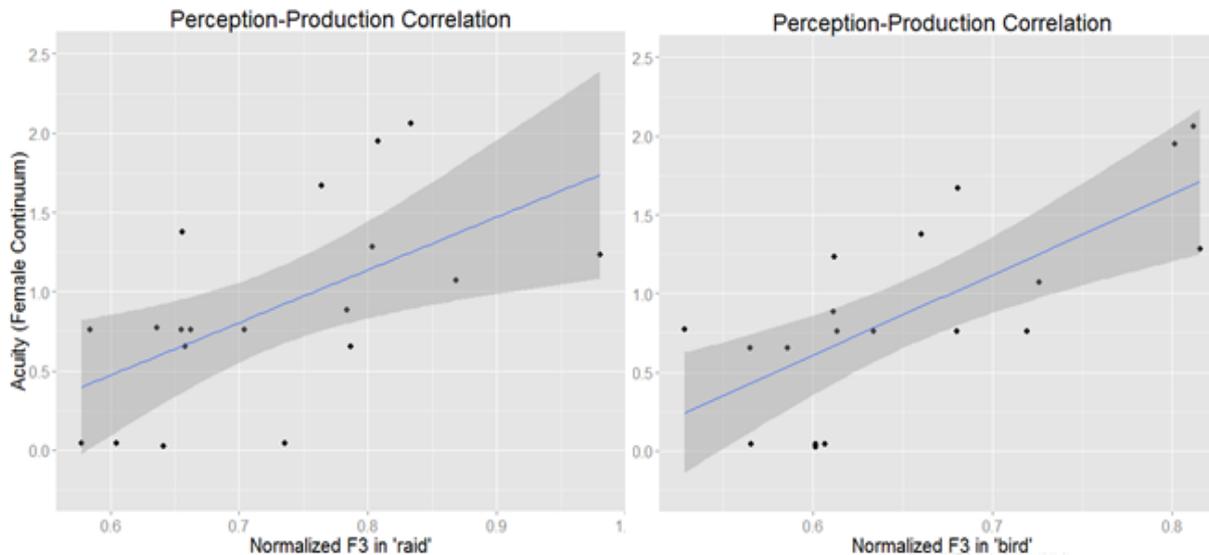
**Production:** The correlation between adjusted F3 and age in months was nonsignificant for both target words *raid* ( $\rho = -.29$ ,  $p = .23$ ) and *bird* ( $\rho = .002$ ,  $p = .99$ ). However, raw F3 height was significantly negatively correlated with age for both *raid* ( $\rho = -.6$ ,  $p < .01$ ) and *bird* ( $\rho = -.52$ ,  $p = .02$ ).

**Perception-production correlation:** A similar pattern of correlations between perception and production measures was observed for both targets *raid* and *bird*. There was a significant positive correlation between normalized F3 and perceptual acuity for the female speaker continuum (*raid*:  $\rho = .61$ ,  $p < .01$ ; *bird*:  $\rho = .7$ ,  $p < .001$ ); see Figure 1. However, correlations for the male speaker continuum did not approach significance (*raid*:  $\rho = .03$ ,  $p = .88$ ; *bird*:  $\rho = .29$ ,  $p = .23$ ). There was no significant correlation between normalized F3 and bias for either the female continuum (*raid*:  $\rho = -.04$ ,  $p = .87$ ; *bird*:  $\rho = -.02$ ,  $p = .92$ ) or male continuum (*raid*:  $\rho = .29$ ,  $p = .23$ ; *bird*:  $\rho = -.33$ ,  $p = .17$ ).

**Discussion.** Contrary to expectation, neither the perceptual identification measures nor the adjusted measure of /r/ production showed a significant correlation with age in months. However, the sample size tested remains relatively modest, and the participants recruited to date have tended to cluster in the middle of the age range. We are now collecting additional data, with a specific focus on testing children aged 9 and 14 years. Based on previous literature, we expect that the inclusion of these endpoints will draw out age-related differences in both perception and production of /r/. Our second hypothesis, predicting a correlation between perceptual acuity for /r/ and the precision with which the speaker realizes the acoustic signature of /r/, was supported by the strong correlations between adjusted F3 and acuity in the perception of the female speaker continuum. The lack of a significant perception-production correlation for the male continuum may reflect the fact that it was significantly skewed in the /w/ direction. It is of interest that significant correlations were observed for measures of perceptual acuity but not of bias, even though one might expect the location of the /r/-/w/ boundary to have a stronger impact on production targets than the sharpness of the boundary. Once the full-scale sample has been analyzed, we anticipate that this investigation will

make a meaningful contribution to our understanding of perception-production relations in later stages of speech development, with implications for the management of residual speech errors.

**Figure 1.** Correlation between adjusted F3 and perceptual acuity for female stimulus continuum. For raid,  $\rho = .61$ ,  $p < .01$ ; for bird,  $\rho = .7$ ,  $p < .001$ .



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## The emergence of gendered speech styles in the first decade of life: A comparison of boys with and without gender identity disorder

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The phonetic characteristics of adult men and women's speech differ. Many of these differences are likely to be due to differences between men and women's laryngeal and vocal tract morphology. Men's larynxes descend lower than women's at puberty, which makes their vocal tracts resonate at lower frequencies than women's. Moreover, post-pubescent men's vocal folds are longer and thicker than women's, leading them to have lower average fundamental frequencies than women. However, not all phonetic differences between men and women can be reduced to anatomical differences in vocal-tract and laryngeal morphology. This conclusion is drawn from a variety of pieces of evidence, including Johnson's (2006) finding that male-female differences in vowels' formant frequencies are not equivalent across a group of typologically diverse languages, and Stuart-Smith's (2007) finding that gender differences in /s/ production are mediated by age and social class. One other key piece of evidence that gendered speech differences are not entirely due to anatomy is the finding that boys' and girls' speech differs before they have reached puberty (Perry, Ohde & Ashmead, 2001). One possible explanation for this is that during language learning an individual adopts the phonetic characteristics of a *subset* of speakers in the ambient language whose speech is associated with a social identity that that person wishes to project. Studies have also shown that the phonetic characteristics of adults' speech differ as a function of their self-reported sexual orientation. This has been documented in a variety of studies from different languages and different dialects of English (Guzik, 2006; Mack, 2010; Munson et al., 2006; Pierrehumbert et al., 2004; Rác & Shepácz, 2013; Smyth, Rogers & Jacob, 2003; Valentovna & Havlíček, 2013). The acoustic differences between gay/lesbian/bisexual (GLB) and heterosexual individuals show interesting parallels to the differences between men and women's speech. The acoustic differences are not consistent with whole-scale differences in vocal-tract or laryngeal morphology, but are instead very phoneme-specific. For example, Munson et al. found that gay and heterosexual men differed in the extent to which they engaged in sound changes in progress in the upper Midwestern US dialect region that affect the TRAP, DRESS, GOAT, and GOOSE vowels. Again, one possible explanation for this is that talkers adopt phonetic variants of a *subset* of speakers in the ambient language whose speech has GLB speech features. Perception studies have shown that listeners are able to use these speech features as cues to an individual's sexual orientation. Those studies have also shown that people's perception is influenced by broadly held social stereotypes about sexuality and speech, even when those stereotypical features are not actually present in the population. For example, Mack and Munson (2012) showed that North American listeners rate talkers as more gay-sounding when the talkers' speech contains a frontally misarticulated /s/. This corresponds to the popular-culture stereotype that gay men lisp. This pattern occurred despite the fact that previous studies in the same dialect region did not find gay men to produce more frontal /s/ variants than heterosexual men.

The *acquisition* of GLB speech styles is a topic of great interest. The development of a GLB identity can occur over a protracted period during adolescence and early adulthood (Remafedi et al., 1992). Hence, the acquisition of this speech style might have a similarly protracted pattern. Alternatively, the style might not be acquired until one has fully adopted a GLB identity in late adolescence or adulthood. It would be logistically challenging to examine the development of GLB speech styles directly, as one would need to follow a cohort of individuals for a very long time-span and track behaviours and beliefs that are potentially very challenging to measure in children and adolescents. However, it is possible to examine this question indirectly by comparing groups of children who differ in their likelihood to adopt a GLB identity as adults. That is the tactic that we take in this

study. Specifically, we examine the development of gendered speech production in boys aged five to 13 years who vary in their gender expression and gender identity. We compare boys with a clinical label of Gender Identity Disorder (GID) to age-matched boys without GID from the same dialect region. A diagnosis of GID is typically made when a child shows distress or discomfort at her or his biological status as a female or male, evidenced by a stated desire to be of the opposite sex or by other signs of gender dysphoria (Zucker & Bradley, 1995). However, children can also be diagnosed with GID for showing gender-nonconforming preferences in terms of their interests, the sex composition of their peer group, or their choice of clothing. The GID population comes to clinical attention because of concern about the boys' well-being on the part of adults (parents, a teacher, the family doctor, another mental health professional, etc.). Long-term investigations of boys with GID (e.g. Green, 1987; Money & Russo, 1979; Singh, 2012; Wallien & Cohen-Kettenis, 2008) show that they are more likely than their gender-conforming peers to identify as gay, lesbian, bisexual, or transgendered as adults, or to elect gender reassignment surgery. This last characteristic of boys with GID explains our motive for examining the speech of these children. Studying the speech of boys with GID gives us a window to examine the development of distinctively gay male speech styles in a group that has not yet developed a sexual orientation. If we find characteristics of gay male speech styles in these boys, then we can conclude that these styles in adults are acquired early, perhaps to index a social meaning other than sexuality per se. By examining a wide age range, we can determine whether distinctively GLB speech features are more likely to be present in the older individuals' speech than in that of younger ones. If this is true, then we can conclude that these differences reflect the accumulated experience of learning speech styles to convey an emerging identity. By including a perception task in which adults rate the gender-typicality of children's speech, we can determine the perceptual cues that listeners used when rating the gender-typicality of children's speech. We can also examine whether listeners' judgments are affected by broadly held social stereotypes, as are judgments of adults' sexual orientation from speech.

In this study, we compared 15 boys with a clinical label of GID with 15 age-matched peers without that label. The individuals ranged in age from five to 13 years old. Participants were recorded producing single words and sentences. These were analyzed acoustically. A subset of approximately 14 words and 14 sentences were used as the stimuli in an experiment in which naïve adults rated the gender typicality of the boys' speech. Separate perception stimuli were conducted for perception of the single word stimuli (n=20 listeners) and the sentence stimuli (n=17 listeners). The inclusion of words as stimuli allowed us to assess whether judgments were linked to the pronunciation of specific vowels and consonants. The inclusion of sentence stimuli allowed us to examine whether distinctive phonetic variants in boys with GID were in more global, sentence-level prosodic features, like patterns of tempo and fundamental frequency. The results of the acoustic analyses found some interesting segmental differences between the groups: boys with GID produced vowels with a higher F2 frequency than did boys without GID, a finding that mirrors differences found between GLB and heterosexual adult men. However, boys with GID produced /s/ with a more diffuse spectrum (suggesting a more dental articulation) than did boys without GID. The latter finding runs contrary to previous work on adults, but is consistent with social stereotypes about adult gay men's speech. None of the global measures of pitch or tempo of the sentences differed between the groups. Two groups of listeners participated in tasks where they rated the gender typicality of single words (group 1) or sentences (group 2) produced by the 30 talkers. Across both experiments, boys with GID were rated as less boy-like than boys without GID. In the experiment using sentence stimuli, these group differences were larger for the 8-13 year-old boys than for the 5-7 year-olds. This finding suggests that these speech styles are gradually learned over the age range we examined. Listeners' ratings were predicted by a variety of acoustic parameters, including ones that authentically differ between boys with and without GID, and ones that are stereotypically associated with less masculine sounding speech in North America. Taken together, these findings are an important first step to understanding the development of distinctive speech styles in adults. They

lay the groundwork for future studies examining the cognitive mechanisms that support the learning of distinctive speech styles during childhood and adolescence.

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## **The social brain in adolescence**

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Adolescence is a period of formative biological and social transition. Social cognitive processes involved in navigating an increasingly complex social world continue to develop throughout adolescence. Research in the past 15 years has demonstrated significant functional and structural changes in the brain during adolescence. Areas of the social brain undergo both structural changes and functional reorganization during the second decade of life, possibly reflecting a sensitive period for adapting to one's social environment. The changes in social environment that occur during adolescence might interact with increasing executive functions and heightened social sensitivity to influence a number of adolescent behaviours. I will discuss the importance of considering the social environment and social rewards in research on adolescent cognition and behaviour.

## THURSDAY AFTERNOON - ORAL SESSIONS

13:30 - 14:10	<b>Keynote 3 – Jack Sidnell:</b> Children's peer interaction: norms, practices and emerging accountability
<b>14:10-15:10</b>	<b>Oral Session 2: Development of communicative abilities</b>
Franziska Köder	Children's struggle to shift perspective in direct speech
Ibon Manterola & Margareta Almgren	Development of oral discourse skills in Spanish L2
Aleksandr Kornev & Ingrida Balčiūnienė	Story (re-)telling and reading in children with dyslexia: Language or cognitive resource deficit?
<b>15:10 – 16:30</b>	<b>TEA &amp; POSTER SESSION</b>
16:30 – 17:10	<b>Keynote 4 – Melissa Redford:</b> Rhythm from reduction: the emergence of prosodic words in children's speech
<b>17:10 – 18:10</b>	<b>Oral Session 3: Development of speech perception in typical populations I</b>
Ewa Jacewicz & Robert Fox	The interaction of linguistic and indexical knowledge in the perception of typically developing 9-12 years old children
Matthew Davis, Samuel Evans, Kathleen McCarthy, Anastasia Giannakopoulou, Lindsey Evans & Joanne Taylor	Lifespan learning of speech perception in native and non-native listeners
Louise Croft, Tom Hope Ōiwi Parker-Jones, Peter Rankin , Cathy Price & Torsten Baldeweg	Age-related changes in the speech perception network from 5-16 years of age

## **Children's peer interaction: Norms, Practices and Emerging Accountability**

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One of the basic findings of Conversation Analysis is that talk-in-interaction is undergirded by a robust architecture of norms to which participants are pervasively oriented. So for instance, in adult conversation the production of a YN-question that selects some specific next speaker as its recipient mobilizes a set of relevancies. Specifically, production of a YN-question makes relevant a response which is, 1) an answer, 2) confirmation of the supposition conveyed and 3) delivered without significant delay. Participants in conversation orient to these norms and where any one of them is breached an account becomes relevant. For instance when one person asks, speaking of a surgery performed on a mutual acquaintance, “en that went wrong?” the recipient accounts for her delayed, non-answering, non-confirming response by saying “We:ll? Uh:m:” thereby indicating some trouble in formulating what she wants to say. The questioner also orients to the delayed non-answering, non-confirming response by following-up with the repair “The surgery I mean” thereby suggesting that she understands a problem of understanding to have prevented the recipient from answering. In this presentation I discuss recent work by Tanya Stivers and myself that investigates the degree to which children aged 4-8 display a reflexive accountability to the underlying norms which organize sequences initiated by YN-questions. Drawing on a mix of qualitative and quantitative evidence, I will suggest that although children at this age do show some awareness of these norms in conversations with their peers they also frequently fail to hold one another and themselves accountable to them.

## Children's struggle to shift perspective in direct speech

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**Introduction.** We all frequently report the speech of others. Many languages – including Dutch – have two different types of speech reports: direct speech (example (1)) and indirect speech (example (2)).

- (1) Direct speech:            *Jan:*    Anna said “I am happy”.  
(2) Indirect speech:        *Jan:*    Anna said that I am happy.

Children start to produce speech reports relatively early in their development, namely with around two to three years of age. Usually direct speech is acquired before indirect speech (Ely & McCabe, 1993; Köder, 2013; Nordqvist, 2001).

The main semantic difference between direct and indirect speech is the context with respect to which pronouns and other deictic expressions have to be evaluated. In indirect speech, the utterance is presented from the actual speaker's perspective. In direct speech by contrast, there is a shift from the perspective of the actual speaker to the perspective of the reported speaker. This perspective shift induces a shift in the interpretation of deictic expressions (like *I, tomorrow, here*) (Kaplan, 1989; Li, 1986; Schlenker, 2011). The first person pronoun *I* refers for instance to the reported speaker Anna in example (1), but to the actual speaker Jan in example (2). Deictic pronouns can therefore have different referents depending on whether they are embedded in direct or indirect speech.

**Research questions.** The current study addresses the following questions: (a) At what age can Dutch children interpret the singular pronouns *ik* ('I'), *jij* ('you') and *hij* ('he') in direct and indirect speech? and (b) Are pronouns easier to interpret when they occur in direct speech or in indirect speech?

**Method.** 136 children aged between 4;1 and 12;8 years of age and 33 adults, all monolingual Dutch speakers, participated in the experiment (see Table 1).

**Table 1.** Participants

Age group	Mean age (y)	Range (y;m)	Number (N)
4	4.5	4;1 - 4;11	20
5	5.7	5;5 - 6;0	23
6	6.5	6;1 - 7;0	29
7	7.7	7;1 - 8;6	25
9	9.9	9;7 - 10;5	20
11	11.9	11;4 - 12;8	19
adults	22.2	18 - 32	33

The experiment is designed as a tablet game. The participants see thirty scenes with three animated animals as protagonists. In each scene, one animal whispers – inaudibly for the experimental participants – into another animal's ear which of the three animals gets a certain object (e.g. a football) (Figure 1a). The original addressee tells the information then to the third animal using either direct speech or indirect speech (Figure 1b). Each direct and indirect speech sentence includes also one of three pronouns *ik* ('I'), *jij* ('you') or *hij* ('he') (see examples (3) and 4)).

- (3) Direct speech:            Aap zei “Ik/ Jij/ Hij krijg(t) de voetbal”.  
   'Monkey said, “I/You/He get(s) the football”.'

- (4) Indirect speech: Aap zei dat ik/ jij/ hij de voetbal krijg(t).  
'Monkey said that I/you/he get(s) the football.'

The task of the participants is to touch on the recipient of the object, who is also the referent of the pronoun (figure 1c). The participants' choices and reaction times are recorded. In Dutch, direct and indirect speech can be distinguished by syntactic (verb-second vs. verb-final word order) and lexical features (*dat*-complementizer in indirect speech). In addition to that, in our experiment the direct speech sentences have a pause of 800ms between reporting clause and quotation and include a slight change of pitch in the quotation.

Figure 1. Test materials

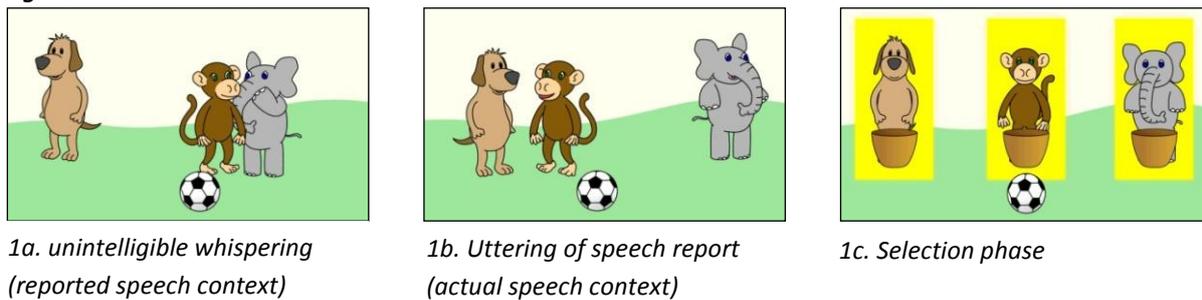
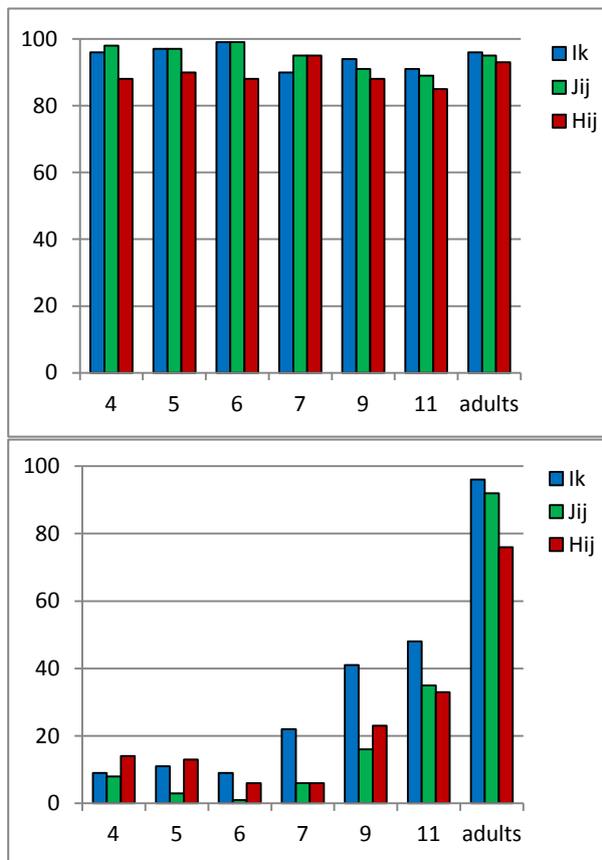


Figure 2. Percentage of correct pronoun interpretation in indirect speech (left, 2a) and direct speech (right, 2b)



**Results.** Figure 2 shows the percentage of correct interpretation of pronouns in indirect speech (2a) and direct speech (2b) for the different age groups. All age groups including adults make significantly

more mistakes in the interpretation of pronouns in direct speech than in indirect speech. Increasing age has a positive effect on accuracy, however only for direct speech sentences. Children perform significantly worse than adults in the interpretation of pronouns in direct speech. Since even 11-year-old children are hardly above chance level in direct speech, the question arises which referent they choose instead. In 98.9 percent of the mistakes children make in direct speech, they interpret pronouns like in indirect speech. That means that they evaluate them with respect to the actual instead of the reported speech context. They therefore fail to perform the required perspective shift in direct speech. The analysis of the reaction times reveals that participants need more time to interpret direct speech sentences. No effect of age on reaction times was found.

**Discussion.** In this experimental setup, pronoun interpretation is associated with a higher processing effort in direct speech than in indirect speech which is indicated by higher error rates and longer reaction times. In order to select the correct referent of a pronoun in direct speech, a hearer must shift from the actual speaker's perspective to the reported speaker's perspective. A perspective shift can only be achieved if (a) the listener recognizes the syntactic, lexical and phonetic cues that indicate that a perspective shift is required and (b) the listener is able to inhibit the representation of the salient actual speech context. I argue that it is the strong attraction of the actual speech context that makes children up to the age of 11 ignore the cues for direct speech. I will point out parallels between my experimental results and grammaticalised features in other languages. In Kwaza for instance, a second person pronoun in direct speech can indeed refer to the actual addressee (Evans, 2013).

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## Development of oral discourse skills in Spanish L2

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This presentation analyses the development of Spanish L2 in a group of children whose L1 is Basque. The corpus includes elicited oral narratives produced at ages 5, 8 and 11. The same 24 children take part at each age and the same story is used.

Basque has been a minorized language for centuries but in the last thirty years efforts have been made for its revival especially in the Basque Autonomous Community. In extended areas, oral transmission of Basque has been interrupted and it is not until its integration in the school system that Spanish L1 children are slowly becoming L2 speakers of Basque. In some areas, however, the transmission of Basque from parents to children was never interrupted and in these areas Spanish can be clearly considered L2 for the children.

Such is the case of the 24 participants in the present study. In the area where they grow up, Basque has a fairly strong social presence, although the use of Spanish is not negligible. According to statistics (Siadeco, 2001; Soziolinguistika Klusterra, 2012), 80% of the population has knowledge of Basque and around 57% makes use of it in everyday life. Our subjects proceed from Basque-speaking homes and they are schooled in Basque with the introduction of Spanish at Primary as a subject matter. The use of Spanish in family, although not predominant, cannot be totally excluded, as is normal in bilingual communities and it is also clear that these children are exposed to Spanish in the sociolinguistic environment.

Literature on L2 narrative development reveals that at age 5 children generally do not produce complete narrative structures. The main thematic components of the story (i.e. setting, main actions and end) tend to appear with increasing age. As to reference to characters, some authors affirm that L2 and L1 development are similar (Severing & Verhoeven, 2001; Kupersmit & Berman, 2001) and thus it is not until ages 6 to 7 that children start to use referential devices appropriately, even if this development may continue for several years more in either case (Hickmann, 2003). Finally, research on text organisers shows that at age 5 children show a very limited repertoire of forms where the arch-connector 'and (then)' is repeated massively and very few different organisers are produced (Lambert, 2003; Vion & Colas, 2001). With increasing age a major diversity of forms and functions of text organisers appears.

Story-telling is a text genre that has been frequently used in psycholinguistic research with the aim of studying the development of discourse skills in children (Berman & Slobin, 1994; Hickmann, 2003; Verhoeven & Strömquist, 2001). It is also a common activity in classroom settings (Grossmann, 1996). A widely-used research tool is the *Frog where are you?* story (Mayer, 1969), where children are asked to produce the story based on pictures without any previous adult model (Berman & Slobin, 1994).

The data collection method used in this research is the following: in groups of five, the children first listen to a story told by an adult. Subsequently three of the children leave the classroom and one child who stays retells the story to the second one. Then the narrator leaves the classroom and the child who has listened in turn tells the story to a third child who enters, and so on until the chain has been completed. It was considered that a larger group than five children might make it too difficult for the children to remember and repeat the task (Grossmann, 1996). The story-telling is supported by 12 colourful pictures illustrating the most relevant episodes of the story, which are shown to the children by the narrator. In the following, the pictures are used by the child-narrator but not shown to the one who listens. These sessions were recorded and transcribed.

As it can be observed, our method has similarities with the *Frog Story* method. Eliciting the same story makes it possible to control the contents of the texts produced by the children, and thus facilitates the comparison across different groups of subjects or different languages. The main difference with the *Frog Story* method resides in supplying an adult model. In our opinion adults' story-telling to children is not only a simple input of contents. It may have positive effects on children's representations of the story-telling activity referring to the communicative situation, the status of the speaker or the goal of the communicative action (Dolz & Schneuwly, 1998). In fact, some works have pointed out that children's narrative performance varies according to different communicative contexts (Gonnand & Jisa, 2000). Furthermore, in a comparison of five to six-year-old children's narratives elicited from distinct methods, Brigaudiot (1993) concluded that the best organised and most coherent narratives are produced by children who have previously listened to the same story told by an adult.

In the first place, our analysis will focus on some elements of discourse structure. These include the point to which the children are able to produce a coherent story with the main thematic components such as the introduction and the end of the story, based on Adam (1992); reference to characters by distinguishing between strong and weak introductions (De Weck, 1991); and finally the production of text organisers that link different parts of the story (Bronckart, 1996). It will be shown that at age 5, the stories produced lack most of these discourse features. There is a clear developmental progress by age 8 and especially by age 11.

Secondly, we will analyse the repair strategies used by both adult and children as a means of providing comprehensible output (Swain, 1985) and achieving the production of the story. We will limit our analysis to two of the repair strategies that are identified by Schegloff (2007): the other-initiation of repair when the adult attempts to tackle the communicative problem and the self-initiation of repair when it is the child who tries to solve the problem.

Our results show that at age 5 few self-sustained stories are produced and the children mainly depend on the interaction with the adult to complete the story. By age 8 the development is considerable and at age 11 practically all children are able to produce self-sustained stories. On the other hand, children are increasingly aware of their own errors and at ages 8 and 11 they produce self-corrections whereas at age 5 they are not able to do so.

The third aspect analysed in the stories refers to dysfluencies such as interruptions, faulty pronunciations and even the production of non-existent lexical items. At age 5 only a few cases of fluent story-telling are attested, since most of the children constantly interrupt themselves, either because they do not remember the development of the story they have listened to in their L2, or because they are not able to reproduce it. This lack of fluency is also due to lexical gaps (De Houwer, 2009) which are sometimes substituted by "invented" lexical items. At this age, pronunciation difficulties in L2 are also apparent, leading to lack of comprehension by the audience. At age 8, these features persist to a minor degree and at age 11 they have practically disappeared.

It can be concluded that oral production skills in Spanish L2 follow a gradual development that clearly go beyond the age of five. Even if all the aspects analysed in this study do not reflect an identical process, data from ages 8 and 11 reveal very interesting developmental aspects. For instance, the fact that the production of temporal organisers and repair strategies such as self corrections increases with age strongly suggests that some communicative strategies continue to develop in pre-adolescence periods. These findings on late L2 development are of great interest not only to language acquisition studies but also to educational contexts.

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## Story (re-)telling and reading in children with dyslexia: language or cognitive resource deficit?

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**Theoretical background.** Dyslexia in children has been the subject of numerous studies in various disciplines related to neurocognitive sciences. The majority of the studies have been focused on phonological and metaphonological skills that considered essential prerequisites for mastering reading. Much less is known about grammatical and discourse characteristics in children with dyslexia; however, following the previous investigations (Westerveld & Gillon, 2008; Vandewalle et al., 2012), narrative skills in children with dyslexia seem to be much less developed in comparison to the typically-developing (TD) peers. According another hypothesis, the core limitations in dyslexics are caused by nonlinguistic factors, namely, by the cognitive resources deficit (Kibby et al. 2004; van der Schoot et al., 2000). For example, working memory resources deficit (especially, so-called phonological loop; see Baddeley, 1986) blocks reaching higher order cognitive processes, thus comprehension difficulties are more likely to occur (Savage, Lavers & Pillay, 2007). This should also be taken into consideration when discussing dyslexia. The present study aimed at experimental verification: does linguistic vs. cognitive resource deficit influence narrative production in dyslexics? During the experiment, children's narrative comprehension and production were evaluated and compared from the perspective of story complexity, narrative mode (story telling vs. retelling), and order of session (1<sup>st</sup> vs. 2<sup>nd</sup> session). The key idea was that a prevalence of the cognitive resource deficit will cause lower results in the 2<sup>nd</sup> ordered session task, despite story complexity and mode. Vice versa, the pure linguistic deficit will be partially compensated by the priming effect (especially, if retelling is followed by telling), thus results of the 2<sup>nd</sup> session task will be higher than those of the 1<sup>st</sup> one.

**Data and research methodology.** The subjects of the experiment were 12 Russian-speaking monolingual dyslexic children (mean age 9 years 9 months) living in Saint Petersburg and attending state schools. Inclusion criteria were extremely low indexes of accuracy and fluency of reading, namely,  $\geq 1.5$  SD below the average for the target age group, according the standardized reading test for Russian-speaking children (Kornev, 2003; Kornev & Ishimova, 2010). Children with mental retardations and vision or hearing impairments were excluded from the experiment. The control group consisted of 12 Russian-speaking monolingual TD peers attending the same schools in Saint Petersburg. Subjects from both experimental and control group performed two tasks, i.e. story generation (so called story-telling) and story retelling; both of the tasks were followed by ten comprehension questions. Each child was tested individually; the 1<sup>st</sup> and the 2<sup>nd</sup> session were separated by a few minutes of free talk between the interviewer and the child. The order of tasks was counterbalanced with regard to story complexity and narrative mode (see Table 1).

**Table 1.** Counterbalancing scheme

Children No.	Session No. 1	Session No. 2
1, 5, 9	Telling <i>Baby-Birds</i>	Retelling <i>Baby-Goats</i>
2, 6, 10	Telling <i>Baby-Goats</i>	Retelling <i>Baby-Birds</i>
3, 7, 11	Retelling <i>Baby-Birds</i>	Telling <i>Baby-Goats</i>
4, 8, 12	Retelling <i>Baby-Goats</i>	Telling <i>Baby-Birds</i>

Picture sequences, *the Baby-Birds* and *the Baby-Goats*, (Gagarina et al., 2012) were selected for eliciting the narratives. Each sequence consists of six colored pictures (10 x 10 cm), without a text; in order to achieve comparability across narratives, the authors of the visual stimuli have aimed for

congruence between the scripts and pictorial content by creating parallel storylines for the picture sequences (see Table 2).

**Table 2.** Pictorial content and macrostructural framework of the *Baby-Birds* and the *Baby-Goats*

	<b>Structural element</b>	<b><i>Baby-Birds</i></b>	<b><i>Baby-Goats</i></b>
	Setting	<i>One day...</i>	<i>Once upon a time...</i>
Episode 1	Internal state term	Baby-birds are hungry.	Baby-goat is sinking.
	Goal	The mother-bird wants to feed her chicks.	The mother-goat wants to help her baby-goat.
	Attempt	The mother-bird flies away.	The goat runs into the water.
	Outcome	The mother-bird comes back with a worm.	The goat pushes her baby-goat out of the water.
	Internal state term	The chicks are happy.	The baby-goat is saved.
Episode 2	Internal state term	A cat is hungry.	A fox is hungry.
	Goal	The cat wants to catch the chicks.	The fox wants to catch the other baby-goat.
	Attempt	The cat starts climbing the tree.	The fox grabs the baby-goat.
	Outcome	A dog stops the cat.	A bird stops the fox.
	Internal state term	The cat is still hungry and scared by the dog.	The fox is still hungry and scared by the bird.
Episode 3	Internal state term	The dog sees the cat climbing the tree.	The bird sees the fox grabbing the baby-goat.
	Goal	The dog wants to help the chicks.	The bird wants to help the baby-goat.
	Attempt	The dog grabs the cat's tail.	The bird grabs the fox's tail.
	Outcome	The cat runs away.	The fox runs away.
	Internal state term	The dog is happy to help the chicks.	The bird is happy to help the baby-goat.

However, the *Baby-Goats* sequence seems to be more complex to perceive because of slightly overlapping episodes and less familiar protagonists. All the stories were recorded, transcribed and encoded according to CLAN (MacWhinney, 2010) tools for automatic linguistic analysis, and the main microstructural (linguistic) and macrostructural characteristics were analyzed. The main microstructural characteristics selected for this study were as follows: 1. General productivity (story length in words and Communicative Units (CU; see Loban 1976: 9), i.e. independent clauses with its modifiers); 2. Lexical diversity (type/token ratio of nouns, verbs, and adjectives); 3. Syntactic complexity (MLCUw – mean length of CU in words and MCCU index – a number of clauses per CU).

The main macrostructural characteristics selected for this study were as follows: 1. Story structure (0–10 points in total); 2. Completeness of narrative episodes (0-12 points in total); 3. A number of internal state terms. Additionally to the microstructural characteristics, distribution of the linguistic errors was analyzed.

**Results.** Comparative analysis of the macrostructural characteristics in the control group confirmed that *the Baby-Goats* story generally is significantly harder ( $p < 0.008$ ) than *the Baby-Birds* story (see Table 3).

**Table 3.** Results of statistical analysis

Story Group	Session No 1								Session No 2							
	<i>Baby-Birds</i>				<i>Baby-Goats</i>				<i>Baby-Birds</i>				<i>Baby-Goats</i>			
	DYS		TD		DYS		TD		DYS		TD		DYS		TD	
Index*	m	$\sigma$	m	$\Sigma$	m	$\sigma$	m	$\sigma$	m	$\sigma$	m	$\sigma$	m	$\sigma$	m	$\sigma$
SS-T	<b>7.3</b>	1.1	8.3	0.6	7.3	1.1	7.7	0.6	<b>9.3</b>	0.6	<b>9.3</b>	1.2	7.7	2.1	<b>6.7</b>	0.6
C-T	<b>8.0</b>	2.0	9.7	0.6	<b>7.7</b>	0.6	8.7	2.3	<b>11.3</b>	1.2	10.7	2.3	<b>9.3</b>	2.5	7.7	0.6
SS-RT	8.7	1.1	8.0	1.0	8.0	1.0	9.3	0.6	<b>9.0</b>	1.7	9.3	0.6	<b>6.3</b>	1.5	7.7	0.6
C-RT	10.0	2.0	8.0	2.0	9.3	1.1	11.3	1.2	10.3	2.9	10.7	1.2	8.3	1.5	9.7	1.6

\*SS-T – story structure in telling; C-T – completeness of episodes in telling; SS-RT – story structure in retelling; C-RT – completeness of episodes in retelling. Figures in bold indicate significant difference.

The main statistical Anova analysis and regression analysis of the effect of independent variables “the story” (*Baby-Birds* vs. *Baby-Goats*) and “the session” (No.1 vs. No.2) highlighted several significant differences. First, the session (No.1 vs. No.2) had significant effect ( $p < .032$ ) on the completeness of narrative episodes in the story-telling in the dyslexic children. This effect was not observed in the TD children. Second, the story (*Baby-Birds* vs. *Baby-Goats*) had near the significant influence ( $p < .067$ ) on the structure of story retelling in the dyslexic children. Again, this effect was not observed in the controls. Third, in dyslexics, completeness of narrative episodes in *the Baby-Birds* story-telling was higher ( $p < .1$ ) if previously (in the 1<sup>st</sup> session) *the Baby-Goats* story was retold. Generally, retelling of *the Baby-Goats* (the more complex story) in the 1<sup>st</sup> session significantly increased all the macrostructural indexes of the story-telling in the 2<sup>nd</sup> session. The reverse order of tasks (i.e. telling of the *Baby-Goats* followed by retelling of the *Baby-Birds*) did not have any significant influence on the macrostructural characteristics. Microstructural characteristics, including general productivity, lexical diversity, and syntactic complexity, were similar in both groups. Error analysis revealed no significant differences between the groups; only semantic errors (namely, incorrect denominations of protagonists and actions) were significantly more frequent in the dyslexic children. Since the protagonists of *the Baby-Goat* story were less familiar to the children, the number of denomination errors was significantly higher there. These results correspond to the findings of the previous studies (Fowler, 2004).

The results of the study lead to a general conclusion that linguistic (namely, semantic) limitations rather than the cognitive resource deficit influence the macrostructure of both story-telling and retelling in dyslexic children. Resource depletion should result in less successful 2<sup>nd</sup> session (trade-off effect); our experiment, on the contrary, highlighted more complex story structure in the 2<sup>nd</sup> session, especially if telling of *the Baby-Birds* was preceded by retelling of *the Baby-Goats* (the more complex story). These results may be explained by a priming effect of the 1<sup>st</sup> session narration.

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## **Rhythm from reduction: The emergence of prosodic words in children's speech**

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Rhythm in spoken language is best defined with respect to alternations in prominence, a perceptually-based linguistic construct (Terken & Hermes, 2000; Arvaniti, 2009). Prominence alternations are themselves described with reference to prosodic units, such as metrical feet and prosodic words (Lieberman & Prince, 1977; Hayes, 1984). Rhythm is central to theories of language acquisition in part because the implied prosodic structures provide a framework for understanding unstressed syllable deletion in early child language (Demuth, 1996; Gerken, 1994; 1996). By hypothesis, children's prosodic representations evolve with their productions. Thus, when children are able to produce all target syllables in multi-syllabic lexical words and lexical items in grammatical multi-word sentences by age 3, they are assumed to have acquired the prosodic structures that define prominence alternations. The problem with this hypothesis is that it leaves unexplained why rhythmic differences between child and adult speech persist until at least age 6. In this talk, I will propose an alternative account of rhythm acquisition that is based on insights gained from research on later stages of speech and language development. The account rests on the view that rhythm, though amenable to linguistic description, is not itself phonology-driven in the psycholinguistic sense. Instead, rhythm is argued to emerge from speech practice and from acquired knowledge about the relative information status of individual lexical items in the phrasal context.

The specific argument I will make is that the prolonged development of articulatory timing control manifests in part as age-related differences in the realization of unstressed syllables at the phrasal level. When expert timing control is coupled with an acquired understanding of what aspects of the message the listener cannot do without, prosodic words emerge along with adult-like rhythms. I will review the literature in support of this argument and present new data from two studies we have recently completed. The first study was based on structured spontaneous speech recorded from 70 school-aged children once a year for 3 years. A team of analysts used a formal prosodic transcription system, the RaP System (Breen et al., 2012), to label perceptual prominences in each child's speech acquired from each of the study years. The results showed a developmental increase in the ratio of non-prominent to prominent syllables in speech from children who were aged 5 and 6 in the first year of study. The change was best explained by a decrease in the number of perceptually prominent function word items and increased articulation rates. Together, the results suggest that developmentally-related rhythmic differences are due to the emergence of prosodic words and the development of timing control that underlies default articulation rates. The second study investigated prosodic word production in 24 five- and eight-year-olds. Phrase-medial determiner phrases were embedded in different metrical contexts, and children's production of the vowels in these phrases were compared with adult productions of the same. Not surprisingly, children produced all vowels with greater temporal variability than adults, but the unstressed vowels in determiners were especially variable. Temporal variability was not affected by metrical context, leaving only a motor skills explanation for the result. Intriguingly, formant measures indicated that determiner vowel quality was **less** variable in children's speech compared to adult speech, suggesting /ə/ as an articulatory target. This latter result may indicate that adult-like cliticization of function words is delayed because children treat the communicative value of vowels in function words similarly to that of those in content words.

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## The interaction of linguistic and indexical knowledge in the perception of typically developing 9-12 years old children

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Research on children's development of speech perception has primarily focused on the early formative years, from infancy through middle childhood (e.g. Jusczyk, 1997; Kuhl et al., 2006). However, relatively little is known about the perceptual abilities of older children, those above 7 years of age, who appear to perform almost as well as adults but are still lacking adult-like consistency. Our research focuses on the interaction between linguistic and indexical knowledge in older children and examines how the relationship between the two types of knowledge is manifested in their perceptual performance. We present here results from two interrelated studies which tested older children's perceptual sensitivity to both fine phonetic detail in vowel quality (the linguistic knowledge) and indexical information about talker characteristics.

The manipulated sources of indexical variation included regional dialect (native and non-native), talker gender and age. In our approach, talker age was reflected not only in voice characteristics but also in dialect-specific generational differences in vowel production resulting from sound change in a speech community (Labov, Ash & Boberg, 2006). Based on the reports in the literature, we expected that children of this age will have developed adult-like abilities to categorize vowels on the basis of their spectral and temporal cues. They will have also developed at least some awareness of regional variation in speech and will display perceptual preferences for the native dialect as well as for female speech. However, we could not predict their ability to deal with extensive talker variability in stimulus material, a skill that characterizes speech processing by adults.

**Study 1.** To determine children's ability to cope with variability in speech, the stimulus set consisted of individual tokens (*heed, hid, heyd, head, had, heard, hod, hawed, hoed, who'd, hood, hide* containing 12 vowels: /i, ɪ, e, ε, æ, ɜ, ɑ, ɔ, o, u, ʊ, aɪ/) which were produced by 120 talkers ranging in age from children to old adults. Each talker produced six different tokens for a total of 720 unique exemplars used in the study. The talkers represented two dialects of American English spoken in North Carolina (NC, Southern English) and Wisconsin (WI, Midwestern English), both genders and three age groups (or generations): (1) children aged 8-12 years, (2) young adults aged 35-50 years and (3) older adults aged 66-91 years. Listeners were 9-12 y.o. children (12 from NC and 13 from WI) and middle-age adults (15 from NC and 15 from WI, aged 43-58 years). Listeners were born and raised in the same geographic locations as the speakers. An identical testing procedure was used with child and adult listeners: the 720 stimuli were presented in three randomized blocks of 240 tokens in the fashion of the classic Peterson and Barney (1952) vowel identification experiment.

The overall mean identification rates (IDRs) were 71.7% for the children and 80.2% for the adults. The 8.5% difference between the groups was shown to be significant using a mixed-design ANOVA. In this analysis, talker dialect, age and gender were the within-subject factors and listener dialect and age (children and adults) were the between-subject factors. The significantly poorer performance by children [ $F(1,51)=22.13, p<.001, \eta_p^2=.303$ ] demonstrates that when faced with extensive talker variability, older children still do not perform as well as adults. Their abilities to cope with indexical information seem to be still maturing and their identification decisions are adversely affected most likely because of their comparatively lesser experience with regional and generational variation. Of note is a significant interaction between the listener dialect and talker dialect which arose because both NC and WI listeners identified vowels in their native dialects more accurately than vowels in their non-native dialects. IDRs were uniformly higher for responses to female speech. Both child and adult listeners were also sensitive to systematic acoustic variations in vowels and

their dynamic structure (formant movement) associated with generational differences in vowel pronunciation resulting from sound change in a speech community (Jacewicz, Fox & Salmons, 2011). It needs to be emphasized that the general pattern of children's confusions was consistent with that of the adults. Overall, the study found that typically-developing older children are generally successful in dealing with both phonetic and indexical variation related to talker dialect, gender and generation. They are less consistent than the adults most likely due to their less efficient encoding of acoustic-phonetic information in the speech of multiple talkers and relative inexperience with indexical variation.

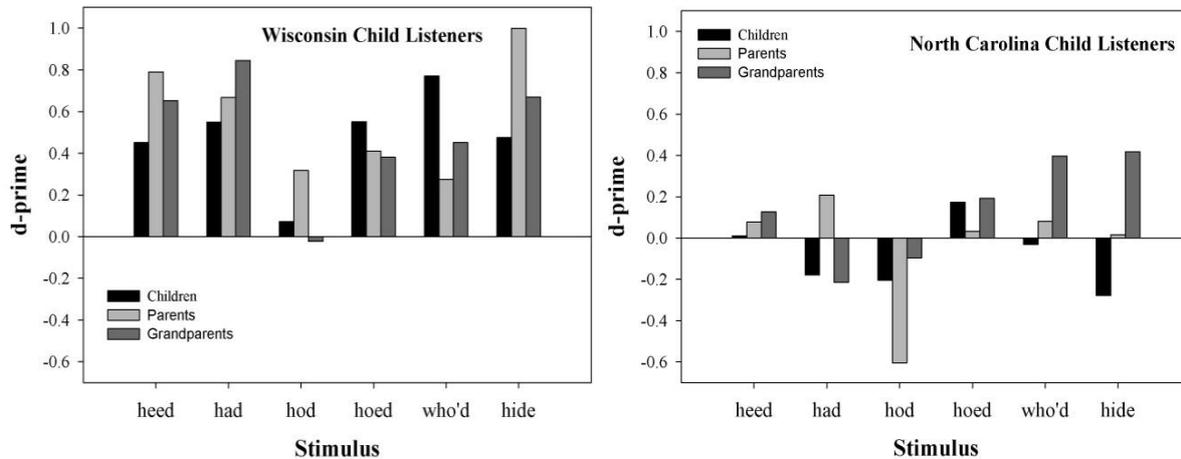
**Study 2.** Our second study examined children's awareness of regional variation in speech. Given the significant cross-dialectal variation in the way vowels were produced, we were intrigued by the fact that children's IDRs in Study 1 were higher in response to their own dialect. If so, then to what extent is the acoustic information in vowels sufficient to allow children to recognize regional accents? Typically, research in perceptual classification of regional accents used several dialect markers in stimulus speech to supply a variety of cues for the listeners (Clopper & Pisoni, 2004). However, can listeners recognize dialect variation only when minimal information is provided such as differences in vowel production? Do listeners "know" which variants belong to their own variety?

The stimulus material was the same as in Study 1. The same listeners participated in a separate session on a different day. In addition, four more children from NC and three more from WI participated for a total of 16 children in each dialect group. The 720 stimuli were again presented in three 240-token blocks. Upon hearing a single token, listeners were to decide whether the word was produced by a WI or a NC speaker (by clicking with the mouse on one of two response boxes: "Wisconsin" or "North Carolina"). The identification responses were converted to  $d'$  values (Macmillan & Creelman, 2005). Correct WI responses to WI tokens were "hits" and incorrect WI responses to NC tokens were "false alarms." These  $d'$  values (calculated not only for the total sets of responses, but for individual vowels, speaker subsets and listener groups) provide a measure of sensitivity to regional variation while eliminating response bias. [As a reference, higher  $d'$  values denote greater sensitivity to dialect variation; typical values are up to 2.0 (69% correct for both NC and WI trials corresponds to a  $d'$  of 1.0)].

The results for adult listeners showed that both NC and WI listeners were almost equally sensitive to regional variation (overall  $d'$  values were .75, and .72, respectively). Adult NC listeners were most sensitive to the accents of older talkers followed by young talkers and children, respectively ( $d'$  of .96, .83 and .45, respectively). Adult WI listeners were comparatively less sensitive to the older talkers but otherwise responded similarly as NC adults ( $d'$  of .83, .80 and .52, respectively). However, the results for child listeners were significantly different. WI children were less sensitive to regional accents compared to adult listeners ( $d'$ =.54) and their  $d'$  values corresponding to the three talker groups (older, young and children) were comparatively lower (.58, .60 and .38, respectively). However, NC children were basically insensitive to regional variation ( $d'$ =.10) although they could still detect some generational differences among the talkers ( $d'$  values for the older, younger and children were .17, .11 and .02, respectively). It is noteworthy that for both groups of child listeners, regional accent identification was better in response to the adults than to their peers (i.e. children).

We expected that some vowels would afford better identification of dialects than others, and this was indeed the case. For example, sensitivity for the WI child listeners was high for *hide* ( $d'$ =.71) but low for the vowel in *hod* ( $d'$ =.11) which was most often confused with *hawed* ( $d'$ =.10). However, the pattern for the NC child listeners was different. They were more sensitive to dialect variation in listening to *who'd* ( $d'$ =.15) and least sensitive to *hide* ( $d'$ =.02). The sensitivity patterns to these and several other selected vowels are illustrated in Figure 1. As can be seen, the  $d'$  differences between the NC and WI child listeners were striking although in each group, listeners were sensitive to generational differences in vowel production.

**Figure 1.** Sensitivity to selected vowels by WI and NC child listeners. “Grandparents” denote the older adults and “Parents” young adults.



Clearly, sensitivity to dialect variation differed between WI and NC children. The close-to-zero sensitivity of NC children was most likely because both the Southern and more general varieties of American English are commonly used and heard in NC as a result of changing demographics in that area. Thus, the WI variants may not have sounded unusual for NC children who were also familiar with other varieties. This familiarity might have decreased their awareness of regional variation in speech. However, WI children were (at least to some extent) able to detect the difference between the dialects as their experience with the Southern English was relatively limited. Since it is less common to hear Southern English in WI, the NC tokens most likely contained a sufficient amount of acoustic information to be perceived as somewhat unusual by WI children. On the contrary, no such differences were found in adult listeners who showed similar sensitivity to regional variation regardless of their dialect background. As a whole, Study 2 suggests that older children may not as yet have established the indexical categories for regional dialects or may not be able to utilize the same acoustic cues to the same degree as adult listeners. Apparently, the ability to make dialect judgments is based on a lifetime of experience hearing different dialects in a variety of cultural situations. Older children are still lacking this ability.

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## Lifespan learning of speech perception in native and non-native listeners

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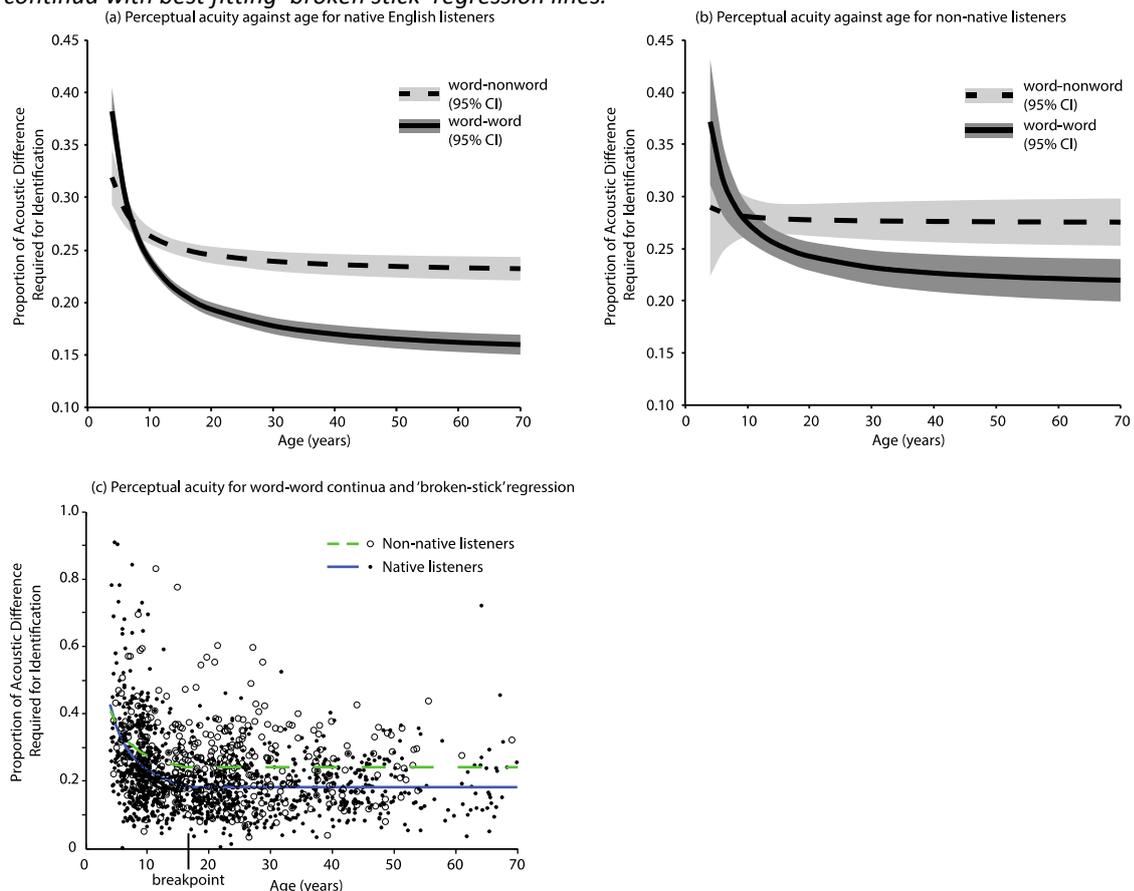
Between 6 and 12 months of age infants discover the key phonetic contrasts required for perception of speech in their native language and lose sensitivity to equivalent contrasts they do not hear in their caregivers' speech (Kuhl, 2004). Despite this early loss of sensitivity to non-native contrasts, studies of second language users suggest marked differences in perceptual abilities in early (10 years) and later learners (>18 years; Baker et al, 2008). These findings suggest that perceptual plasticity continues beyond the first year of life. However, the perceptual abilities that provide an advantage for pre-adolescent language learners and the changes that lead to a loss of plasticity in adulthood remain unspecified. Existing findings suggest less graded, and more categorical perception of speech in older children (e.g. 6 vs 12 year olds; Hazan & Barrett, 2000). However, these results leave unclear whether perceptual or non-perceptual changes (e.g. to decision making mechanisms) are responsible. In existing studies performance was assessed using repeated presentations of speech tokens and hence developmental improvements in response consistency could also give the appearance of more categorical perception.

We administered an adaptive speech perception task using trial-unique stimuli, to 2422 visitors to the Science Museum in London. Our task assessed perceptual acuity for distinguishing minimal word pairs (e.g. bear-pear), and word-nonword pairs (e.g. bag-pag). We used an XAB, 3-interval 2-alternative forced-choice task in which the referent word (e.g. bear) was spoken in a female voice and accompanied by a colour photograph to minimize memory demands. Each referent word was followed by presentation of two syllables spoken in a male voice combined with child-friendly animations of two aliens learning to speak English. Participants chose which of the syllables was more correct ("who said it right") making their response using a touchscreen. Referent words for each trial were selected at random without replacement from a set of 60 early-acquired English monosyllables accompanied by a word or nonword minimal pair. Critical syllables were generated using an automated audio-morphing procedure implemented using STRAIGHT combined with custom scripts (Rogers & Davis, 2009). This morphing procedure allowed us to present speech tokens with a reduced amount of the acoustic differences that exist between naturally-recorded minimal pair speech tokens. Our test measured the Proportion of the Acoustic Difference Required for Identification (PADRI) by assessing the amount of acoustic difference required for 80% correct identification using a 3-down, 1-up adaptive procedure (cf. Levitt, 1971). We used a large set of phonetic continua (60 word-word and 60 word-nonword pairs), including most English single-feature consonant changes, e.g. voicing (bear-pear) and place changes (kite-tight), at syllable onset and offset for stops (kite-tight/fork-fort), nasals (meat-neat/screen-scream) and fricatives (sing-thing/mouse-mouth). The adaptive procedure continued for eight turning points for each track. Adult, native-English listeners on average completed the test in 36 word-word and 37 word-nonword trials and therefore heard each of the referent words (at most) twice, and no repetitions of the foil words.

For each adaptive track and participant, we fitted a logistic function in R and used the slope of the fitted function, combined with visual inspection to reject participants whose responses indicate failure to understand the task, inattention or inability to do the task even with unmodified speech tokens. We included data from 1537 participants aged between 4 and 70 years for whom language background was known. Of these participants, 50.5% were >18 years, and 74.9% were native English speakers.

From each of these logistic fits we computed a measure of perceptual acuity (80% PADRI threshold) that was entered into statistical analyses. Regression analysis confirmed that reciprocal age ( $1/\text{age}$ ) was the best predictor of changes to PADRI threshold with age ( $R^2(1535)=.118$ ). The relationship between age and PADRI for both continua in native and non-native listeners is shown in Figure 1a/b, with individual participant data for word-word continua shown in Figure 1c. We conducted an ANCOVA including reciprocal age as a covariate, native/non-native listener as a between-subject factor, and track (word-word, word-nonword) as a within-subject factor. This showed significant main effects of track, age, and language status (all  $p < .001$ ) with greater perceptual acuity for word-word pairs, in older, native listeners. These results are in line with previous studies using more conventional perceptual measures, which show that perceptual development continues into adolescence with marked differences between native and non-native listeners (cf. Figure 1a/b). There was also a significant interaction between track and age and between track and language-status (both  $p < .001$ ) such that effects of age and language on perceptual acuity were more pronounced for word-word continua. Thus, developmental changes in perceptual acuity are most apparent when listeners use their knowledge of spoken words in identifying speech. This suggests that additional lexical experience contributes to effects of age and language on speech perception.

**Figure 1.** The best fitting relationship between perceptual acuity (PADRI threshold, lower numbers are better) and reciprocal age as estimated by linear regression, for: (a) native English, and (b) non-native listeners. Shaded areas show the 95% confidence interval for the regression line. (c) Individual thresholds for word-word continua with best fitting 'broken stick' regression lines.



To follow-up on these findings, we focused on perceptual acuity for word-word continua and conducted further regression analyses including age, second language status and proficiency as predictors. Once more, reciprocal age ( $\beta=.363$ ,  $p < .001$ ) and native/non-native language status

( $\beta=.169$ ,  $p<.001$ ) were reliable predictor of PADRI thresholds with older, native speakers having greater perceptual acuity (Figure 1c). However, the interaction between these two factors only approached significance ( $\beta=-.147$ ,  $p=.071$ ), suggesting that native and non-native listeners showed similar changes in perceptual acuity with age. For non-native listeners, reciprocal age ( $\beta=.160$ ,  $p<.001$ ) and self-rated proficiency ( $\beta=.006$ ,  $p<.05$ ) were reliable predictors of PADRI threshold suggesting that proficiency (perhaps due to additional exposure) influences perceptual acuity.

Finally, to assess evidence for critical period effects we conducted broken-stick regression analyses to determine the age at which we no longer see age-related improvements in perceptual acuity for word-word continua. For this analysis we determined the 'breakpoint' value at which root-mean-square error (RMSE) was minimized when a constant value of perceptual acuity was specified (i.e. the age at which performance no longer improves). This showed reduced RMSE for broken stick compared to conventional reciprocal regression for native listeners (0.1015 vs 0.1027). For non-native listeners the equivalent difference in RMSE was smaller but still apparent (0.1143 vs 0.1145). These findings provide statistical confirmation of an extended critical period for improvements in speech perception, particularly for native listeners. The observed breakpoints of 16.7 years for native listeners and 16.8 years for non-native listeners correspond closely to results from comparisons of early and late second language learners (Baker et al., 2008).

Our data suggest a continuing role for childhood and adolescent experience in shaping perceptual acuity for speech sounds even in native listeners. Rather than a single, early critical period in which perceptual categories are formed that remain unchanged in later life, native listeners continue to show improvements in perceptual identification of spoken words throughout adolescence. These findings naturally lead us to question the traditional view of phonological development as occurring in a single, early period. Rather, experience of hearing spoken words in childhood and adolescence has an incremental and continuing impact on speech perception abilities.

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### Age-related changes in the speech perception network from 5-16 years of age

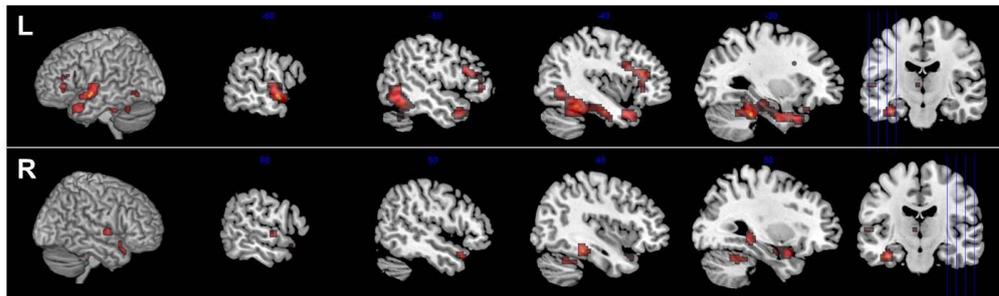
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Previous studies have shown age related changes in the language network into early adolescence (Brown et al., 2005; Holland et al., 2007; Szaflarski et al., 2012; Vannest et al., 2009). However, whether these changes relate to age, task performance or effort is not clear. We developed a child-friendly and age-adjusted functional magnetic resonance imaging (fMRI) protocol which aims to control for age-related differences in task performance and effort. The protocol included engaging information about brain scanning, a mock scanning procedure and pre-scan task practice. Tasks were also designed with age-adjusted difficulty levels, such that in-scanner task performance did not differ with age ( $p>0.25$ ). Using this procedure, and analysing only correct response trials, we aimed to investigate developmental changes in the speech perception network in healthy children ( $n=36$ , 5-16 years, mean age = 11 years, 19 females, mean IQ = 120), independent of task performance. During fMRI scanning all participants performed an auditory comprehension task with overt speech responses (the *Listen and Name Game*) and a relatively high-level sensory-motor baseline task to control for auditory processing, word retrieval and articulation (the *Alien Game*). During the *Listen and Name Game* participants heard sentence-level descriptions of animals and objects spoken by a male and a female, and were instructed to say the name of the item being described. During the *Alien Game* participants heard spectrally rotated versions of the item descriptions, and were asked to say if the alien speaking was a boy or girl (inducing word retrieval but with minimal semantic load). By contrasting these two tasks we were able to localise the neural network supporting sentence-level semantic and syntactic processing (Figure 1). This network included known speech perception regions (Price, 2012; Scott & Johnsrude, 2003), including: bilateral (left>right) superior temporal pole, left pars orbitalis and triangularis, bilateral fusiform gyri, and parahippocampal gyrus ( $p<0.05$ , small volume correction for multiple comparisons).

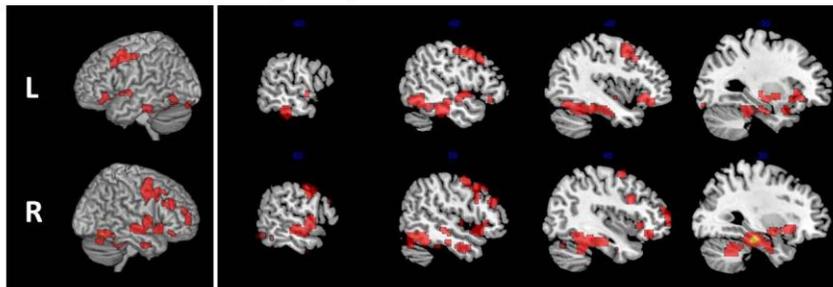
Age-related increases in activation were seen in several regions during auditory comprehension (Figure 2A), including fronto-temporal language regions (Pars Orbitalis, superior temporal gyrus/sulcus, and left anterior insula), and regions associated with cognitive control (bilateral dorsolateral prefrontal cortex) (MacDonald et al., 2000). Regions associated with sentence-level semantic and syntactic processing also showed increasing activation with age (Figure 2B), including: bilateral posterior fusiform gyrus and the left occipitotemporal region. These regions have been implicated in many cognitive processes, including: picture naming, reading, semantic categorisation and mental imagery (Price & Devlin, 2003). Our findings suggest the speech perception network develops across childhood and adolescence, characterised by increasing contribution from bi-frontal regions associated with cognitive control. Core semantic processing regions also show on-going development, and suggest increasing cross-modal integration of semantic information with age.

**Figure 1.** Significant activation in regions associated with sentence-level semantic and syntactic processing regions in children and adolescents aged 5-16 years ( $n=36$ ). Results are shown at two thresholds:  $p<0.05$  corrected for family-wise error (yellow) and  $p<0.01$ ,  $k>10$  uncorrected (red).

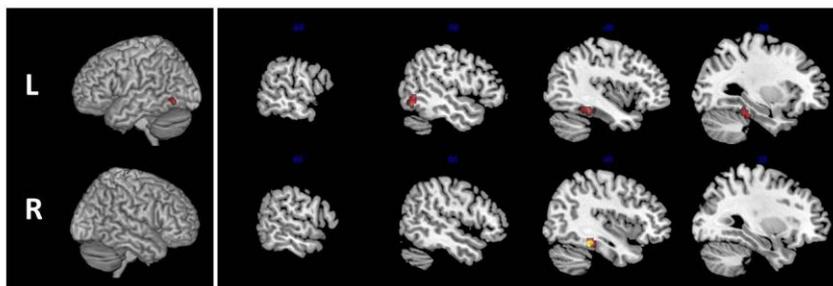


**Figure 2.** Age-related increases in activation found throughout the brain during performance of an auditory comprehension task (A), and limited to regions associated with sentence-level semantic and syntactic processing (B). Results are displayed for the left (L) and right (R) hemispheres on a rendered surface of the brain (left) and on sagittal slices (right), at two thresholds:  $p<0.05$  corrected for family-wise error (yellow) and  $p<0.01$ ,  $k>10$  uncorrected (red).

**A. Listen and Name (>rest)**



**B. Listen and Name > Alien Game**



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## FRIDAY MORNING - ORAL SESSIONS

09:20 - 10:00	<b>Keynote 5 – Bill Wells:</b> Intonation in the school years: interactional and psycholinguistic perspectives
<b>10:00 - 11:00</b>	<b>Oral Session 4: Speech development in L2/bilinguals</b>
Kathleen McCarthy, Merle Mahon, Stuart Rosen & Bronwen G. Evans	Acquiring a second language in childhood: The phonemic development of sequential bilingual children
Siobhán Nic Fhlannchadha & Tina Hickey	Understanding the later acquired aspects of the Irish language in children and adults
Bencie Woll & Joanna Atkinson	Learning a sign language as an L1 in adulthood: Implications for notions of a sensitive period in phonological development
<b>11:00 - 11:30</b>	<b>COFFEE BREAK</b>
11:30 - 12:10	<b>Keynote 6 – Lorna Halliday:</b> Development of auditory processing skills in children with mild to moderate hearing loss: Links to language?
<b>12:10 - 13:10</b>	<b>Oral Session 5: Speech development in children with SLI</b>
Victoria Knowland, Sam Evans & Stuart Rosen	Audio-visual speech perception in school-aged children with and without language impairment
Rob Zwitserlood, Marjolijn van Weerdenburg, Frank Wijnen & Ludo Verhoeven	Speech disruptions in school-age children with SLI: A developmental perspective
Iris Duinmeijer, Anne Baker, Jan de Jong & Fred Weerman	Perception and production of subject verb agreement in children and adolescents with and without Specific Language Impairment

## Intonation in the school years: interactional and psycholinguistic perspectives

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My research on children's intonation takes a functional approach (Wells & Stackhouse, forthcoming), motivated by questions such as:

How can children with speech and language impairments make use of intonation in their spoken interactions to compensate for difficulties at other linguistic levels e.g. grammar, vocabulary, segmental phonology (cf. Wells & Local, 2009)?

How may the communicative functionality of intonation be impaired in developmental conditions such as autism or profound hearing impairment (cf. Anstey & Wells 2013)?

In order to address these broad questions, it is crucial to understand the developmental trajectory of intonation systems through childhood and the communicative functions in which they are implicated. In this talk two questions will be addressed in relation to children who have typically developing intonation:

- 1) What intonational competences do children have by the age of five?
- 2) What more does a child have to master during the school years?

The first question is approached through analysis of a short extract from video-recorded interactions involving three five-year-old male friends. The data were collected in the classroom during 'free play', over a six week period, for a study focussing on the management of arguments and alliances in peer interaction (Tempest & Wells 2012). Detailed analysis revealed that in order to pursue arguments and create alliances, all three children competently deployed a range of lexical and grammatical devices. An additional resource for accomplishing joint play, including the management of shifting alliances and the conduct of arguments, is provided by intonation. The boys draw on their competence in each of the following intonation systems to accomplish their interactional ends:

- i) The placement of the Tonic to identify topical focus;
- ii) The use of Tonic to project the upcoming completion of the speaker's turn;
- iii) The use of a matching Tone to align with the prior speaker's agenda; or conversely of a contrasting Tone to initiate a new action.

The establishment of these three systems in very early childhood will be briefly described. From a theoretical point of view, the important feature that the systems have in common is that each is *locally managed* as the interaction unfolds on a moment-by-moment basis. The current speaker chooses which Tone to use and where to place the Tonic by referring to the prior speaker's Tone and Tonic placement, rather than by accessing his own stored lexicon of intonational meanings. Thus the intonational design of a speaker's turn is shaped principally by its relation to the previous speaker's immediately prior turn, and itself displays an analysis of that prior turn. This can be represented psycholinguistically in a model that explicitly incorporates two participants, using a format that draws on the 'interactive alignment model' of Pickering and Garrod (2004).

Turning to the second question, "What more does a child have to master during the school years?" the short answer might seem to be "not much", given the competences displayed in the extract above. The three systems continue to play a fundamental role in spoken interaction: Hellermann (2003), for instance, demonstrates the importance of pitch contour matching for the management of

teacher-student pedagogical interactions in the physics classroom. However, it is also important to recognise the role that intonation may play in new communicative challenges that the child will face. With regard to comprehension, these new challenges include having to listen to wider range of discourse types, media and speakers, including peers and teachers using a range of less familiar accents. As for production of intonation, challenges may include various kinds of public performance, drama, oral presentations and, almost inevitably, reading aloud.

Much of the research into intonation in the school years has involved the construction and administration of tests of intonation, rather than the analysis of interactional data. An example is the study of 5,8,10 and 13-year-old English-speaking children by Wells, Peppé and Goulondris (2004), using subtests from the PEPS-C battery. On the production side, results mainly confirmed the expectation that there is little left to learn, as 5-year-old children passed most of the production subtests. The remaining challenges seem to involve integration of intonation with particular grammatical structures, for example “coffee-cake and tea” vs. “coffee, cake and tea”. However, there were developments, at least to age 11, in the functional comprehension of intonation. Moreover, children’s performance on the intonation comprehension tasks correlated strongly with measures of grammatical comprehension and expressive language development. This suggests that during the school years, intonation competence, as measured by input tasks, develops in line with other aspects of grammatical comprehension and production. For the child the key issue, in this respect, is to integrate competence in the basic intonation systems with an expanding range of grammatical structures: the development and refinement of ‘text-to-tune mapping’.

At the same time, Wells, Peppé and Goulondris (2004) found a wide variation in performance among children in the same age band. For instance, on the ‘Chunking Input’ task, involving stimulus pairs like “coffee-cake and tea” vs. “coffee, cake and tea”, the five-year-old children attained 75% accuracy, yet the range of scores for each of the four age groups shows that the task is sensitive to individual variability: while some children were at ceiling, there were some ten-year-olds still responding at chance level. Similarly on the corresponding production task, it was the case in all age groups that while some children were at ceiling others scored around half marks. There was variability both across children in the same age band and within the individual child (Dankovicová, Pigott, Peppé & Wells, 2004). Even though the test results show rather high degrees of variability, it seems unlikely that these otherwise typically-developing children would have many problems with intonation in their everyday spoken interactions. Indeed, similar variability has been found for adults (Peppé, Maxim & Wells, 2000). A more plausible interpretation is that off-line tests of intonation such as those in the PEPS-C battery, rather than accessing intonation competence, tap into the child’s meta-intonational awareness and the ability to demonstrate that awareness in a test situation.

Interpreted in this way, the results of test-based studies may be of particular relevance when considering the major intonational challenge that faces school children: learning to read. Researchers and educationalists have been interested in identifying what contributes to perceived ‘expressiveness’ in reading aloud (e.g. Perera, 1985; Cowie, Douglas-Cowie & Wichmann, 2002; Miller & Schwanenflugel, 2008), which can be viewed as a desirable outcome measure of reading attainment. From a psycholinguistic perspective, intonation in reading aloud uses quite different mechanisms from intonation in interaction, being essentially a process of ‘tune-to-text’ mapping. This can be represented in an autonomous processing model (Pickering & Garrod, 2004) which draws on a lexicon of intonational meanings. This being the case, in order to give a prosodic interpretation to written language conventions such as the full stop, the question mark and the exclamation mark, it may be necessary for the child to buy into some prevailing intonational fictions: that at the level of intonation there is a formal distinction between questions from statements; and that intonation is used to distinguish between different emotions.

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## Acquiring a second language in childhood: the phonemic development of sequential bilingual children

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**Background.** The majority of research on bilingual speech development has focused on the first year of life, and has concentrated predominantly on children who acquire both languages simultaneously from birth (e.g. Garcia-Sierra et al., 2011; Sundara, Polka & Molnar, 2008). Yet, for many bilingual children growing up in dense immigrant communities in large multicultural cities such as London, their language experience is typically very different. These children, often referred to as sequential bilinguals, are initially exposed to their heritage language (L1) within the home and in many cases are only immersed in the host country's language (L2) when they start full-time education at around 4-years-old. Depending on the family network, these children are likely to be exposed to differing amounts of the L1 and L2, as well as regional and foreign-accented variants of the L2. To date, little is known about the developmental trajectory of sequential bilinguals. One possibility is that, like monolinguals, these children will initially be sensitive to the phonemic contrasts in their L1 (e.g., Kuhl et al., 2006). In turn, when they start to acquire their L2, on entry to full-time education, they may display difficulties with L2 phonemic contrasts that do not exist in their L1.

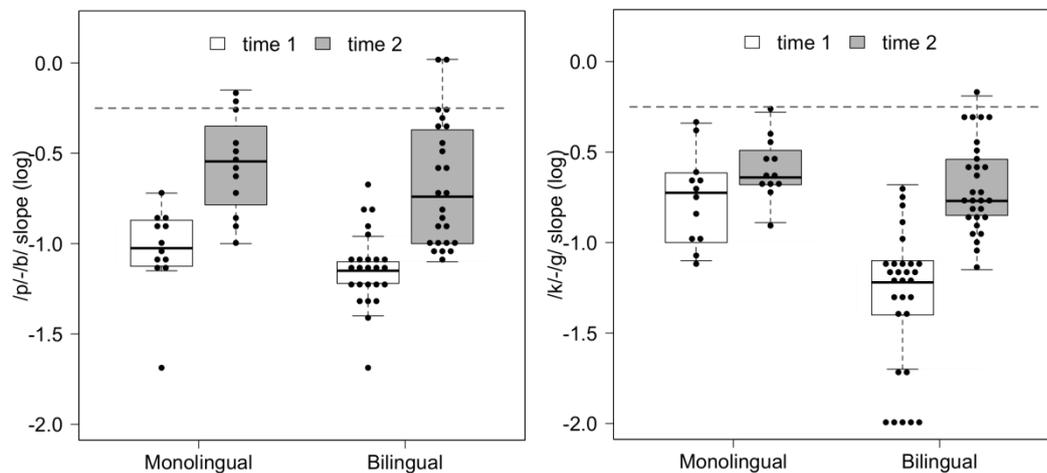
Using a longitudinal design, the current study tracked the acquisition of the English voicing contrast and monophthongal vowels by Sylheti-English speaking sequential bilingual children from the London-Bengali community. What is particularly interesting for the purpose of this study is the overlap between the voiced stops in English and the voiceless stops in Sylheti: the English voiceless stops (/b/, /d/, /g/) fall into the same voice onset time (VOT) region as Sylheti voiceless stops (/p/, /t/, /k/). For vowels, Sylheti has a much smaller vowel inventory (7 monophthongal vowels, no diphthongs), where tense-lax pairs (e.g., /i/-/ɪ/) do not exist (McCarthy et al., 2013).

**Materials and method.** 55 children took part in the study (40 Sylheti-English & 15 monolingual English-speaking controls). All children were tested twice: during the first year of preschool (mean age: 54 months old, Time 1) and again one year later during their first year of school (Time 2). Before starting pre-school the bilinguals had been exposed to a maximum of 20% English from their main caregivers. Categorisation of a *pea-bee* and *coat-goat* voicing continua were evaluated using a two-alternative forced-choice adaptive identification task. Vowel perception was assessed using a real word three-alternative forced-choice task, in noise and quiet. For production, English bilabial and velar stops were elicited in word-initial stressed position and vowels in a CVC context, using a picture-naming task. An acoustic analysis of VOT (stops) and formants (vowels) was conducted. To investigate the influence of language exposure and fine-grained phonetic variation on the children's speech perception and production, detailed caregiver interviews were conducted. For language exposure, data regarding the children's social networks (e.g., main interlocutors, language/s spoken to the child, number of hours spent with the child) was collected. For caregiver speech, recordings of the same English words produced by the children were made. Based on an acoustic analysis of VOT (stops) and formants (vowels), caregivers were grouped as high-accented or low-accented.

**Results and discussion.** Overall, the results indicate that sequential bilingual children are initially sensitive to their ambient L1 input. At Time 1, the bilinguals had significantly shallower categorisation slopes for the *coat-goat* voicing continuum than did their monolingual peers ( $p < .001$ ), indicating that bilingual children had less refined phonemic categories for English velar stops (see Figure 1). For *pea-bee*, there was no significant difference between the bilinguals and monolinguals ( $p > .05$ ). For vowel identification, the bilinguals had significantly lower accuracy scores than did the monolinguals ( $p < .001$ ). For production, the bilingual children used a significantly shorter VOT for

English bilabial and velar stops than did the monolinguals ( $p < .001$ ). However, for vowel production, there was no significant difference between monolinguals and bilinguals. At Time 2, there was no significant difference between the monolinguals and bilinguals for perception and production ( $p > .05$ ) indicating that on starting school, the bilingual children had acquired new categories in their L2 that closely matched those of their monolingual peers. Additionally, the results suggest that sequential bilingual children are particularly sensitive to the amount of exposure to each language as well as fine-grained phonetic differences in caregiver speech. Specifically, at Time 1, children who were exposed to more English and native-like English speech input from their main caregiver had categorisation slopes and vowel identification scores that were closer to that of their monolingual English peers than did the bilingual children with lower English exposure and Sylheti-accented input. These findings have implications for our understanding of language acquisition in complex multilingual settings.

**Figure 1.** Box plots of slope values for monolingual and bilingual children's /p-/b/ and /k-/g/ identification function. A higher log value indicates a steeper slope. The white boxes represent Time 1, and the grey boxes represent Time 2. The black dots are the individual data points. The dashed line is the adult monolingual English mean slope value.



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## **Understanding the later acquired aspects of the Irish language in children and adults**

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While it is accepted that children typically make great progress in their language acquisition in the years to age five, some complex language features have been shown to have a longer trajectory of development, well into the school years. For example, studies of the acquisition of noun gender in French found evidence of on-going development in middle childhood. Research indicates that such later-acquired features of language may be particularly dependent on quantity and quality of input. Different levels of accumulated exposure to native speakers may be necessary to acquire specific constructs, due to the variability in transparency in terms of form-function mapping and in formal and reliable cues (Gathercole, 2002c; Alarcón, 2010).

Irish is a threatened language undergoing accelerated change and convergence with English. This has contributed to inconsistency in the use of some of the later-acquired features like grammatical gender, even among highly proficient adult speakers of Irish. This has implications for young native speakers, since a lack of consistent and accurate input means that they may be delayed in acquiring, or indeed may not acquire, those features normally acquired in middle childhood 'by ear'. Gathercole and Thomas (2009) studied some of these later-acquired aspects of Welsh among emerging Welsh-English bilinguals and found that performance in these bilinguals' languages is significantly correlated with their language experience in each. They argued that language learners may need to be exposed to a "critical mass" of grammatical speech in a language in order to successfully master the later-acquired aspects of that language.

The question of what constitutes the criterion for successful acquisition is problematic if the norms of current adult usage present a moving target. Typical adult use of a language feature is often used as the marker for successful acquisition, but in current use of Irish among adults, performance on a number of later-acquired aspects of morphosyntax is either inconsistent or inaccurate. As adults are potential input sources to children, their performance on these aspects of Irish which are known as later acquired is central. Thus a key issue considered here concerns the assessment of children's performance in a context in which the language they are hearing around them is showing high levels of variability and change. Due to the convergence and change in current Irish use under the influence of English (Hickey, 2005), it is difficult to know the "end-point" towards which children's acquisition is progressing.

The present study is composed to two parts: adult data and child data. Adult (n=77) performance was examined using three tasks designed to measure morphosyntactic knowledge of grammatical gender following the definite article and with adjectives, and marking of possession which requires selective initial mutation in Irish. Examination of the results indicates that even highly proficient adults did not have full mastery of these aspects of Irish morphosyntax. The results show variability in performance, with very few proficient speakers reaching ceiling on the tasks.

In order to explore the adult norms further, semi-structured interviews were carried out with 11 young adult Irish speakers raised outside of the Gaeltacht and eight young adult speakers raised in the Gaeltacht with a view to qualitatively exploring the sociolinguistic context in which children acquiring Irish grow up. The interviews were analysed using thematic analysis. The main themes identified with regard to the participants' views on accuracy and expertise will be explored. Both the qualitative and quantitative data will be discussed with consideration of the sociolinguistic context this creates for new learners acquiring the language.

The results of the adult study will be considered in conjunction with data from children aged 7-11 who come from a range of language backgrounds (spanning Irish-dominant homes, bilingual homes and English-dominant homes), all of whom are also attending Irish medium primary schools. Data collection for this study is ongoing, and therefore the results presented will be preliminary (based on approximately 50 children). In this study, the same three tasks used with the adult sample were used to measure children's productive morphosyntactic knowledge in Irish and to assess when the ability to use this knowledge had been acquired. A measure of receptive morphosyntactic knowledge was also administered in order to investigate differences in receptive and productive use of these aspects of morphosyntax. Finally, measures of non-verbal intelligence and English were administered, thereby controlling for the variables of non-verbal IQ, English ability and age. Performance on this battery of measures will be reported. In addition, this paper will feature a discussion of what constitutes successful acquisition of these later-acquired aspects of Irish morphosyntax at a point when adult use of such morphosyntactic markers shows great variability, and when there is a decline in the value accorded to native speaker norms, given the current prominence of the non-native model of Irish proficiency.

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## **Learning a sign language as an L1 in adulthood: implications for notions of a sensitive period in phonological development**

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There is a large and comprehensive body of literature on the effects of linguistic isolation on the acquisition of language. Deaf children with hearing parents may receive very limited input of spoken language because of their deafness. In addition to lack of access to spoken language, some individuals may not be exposed to a sign language in childhood or adolescence. Some individuals may never be exposed to a sign language. Such cases have been reported among individuals who live in non-Western communities where they are the only deaf person in the community and where there is no access to formal schooling (Washabaugh, 1986; Morford, 1995, 1996; Torigoe & Takei, 2002).

Deaf adults who acquire a sign language in infancy outperform deaf adults who acquire a sign language as a first language in adolescence or later. Studies have used grammaticality judgments and a wide variety of production tasks, such as the use of verb morphology, sentence shadowing and recall, and various language processing tasks. Mayberry and colleagues (2002) have consistently reported problems in the comprehension of both American Sign Language and Signed English in signers with delayed exposure. During sentence recall and shadowing, adolescent delayed/late first-language learners produce a number of phonological<sup>1</sup> substitutions in target signs. Mayberry (1993: 1268) has interpreted this result as evidence that late first-language learners are “intermittently stuck at the surface level of language structure”. A study by Emmorey and Corina (1990) produced results consistent with this interpretation, showing that deaf individuals who acquired signing late take longer and need more visual information than native signers to identify signs. Adolescent learners of ASL as a first language show severe difficulties with comprehension and processing tasks. Morford (1995; 1996) has shown that such individuals can comprehend sentences in ASL under ideal, but not normal, conditions, requiring repeated or slowed (on video) presentation of signs for comprehension.

The data for the case study reported here were collected in the context of an assessment of fitness of a middle-aged deaf man to stand trial for several sexual assault charges. Muniram was born in Tanzania and is the only deaf person in the family. He did not attend school and had no contact with signers before his arrival in the UK in the 1970s when he was in his late 20s. He has some links with the local deaf community centre, using specialist social workers to help him with official correspondence.

The assessment comprised 3 sections:

- A. assessments of non-linguistic ability
- B. assessments of BSL (British Sign Language) and gesture (production and comprehension)
- C. interviews with Muniram

Assessments of BSL included sign comprehension and sign production tasks: Sign to Picture Matching; Naming, BSL Receptive Skills, and BSL Productive Skills. On Sign to Picture matching,

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<sup>1</sup> The term ‘phonological’ in sign language research refers to the level of sign structure comparable to the phonological level in words. The sign CAT consists of a specific handshape (thumb and index finger touching), location (cheek) and movement (repeating contact).

Muniram scored 16/40 correct (Deaf controls perform at ceiling). Unlike aphasic signers, who show no effect of iconicity, Muniram only scored 5/20 correct on non-iconic signs, a comparable score to that of hearing non-signers. His error patterns are revealing since 38% of his errors constituted choosing the visual distractor; a pattern never seen either in unimpaired or aphasic deaf signers. In this respect, he closely mirrored non-signers in the type of errors made, indicating that he has little knowledge of BSL phonology.

In the sign production task, Muniram scored 15/30 correct on highly familiar items. His errors comprised seven gestures, and seven cases where he produced incorrect (idiosyncratic) signed responses (for example, NIGHT SUN for MOON, GREEN BIG-UPRIGHT-OBJECT for TREE). He did not respond to one item. On low familiarity items, his performance was slightly poorer, scoring 12/30 correct. Errors comprised 12 gestures, two incorrect signed responses, and four no response. Muniram's gestures were very similar overall to the target BSL signs on the production test, but when the same sign was used in the comprehension task, he often did not recognise it, suggesting that Muniram was not using conventional strategies involving access to the language lexicon during this task, but rather using a gestural route.

Muniram was interviewed and assessed by a Deaf clinical psychologist who is a fluent user of BSL and English. We also had access to video recordings of police interviews conducted with a BSL interpreter. Muniram vocalises and 'mouths', although this is not intelligible, and he does not lipread<sup>2</sup>. He reported that he did not understand fingerspelling, but showed some knowledge of fingerspelling orthography when he tried to (incorrectly) fingerspell personal names and street names.

There are many atypical features in his spontaneous signing: phonological errors (e.g. handshape substitutions<sup>3</sup>); idiosyncratic vocabulary; grammatical errors (lack of verb agreement and indexing (i.e. It is impossible to always be clear who is the subject); poor time referencing (i.e. impossible to always be clear how events are linked in time); extensive use of gesturing in place of BSL. This is difficult to understand and interpret. Examples of these are described below:

### **1. Limited skills in using and understanding fingerspelling**

Muniram: ... J, CAN'T REMEMBER NAME, J, NEAR AROUND-CORNER (translated in the transcript as "Begins with a 'J', I can't remember the name of it, it begins with a 'J', it's just around the corner.")  
Interviewer: "A 'J'? I actually think that the address is 24 Christopher Close?"  
Muniram: YES, YES 24.  
Muniram sometimes uses 'sj' and sometimes 'js' to refer to Sainsbury's supermarket, demonstrating a lack of permanence in his conceptualisation of written English orthography and how fingerspelling maps onto this. His articulation of fingerspelling is very unclear and shows similar problems to those found in his use of BSL signs. He uses 'lc' for Leicester at one point, but immediately following this his articulation looks like 'nc' (Newcastle) and then 'mc' (Manchester). This shows difficulties with maintaining the contrasts necessary to produce 'l' distinctly from 'm' or 'n' (see footnote 2 above). It also signifies a lack of awareness that these contrasts are vital for communication partner comprehension.

### **2. Use of non-standard signs and phonological errors**

Muniram often produces signs with inconsistent and non-standard handshapes. For example, he produces LIE (in the context of telling untruths) with a variety of different handshapes which sometimes make LIE look like the signs for 'good' or 'nice', indicating the absence of a sub-lexical level of contrasts.

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<sup>2</sup> The ability to mouth isolated lip patterns of words in the absence of full knowledge of a language, or being able to lipread has previously been reported in deaf individuals (Schroeder, 1986; Vogt-Svendsen, 2001)

<sup>3</sup> In BSL substitution of different handshapes or locations makes a difference in meaning (e.g. METAL (bent index finger taps chin) vs. UNCLE (bent index and middle fingers tap chin)).

### 3. Observations by interpreters of communication difficulties

There are numerous occasions where the interpreter or other signers present observe that communication has broken down and attempt to repair the communication, although these attempts are less frequent than the number of points where such breakdown occurs. Muniram may use a non-standard sign: "... Muniram's sign for a couple of things don't match what I understand to be appropriate signs ... The start of the tape will show that he uses this sign, which I understand to be 'kiss' but then when we clarify it he uses a different sign which is this, which I understand to be morning..." so that was an error on my part, the interpreter could clarify this"; or he may articulate a sign incorrectly: "Can I just clarify for the video, I think the sign that he used there for mistake – he was actually meaning 'When'<sup>4</sup>".

Assessments of non-linguistic abilities included both standardised and non-standardised assessments. Standardised cognitive assessments were administered in order to obtain a picture of non-verbal abilities. These included: Raven's Standard Progressive Matrices (Raven et al., 1997) and two subtests from the performance battery of Wechsler Adult Intelligence Scale-Third Edition (WAIS-III). Non-standardised tests included a picture sequencing task and a test of gesture comprehension. Muniram's scores suggest that his intellectual abilities lie towards the lower end of the average range in the general population. It would be possible to undertake a full performance IQ assessment, but the tests completed give sufficient information to conclude that he is a man with unimpaired intellect in the face of severe language deprivation.

Muniram's difficulties suggest that he has little or no access to BSL phonology, and that his skills and experience in gesturing do not compensate for his lack of exposure at a sensitive period for phonological development. His difficulties are supported by MacSweeney et al.'s (2008) study of phonological processing in spoken and signed language. This fMRI study demonstrated that a left-lateralised fronto-parietal network is engaged during phonological similarity judgements made in both BSL (A) and English (B), suggesting that the neural network supporting phonological processing is, at least to some extent, supramodal, and therefore should reflect similar plasticity effects in regard to phonological development. In that study, non-native signers activated the left inferior frontal gyrus more than native signers during the BSL task, and also during the task performed in English, indicating that phonological processing required greater effort when a first language was acquired late, whether it was a sign language or a spoken language. Timely exposure to and development of a first language must be considered to be of critical importance in interventions with deaf children.

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<sup>4</sup> the sign MISTAKE is located on the chin; WHEN is located on the cheek, but they both have the same handshake and movement

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## Development of auditory processing skills in children with mild to moderate hearing loss: Links to language?

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Impaired auditory processing has been proposed as a primary deficit in developmental disorders of language, including dyslexia and specific language impairment (Goswami, 2011; Tallal, 2004). However, it remains uncertain whether deficits in auditory processing are causally related to the language problems seen in these groups (Rosen, 2004). Children with mild to moderate sensorineural hearing loss (MMSNHL) offer a unique opportunity to investigate the link between auditory processing deficits and language disorders from a causal perspective.

In this talk, I will present behavioural and electrophysiological data from a recent cross-sectional study that examined the development of auditory processing and language skills in 49 8-16 year-old children with MMSNHL and 41 age-matched typically-developing controls. Auditory processing abilities were assessed in two ways. First, child-friendly psychophysical techniques were used to obtain discrimination thresholds for stimuli spanning three different timescales ( $\mu$ s, ms, seconds), and across three different levels of complexity, from simple nonspeech tones (frequency discrimination, frequency modulation detection, rise-time discrimination), to complex nonspeech sounds (assessing discrimination of modulations in formant frequency, fundamental frequency, and amplitude), and speech sounds (/ba/-/da/ discrimination). Thresholds were obtained both when children with MMSNHL were wearing hearing aids and when they were not. Second, long-latency auditory event-related potentials (ERPs) to pure tones, complex tones, and speech sounds were recorded, and the intra-class correlation (ICC) method was used to assess the age-appropriateness of each child's ERP relative to that of the control group average for young (8-12 years) and older (13+ years) age bands (see Bishop et al., 2007). Language abilities were assessed using a battery of standardised assessments of phonological processing, reading, vocabulary, and grammar.

At the group level, children with MMSNHL performed significantly more poorly than controls on all but one of the psychophysical measures of auditory processing, and these deficits were not fully remediated by the wearing of hearing aids. Children with MMSNHL also showed ERPs that were less age-appropriate than those of controls, particularly amongst the older age band. Finally, children with MMSNHL scored more poorly than their peers on the tests of phonological processing, vocabulary, and grammar but, marginally, not on tests of word and nonword reading. However, at both the group and individual level, deficits in auditory processing were not reliably associated with impairments in language ability.

Our findings challenge the proposal that deficits in auditory processing are either necessary or sufficient to cause developmental disorders of language. Results will be interpreted in the context of a multiple-risk factor model whereby impaired development of auditory processing skills constitutes one of a number of risk factors for impaired language development.

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## **Audio-visual speech perception in school-aged children with and without language impairment**

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Visual speech cues are known to provide a powerful source of information for adults. They confer a significant advantage for speech perception in auditory noise (Grant & Seitz, 2000; Sumbly & Pollack, 1954), and result in some persuasive illusions affecting both the content (McGurk & MacDonald, 1976) and location (Alais & Burr, 2004) of the auditory speech signal. Given that infants show sensitivity to audio-visual speech from just two months of age (e.g. Burnham & Dodd, 2004; Patterson & Werker, 2003), it is surprising that around age five children appear not to be influenced by visual speech information (Tremblay et al., 2007; Wightman, Kistler & Brungart, 2006). This inconsistency highlights how little is understood about the developmental trajectory of audio-visual speech perception, and the role that visual speech cues might play in the development of language.

Besides understanding the role that visual speech cues play for typically-developing children, one important area of enquiry is the benefit, or potential benefit, they provide for children growing up with language impairment. Children with language impairment frequently show deficits in auditory speech perception (at least at a group level); including difficulties perceiving speech in noise (Ziegler et al., 2011). Currently, almost all the work pertaining to speech perception has been carried out in the auditory domain, thereby contrasting with naturalistic speech environments which are typically audio-visual. The value of visual speech cues during speech perception in noise suggests that visual information may ameliorate processing difficulties. This is important given that auditory processing difficulties have been speculated to be significant in the aetiology of the language impairment and in on-going issues with language development through childhood; at least for a subgroup of children.

In the current study 4-11 year-old children with and without a language impairment were assessed on a range of language and speech perception tasks. 41 typically developing children (mean age: 8y 0m, range: 4y 5m – 11y 10m) and 27 children with a diagnosis of specific language impairment (mean age: 8y 10m, range: 5y 2m – 11y 6m) were included. Diagnosis was supported with administration of the following standardised assessments: the BPVS2 (Dunn et al., 1997); the TROG2 (Bishop, 2003); the Castles and Coltheart Test 2 (Castles et al., 2009), the Recalling Sentences subtest from the CELF4 (Semel, Wiig & Semel, 2006); the Non-Word Repetition subscale from the CTOPP (Rashotte et al., 1999); and the Pattern Construction subscale from the BAS2 (Elliott, Smith & McCulloch, 1997). Criterion for inclusion in the Language Impaired (LI) group was having z-scores of at least -1 on more than one of the standardised language tasks. Three children recruited with a diagnosed impairment did not meet this criterion and one child recruited into the Typically Developing (TD) group did meet it, resulting in 43 children being included in the TD group and 25 children in the LI group.

The two main experimental procedures carried out were: 1) the Test of Child Speechreading (ToCS; Kyle et al., 2013), which was developed to assess silent speechreading ability at the word, sentence and short story levels; and 2) a test of speech in noise perception (SpiN) with and without visual support to assess the benefit of being able to see the talking face under the challenging listening condition of two competing speakers.

Full sentences were used as both target and distractor stimuli for the SpiN task. Each child completed two conditions of this task, run as two separate blocks. The first condition was Auditory-Only (AO), where both target and distractor stimuli were auditory, and the second was Audio-Visual

(AV), where the target sentences were audio-visual (videos) and the distractor stimuli were auditory. Target sentences were spoken by a female speaker and were of the form “Show the dog where the X is”, where X denotes a single syllable, highly imagable, noun with mean age of acquisition 4.2 years (Kuperman, Stadthagen-Gonzalez & Brysbaert, 2012), such as ‘key’ and ‘bear’. The distractor sentences, spoken by a male speaker, took the form “Show the cat where the X is”. Distractor nouns were similar to the target nouns, but non-overlapping, and had an age of acquisition of 4.0 years, for example ‘moon’ and ‘clock’. Each trial consisted of a stimulus presentation immediately followed by the response screen, in which children were presented with an image of a dog next to four picture responses: the target plus three distractors, each of which was a minimal pair with the target. For example, the target ‘chair’ was presented with the response options ‘chair’, ‘hair’ ‘pear’ and ‘bear’. A four-alternative forced-choice pointing response was required. The SpiN task used an adaptive staircase procedure to find threshold signal to noise ratio (SNR) for performance at 70.7% accuracy. A two down one up decision protocol was adopted, with starting SNR at -20dB, initial steps of 10dB and proceeding steps of 4dB. For each condition the task ran until six reversals of direction had been made, or 32 trials, whichever was the shorter.

Analysis of ToCS revealed no main effect of Group but main effects of Condition and Age and an Interaction between Age and Group. This suggests that silent speechreading ability improves over mid-childhood, but over that time children with language impairment gradually fall behind their typically-developing peers. Language ability (measured by BPVS) predicted speechreading ability over and above chronological age.

For the SpiN task mean dB over the reversal trials was used as the dependent variable. Here, main effects of Condition, Age and Group emerged but no interaction between Group and Age. Again language ability predicted performance on this task better than age. Notably, no variables included were able to predict the difference between the AO and AV conditions, that is, the benefit of visual cues. The absence of an interaction between Age and Condition suggests that even the youngest children (aged 4) were able to use visual cues to support auditory speech perception. Also, while those children with language impairment did perform significantly worse than their peers on this task, they were able to benefit from the visual cues and they did not fall progressively behind over developmental time, unlike in the speechreading task.

The SpiN data were additionally analysed by establishing the psychometric functions for performance accuracy by SNR for each group. We tested the degree of non-linearity in the group data for each condition and found that under the AO condition the TD group showed a linear relationship between SNR and performance accuracy, but for the LI group the data was better described by a quadratic function. This indicates that the LI group actually did better on the task given low-level auditory noise. One possible explanation for this result is a phenomenon known as *stochastic resonance*, whereby low-level noise assists signal detection by resonating with the signal at co-occurring frequencies. Stochastic resonance is seen in a wide variety of non-linear biological systems (Hanggi, 2002) and has, on a very few occasions, been applied to studies of human performance, for example to explain better cognitive performance in noise in children with ADHD (Söderlund, Sikström & Smart, 2007). The effect of visual support on each group’s psychometric function also revealed an interesting difference. For the TD group visual support essentially just shifted the function to the left, as would be expected, while for the LI group visual support flattened the function, such that it became harder to describe the relationship between SNR and performance.

These data suggest that some aspects of sensitivity to visual speech develop over mid-childhood, while other aspects remain consistent over this period. There are implications here for understanding the development of audio-visual speech perception over typical development, as well as for both the aetiology and clinical management of school-aged children with Language Impairment. We suggest that it is important to consider the role of visual information during

language acquisition generally, and to explore the nature of the support that visual cues might offer children, especially given the type of auditory noise experienced in learning environments. With respect to Language Impairment, a question arises regarding the potential to train speechreading ability with a view to supporting auditory speech perception and broader language development.

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## Speech disruptions in school-age children with SLI: a developmental perspective

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The purpose of this study was to describe the development of speech disfluency in school-age children with specific language impairment (SLI). To date, longitudinal studies of speech disfluencies in children with SLI have remained scarce. Speech disruptions in the narratives from 30 children with SLI were analysed and compared to 30 language-matched (LA) and 30 age-matched (CA) typically developing children. The three groups were measured once a year with a story generation picture narrative task. At the three time points, the children with SLI had a mean age (SD in months) of 8;5 (1.7), 9;4 (1.6), and 10;4 (1.9) years, the LA control children were aged 6;5 (2.4), 7;5 (2.4), and 8;5 (2.4) years, and the CA control children were aged 8;5 (3.5), 9;5 (3.5), and 10;5 (3.5) years, respectively. Descriptives of non-verbal IQ, Kaufman sequential memory tests and subtests of the Language Proficiency Test (LPT, TAK; Verhoeven & Vermeer, 2001) are presented in Table 1. The three groups did not differ on non-verbal IQ, but the SLI group performed very poorly on the sequential memory tasks compared to both control groups. The SLI group and the LA group did not differ on any of the LPT language subtests. The CA group scored significantly higher on all LPT subtests when compared to the LA and SLI groups.

**Table 1:** Non-verbal IQ, Sequential Memory, and LPT Subtests in the three Groups at T1

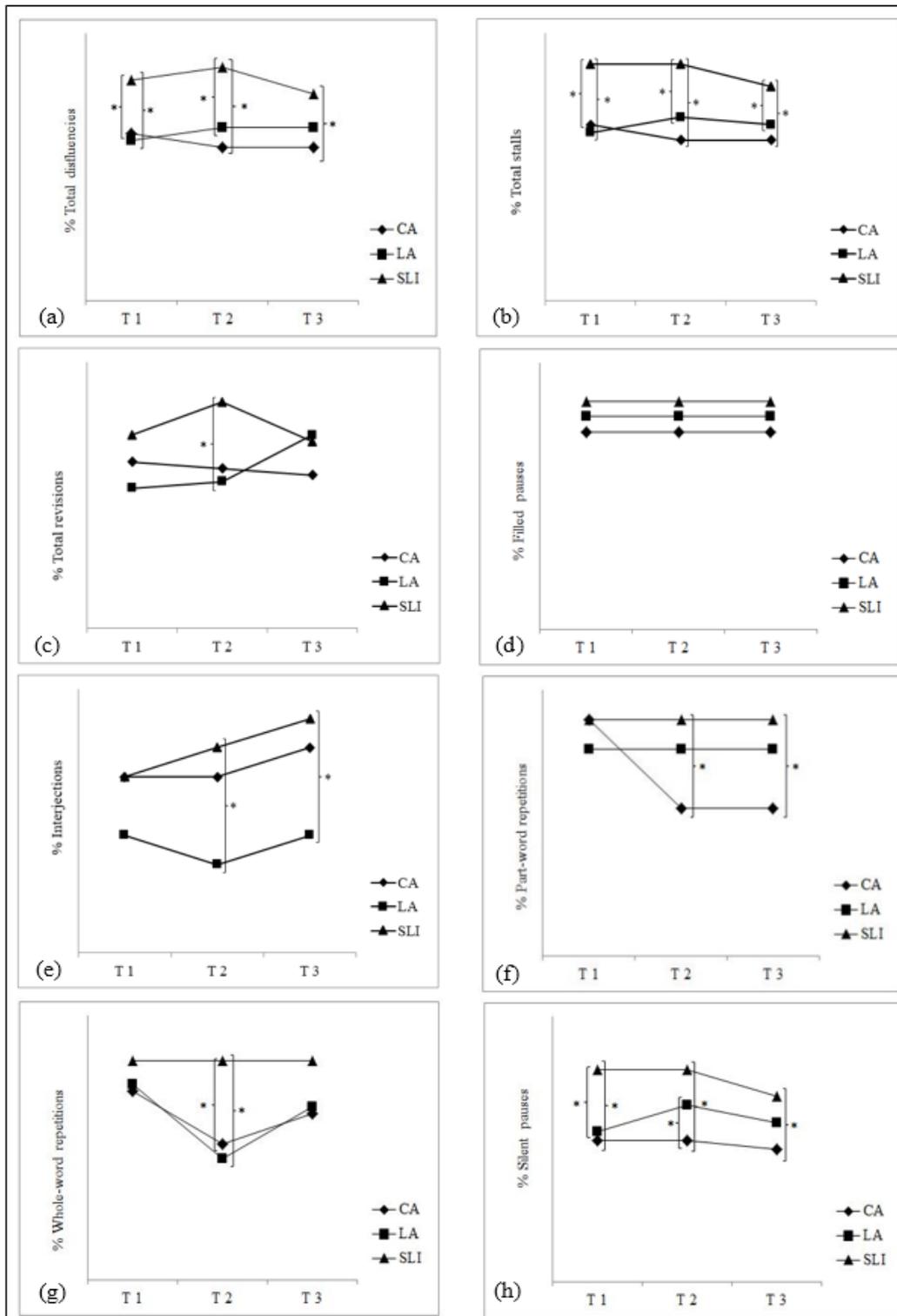
	Max. score	SLI ( <i>n</i> = 30) <i>M</i> ( <i>SD</i> )	LA ( <i>n</i> = 30) <i>M</i> ( <i>SD</i> )	CA ( <i>n</i> = 30) <i>M</i> ( <i>SD</i> )
Raven CPM <sup>a</sup>		6.04 (1.98)	6.32 (1.79)	6.81 (1.75)
Kaufman ABC seq. memory <sup>b</sup>		84.27 (9.38)	96.03 (11.24)	100.03 (10.67)
LPT Receptive vocabulary <sup>c</sup>	96	75.73 (9.27)	77.33 (6.85)	88.10 (4.44)
LPT Sentence comprehension I <sup>c</sup>	42	37.67 (2.25)	36.90 (2.17)	40.37 (1.81)
LPT Sentence comprehension II <sup>c</sup>	42	36.37 (3.07)	35.40 (2.51)	38.27 (1.91)
LPT Morphology <sup>c</sup>	24	17.43 (5.02)	16.57 (5.56)	22.80 (1.42)

*Note.* <sup>a</sup>standard score (range +/- 1 *SD* = 3.0-7.0), <sup>b</sup>quotient score, <sup>c</sup>raw score. LPT Sentence comprehension I measures function words, LPT Sentence comprehension II measures syntactic patterns, and LPT Morphology measures production of noun plurals and past participles.

Speech disfluencies were analysed for frequencies, types (i.e. silent and filled pauses, part-word and whole-word repetitions, interjections, and revisions), and syntactic positions (i.e. utterance-initial, clause-initial, phrase-initial, and word-initial). In addition, silent pause duration was measured in four duration categories: (a) 250-500 ms, (b) 500-1000 ms, (c) 1000-2000 ms, or (d) > 2000 ms. This disfluency taxonomy was adopted from Guo, Tomblin and Samelson (2008). Disfluency rates of the types were computed by dividing the number of each type by the number of intended (fluent) words (Dollaghan & Campbell, 1992). Disfluency rates at the onset of syntactic positions were computed by dividing numbers of disfluencies by the possible syntactic positions (i.e. number of utterances, clauses, phrases, and words).

Results of frequencies and types of disfluencies in the three groups at T1, T2 and T3 are presented in Figure 1. On the composite measure total disfluencies, the percentages exhibited by the children with SLI were significantly higher than in the CA group at all three time points, and higher than in the LA group at T2 and T3. Total speech disfluencies were subdivided further into stalls and revisions.

**Figure 1.** Disfluencies in the Groups at the three Time Points: (a) Total disfluencies, (b) Total stalls, (c) Total revisions, (d) Filled pauses, (e) Interjections, (f) Part-word repetitions, (g) Whole-word repetitions, and (h) Silent pauses (schematic outline, \* = significant difference between groups).



Stalls can be regarded as a strategy to gain time in the sentence formulation process, because of problems with conceptualising, building up syntactic structures or lexical retrieval (Rispoli, 2003). Revisions are repairs of already produced material and can be either grammatical, semantic or phonological. The children with SLI produced more stalls (i.e. silent and filled pauses, part-word and

whole-word repetitions, and interjections) than both the LA and CA groups at all three time points. The analysis of the separate stalls showed that the three groups did not differ on filled pauses. Filled pauses are generally regarded as a way to keep the floor (Clark, 2002). However, the SLI group had more silent pauses than the CA group, and also had more (stutter-like) part-word repetitions at T2 and T3. According to Guo et al. (2008), part-word repetitions may arise from difficulties in retrieving the phonological information of lexical items. The SLI group also produced more whole-word repetitions at T2 than both control groups. Whole-word repetitions may function to accommodate the listener by keeping the syntactic units intact (Clark, 2002). Percentages of interjections in the SLI group were similar to the CA group, but were higher than in the LA group. The percentages of revisions did not differ significantly between the three groups.

With respect to the distribution of speech disfluencies, we found that in all three groups the highest speech disruption rates were found at utterance onset, followed by clause-initial, phrase-initial and word-initial positions. The SLI group had more word-initial disfluencies than the CA group at all three time points. The only difference between the CA group and the LA group was found for silent pauses in the 250-500 ms category.

Furthermore, only relatively minor changes in speech disruption patterns were found across time points in the three groups. Over time, silent pause rates steadily decreased in the SLI group, but no changes were observed for the other types of disfluencies. In all three groups, silent pauses > 2000ms decreased over time. In the LA group, revisions increased between T2 and T3, suggesting that monitoring still develops in younger typically developing children. In addition, in the CA group part-word repetitions and phrase-initial disfluencies decreased between T1 and T3. This result was not observed in the SLI and LA groups, suggesting that a decrease of these stutter-like and phrase-initial disfluencies might reflect further linguistic sophistication in the older TD children.

It was concluded that speech disfluency is related to language abilities, as the SLI group (and to some extent) the LA group demonstrated higher disfluency rates than the – linguistically more advanced – CA control group. The higher disfluency rates at word onset indicate that difficulty with lexical retrieval may contribute to their disfluency. The findings suggest that, although some improvement in speech fluency is seen, sentence formulation continues to be challenging for older school-age children with SLI. The higher disfluency rates in the SLI group reflect their compromised expressive language skills.

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## Perception and production of subject verb agreement in children and adolescents with and without Specific Language Impairment

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Children with specific language impairment (SLI) have profound problems in learning and using the linguistic rules of their language while there is no clear aetiology for these problems. Although there is much literature on children with language impairments in primary school, little is known about the language symptoms of SLI at an older age. This is one of the questions of this study.

The limited literature indicates persistent problems, but also shows variability in individual performance depending on the task and context. Children for instance use the correct inflection of a verb in one context, but choose an erroneous form in another context (Bishop, 1994). It has been hypothesized that this variability in performance can be explained by processing problems in the SLI population. Children with SLI often have problems in aspects of information processing (e.g. working memory). This may affect rule learning (and thus rule knowledge) but at the same time may also affect rule implementation once the rules have been learnt (Bishop, 1994). The question remains to what extent problems in SLI can be attributed to problems in rule knowledge or to problems in rule implementation, and what factors are of influence on the implementation of rules.

To answer these two questions, a group of Dutch speaking children with SLI (aged 6-10 years) and a group of adolescents with SLI (aged 12-16 years) were compared to two age-matched typically developing (TD) groups (N=±30 per group). They were tested on their perception and production of subject verb agreement, a grammatical variable known to be vulnerable in SLI. Perception of this linguistic variable was tested using a judgement task, while production was tested via elicitation. Both the perception and the elicitation task were constructed to include variance in phonological complexity of the coda of the verb stem (one or two consonants), consonant type in the coda of the verb stem (sonorant, fricative or plosive) and syntactic complexity was varied in the elicitation task to test the effect of different linguistic contexts. Furthermore, the children were tested on working memory and phonological processing as measures of processing abilities.

The first results indicate significant differences between children with SLI and their TD peers in accuracy on subject verb agreement, both in production and perception. Although a cross-sectional comparison between the children and adolescents with SLI shows development in their accuracy on subject verb agreement, it also indicates persistent problems in the adolescent SLI population.

**Table 1.** Perception and production of subject verb agreement in children and adolescents with and without SLI

	Perception		Production	
	N	Accuracy	N	Accuracy
Children SLI	32	61.52	24	79.20
Children TD	27	91.48	22	97.74
Adolescents SLI	31	93.63	31	87.37
Adolescents TD	29	98.43	30	95.33

Comparisons between verbs with a simple or a complex coda and between verb stems ending in a sonorant, a fricative or a plosive indicate that both the complexity of and the consonant type in the coda influence performance, especially in the SLI groups. Suffixes for subject verb agreement are more difficult to perceive and produce in verbs with a complex coda than in verbs with a simple coda. Furthermore, both perception and production of subject verb agreement is more difficult with

verb stems with codas ending in a fricative, compared to sonorant and plosive endings. Apparently, the phonological form of the verb affects implementation of the rule for subject verb agreement.

Comparisons between different syntactic contexts will be presented and correlations between the linguistic data and the processing measures will be discussed. The results will be evaluated in the light of theoretical explanations for SLI and clinical implications will be addressed.

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## FRIDAY AFTERNOON - ORAL SESSIONS

14:00-14:40	<b>Keynote 7 – Natalia Zharkova:</b> Speech motor control development in children between 5 and 13 years old: evidence from ultrasound imaging of tongue movements
<b>14:40 - 15:20</b>	<b>Oral Session 6: Development of speech production in typical populations II</b>
Yvonne Wren, Sharynne Mcleod, Paul White, Laura Miller & Sue Roulstone	Speech development at age 8: Findings from a longitudinal population study
Saloni Krishnan, Katherine Alcock, Daniel Carey, Lina Bergström, Annette Karmiloff-Smith & Fred Dick	Oromotor control and imitation predict novel word production in the school years
<b>15:20 - 15:50</b>	<b>TEA</b>
<b>15:50 - 17:10</b>	<b>Oral Session 7: Development of speech perception in typical populations II</b>
David Maidment, Hi Jee Kang, Hannah Stewart & Sygal Amitay	The development of audiovisual integration in children listening to noise-vocoded speech
Jenni Heikkilä, Eila Lonka, Sanna Kuitunen & Kaisa Tiippana	Speechreading skills in Finnish-speaking adults, typically developing children and children with specific language impairment
16:30 - 17:10	<b>Keynote 8 – Stuart Rosen:</b> Developmental aspects of understanding speech in noisy backgrounds

## **Speech motor control development in children between 5 and 13 years old: evidence from ultrasound imaging of tongue movements**

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There is growing evidence of protracted development of spatiotemporal motor control in speech. Studies addressing this topic have used acoustic analyses (e.g. Lee et al. 1999; Romeo et al. 2013), as well as articulatory techniques, such as tracking lip and jaw movements (e.g., Walsh and Smith 2002; Smith & Zelaznik 2004; Sadagopan & Smith 2008), measuring oral airflow (Koenig et al. 2008), or imaging tongue movements (Zharkova et al. 2011; 2012; in press). This presentation will focus on the development of lingual coarticulation in children and on the changes in variability of tongue shape and position with increasing age, examining ultrasound imaging data on tongue movements.

Previous studies of lingual coarticulation in children and adults have produced conflicting evidence on the relative extent of vowel-on-consonant coarticulation in children and adults (e.g. Kent 1983 versus Nittrouer et al., 1989). There is also evidence that different consonants behave differently depending on age (Katz & Bharadwaj, 2001; Zharkova et al., 2011; 2012). In Zharkova et al. (2011; 2012), consonant-vowel syllables with the consonant /s/ or /ʃ/ and the vowel /a/ or /i/ were produced by adults and 6-9-year-old children in the carrier sentence "It's a ... Pam". Midsagittal tongue curves at mid-consonant were compared across vowel contexts. For /ʃ/, there was a significant vowel-related difference in tongue position for both groups of speakers, and the difference was significantly greater in the children than in the adults. For /s/, a vowel-related difference was observed in the adults, but not in the children.

With respect to token-to-token variability in tongue posture, at mid-consonant both /s/ and /ʃ/ were found to vary more in 6-9-year-old children than in adults (Zharkova et al., 2011; 2012). Using the same methodology, Zharkova et al. (in press) compared token-to-token variability in 10-12-year-old preadolescents and in adults, and found no significant difference across age groups. The amount of vowel-induced coarticulation at mid-consonant was also similar across age groups, for both /s/ and /ʃ/. However age-related differences were reported in the timing of coarticulation, with the preadolescents having an adult-like pattern for the onset of a vowel-on-/s/ effect, but a later-than-adult onset of coarticulation for /ʃ/. Zharkova et al. (in press) concluded that age-related differences in motor programming, which depend on the articulatory properties of individual segments and combinations of segments, can occur until at least the age of 12 years.

Further investigation of the developmental changes in segment-specific lingual coarticulation is carried out in an ongoing study collecting synchronised acoustic and high speed ultrasound tongue imaging data from children between the ages of 3 and 13 years old, in several tightly spaced age groups. Four consonants differing in the degree of articulatory constraint on the tongue (in increasing order, /p/, /t/, /s/ and /ʃ/; cf. Recasens et al., 1997) are recorded in consonant-vowel syllables in a carrier phrase, with five repetitions per target syllable. Some findings on consonant-specific coarticulation for 5-year-olds, 9-year-olds and 13-year-olds will be presented. The findings from this and previous ultrasound studies will be discussed in relation to existing theoretical approaches to the development of coarticulation in children, as well as to the Degree of Articulatory Constraint model of lingual coarticulation (Recasens et al., 1997), which has been used in numerous studies of adult speech to explain differential coarticulatory patterns across speech sounds.

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## **Speech development at age 8: Findings from a longitudinal population study**

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Studies of speech sound development and disorder have typically focused on early development prior to school entry. This is understandable given the findings that speech disorder which persists beyond age 5 is associated with a risk of poor outcomes in terms of learning and later employment prospects (Felsenfeld, Broen & McGue, 1992/1994; Stothard et al., 1998). However, less is known about the nature of speech development and disorder in the early years of primary education.

It is generally agreed from studies of speech acquisition that the process of learning to use a system of speech sounds is usually complete by age 8 (Dodd et al., 2003; James, 2001; Smit, 1993a, 1993b). While it is known that for some children, difficulties with their speech persist beyond age 8, there is limited information about the nature of such children's difficulties and how they compare with children who have typically-developing speech at the same age.

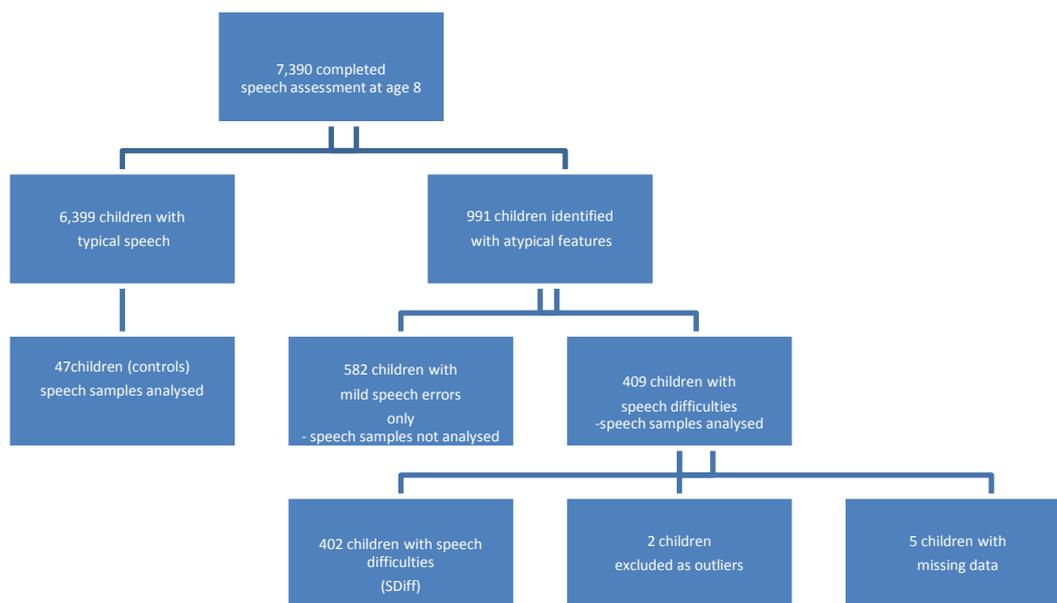
The aim of the study reported in this paper was to describe the speech production of children aged 8 in a population study. A community sample of 7,390 children in Avon, an area in the South-West of England, was assessed on a range of speech and language tasks as part of a large scale longitudinal study of children's health and development (ALSPAC – Avon Longitudinal Study of Parents and Children). The assessments took place in a university clinic and were carried out primarily by speech and language therapists and on occasion, by psychologists who had been trained by the speech and language therapists. Specifically, the children completed tasks which resulted in speech samples of single word naming, continuous speech (picture description and exposition) and non-word repetition.

Those collecting the speech samples were asked to identify children with atypical features in their speech. In particular, they were asked to listen for children who produced errors in their speech which were not compatible with the local regional accent and which could not be blamed on an idiosyncratic production. Whilst not all of these children would have received a formal diagnosis of speech sound disorder following a diagnostic assessment, the aim was to identify how children with a broad range of speech difficulty compare with children with typically-developing speech on a range of speech measures.

A total of 991 (13.4%) children were identified this way and they included a range of children from those with mild occasional errors to others who had a significant loss of intelligibility. Of these 991 children, 582 (7.88%) children were identified with 'speech errors' only, as defined by Shriberg et al., (2010), i.e. problems with sibilants and rhotics alone. Five children had missing data and the remainder, two children had data which showed as outliers and suggested that their data had been corrupted. The remaining 402 (5.43%) children, were identified as having a broader range of speech difficulties (that could include difficulties with sibilants and rhotics). The speech samples of these 402 children were transcribed and analysed in depth using the PROPH programme in Computerized Profiling (Long, Fey & Channell, 2006) alongside those of 47 children with no known speech difficulties (controls). The 47 controls were selected at random from the rest of the cohort of 6399 children who appeared to have typically-developing speech.

Transcribed samples of the single word, continuous speech and nonword repetition were analysed in terms of percentage consonants correct measures, error types (substitution, omission, distortion, addition) and syllable structure. The patterns of speech production of children who were identified as having difficulties were then compared with the 47 children who were typically developing. Figure 1 summarises the sample at each stage of assessment and analysis.

**Figure 1:** Summary of sample progression



Statistical analysis of the data showed that the 8-year-old children with speech difficulties had more difficulty than the controls in correctly producing late 8 consonants, fricatives, affricates, and consonant clusters. In addition, substitutions and distortions were more common than omissions and additions. Groups were distinguished in the single word samples by percentage of substitutions and distortions; in the continuous speech samples by percentage vowels correct, percentage omissions of singletons, omissions of the entire cluster and stress pattern matches; and in the nonword repetition task by percentage vowels correct, percentage of entire cluster omissions, percentage of distortions and percentage stress pattern matches. Details relating to the statistical analysis will be provided during the presentation.

Despite the heterogeneity of the group of children with speech difficulties in terms of severity and nature of error, they were nevertheless distinguishable from the controls in terms of the characteristics of their speech output. These findings suggest that while some children may not be considered part of a clinical population in all cases or included in estimates of prevalence, they may still exhibit characteristics within their speech which are atypical when compared with their peers.

The clinical implications of these findings suggest that connected speech and non-word repetition should be used routinely to supplement information from single word analyses for children of this age as these are more likely to highlight problems with vowels and stress patterns. There is also a need for discussion around the issue of acceptability and intelligibility. Whilst many of the children in the speech difficulties group reported in this paper may have had intelligible speech, they may not have had 'acceptable' speech in their own eyes or those of their peers. The interaction between acceptability and other factors such as personality and resilience could impact on an individual

child's social and emotional development and needs to be considered in the management of older children's speech.

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## Oromotor control and imitation predict novel word production in the school years

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The school years see considerable increases in the number of words children understand and produce, and the sophistication with which they can put these words together. In the same period there are marked improvements in control of speech articulators. When children hear and then utter a newly acquired word for the first time, they must transform a novel speech signal into a series of coordinated, exquisitely timed oral motor movements. This ability - the reproduction of novel nonwords - is a sensitive marker of language impairment. Although considerable work has been carried out regarding the relationship of nonword repetition to phonological memory and 'low-level' auditory abilities, much less is known about how children's oral motor control and imitation skills might influence their ability to repeat novel nonwords.

We targeted the relationship between oromotor control (Alcock et al., 2000; Krishnan et al., 2013) and nonword repetition (CTOPP; Wagner, Torgesen & Rashotte, 1999) in two cohorts of school-age children. The first cohort consisted of 40 typically developing children between the ages of 7-12 years. The second cohort was recruited at a later stage, and consisted of 37 typically developing children (age range: 6;9-7;7 years). Even when controlling for a range of auditory-motor and language abilities, we found that in both cohorts, oromotor control/imitation strongly predicts nonword repetition. In a second study, we studied the relationship between oromotor control/imitation, short-term memory (forward digit span from the WMTB-C; Pickering & Gathercole, 2001) and diadochokinetic ability, and assessed each of their contributions to nonword repetition. We tested 35 typically developing children between the ages of 5-8 years for this study. We found that individual differences in oromotor control/imitation predicted nonword repetition scores above and beyond the variance accounted for by short-term memory measures. These findings suggest that school-age children's nonlinguistic oromotor skill and nonword repetition abilities are meaningfully linked. Further, they indicate that aspects of language learning and perhaps, consequent language deficits, may be rooted in the ability to perform complex sensorimotor transformations.

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## **The development of audiovisual integration in children listening to noise-vocoded speech**

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Speech is a multimodal experience: Visual information derived from a speaker's mouth movements significantly improves auditory speech perception, particularly during adverse listening conditions (Bishop & Miller, 2009; McGettigan et al., 2012; Ross et al., 2007; Sumbly & Pollack, 1954; Summerfield et al., 1989). A large body of empirical work has also been devoted to understanding the developmental trajectory of audiovisual integration skills in children. It has been argued that the ability to integrate auditory and visual sources of verbal information develops at a very young age, and is even evident before the acquisition of language. This has been shown using the well-documented McGurk effect (McGurk & MacDonald, 1976), where infants as young as four months of age display a preference for congruent, as opposed to incongruent (i.e. McGurk) stimuli (Dodd, 1979; Hollich, Newman & Jusczyk, 2005; Kuhl & Meltzoff, 1982; Lewkowicz, 2010; Walton & Bower, 1993).

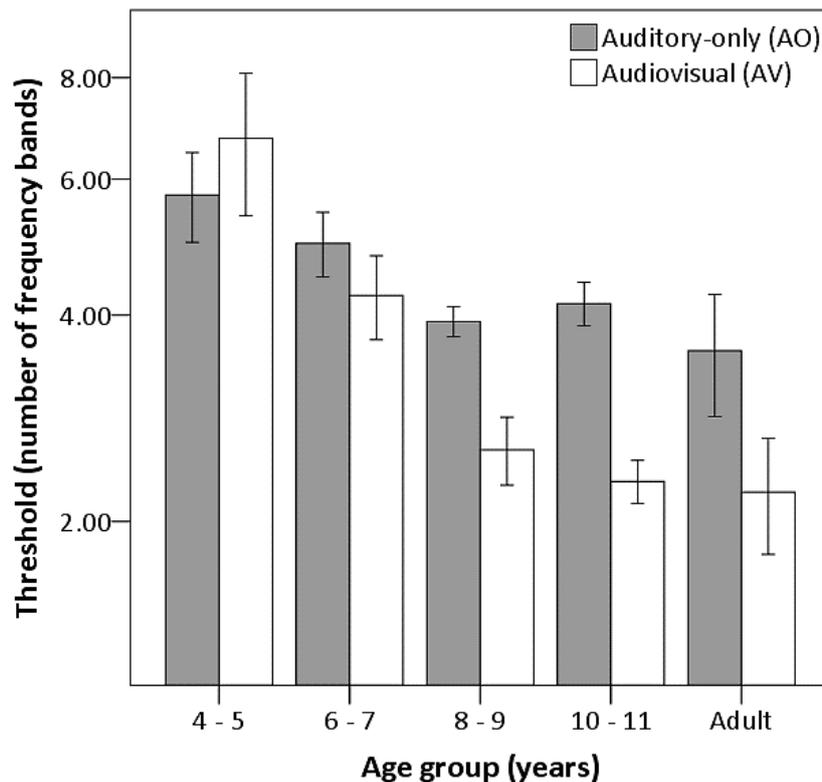
However, evidence derived from the McGurk effect may instead measure an infant's ability to identify whether information across two channels matches, as opposed to the ability to combine both inputs in order to improve perception. Although visual articulations have been shown to improve auditory speech perception in children between 4-14 years of age when presented in background noise, the magnitude of benefit is comparatively less than that observed in adults (Desjardins & Werker, 2004; Ross et al., 2011; Sekiyama & Burnham, 2008). The ability of children to perceive speech has also been investigated when the verbal signal is distorted, rather than masked by noise. Noise-vocoding degrades the spectral (frequency) content of the auditory speech signal, while retaining its temporal envelope dynamics (Shannon et al., 1995). Critically, it has been shown that children require more spectral resolution in comparison to adults, measured in terms of the number of frequency bands presented in the noise-vocoded manipulation, to accurately identify the content of the speech signal (Eisenberg et al., 2000; Newman & Chatterjee, 2013; Vongpaisal et al., 2012).

Here we asked whether additional visual cues can improve children's perception of noise-vocoded speech. The objective of the current study was to investigate the developmental trajectory of audiovisual integration skills in children from 4-11 years of age, defined in terms of the ability to combine auditory and visual cues in order to improve perception relative to a unimodal, auditory-only (AO) condition. Children (n=62) and adults (n=10) were presented noise-vocoded sentences from the Children's Co-ordinate Response Measure (CCRM; Rosen, 2011) in AO or audiovisual (AV) conditions. The CCRM presents listeners a target sentence taking the form, 'Show the dog where the (colour) (digit) is'. The target response required of a listener is to identify the colour (blue, black, green, pink, red, or white) and digit (1 to 9, excluding 7) from the sentence. Each sentence was filmed in black and white when spoken by a single female in a monotone voice. Videos were cropped so that only the mouth and lower jaw were visible. The number of vocoded frequency bands was adaptively varied to modulate the degradation of the auditory signal, with the number of bands required for ~79% correct identification calculated as the threshold.

The data revealed two distinct findings (Fig. 1): First, we replicated previous work (Eisenberg et al., 2000; Newman & Chatterjee, 2013; Vongpaisal et al., 2012) showing that, regardless of visual information, younger children between the ages of 4-5 years required a greater number of frequency bands in order to identify speech in comparison to older children (6-11 years) and adults. Second, we found that visual information improved vocoded speech perception in all but the youngest children. Complimentary support for this finding was garnered from a measure of AV gain – calculated by subtracting AO speech reception thresholds from those obtained during the AV

presentation condition. While there was no AV gain in 4-5 year old children, it began to reach adult levels between 6-11 years of age. A similar developmental trajectory of AV gain has also been found when auditory speech is masked by noise (Barutchu et al., 2010; Ross, et al., 2007, 2011; Wightman, Kistler, & Brungart, 2006), suggesting that the same processes of integration might be involved when the auditory speech signal is spectrally degraded.

**Figure 1.** Threshold estimates by age group – the number of frequency bands required to achieve accurate speech identification in AO and AV presentation conditions. Error bars denote  $\pm 1$  standard error of the means.



One possible explanation for the observed maturation of audiovisual integration skills could be the onset of mainstream schooling from 6 years of age. At this stage of development greater demands are beginning to be placed on AV integration skills due to growing exposure to background noise. Learning to use visual speech information, such as that derived from the lips, may therefore be of critical importance. In addition to increasing exposure to AV speech in noisy environments, it is likely that this developmental trajectory also reflects the maturation of cognitive, sensory and perceptual abilities. This evidence not only has the capacity to inform our understanding of the development of audiovisual perception skills in normal-hearing listeners, but might have critical implications for developing new treatment and intervention strategies for accurate speech perception in hearing-impaired children.

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## **Speechreading skills in Finnish-speaking adults, typically developing children and children with specific language impairment**

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**Background.** Speech perception is not only auditory, but audiovisual in nature. Visual information from speaker's face plays an important role in understanding spoken language. Previous studies indicate that speechreading is an integral part of speech processing (Woodhouse et al., 2009). In children speechreading skills are age-related, and speechreading ability of both words and sentences improves with age (Kyle et al., 2013). Many studies of speechreading have been conducted with typically developing participants and participants with hearing loss. Less is known about speechreading in other clinical groups, for example in children with language disorders. Recently, Meronen, Tiippana, Westerholm and Ahonen (2013) showed that the perception of audiovisual and visual consonants is impaired in children with developmental language disorder compared to typically-developing children. However, word-level speechreading has not been previously investigated in children with developmental language disorders.

**Aims.** The aim of this research was to study word-level speechreading in Finnish-speaking adults, typically developing children and in children with specific language impairment (SLI). SLI refers to the condition in which a child fails to develop his or her native language while the non-verbal and social skills are within a normal range. In SLI, usually both expressive and receptive language skills are delayed, and problems in phonological processing are often present. The hypothesis was that children with SLI would have poorer speechreading skills than age-matched controls, and that adults would perform better than children. The study also aimed to investigate the relationship of speechreading skills and phonological processing in typically developing children and children with SLI.

**Method.** Twenty adults, 40 typically developing children (aged between 6;9 and 10;11 years) and 20 children with SLI diagnosis (aged between 7;2 and 10;11 years, mean age 8;11 years) participated in the study. Typically developing children were divided in two groups: first-grade children (n=20, mean age 7;3 years) and a group that was age-matched with the children with SLI (n = 20, mean age 8;11 years). All participants had Finnish as their mother tongue.

A computer-based test was designed to measure speechreading performance. The speechreading test included 17 Finnish words presented as silent video clips. First, a female speaker uttered a word. After the video, four pictures were presented: one that matched the word, and three distractor pictures. The participant's task was to speechread the word and to select the corresponding picture. The words were common, concrete, Finnish nouns. The word length varied between two and four syllables. Furthermore, children's phonological processing skills were assessed by the subtest Phonological Processing from NEPSY-II (Korkman, Kirk & Kemp, 2008).

**Results.** The adults mastered the word-level speechreading test well (93% correct). For typically developing first-grade children the task was significantly more difficult but they could speechread at a rate of 52% correct words. There was great variation in the speechreading performance of typically-developing first-grade children; the individual speechreading performances varied between 12% and 94% words correct. For children with SLI, the mean speechreading score was 42 %. The individual performances of SLI children varied between 18% and 71% words correct. The typically-developing, age-matched group of children had a mean score of 68% that varied between 35% and 94% of correct answers. Speechreading scores were significantly better for adults than all groups of

children. The older group of typically-developing children performed significantly better than the younger group and children with SLI. The two latter groups did not differ from each other.

Pearson correlations revealed significant positive correlations between speechreading scores and phonological processing scores in typically developing children ( $n=40$ ,  $R=.445$ ,  $p<.01$ ). No significant correlations between speechreading scores and phonological processing scores were found in children with SLI.

**Conclusions.** The results show that typically-developing children are capable of word-level speechreading, and that the speechreading skills improve with age. Adults outperformed children in the speechreading test. The speechreading ability was found to be related to phonological processing in typically-developing children; skilled speechreaders had better phonological processing skills and vice versa. Children with SLI had poorer speechreading skills than their typically-developing, age-matched peers. Speechreading skills develop with age, and a delay in this development may contribute to the language problems in children with SLI.

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## **Developmental aspects of understanding speech in noisy backgrounds**

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An interesting and important question concerns the extent to which children and adults differ in their abilities to hear speech in the background of other sounds, and how children's abilities change as they develop. It has become increasingly clear, through work with adults, that background noises exert their effects on the intelligibility of speech through at least three different types of masking – energetic, modulation and informational (Shinn-Cunningham, 2008; Stone, Fullgrabe, & Moore, 2012). Energetic and modulation masking, as exemplified by an unvarying noise of fixed spectrum, are thought to exert their effects primarily in the cochlea, where the energy in the masker can directly interfere with the speech. Informational masking, as exemplified by a single background talker, is presumed to occur at higher auditory centres, arising from a distracting effect of the masker, or from confusion between target and masker in selective attention. In two studies, we investigated developmental trends in these three types of masking through use of a child-friendly version of the Coordinate Response Measure (Bolia, Nelson, Ericson, & Simpson, 2000). Here, target sentences are of the form 'Show the [animal] where the [colour] [digit] is' where it is possible to have combinations of 6 animals, 6 colours and 8 digits

In the first study, target sentences always containing the animal 'dog' were recorded by a young female talker. Participants (young adults and primary school age children, aged 5-11 years) indicated only which colour was heard. Three maskers were used: one primarily informational (a randomly chosen distractor sentence from the same corpus, recorded by a male talker, but never using 'dog' as the animal), and two energetic/modulation (a steady-state speech-spectrum noise, and the same noise modulated with the envelope of a randomly chosen male distractor sentence). Adaptive tests varied the signal-to-noise (SNR) of the target and masker to find the SNR leading to 79% correct performance (the so-called SRT – speech reception threshold). All SRTs were better (lower) in adults than in children: by a wide margin for the speech masker ( $\approx 15$  dB), but a much smaller one for the noise maskers ( $\approx 3-4$  dB). Strikingly, adults performed best with the speech distractor, whereas children – even the oldest tested – performed worst in this condition. Improvements in SRT through primary school for the speech distractor were also much more marked than for the two noise maskers. Interestingly, children also showed little or no ability to exploit 'glimpses' in the modulated noise.

In a second study, we investigated the impact of child and adult interfering talkers on children's ability to focus on child and adult target talkers. Target stimuli again always contained the animal 'dog', but were uttered either by an adult female talker, or an 11-year old female child. The listener was required to select the corresponding coloured number from an on-screen response grid. In the two conditions with speech maskers, sentences were of the same form as the targets but with a different animal, colour and number. Speech Reception Thresholds (SRTs) were measured adaptively for four conditions: target child speech with masking adult speech, target adult speech with masking child speech, and the same two target speakers in the presence of speech-spectrum-shaped noise matched to the talker. Participants consisted of adults (17 to 51 years) and primary-school-aged children (4 to 12 years).

On the whole, performance for children with the noise maskers was similar to that of adults, and changed slowly over age. Both adults and children found the adult talker more intelligible. Performance for children with speech maskers was typically worse than that shown by adults,

especially for younger children, and improved quickly over age. Perhaps surprisingly, it was irrelevant whether a child was supposed to attend to the child or adult talker, whereas for the adults, the adult talker led again to better performance. It therefore appears that children are more likely to be distracted by a child talker in the background, rather than an adult.

**Conclusions.** Children, especially those of early school age, find it more difficult to understand a talker when the competing sound consists of a single other talker than when they are listening in a background of steady-state noise. In our view, this happens because children are more likely to be distracted by speech, and is consistent with the protracted maturation of frontal lobe networks responsible for executive functions related to attention. In addition, the fact that children find an adult talker to be more intelligible in noise, yet of equal intelligibility to a child's voice when masked by other speech, might indicate that another child's voice is more distracting than an adult's. Such a result has clear implications for listening in the classroom, and unusual distractibility to other voices may be a factor in determining if a child is suspected of auditory processing disorder (APD).

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## **THURSDAY AFTERNOON - POSTER SESSION**

- [1] Eva Aguilar-Mediavilla, Lucia Buil-Legaz, Josep Pérez-Castelló and Daniel Adrover-Roig: Predicting late language comprehension from early processing abilities in children with and without Specific Language Impairment.
- [2] Anita Auszmann and Tilda Neuberger: Vowel stabilization process in Hungarian children.
- [3] Ingrida Balčiūnienė and Eglė Krivickaitė: Linguistic disfluency in 6-years olds' narrative speech.
- [4] Eleni Baldimtsi, Eleni Peristeri and Ianthi Maria Tsimpli: Mental state terms and the role of working memory in high functioning autistic children's story generation from picture-stories.
- [5] Johanna Barry and David Moore: Profiling listening difficulties with respect to developmental disorders of language, literacy, and social skills.
- [6] Adelina Castelo: The Phonological Awareness between Grade 5 and College in Portuguese Students.
- [7] Bénédicte Grandon, Anne Vilain, Hélène Løevenbruck and Sébastien Schmerber: Vowel spaces in French children wearing cochlear implants.
- [8] Sonia Granlund, Valerie Hazan and Merle Mahon: Acoustic-phonetic adaptations to a hearing-impaired listener by normally-hearing and hearing-impaired children and adolescents.
- [9] Hélène Guiraud, Sonia Krifi-Papoz, Vania Herbillon, Aurélia Bascoul, Sibylle Gonzalez-Monge, Lydie Merle, Véronique Boulenger: Processing of natural fast speech and time-compressed speech in children with speech output disorders.
- [10] Viktória Horváth: Temporal properties of 9-year-old children's spontaneous speech.
- [11] Alisa Ikonen, Arja Voutilainen, Kaisa Launonen & Anu Klippi: Specific language impairment from childhood to adolescence; diagnosis, evolution and risks of well-being.
- [12] Saloni Krishnan, Robert Leech, Evelyne Mercure, Sarah Lloyd-Fox and Fred Dick: The effects of perceptual distortion, age and proficiency on functional neural activation for sentence processing.
- [13] Saloni Krishnan, Robert Leech, Jennifer Aydelott and Fred Dick: Recognising environmental sounds in complex sound scenes: Change over the school years.
- [14] Keith Nelson and Kiren Khan: How the Cognitive System Supports the Development of Complex Narrative Abilities in Children.
- [15] Magdalena Smoczyńska, Ewa Haman, Magdalena Kocharńska, Magdalena Łuniewska: Describing complex pictures as a method of eliciting speech samples from children aged 5 to 10: Syntactic characteristics of the speech of Polish children
- [16] Hannah Stewart and Sygal Amitay: Development of Auditory Attention: Distractibility and Conflict Resolution.
- [17] Krisztina Zajdó: Spelling long vowels and consonants in children with learning difficulties including those with mild intellectual disability: Results from 8th and 11th grade students.

## Predicting language comprehension from processing abilities in children with and without Specific Language Impairment

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Children with specific language impairment (SLI) show language acquisition difficulties without any of the causes that usually explain language problems, such as hearing impairment, intellectual disability, neurological damage or socio-emotional deprivation (Stark & Tallal, 1981). Nevertheless, this definition is static and does not capture different development trajectories in children with SLI (Conti-Ramsden et al., 2012). Recovery from this disorder is extremely difficult and, even after treatment, preschool children with SLI continue to have language problems during school-age and adolescent years (Nippold & Schwarz, 2002). Recent studies (Conti-Ramsden et al., 2012) have shown that children with SLI have stable cognitive and linguistic skills during their development but differ in their trajectories and between their severities. Nevertheless, evidence is lacking about which variables constitute early indicators of the persistence of language difficulties in children with SLI. The prediction of which children are more at risk to maintain their language difficulties is an important question that still needs to be responded to. Thus, the aim of the present study was to disentangle those variables that might predict the later persistence of language problems in children with SLI.

**Table 1.** Sociodemographic data of the sample

	Control	SLI
N	19	19
Sex		
Males	11	9
Females	8	10
Socioeconomic status		
High	1	1
Medium	14	13
Low	4	5
Family Language		
Catalan	8	4
Spanish	10	13
Spanish and Catalan	1	2
	<b>Mean (SD)</b>	<b>Mean (SD)</b>
Age Time 1	6.4 (.5)	6.1 (.6)
Age Time 2	11.9 (.3)	11.8 (.2)
Language assessment at 5;6	10.32 (1.73)	8.16 (1.77)
Nonverbal-IQ	110.63 (11.78)	102.05 (10.40)

The sample was made up of 19 Spanish-Catalan bilingual children with SLI, with a mean age of 6;1 years at the beginning of the study and 11;7 years at the end of the study. The children with SLI were paired with 19 age-matched controls, who were also Spanish-Catalan bilinguals. All children in the study group fulfilled the established criteria for diagnosing children with SLI at 5;6 years (Stark & Tallal, 1981; Tomblin, Records et al., 1997; Tomblin, Smith et al., 1997). These children were followed during their development from 6 to 11 years of age. Sociodemographic characteristics of both groups are shown in Table 1.

We tested eight processing abilities related to phonological processing (phonological memory, phonological awareness and Rapid Automatic Naming [RAN]), attention processing (visual and

auditory) and language processing (sentence repetition, verbal fluency and language comprehension) in both groups at 6 years of age using the NEPSY: Developmental Neuropsychological Assessment (Korkman, Kirk & Kemp, 1998; Aguilar-Alonso & Moreno-González, 2012; Aguilar-Mediavilla et al., submitted). The NEPSY is designed to measure neuropsychological processing from 3 to 16 years of age.

Five years later, at 11 years of age, language comprehension was assessed through CEG: Grammatical Structure Comprehension Test (Mendoza et al., 2005). This instrument measures the understanding of 20 grammatical constructs four times each using different test stimuli; each test stimulus is presented in a four-picture multiple-choice format with lexical and grammatical foils. Difficulty range has been increased from 6 to 11 years of age.

We analyzed the data through non-parametric independent sample tests and a step-wise regression. The results showed that children with SLI at 11 years of age had significantly lower scores in comprehension of grammatical structures than children in the control group (see Table 2). From the SLI group, 10 children had scores that could be classified as comprehension difficulties, while nine fell outside the range of being classified as having comprehension difficulties. The processing ability that best predicted grammatical comprehension at 11 years of age was sentence repetition examined at 6 years of age (see Table 3).

**Table 2:** Mean and standard deviation of comprehension of grammatical structures: significant differences with Mann-Whitney-U and effect size with *r*.

Variable	SLI		Age controls		<i>U</i>	<i>p</i>	<i>r</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Comprehension of grammatical structures							
Direct score	70.5	4.2	73.9	3.5	105.5	.027	.44
Percentile rank	42.9	24.7	63.5	22.5	105.5	.027	.40

**Table 3:** Step-wise regression analysis with sentence repetition as the predictor variable, and CEG total score CEG as the predicted variable.

Predictor	Comprehension of Grammatical structures		
	<i>B</i>	$\Delta R^2$	<i>p</i>
Enterer			
Constant	-13.18		.367
Sentence repetition	4.08	.388	.000
Excluded			
Phonological awareness			.322
Phonological memory			.409
RAN			.520
Auditory attention			.461
Visual attention			.854
Language comprehension			.338
Verbal fluency			.794

We report that children with SLI maintain lower language scores during their development, which is in line with other recent works (Nippold & Schwarz, 2002; Conti-Ramsden et al., 2012). Nevertheless, only 10 of the children with SLI (52.6%) persisted with their difficulties in language comprehension. Other studies, such as Conti-Ramsden et al. (2012), have also found differences in severity between children with SLI through their development. Our results also show that most of

the variance of language comprehension at 11 years of age could be explained by sentence repetition at 6 years of age. Sentence repetition measures language imitation capacity and grammatical capacity.

We believe our results might be analysed through a causal developmental model that allows better understanding of the developmental trajectories of children with SLI. This model takes into account the mutual interdependence between cognitive and linguistic deficits (Morton & Frith, 2001; Scarborough, 2009). According to this model, language difficulties in children with SLI might be considered as an extension of their previously existing phonological problems. Thus, their language profiles would change with the acquisition of new skills, while previous abilities would remain underdeveloped. Hence, children with SLI might show different patterns of difficulty at distinct developmental stages. These difficulties might not only be caused by a common factor affecting the whole acquisition process, but also might arise from a causal influence of previous problems that would have an impact on subsequent acquisitions.

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## Vowel stabilization process in Hungarian children

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**Introduction.** Children gradually acquire their mother tongue during their first years: their vocabulary expands constantly; they can create more and more complex statements. In order to construct meaningful utterances, development is necessary in many aspects of language: phonological (e.g. Vihman, 1996), lexical (e.g. Nelson, 1973), morphological (e.g. Brown, 1983), syntactic (e.g. Bloom 1970) and pragmatic development (e.g. Ninio & Snow, 1996). At the beginning, quantitative development is essential while after the age of six quality changes can be observed in children's speech. The present study aims to investigate the development of vowel production by analysing acoustic data.

The stabilization process of vowels is an important part of language acquisition. In Hungarian, the vowels are clearly identifiable by their first and second formants (Gósy, 2004). The acoustic structure of vowels is influenced by numerous factors such as age, physical status or gender of the speaker. As the length of the vocal tract determines the overall pattern of formant frequencies, these patterns change with age (Fant, 1975; Vorperian et al., 2005). According to the literature concerning English, children's pronunciation is largely the same as the adults' around the age of 10, and discrete male-female differences in F0 are evident around the age of 12 (Lee et al., 1999). Based on studies with 6- and 7-year-old Hungarian preschoolers (Deme, 2012) we can see that vowel formants in children's spontaneous speech are realized in higher frequency values as in adults' pronunciation.

The purpose of our study is to describe vowel structure in various ages and thus to investigate the development of pronunciation. The main question is at which age the children's vowel production will converge to adult level. Our hypothesis is that the pronunciation of vowels would be largely the same as that of adults by the age of 10 in Hungarian.

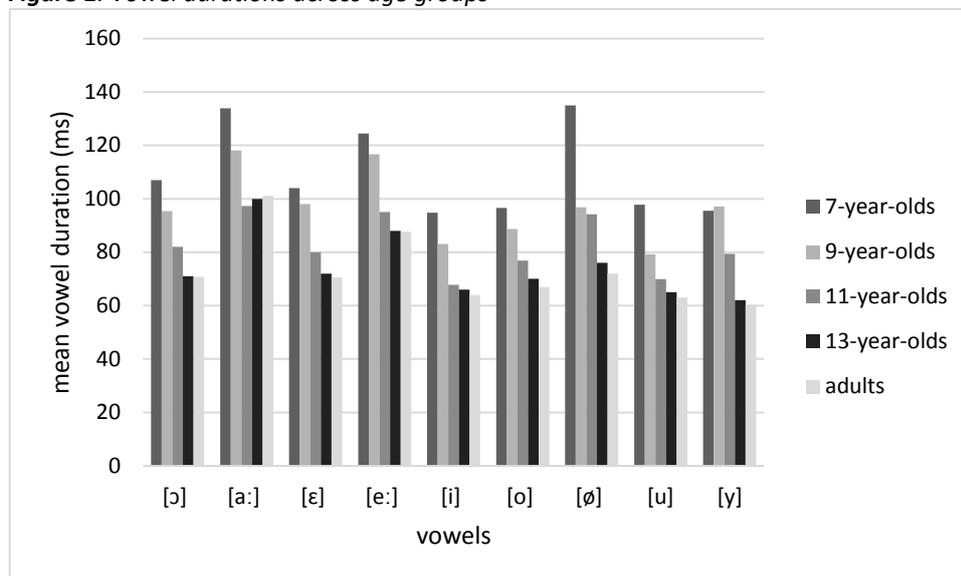
**Participants, material and method.** Speech material consisted of recorded spontaneous speech samples of 80 7-, 9-, 11- and 13-year-old typically developing, Hungarian-speaking children. None of the children had any hearing disorders and their intelligence fell within the normal range. The corpus was recorded in kindergarten and at school in the capital city of the country. Twenty children (10 boys and 10 girls) from each age group talked about their family, school and free time activities. Subjects were tested individually.

In order to compare the data, we analysed a 1-minute-part from each recording. The data set contained more than 8,000 tokens of manually measured vowels. The recordings were annotated and measurements were conducted using Praat 5.3 software (Boersma & Weenink, 2011). We analysed the fundamental frequency (F0) of the children's speech, the duration, the first two formants (F1, F2) of nine vowels. The formant frequency values of the vowels were normalized (based on group mean, standard deviation) to reduce the effect of vocal tract differences within each age group. The data were compared with the vowel structures of preschoolers and adults. Statistical analysis was conducted using SPSS 17.0 software.

**Results.** Based on the results we can claim that there are large individual differences in the vowel pronunciation of children in each age group. Due to the children's slower speech rate their vowel duration is longer than that of adults (adults' data from Gósy & Beke, 2010; Bóna, 2014) (Figure 1).

As the mean values of vowel duration indicated, a linear decreasing tendency could be found from the age of seven to adulthood for most of the vowels.

**Figure 1.** Vowel durations across age groups



In terms of formant frequencies 9-year-old children's vowels showed more similarity to 7-year-old children's vowels than to adults' vowels. As assumed, during the first few years of schooling the changes of vowel pronunciation were faster and larger. Statistical analysis revealed the greatest differences between the pronunciation of 9-year-old and 11-year-old children.

'Age' proved to have significant main effect on the data of F1 in the case of: [ɔ] [F(3, 974)=23.594;  $p < .001$ ]; [a:] [F(3, 414)=7.911;  $p < .001$ ], [ɛ] [F(3, 1186)=10.849;  $p < .001$ ]; [i] [F(3, 590)=5.437;  $p < .001$ ]; [o] [F(3, 671)=12.687;  $p < .001$ ]; [ø] [F(3, 161)=8.231;  $p < .001$ ]; and on the data of F2 in the case of: [ɛ] [F(3, 1186)=10.533;  $p < .001$ ]; [e:] [F(3, 335)=8.978;  $p < .001$ ]; [i] [F(3, 590)=30.421;  $p < .001$ ]. The pronunciation of 11-year-old children is still not the same as that of the adults while children's pronunciation becomes similar to that of adults up to the age of 13.

**Conclusions.** The purpose of this study was to analyze the duration and formant-frequency patterns of Hungarian vowels during the developmental period from the age of seven to adulthood. Our hypothesis that formant structure of 10-year-old children's vowels would converge to adult level could not be supported by the data. We found the same tendency in the change of the vowel durations. It is likely that vowel stabilization process would continue up to the age of 13. As time goes by, children are getting more proficient in speech, so their data becomes more like the adults. In our planned future study beside age-related changes we intend to examine gender-related differences of children's vowel production. Results of our research can help to describe the acoustic-phonetic features of typically developing children's speech and can be used in speech disorder diagnostic procedures as well.

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## Linguistic disfluency in 6-years olds' narrative speech

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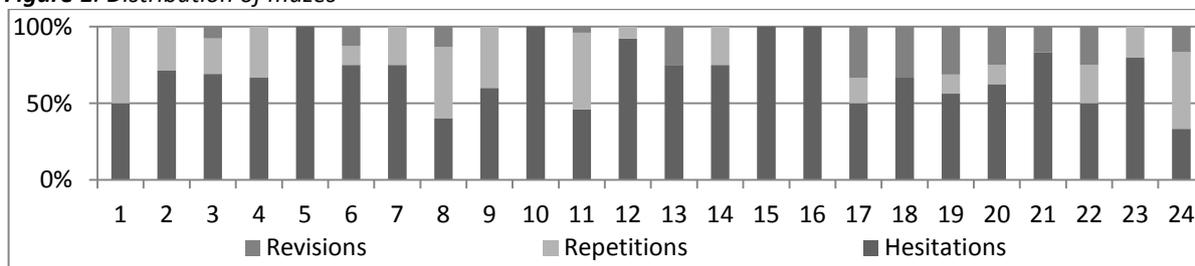
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Speech disfluency can generally be distinguished as being either stuttering or linguistic disfluency (Sieff & Hooyman, 2006). The second one, also called mazes (Loban, 1976), can be divided into categories such as *hesitations*, *fillers*, *repetitions*, and *revisions* (Fiestas et al., 2005). Despite the fact that all children demonstrate linguistic disfluency (Shapiro, 1999), language-impaired (LI) children tend to produce more mazes than do typically-developing (TD) children (Redmond, 2004), thus general number and proportions of linguistic disfluencies can potentially indicate language impairment and help to distinguish between TD and LI children. However, linguistic disfluency in children has not been widely investigated; moreover, previous studies have been based mainly on English language data. Thus we still need more comprehensive studies based on other languages in order to develop (cross-) linguistic profiles for TD vs. LI children from the perspective of linguistic fluency. The current study focuses on the production of mazes in Lithuanian monolingual TD 6-year olds. The questions addressed in this study include: 1. What are the number and distribution of mazes in Lithuanian monolingual TD 6-years olds? 2. How is production of mazes related to the main microstructural indications in narrative text?

**Data and research methodology.** The subjects of the study were 24 monolingual TD children (mean age 82 months), attending state kindergarten in Kaunas (Lithuania). *The Cat Story*, which is a sequence of pictures developed by Hickmann (2003), was used to elicit children's narratives. All the stories were audio-recorded, transcribed and coded according to CLAN tools (MacWhinney, 2000) for automatic analysis of the mazes and the main microstructural indications. During the analysis, all the mazes were grouped into hesitations, repetitions, and revisions. Individual numbers and distributions were indicated and compared within a sample. Then the main microstructural measures, namely, MLCUw and CL/CU index, were analyzed and compared to the production of mazes. MLCUw is a mean length of Communication Unit (CU which is defined as "independent clause with its modifiers", see Loban, 1976: p.9) in words. CL/CU (i.e. mean number of clauses per CU; see Hughes et al., 1997) measure is usually used to provide an indication of syntactic complexity of utterances.

**Results.** The findings indicate that TD children produced all types of mazes in the stories (see Figure 1).

**Figure 1.** Distribution of mazes

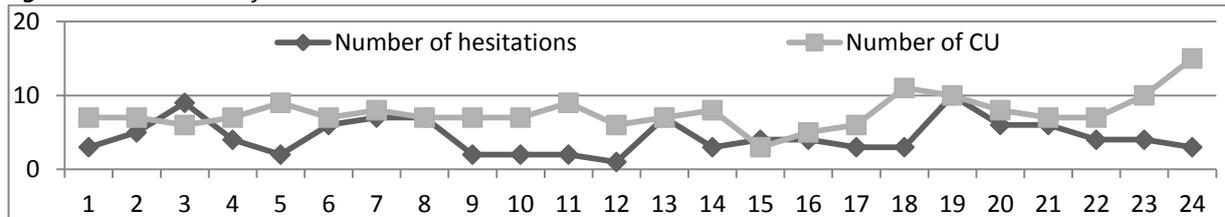


In total, 181 mazes were observed in the stories. The majority of them (64%) can be identified as hesitations, while repetitions (25%) and revisions (11%) were much rarer. These findings confirm a prediction that filled pauses, incomplete phrases, and repetitions are more immature disfluencies, while other types of disfluencies are more characteristic at the later stages of language acquisition (DeJoy & Gregory, 2012). Proportions of different types of mazes seem to be rather individual than

universal, e.g., in the speech of a few subjects, only hesitations were observed, while other subjects produced two or three types of mazes (but the proportions still were different). However, statistically significant positive correlation ( $p < 0.05$ ) between hesitations and revisions was found, i.e. hesitations were followed/supplemented by revisions rather than repetitions.

*Hesitations* (see Figure 2) can be described as silent (unfilled) or filled pauses (also called *fillers*) involving the articulation of some sound/word during the delay (Watanabe & Rose, 2012). During the investigation, the majority of the fillers were identified as non-lexical units, whereas only a few of them (6 of 32) were actual words.

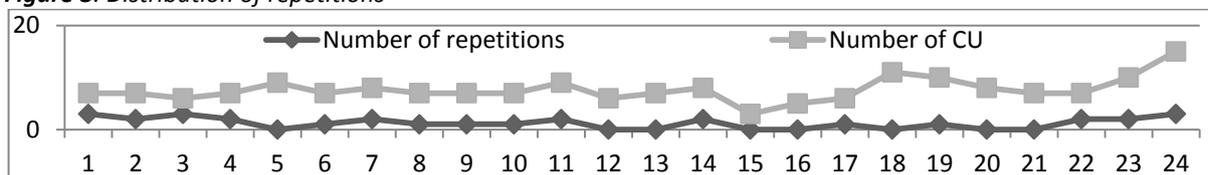
**Figure 2.** Distribution of hesitations



Following previous research (Corley & Stewart, 2008), fillers “are most likely to occur at the beginning of an utterance or phrase, presumably as a consequence of the greater demand on planning processes at these junctures”. However, in our study, the majority (111 of 116) of hesitations occurred within a CU. Although we still need more data and comprehensive studies, one can observe that children tend to hesitate before object naming. This presumably can be related to vocabulary limitations and its influence on the speech planning processes.

*Repetitions* (see Figure 3) can be grouped into repeated phrases, words and parts of word.

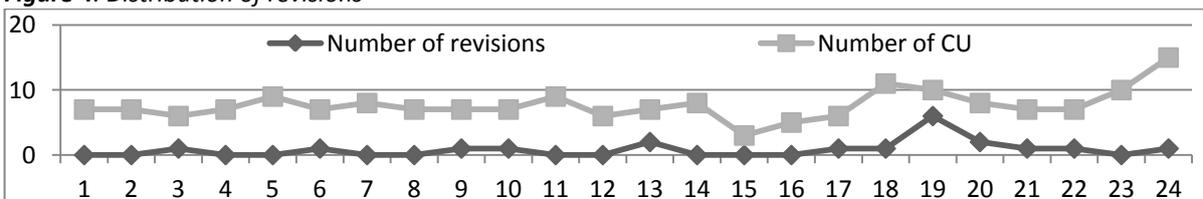
**Figure 3.** Distribution of repetitions



Following the results, repeated words (44%) and parts of word (40%) are much more frequent in comparison to repeated phrases (16%). Among the repeated words, conjunctions and discourse markers were dominant.

*Revisions* (see Figure 4) can be classified as phonological, lexical, and grammatical modifications of speech.

**Figure 4.** Distribution of revisions



As it was mentioned above, a statistically significant positive correlation ( $p < 0.05$ ) between hesitations and revisions was found. Nevertheless, comparison between revisions and repetitions did not show any statistically significant correlation. Moreover, production of mazes did not

correlate to either story length in CU or to CL/CU ratio. These findings disconfirmed expectation that hesitations occur rather in more productive stories or syntactically complex phrases. Naturally, relatively more hesitations were observed in the longer stories than in the brief ones, but the difference was not significant statistically.

**Conclusions.** The study highlighted the main tendencies of narrative speech disfluencies in Lithuanian monolingual TD 6-year olds. Lots of variations between children rather than patterns which are identical across the subjects were observed. However, a correlation between hesitations and revisions as well as the absence of correlation between production of mazes and microstructural characteristics (namely, story productivity and syntactic complexity) should be taken into account when developing linguistic profile of TD monolingual children.

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## Mental state terms and the role of working memory in high functioning autistic children's story generation from picture-stories

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**Introduction.** As previous research has shown, children with high functioning autism (HFA) usually present intact grammatical ability, age-appropriate morphological and syntactic abilities but disparate language behaviour mainly characterized by atypical patterns in semantic and pragmatic language use (Klin, Sparrow & Volkmar, 2000; Tager-Flusberg, 2000). These problems have been related to their reduced ability to invest sentences with global meaning (*weak central coherence account*; Booth & Happé, 2010; Happé, 1999; Jolliffe & Baron-Cohen, 1999; Lopez & Leekam, 2003; Nuske & Bavin, 2011) and/or a tendency to disregard the needs of others in structuring discourse (*deficit in the Theory of Mind (ToM) construct*; Happé, 1994; Tager-Flusberg, 1999).

Although these are reasonable explanations, the underlying causes of disproportional impairments in the semantic and pragmatic language abilities of children with HFA are still elusive in current literature. The present work uses narrative production to tap into structural linguistic aspects that may lead to semantic and pragmatic difficulties. The ability to tell stories requires an understanding of linguistic, cognitive and social domains (Tager-Flusberg & Sullivan, 1995). An effective narrator not only has to structure the story in an intelligible way so that the listener understands the setting, characters, events, and outcomes of the story (Rumpf et al., 2012), but also needs to consider the perspectives of the characters in order to explain their motivations and reactions (Stein & Glenn, 1979). Especially, the use of mental state language in narratives is considered to be a powerful index of children's understanding of characters' feelings and thoughts and that characters can have different perspectives on the same event.

The main goal of the present study was to tap into the narrative production of children with HFA in order to investigate two linguistic aspects of connected discourse, namely, lexical diversity and syntactic complexity. To this end, we analysed: (i) length measures, i.e. number of words, clauses and T-units; (ii) measures of syntactic complexity, i.e. clauses per T-unit further divided into subordinate and coordinate clauses; and (iii) lexical measures, i.e. lexical diversity quantified through the use of mental state terms divided into three subcategories: affective (e.g. *happy, sad, feel*), cognitive (e.g. *think, remember, know*) and perception terms (e.g. *see, hear, touch*). An investigation of mental state terms in the narratives of TD children and children with HFA sheds light on the developmental patterns for cognitive, emotional and perceptual state terms of children with HFA relative to TD controls.

The second goal of the present work was to explore the role of working memory in the narrative performance of children with HFA. Crucially, language behaviour in HFA has been frequently linked to verbal working memory processes which have been found to be impaired relative to TD children (Peristeri & Tsimpli, 2013; Russell, Jarrold, & Henry, 1996). None of the existing studies, though, has addressed the role of verbal working memory capacity in language production in HFA and, more specifically, whether an imbalance of working memory development may correlate with specific aspects of narrative production, including lexical diversity-density and syntactic complexity. To the extent that discourse production depends on specialized language-specific resources, we might expect it to be unimpaired in highly-verbal children with HFA. To the extent it involves a general verbal working memory system, we might expect otherwise.

**Method.** *Participants:* Twenty-three children with HFA (age range: 6-14 years old) participated in the study. Children had received prior clinical diagnosis confirmed by using the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter & Le Couteur, 1994). All children with HFA performed within the normal range of intelligence and were matched to two groups of TD children on the basis of chronological age and expressive vocabulary (Vogindroukas, Protopapas & Sideridis, 2009). *Materials:* Oral narratives were elicited using the Edmonton Narrative Norms Instrument (ENNI; Schneider, Dubé & Hayward, 2005) and two children's picture books, namely, "Harry the dirty dog" and "Peter's chair" (Keats, 1967). The ENNI stimuli consist of 2 sets of wordless picture series, each with three levels of length and complexity, which are presented in a story generation task. The stories depict situations involving opportunities for describing cognitive, emotional and perceptual responses of the characters. Children were shown each picture set and asked to tell a story based on the pictures to the examiner, who could not see the pictures. The same children were asked to listen to the same stories after a certain period of time (7-10 days) and retell the four stories. Concerning the two picture books, the children had to look at the picture sequences and tell a story of their own based on what they saw. Then, the participants listened to a playback of the story. After that, they had to retell the story. Sessions were audio-recorded and the children's stories were transcribed. Children's verbal working memory capacity was measured with two tasks: sentence recall (DVIQ test; Stavrakaki & Tsimpli, 2000) and Digit Span Backward of the Wechsler Intelligence Scale for Children (Wechsler, 1991).

**Results.** To examine relationships between age and types of mental state terms (i.e. emotional/affective, cognitive, perception) in each group, we conducted tests of bivariate regression with age as the predictor variable and cognitive, emotional and perception mental state terms as the criterion variables. Children with HFA were found to use significantly fewer emotion terms to describe characters' mental states in the stories relative to TD children. Crucially, emotion terms were found to increase with age only for TD children. On the other hand, children with HFA were found to use more perception terms than TD children in story telling only, yet, this use tended to decrease with age. Finally, no significant between-group difference was revealed for the use of cognitive terms. Moreover, analyses conducted on children's WM scores revealed that children with HFA had significantly higher performance scores in both verbal working memory tasks used in the present study. Further correlation analyses conducted between working memory scores and narrative length revealed significant positive correlations between the two variables for TD children across both the sentence repetition and the digit span backward test. On the other hand, no significant correlations between narrative length and working memory scores in either task were revealed for children with HFA.

**Discussion.** More limited use of emotion words, as well as lack of a developmental increase in the use of emotion words with age in the group with HFA in contrast to TD children, who used more emotion words with age, suggest an atypical pattern in the development of affective mental state words for the children with HFA. Target-deviant development was also observed in the way children with HFA used terms that referred to the perceptual states of others. The lack of difference in the use of cognitive terms in children with HFA and TD children implies that the group with HFA shows no delay or deficit in the development of cognitive terms. Finally, the results from the working memory analyses show that though children with HFA showed higher verbal working memory capacity with respect to TD controls, such cognitive advantage did not seem to affect narrative length in children with HFA. Such finding implies that even though working memory scores were higher in children with HFA working memory resources were not sufficient enough to support their narrative production.

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## Profiling listening difficulties with respect to developmental disorders of language, literacy, and social skills

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**Background.** Some children have inordinate difficulty understanding speech in noise despite normal hearing. Until relatively recently, the accepted view was that these children had some form of impairment of the central auditory pathway and they were described as having a (Central) auditory processing disorder ((C)APD). However, the disorder has been called 'a riddle wrapped in a mystery inside an enigma' (Rosen, 2005) because few if any children diagnosed with (C)APD have difficulties specific to the auditory system alone. More typically, they also demonstrate poorer short-term memory, poorer attention, as well as delayed development of language or literacy (e.g. Moore, 2011; Moore et al., 2013). Moreover, the sorts of listening difficulties associated with (C)APD are not unique to the disorder. Children diagnosed with specific language impairment (SLI), developmental dyslexia (DD), and high functioning autism (HFA) often demonstrate similar symptoms of listening difficulty and currently available tests for diagnosing (C)APD are unable to reliably discriminate (C)APD from any other developmental disorder (Dawes & Bishop, 2009). It is not therefore clear that (C)APD should be recognised as a distinct disorder. Yet the fact remains that children follow different referral routes and the question is why? We hypothesise that choice of referral route (an important factor in ultimate diagnosis) reflects distinct combinations of presenting symptoms and that these may in turn be important for addressing the question about whether or not (C)APD is a valid diagnostic category.

**Methods.** To test our hypothesis, we developed a novel scale of listening difficulties: the Evaluation of Children's Listening and Processing Skills (ECLiPS). Unlike most scales of listening difficulty, the ECLiPS explicitly acknowledges that listening difficulties can occur in the context of other developmental disorders. The scale comprises 35 simple statements of behaviour. Parents indicate on a Likert scale the extent to which they agree or disagree with each item. The items group into five factors assessing different domains relevant to listening difficulties and related developmental disorders (i.e. SLI /DD/HFA). These factors were called: *Speech & Auditory Processing, Environmental & Auditory Sensitivity, Language/Literacy/Laterality, Memory & Attention, and Pragmatic & Social Skills.*

The study comprised 78 children (aged 6-11 years) with language, literacy or social difficulties who were recruited from schools around England. Parents were requested to fill out four questionnaires about listening, language and social difficulties. These were (a) a family history questionnaire (developed in-house), (b) a scale commonly used in clinics to support assessment of (C)APD, the Children's Auditory Processing Scale (CHAPS; Smoski, Brunt & Tannahill, 1992), (c) a scale to screen for autism, the Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003), and (d) a scale commonly used to assess language difficulties, the Children's Communication Checklist (CCC-2; Bishop, 2003). The family history questionnaire was used both to support classification of children into different developmental groups and to screen out children with hearing impairment, neurological difficulties or developmental disorders in addition to those of interest in this study.

Children with DD (n= 19) were identified purely based on a report of a diagnosis of DD (family history questionnaire). Some children with DD (approx. 42%) had comorbid language difficulties (CCC-2). Children classified as suspected-HFA (sus-HFA, n=18) either had a report of diagnosis (family history) or had scores > 15 on the SCQ. Children classified as suspected-SLI (sus-SLI, n= 41)

either had a parental report of diagnosis (family history questionnaire) or were identified using the screening questionnaires (GCC score < 55 (CCC-2); SCQ score < 15). After initial classification into developmental group, the groups were further subdivided (CHAPS) according to whether or not they had significant listening difficulty: 'Yes' (n=44), 'No' (n=34).

**Results.** Mean scores on each of the five factors of the ECLiPS were entered into a repeated measures ANOVA with Developmental group (DD; sus-SLI; sus-HFA) and Listening difficulty (Yes; No) as the between-subjects factors. There was a main effect of developmental group ( $p < .05$ ) on overall mean score on the ECLiPS. The mean ECLiPS scores for the sus-HFA group were significantly higher (i.e. more extensive difficulties) than for the DD group ( $p < .001$ ).

There was also a significant interaction between the ECLiPS factors and Developmental group ( $p < .01$ ). Children with sus-HFA demonstrated more difficulties across all domains assessed by the ECLiPS, except *Language/Literacy/Laterality*. The difficulties of the children with a diagnosis of DD tended to be restricted to the domains of *Memory & Attention* and *Language/Literacy/Laterality*. The children with sus-SLI, by contrast, demonstrated difficulties across all domains except *Environmental & Auditory Sensitivity*.

There was a significant difference in overall ECLiPS scores and whether or not parents reported listening difficulty on the CHAPS ( $p < .05$ ), but no interaction with the ECLiPS factors. Children rated as having listening difficulties tended to demonstrate more severe difficulty across all domains, rather than a marked increase in difficulty in any one domain, e.g. *Speech & Auditory Processing*.

**Discussion.** This study represents a first step towards addressing the question regarding whether differences in presenting symptoms influence referral route. In the larger study specifically aimed at addressing this question, one might predict that children referred to pediatric audiology for suspected APD (listening difficulty) would score particularly highly on the *Speech & Auditory Processing* factor in the ECLiPS. The findings from this study, however, provide little evidence for such a prediction. No single factor in the ECLiPS emerged as being more closely associated with reported listening difficulty (CHAPS). Instead, parental report of listening difficulty was associated with an increase in the severity of symptoms observed across all the domains assessed by the ECLiPS. This suggests much as Dillon and colleagues (2012) have argued, that listening difficulties are not unique to a single disorder and children referred for suspected APD are fairly heterogeneous.

In the present study, all but two children with sus-HFA were rated by their parents as having significant listening difficulties. Given that *Language/Literacy/Laterality* was a relative strength for these children, this observation underlines how listening difficulties do not automatically imply deficits in language or literacy development.

In contrast with the sus-HFA group, both the DD and sus-SLI groups were evenly divided according to whether or not their parents rated them as having listening difficulties. Parental report of listening difficulties in these two groups associated with more severe deficits in language, memory or pragmatic/social skills. We suggest that this provides further evidence for the notion that auditory difficulties may be a consequence rather than an endophenotype of language learning difficulties (Bishop, Hardiman & Barry, 2012).

This study was based on children recruited as part of the process of developing the ECLiPS. As a consequence, the data were based on parental report collected by post, and the classification of the different developmental groups is necessarily not as precise as can be achieved in more standard behavioral studies. Nonetheless, the data from the ECLiPS seem to provide interesting insights into the relationship between listening, language, literacy and social difficulties. In future studies, it will

be interesting to use the ECLiPS in combination with behavioral measures to further assess these insights.

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## The phonological awareness between Grade 5 and College in Portuguese students

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Researchers in Educational Linguistics have argued that the promotion of language awareness is a means to achieve several educational goals, namely that it should be considered instrumental in improving the native language communication skills (e.g. Duarte, 2008; Freitas et al., 2012; Garrett, 2006; Hudson, 2008). Also, empirical evidences show the impact of metalinguistic knowledge on the mastering of oral and written language (e.g. Bryant, Nunes & Bindman, 2000; Goswami, 2006; Kolinsky, 1998). Consequently, studying the development of language awareness will give us a better understanding of which aspects should be promoted and how to do it, so that a good level of metalinguistic knowledge can be the basis for an excellent mastering of speech and communication skills. However, there is a lack of research on phonological awareness (a component of language awareness or metalinguistic knowledge) in Portuguese subjects that have already completed primary schooling.

The goal of this study is to understand phonological awareness development between grade 5 and College in typically developing Portuguese students. For that, the performance of four groups of subjects in different metaphonological tasks was assessed. Table 1 presents those groups.

**Table 1.** Groups of subjects

	Grade 5	Grade 7	Grade 10	College
Total (= male + female)	36 (=19+17)	34 (=16+18)	34 (=16+18)	36 (=19+17)
Mean Age (years; months)	10; 8	12; 9	15;10	19;3

The subjects were individually tested. They heard recorded words or pseudowords and had to solve phonological awareness tasks by saying aloud their responses, which were also recorded and later phonetically transcribed. We used five tasks, in which the stimuli were manipulated in terms of vowel quality and controlled for several linguistic factors such as syllabic format and stress pattern. The tasks and examples of stimuli can be found in Table 2. While the three tasks of segmental (or sound) awareness were adapted from common tasks in literature on phonological awareness (see, e.g., Morais et al., 1986, for sound detection; Ryder, Tunmer & Greaney, 2008, for substitution; Wagner, Torgesen & Rashotte, 1999 for word segmentation), the one of phonological process awareness and the one of explicit phonological knowledge were created for this research.

**Table 2.** Results obtained in each task by subject group

Assessed meta-phonological skills	Tasks	Examples of stimuli (expected responses in bold)
Segmental awareness	<b>Sound detection</b> (identify the odd V1)	[ˈmɔdu] / [ˈtudu] / [ˈmudu] ‘manner’, ‘everything’, ‘dumb’ >> <b>[ˈmɔdu]</b>
	<b>Sound substitution</b> (replace V1 by [i])	[ˈmudu] ‘dumb’ >> <b>[ˈmidu]</b>
	<b>Word segmentation</b>	[ˈmudu] ‘dumb’ >> <b>[m-u-d-u]</b>
Phonological process awareness	<b>Phonological process deactivation</b> (deactivate a phonological rule as vowel reduction, in V1 of pseudowords)	<i>Deactivate vowel reduction:</i> (from [ˈtobe]) [tuˈbadu] >> <b>[toˈbadu]</b>
Explicit phonological knowledge	<b>Phonological process explanation</b> (account for the observed differences, explain the V1 contrast’s cause)	[ˈbobe] / [ˈbõbe] ‘silly’, ‘bomb’ >> <b>The difference is due to the fact that nasalization (air release through the noise) occurs only in the 1st vowel of the 2nd word</b>

In Table 3, a summary of the results is presented. The statistically significant differences between performance of distinct groups in the same task are indicated by means of different letters. The colours aim to help distinguishing the students' performance level: very low (< 30%) in red; low (30%-49%) in orange; medium (50%-74%) in yellow; high (75%-89%) in green; very high (90%-100%) in blue.

**Table 3.** Mean scores obtained in each task by subject group

Tasks	Grade 5	Grade 7	Grade 10	College
Sound detection	76% a	81% a	93% b	90% b
Sound substitution	43% a	50% a	52% a	50% a
Word segmentation	58% a	65% ab	79% b	73% ab
Phonological process deactivation	41% a	48% a	61% a	60% a
Phonological process explanation	--	--	7% a	11% a

The performance levels obtained in tasks of segmental awareness show two distinct trends. On the one hand, they were lower in grades 5 and 7 than in grade 10 and college and some of these differences reached statistical significance, which suggests the existence of a certain growth in phonological awareness. On the other hand, several facts show that the differences between subject groups are not very marked. For instance, (i) there is no significant difference between grades 5 and 7 or between grade 10 and college, (ii) the response types reveal the use of the same strategies (e.g. letter naming instead of sound isolation) by the different groups when task solving and (iii) there are some cases of lower level of success in college students than in 10<sup>th</sup>-graders. Besides, these results also reveal that the level of segmental awareness in older students is not totally satisfactory.

The results in phonological process deactivation also show distinct tendencies. The difference between grades 5 and 7 vs. Grade 10 and college is close to statistical significance. However, there is no statistically significant difference between the several grades and the response types are similar.

Finally, the performance level in the task of explicit phonological knowledge is very low in the two groups who resolved this task. Besides, there seems to be no positive evolution that can be associated with the schooling grade.

In the results' discussion, we must take into account the mother tongue syllabus which determined the subjects' curriculum. This syllabus prescribes the study of: some contents that should promote segmental awareness (e.g. linguistic variation, figures of speech related to the phonetic form of words) in grades 5 to 9; phonological processes (of sound insertion, deletion and replacement) in grades 9 and 11. Consequently, the level of segmental awareness should be higher in the older students; the phonological process awareness and the explicit knowledge of phonological processes should increase between grade 7 and 10, as well as between grade 10 and 1st year of college; the final level of metaphonological competence should be very good.

However, the results show that the general level of metaphonological competence is not satisfactory, and consequently insufficient to serve as a basis for the promotion of excellence in oral and written uses of mother tongue, as proposed by educational linguists. This fact and the lack of competence evolution in some tasks, in spite of the phonological contents' teaching, can be attributed to an incorrect or superficial way of promoting metaphonological abilities. All these results and interpretations suggest that the better performance level by older groups in some tasks can be caused not by a real improvement in metaphonological competence but by the development of more general skills such as working memory, attention and cognitive flexibility.

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## Vowel spaces in French children wearing cochlear implants

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**Background.** While it is true that cochlear implants (CI) restore access to a large part of the audio information for profoundly deaf individuals, their spoken language development remains delayed compared to their peers with normal hearing, even after several years of CI use (Giezen, 2011). However, speech production in CI children has been little studied. Most studies on speech production after cochlear implantation bear on its evolution in the months and years following intervention, and usually document a positive evolution of intelligibility and fluency, towards typical developmental norms (see for a review: van Lierde et al., 2005). Only a limited number of studies are concerned with the long-term consequences of implantation, and among these, very few are phonetic studies and even fewer are concerned with prelingually deaf CI children.

Studies on vowel production provide contradictory results on differences in vowel space size: Horga & Liker (2006), Liker, Mildner & Šindija (2007) and Löfqvist, Sahlén & Ibertsson (2010) find smaller vowel spaces in CI than NH, while Baudonck et al. (2011) find the opposite. Results are also conflicting as concerns formant values: Liker et al. (2007) find higher F2 values in CI than NH, Löfqvist et al. (2010) find lower F1 values in CI children and smaller F2 ranges, Baudonck et al. (2011) do not find any difference. These conflicting results are probably due to methodological discrepancies, such as different vowel space measures, and most importantly differences in data normalization procedures: some of these studies compare un-normalized data from individuals differing greatly in age.

**Objective and method.** We carried out a pilot acoustic analysis of vowel production by five French prelingually deaf CI children (three girls and two boys) aged 5 to 10 years (mean age: 8;3 years, mean age of implantation: 3;3 years), who are compared to a group of 7 NH children (4 girls and 3 boys) aged 6 to 8 years (mean age: 6;9 years). A word repetition task and an Oral Language Assessment test for all children (ELO; Khomsi, 2002) were recorded. The corpus included all French oral vowels in word-initial position: [i e ε a ɔ o u y ø œ] with two words per vowel and one to two repetitions per word depending on the child's cooperation.

**Analyses.** An accuracy score (1 when the target vowel is correct, 0 when incorrect) was assigned perceptually to each production by a trained phonetician. Acoustic measurements were carried out for accurate vowels and consisted of F0, F1, F2 and F3 values (automatically extracted with Praat and checked manually). Two normalisation procedures were compared on the NH data: transformation in Bark:  $F_{n\_bark} = 26.81/(1+(1960/F_n)) - 0.53$  as in Löfqvist et al. (2010), and Lobanov's (1971) z-score:  $F_{n\_lobanov} = (F_n - \text{mean}(F_{n\_all\_vowels}))/\text{std}(F_{n\_all\_vowels})$ . Figure 1 provides the F1/F2 values for all the accurate vowels of NH children in the normalised spaces.

We computed an index to quantify the normalisation procedures' capacity to reduce the intra-category variability while increasing the inter-category distances: we calculated the areas of the intersections between ellipses and divided it by the total area of the ellipses. The index was lower for Lobanov's z-scores (0.46) than for Bark (0.66) and Hertz (0.71). Therefore all data were normalised using Lobanov's z-scores.

**Results and discussion.** Accuracy scores are systematically lower in CI than in NH, for vowels (CI: 83.5%; NH: 95.8%,  $t(268)=-4.55$ ,  $p<.01$ ). Vowel spaces were computed using Löfqvist et al. (2010)'s method and were not found to be significantly different (CI: 1.266; NH: 1.276), contrary to their

previous results. This might be due to the use of a more adequate normalisation procedure. F1 and F2 ranges were significantly smaller for CI children than NH (Figure 2; right; F1:  $t(333)=14.75, p<.01$ ; F2:  $t(194)=15.07, p<.01$ ). Table 2 provides other measures of F1/F2 excursion in the two groups. These findings altogether suggest that CI children exploit a narrower acoustic space than NH (cf. maximum F1/F2 square area = F1range x F2range: smaller in CI than NH), and that they produce more intra-category variation (cf. mean area of the ellipses larger in CI than NH) and less inter-category distances (cf. sum of the intersections between ellipses larger in CI than NH).

F1 and F2 values were also compared for each vowel for the two groups (Figure 2 left and centre): the only significant differences are summarised in Table 1 below. However, there seems to be a tendency for high and low vowels to be higher in CI children than in NH, and for mid vowels to be lower. This tendency will have to be further tested with more participants.

Our future studies will aim at relating these results with the duration of auditory experience, and with the speech perception abilities of the CI children.

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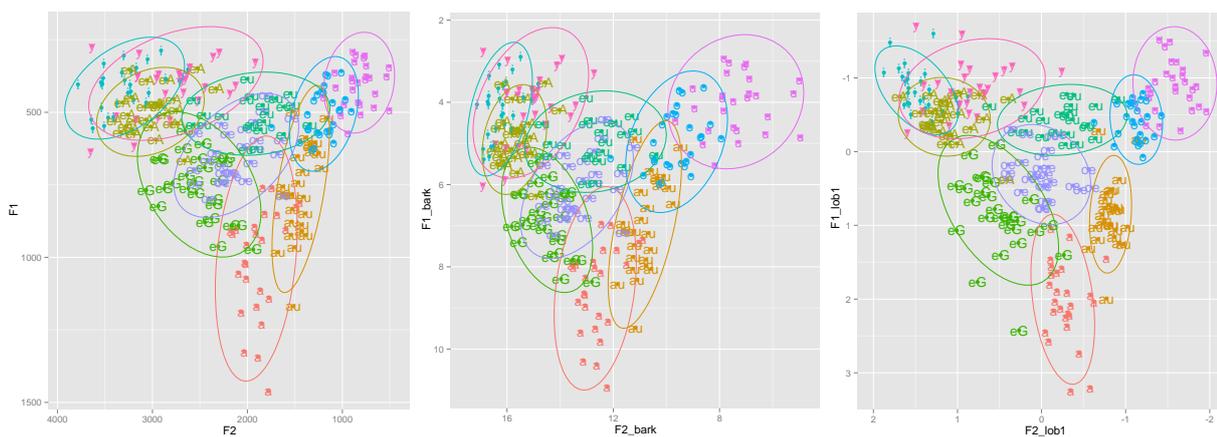
**Table 1.** Significant differences between the two groups for F1 and F2 for each vowel, as tested with Welch's t-tests

	F1	F2
i		NH > CI ( $t(29)=2.30, p=0.01$ )
e	NH < CI ( $t(32)=-1.77, p = 0.04$ )	
a	NH > CI ( $t(28)= 1.69, p=0.05$ )	
u	NH > CI ( $t(35)=2.49, p<0.01$ )	NH < CI ( $t(20)=1.96, p=0.03$ )
o	NH < CI ( $t(19)=1.92, p=0.03$ )	
ɔ		NH > CI ( $t(25)=2.82, p<0.01$ )

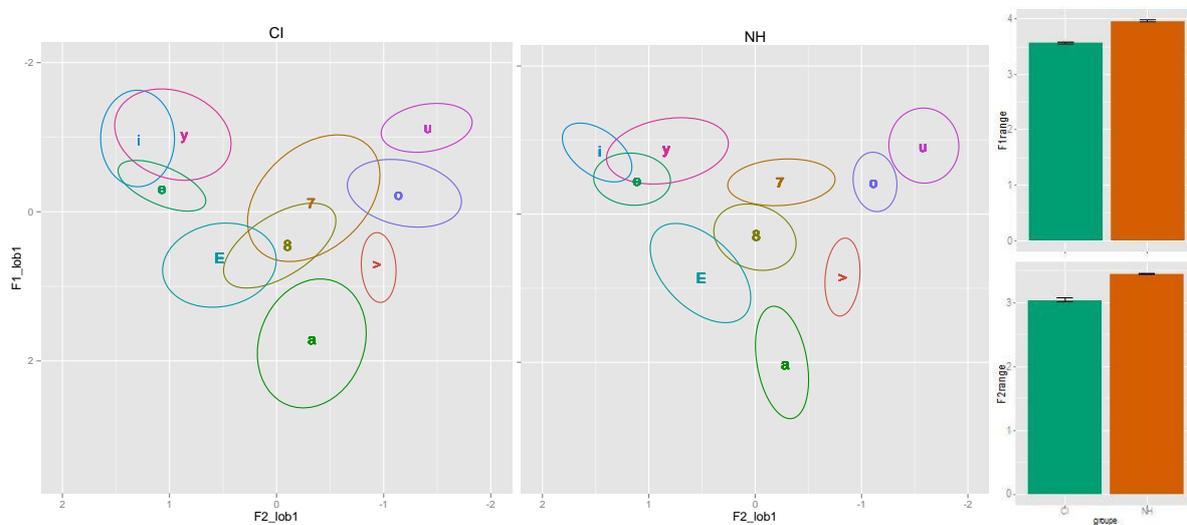
**Table 2.** Characterisation of the vowel spaces in the two groups

	CI	NH
maximum F1/F2 square area	15.6	19.0
mean area of the ellipses	3.1	1.7
sum of the intersections between ellipses	50.5	16.3

**Figure 1.** F1/F2 data for NH children, in Hertz (left), Bark (centre), and Lobanov's z-score (right), with 95% confidence ellipses.



**Figure 2.** F1/F2 95% confidence ellipses for the 10 French oral vowels for CI children (left) and NH children (centre); right: F1 (top) and F2 range (bottom) for CI (green, leftmost bar) and NH (red, rightmost bar)



## **Acoustic-phonetic adaptations to a hearing-impaired listener by normally-hearing and hearing-impaired children and adolescents**

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Approximately 82% of children with a hearing impairment (HI) attend mainstream schools in England (CRIDE report, 2012). Therefore HI children and their normally-hearing (NH) peers are in frequent interaction with one another – requiring both HI and NH children to adopt strategies for dealing with possible speech perception and production problems in conversation. To gain a better understanding of the communication difficulties that HI children face and the strategies they and their peers use to overcome them, this study investigates whether NH and HI children adapt to the needs of a hearing-impaired interlocutor, focusing mainly on the acoustic-phonetic properties of their speech.

According to Lindblom's (1990) Hyper-Hypo theory of speech production, speakers are able to control the variability in their speech to adapt to different communicative situations – increasing articulatory effort when the listener has difficulty understanding them (hyperarticulation), but decreasing their speaking effort when there are no communication difficulties (hypoarticulation). While several studies have shown that adults are able to make acoustic-phonetic adaptations to their speech when asked to speak 'as if to a hearing-impaired listener' (c.f. Smiljanic & Bradlow, 2009, for a review), children are more variable than adults in their speech production (e.g. Lee, Potamianos & Narayanan, 1999), and may therefore not have the control needed to adapt their speech to situations as required. Few studies have investigated the adaptations used by speakers when talking to a hearing-impaired listener or explored the strategies used by HI children themselves to increase the intelligibility of their speech when needed, although miscommunication is likely to be common for them (e.g. Caissie & Wilson, 1995).

This study uses two problem-solving tasks involving pairs of speakers to elicit NH- and HI-directed speech in a controlled but naturalistic context, similar to those that NH and HI children may regularly face in an educational setting. All participants frequently interact with HI peers, and therefore the speech produced will reflect everyday speech input for the HI children in the study. Importantly, we also investigate the strategies used by HI children themselves to clarify their speech.

Thirty-six participants in nine groups of four (each with two HI and two NH participants) took part in the experiment. The groups were recorded in schools in London and the South-East of England, all of which had a Hearing-Impaired Unit attached to a mainstream school. The mean age of the 18 NH participants was 12 yrs (range: 9;0 to 14;5 yrs); the mean age of the 18 HI participants was also 12 yrs (range: 9;7 to 15;2 yrs). The hearing loss level of the HI participants ranged from moderate to profound. Seven HI participants had one or two cochlear implants, and the remaining eleven HI participants wore bilateral hearing aids. Of the HI participants, nine were monolingual Southern British English speakers; four HI participants' parents spoke English as an additional language; three HI participants spoke an additional language at home, and one participant had British Sign Language as her first language. Of the NH participants, 15 were monolingual Southern British English speakers; two NH participants spoke an additional language at home, and one was bilingual. Three HI participants and two NH participants were assessed as having some mild additional special educational needs.

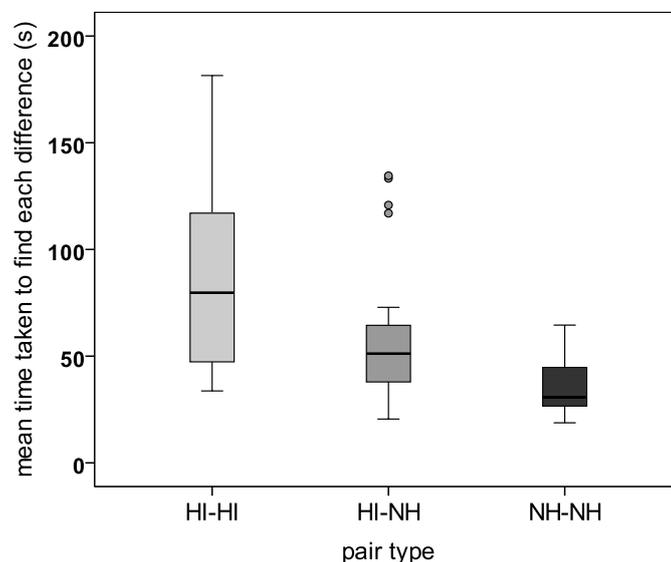
Each participant took part in two 'communication' sessions: once with a normally-hearing friend (to elicit NH-directed speech) and once with a hearing-impaired friend (to elicit HI-directed speech). Each communication session involved playing two problem-solving games with the friend; a 'Grid' game, and a 'Diapix' game, using the DiapixUK picture materials (Baker & Hazan, 2011). The 'Grid'

task was developed to obtain multiple repetitions of three different types of speech contrasts in spontaneous speech. The Diapix task (Baker & Hazan, 2011) is a 'spot-the-difference' picture description task, and was used to elicit a wider range of vocabulary and syntactic structures than in the Grid task. In these tasks we explore whether global acoustic-phonetic aspects of the children's speech are enhanced in speech directed to a HI peer compared to that elicited when speaking to a NH peer. In a third session, speech perception tests were run on each participant individually. In this task, we only report results obtained for the Diapix task.

In order to examine whether there were perceptible changes in speech clarity for each speaker in HI-directed speech compared to NH-directed speech, short snippets taken from the recordings were used to construct a clarity rating experiment. Twenty normally-hearing monolingual Southern British English adult listeners (15F, 5M; age range: 18;10 to 26;3 yrs) were asked to rate each snippet from 1 (very clear) to 7 (not very clear).

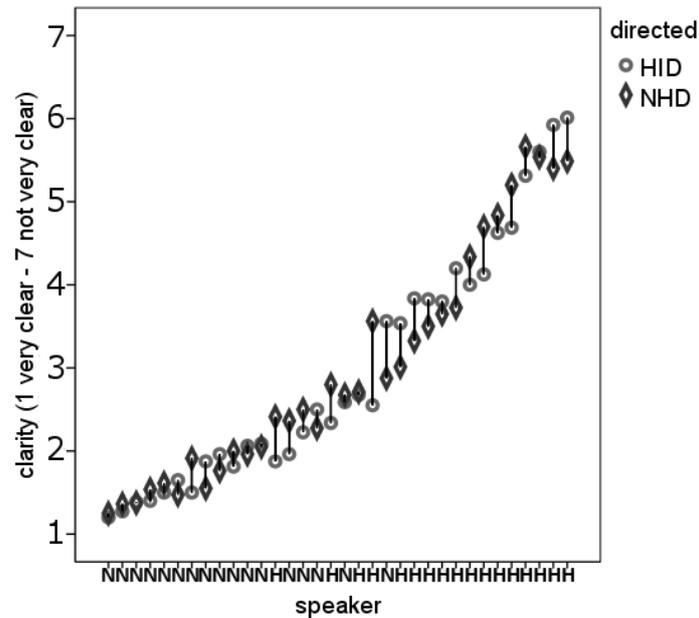
In the Diapix task, for the first 8 differences found, the mean time taken to find each difference per picture was taken as a measure of task difficulty in each condition. If less than 8 differences were found, the measure was the mean time taken to find each difference. A two-way mixed ANOVA was run on this measure, with speaker hearing status (HI, NH) as between-subjects factor and interlocutor hearing status (HI, NH) as within-subjects factor. There were significant main effects of speaker hearing status [ $F(1,30)=4.2, p=.05$ ], and of interlocutor hearing status [ $F(1,30)=6.3, p<.05$ ]. The time taken to find each difference was shorter when completing the task with a NH interlocutor (mean: 52.7s) than with a HI interlocutor (mean: 83.3s). However, there was no significant interaction between factors. This suggests an increase in task difficulty for speakers when talking with an HI interlocutor, regardless of speaker hearing status (see Figure 1). This condition is therefore likely to require adaptations in the communication strategies used by NH and HI speakers.

**Figure 1.** Mean time taken to find each difference (in seconds) per Diapix picture for each pair type. For HI-HI pairs,  $n=15$ ; for HI-NH pairs,  $n=30$ ; for NH-NH pairs,  $n=16$ .



In the clarity rating study, the HI speakers were generally rated as being less clear than the NH speakers (see Figure 2). However, there were no perceptible changes in the clarity of the participants' speech in conditions involving a HI interlocutor compared to those involving a NH interlocutor, for either NH (means: NHD: 1.9; HID: 1.9) or HI speakers (means: NHD: 4.1; HID: 4.1).

**Figure 2.** Means of listeners' ratings of speech clarity for each speaker (H: hearing impaired; N: normally-hearing), when talking to a hearing-impaired (HID) or normally-hearing (NHD) peer.



These results imply that the speakers did not enhance their speech to a great extent when speaking to their HI peer. However, it is possible that due to the large differences in speech clarity between the NH and HI participants, any changes according to speaking style, especially by NH speakers, may not be revealed in the current clarity ratings. Alternatively, speakers may only be making subtle or inconsistent differences to their speech in the HI-directed condition compared to the NH-directed condition. The results will be further discussed in conjunction with acoustic-phonetic measures of the participants' spontaneous speech, including median F0, F0 range, speech rate and pausing, to explore whether participants nevertheless made adaptations to their speech when talking with a HI interlocutor.

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## Processing of natural fast speech and time-compressed speech in children with speech output disorders

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**Introduction.** Every listener has experienced the difficulty of understanding a conversation with someone speaking very fast, and has noticed that, over time, comprehension becomes much easier. This gradual, yet rapid adaptation to speech rate variations illustrates the remarkable flexibility of our perceptual system to continuously normalize for changing parameters to eventually understand the message. Increasing speech rate elicits more phonetic phenomena (coarticulation, assimilation) than speaking at a normal rate (Byrd & Tan, 1996; Koreman, 2006), and this increase is nonlinear (the duration of vowels and unstressed syllables is more reduced than that of consonants and stressed syllables in English and Dutch) (Max & Caruso, 1997; Janse, Nootboom & Quené, 2003). These timing changes and extra amount of segmental overlap may be particularly challenging for listeners, demanding additional processing time and cognitive resources. Previous studies have revealed that young and older adults are able to adapt to natural fast speech (Adank & Janse, 2009) and to artificially time-compressed speech (Dupoux & Green, 1997). However, adaptation to natural fast speech seems slightly more difficult, as it requires a longer exposure time to stimuli to occur (Adank & Janse, 2009). Natural acceleration of speech indeed induces both temporal and spectral changes of the signal, therefore making speech perception more complex, whereas time-compressed speech only alters the temporal structure (Janse, 2004). In a recent study (Guiraud et al., 2013), we investigated whether children also show rapid adaptation to changes in speech rate. Results showed that healthy children aged 8-11 years old, like adults, quickly adapt to natural fast speech and time-compressed speech. The speed of adaptation was comparable for the two types of speech, but response accuracy was lower in the natural fast condition, which may reflect qualitative differences in the processing of speech that is accelerated naturally vs. artificially. We suggested that in order to deal with the spectro-temporal changes and the strong segmental overlap that accompany natural fast speech, the listener may switch to a different system of acoustic-phonetic rules to extract relevant cues for phoneme identification [see also Golomb, Peelle & Wingfield, 2007]. This demanding process at the cognitive level probably recruits additional brain areas. In contrast, processing linearly time-compressed speech should not necessarily require changing to a completely different set of rules than for normal rate speech. An fMRI study in adults however showed specific activation of the left premotor cortex during time-compressed speech perception whereas this brain area was not activated for normal rate speech (Adank & Devlin, 2010). This is an agreement with the dual-stream model of speech perception (Hickock & Poeppel, 2007) suggesting the involvement of two pathways: a ventral temporal stream for signal recognition, matching phonological to semantic representations, and a dorsal parieto-frontal stream that acts as a sensorimotor interface, matching phonological and articulatory representations and assisting the ventral stream to understand the message, particularly in adverse conditions. If articulatory regions of the brain play a role in the perception of (degraded) speech, children with specific language impairment (SLI) with marked production deficits (i.e. phonological programming deficit) and children with apraxia of speech (i.e. dysfunction in the programming of articulatory movements) should experience specific difficulties in perceiving fast speech. Studies have revealed that children with SLI or dyslexia have trouble to adjust to the slow rate of a metronome (2 Hz) in tapping tasks, thus revealing comorbidity between language and movement disorders for slow rhythms (Corriveau & Goswami, 2009; Thomson et al.,

2006). In addition, studies in children with apraxia of speech showed correlations between performance in production and perception tasks involving phonemes, for instance when children had to discriminate the border between /d/ and /b/ (Groenen et al., 1996; Nijland, 2009).

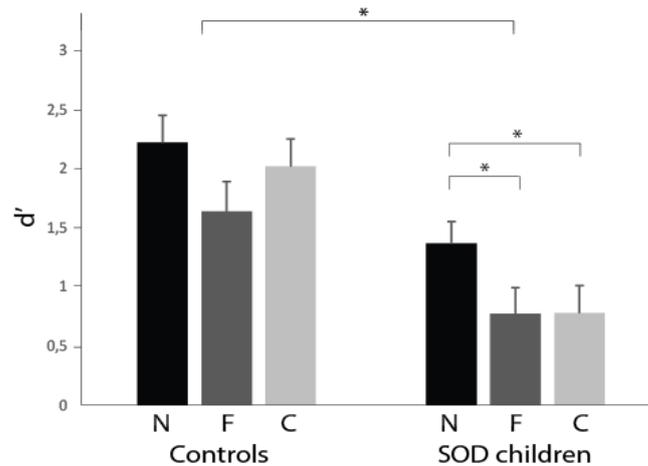
In the present study, considering the close relationship between speech perception and production systems, we investigated how children with SLI (with more pronounced deficits in speech production: phonological SLI) or with apraxia of speech process time-compressed speech and natural fast speech, compared to controls. We hypothesized that children with articulatory deficits should show specific difficulties in perceiving fast speech, particularly when it is accelerated naturally.

**Method.** Seventeen children with specific speech output disorders (SOD) (13 phonological SLI and 4 with apraxia of speech) aged 8-13 years old participated in the experiment. Children were right-handed French native speakers, with no hearing problem, no Attention Deficit Hyperactive Disorder, no Pervasive Developmental Disorder and with an IQ > 70. Each child with SOD was matched to a control child of the same chronological age and sex. We used a battery of additional neuropsychological tests (Raven matrices, assessment of oral language, phonological awareness and digit span of the BALE) to ensure the preservation of certain aspects of the diagnosis to include children with SOD in the study.

Our stimuli were composed of 300 sentences, with the last word being congruent or not with the context. Each sentence was produced by a French native male adult, at a normal rate (6.76 syllables/s) and at a fast rate (9.15 syllables/s). Time-compressed sentences were created from the normal rate sentences (PSOLA algorithm) to match the rate of natural fast sentences. The total of 900 sentences was split into 12 experimental lists, each composed of 3 experimental blocks (25 items/block; 13 congruent/12 incongruent) corresponding to the 3 speech rate conditions (blocks always presented in the same order: normal, natural fast and time-compressed (Adank & Janse, 2009)). Children had to listen to sentences from one of the 12 lists and judge their semantic coherence by pressing one of two keys on the keyboard. Accuracy was measured and performance was analysed with signal detection theory calculating discrimination sensitivity with  $d'$  for each participant and each speech rate condition. These analyses are based on the proportion of hits (i.e. correct responses for incongruent sentences) and false alarms (i.e. errors for congruent sentences) (Macmillan & Creelman, 1991). Mean  $d'$  were entered into a two-way ANOVA including the factors Speech Rate (normal vs. natural fast vs. time-compressed) and Group (SOD vs. controls). In case of significant interactions, Tukey post-hoc tests were performed.

**Results.** The ANOVA on  $d'$  revealed a significant effect of Group ( $F=13.13$ ,  $p<.01$ ), with reduced sensitivity to semantic incongruency in SOD children ( $d'=1.13$ ) than in controls ( $d'=1.96$ ; Figure 1). A significant effect of Speech Rate was also observed ( $F=8.94$ ,  $p<.001$ ). Post-hoc tests showed that the two groups of children tended to be less sensitive to semantic incongruency when speech was naturally accelerated ( $d'=1.27$ ) compared to the normal rate condition ( $d'=1.88$ ,  $p=.06$ ). No interaction between Speech Rate and Group was found. Given the results on Figure 1 and our hypothesis of stronger difficulties to process fast speech in SOD children than in controls, we conducted an ANOVA with the factor Speech Rate for each group separately. Results revealed that whereas no significant effect of Speech Rate was observed in controls, this factor significantly affected performance in SOD children ( $F=60.13$ ,  $p<.01$ ). Mean  $d'$  was lower in the natural fast speech ( $d'=0.78$ ) and the time-compressed speech ( $d'=0.78$ ) conditions than in the normal rate condition ( $d'=1.37$ ;  $p<.01$ ). This suggests that children with SOD experience more difficulty in identifying incongruent sentences when speech is accelerated, both naturally and artificially.

**Figure 1:** Mean sensitivity index  $d'$  of children with speech output disorders (SOD) and their controls for the three speech rate conditions: normal speech (N), natural fast speech (F), time-compressed speech (C). (\*) indicates a significant difference between conditions. Error bars indicate between-participants standard errors.



**Conclusions.** These preliminary results suggest that children with speech output disorders, either at the level of phonological programming or of articulatory gestures programming, seem to show specific difficulties in processing fast speech, compared to controls, and compared to speech produced at a normal rate, as reflected by their lower sensitivity to semantic incongruity in the natural fast speech and time-compressed speech conditions than in the normal rate condition (Figure 1). In other words, their abilities to discriminate incongruent from congruent sentences are reduced when speech is accelerated, either naturally or artificially, and they make more errors in the semantic judgment task. This indicates the existence of difficulties in processing rapid changes in spectral and temporal speech cues. The analysis performed separately for each group of children shows that speech rate significantly affected  $d'$  in SOD children but not in controls. These results therefore suggest that children with expressive language deficits could be particularly impaired at detecting semantic abnormalities in sentences that are auditorily presented compared to controls. Our data do not show a greater deficit for natural fast speech, despite its strong articulatory dimension, compared to time-compressed speech; however, note that more children with apraxia of speech need to be included in the study and a fine-grained distinction then needs to be carried out between children with phonological SLI and children with apraxia of speech, who may show stronger deficits for natural fast speech due to their speech programming deficit. Overall, our results seem consistent with the dual-stream model (Hickock & Poeppel, 2007), which assumes that articulatory patterns involved in the dorsal pathway play a role in (degraded) speech perception (Adank & Devlin, 2010), thus allowing more efficient processing of the signal. In children with expressive disorders, the dorsal stream that matches phonological to articulatory representations may not be as efficient as in control children. Therefore, when these children face speech produced at a rapid rate, they may experience specific difficulties. Pursuing this study as well as future neurophysiological studies should allow strengthening our assumption that the speech production system is specifically involved in fast speech perception.

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## Temporal properties of 9-year-old children's spontaneous speech

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**Introduction.** Psycholinguistic studies generally focus on the earlier periods of language acquisition. Although there are significant changes spontaneous speech samples of school-age children, less is known about the details of the outcomes of their speech production (Loban 1976; Ferrand–Bloom 1996; Hacki–Heitmüller 1999; Nippold 2006). Sporadic data can be found about the temporal characteristics of speech sounds and speech tempo values of school-age children's spontaneous utterances. Data supported that the variability of durations of the speech sounds would decrease between the ages of 9 and 12. The 12 year-old children's data were close to the adults' speech sound durations (Lee, Potamianos & Narayanan, 1999). This tendency was confirmed also for the variability of the VOTs of the stop consonants where the values were shown to decrease between the ages of 9 and 11 (Whiteside, Dobbin & Henry, 2003). Speech rate increases with age (Hulme et al., 1984), although individual differences may influence the speech rate to a greater extent than the children's age (Smith, Kenney & Hussain, 1999).

The aim of this study was to describe the temporal properties of the spontaneous speech samples of 9-year-old children. This is the first study that attempts to focus on this topic in Hungarian-speaking children's narratives. We hypothesized that (i) durations of phrases, filled and silent pauses, word counts within the phrases and speech tempi would differ from those of adults'; (ii) children's phrases would contain less words than adults would, and (iii) significant differences would be expected depending on gender.

**Participants, material, method.** Eighteen narratives were recorded for the sake of this study. Recordings were made at the children's school in a silent room using a Sony ICD-SX700 tape-recorder. 9-year-old children (nine boys and nine girls) participated in the experiment. All of them were native speakers of Hungarian with normal hearing and typical language acquisition. Children were asked to speak about their family, school and hobbies for as long as they could. The total material was 67 minutes long (four minutes per informants, on average). The material was annotated using Praat 5.1 (Boersma & Weenink, 2010) at three levels (phrases, words, speech sounds). Phrases were defined as an utterance flanked by (silent or filled) pauses on both sides. The duration of the phrases and pauses, the rate of speech articulation tempo was extracted automatically using a specific Praat script. The phonetic forms of filled pauses were also analyzed. Statistical analysis was carried on the data using SPSS 13.0 program (analysis of variance, Mann–Whitney U test, Kruskal–Wallis test, as appropriate).

**Results.** The corpus included 1695 phrases with a mean duration of 1241 ms (SD: 907 ms). The shortest phrase took 12,7 ms, and the longest took 6213 ms. The variability across speakers was large. Data showed that girls produced significantly longer phrases in their narratives than boys did (Mann–Whitney U test:  $Z=-6.728$ ;  $p<.001$ ). The average duration of the phrases was 1404 ms (SD: 1008 ms) in the girls' narratives and 1056 ms (SD: 736 ms) in the boys' narratives.

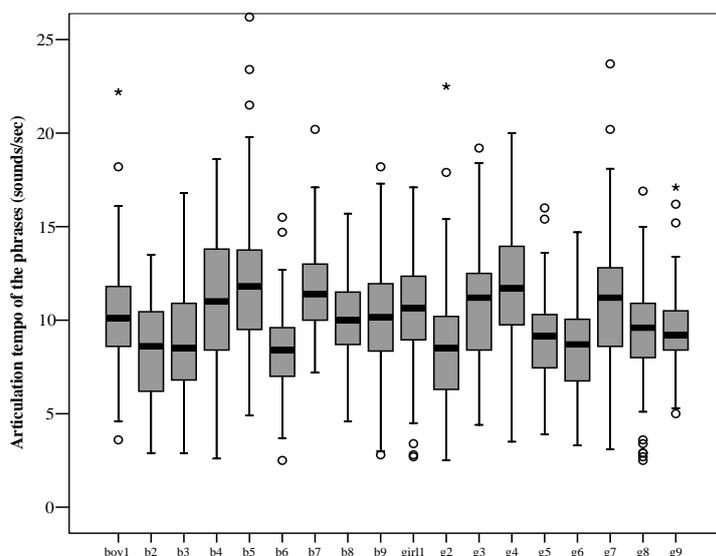
The temporal properties of phrases included also the analysis of the number of words each phrase contained. The phrases contained 2.66 words, on average (SD: 1.59). 50.1% of all phrases consisted of only one word (e.g., *eszem* 'I am eating', *ezt* 'this', *játszok* 'I'm playing', *régi* 'old', *Németországban* 'in Germany') that convey sometimes complex morphological and syntactical structures. (We have to note that the number of syllables in Hungarian spontaneous speech is about 3.5.) The maximum number of words was 18 in a phrase. Data showed large variability across children in the number of words in the phrases. Girls produced significantly more words in phrases than boys did [ $F(1,$

1694)=43.676;  $p<.001$ ]. The phrases in the boys' narratives contained 2.29 words, on average (SD: 0.57) while those of the girls' contained 3.03 words, on average (SD: 0.32).

Since the occurrences and durations of both filled and unfilled pauses define the temporal characteristics of narratives, analysis was carried out also in this respect. The corpus included 1842 silent pauses and 374 filled pauses. The mean duration of the silent pauses was 944 ms (SD: 1380). The shortest silent pause took 31 ms while the longest one took almost 1.5 s (14513 ms). Statistical analysis confirmed significant difference in the durations depending on gender (Mann–Whitney U:  $Z=-3.280$ ;  $p=.001$ ). Boys' narratives were characterized by longer silent pauses (mean: 1071, SD: 1415) than the girls' narratives (mean: 881 ms, SD: 1345). Twelve silent pauses were found in the corpus, which occurred within words. They appear because of the uncertainty of the speech planning processes. Their mean duration was 319 ms; the shortest one was 55 ms and the longest one was 660 ms long. We analysed the occurrence, forms and the duration of the 374 filled pauses. 5.6 filled pauses occurred in the corpus per minute on average. Although girls produced filled pauses more frequently (mean: 6.9 filled pause/minute, SD: 5.5) than the boys (mean: 3.1, SD: 2.7); however, the difference was not proved to be statistically significant. The mean duration of the filled pauses was 379 ms (SD: 208 ms). The shortest one was 21 ms and the longest one was 1556 ms. The filled pauses were produced in various phonetic forms (neutral vowel, bilabial nasal sound, the combination of them, etc.). The duration of the filled pauses was significantly different depending on the phonetic form (Kruskal–Wallis test:  $\chi^2=89,612$ ;  $p<.001$ ).

The speech tempo of children was 75 words per minute, on average (SD: 23.14). Girls' speech production was slightly faster than that of the boys, but the difference was not statistically significant. Girls exhibited 83 words per minute, on average (SD: 21) while boys produced 67 words per minute (SD: 23). The tempo of articulation was measured in each phrase (Figure 1). The mean articulation tempo was 10.3 sounds/s (SD: 3.21). There was no difference depending on gender. The mean tempo was 9.9 sounds/s (SD: 3.2) in the girls' narratives while 10.1 sounds/s (SD: 3.2) in the boys' narratives. Statistical analysis confirmed significant differences in the tempo of articulation across speakers (Kruskal–Wallis test:  $\chi^2=216.080$ ;  $p<.001$ ).

**Figure 1.** Articulation tempo of the phrases



**Conclusions.** The aim of this study was to describe the temporal properties of the spontaneous narratives of 9-year-old children. The phrases were shorter in children's narratives and contained less words compared to those of adults' narratives (for adults: Gósy et al., 2011). This finding can be

explained by the children's less routine in language use (than that of adults) that may result in more difficulties in their speech planning processes. Pauses occurred in a greater extent in the 9 year-olds' narratives than in the adults' narratives. In addition, children's silent pauses were twice as longer as the adults' pauses, on average (944 ms and 510 ms, see Gósy et al., 2011). Children's frequent and longer silent pauses reflect their necessity to gain more time to perform the speech planning processes. As expected, adult speakers produced twice as many words per minute as our children did (see Gósy 2003; Gyarmathy 2007). The children's mean tempo of articulation was slower by three speech sounds than that of adults. Statistically significant differences were found in the duration of phrases and silent pauses depending on gender. However, there were no such differences in speech and articulation tempo. The findings of the present paper demonstrated some temporal properties of the 9-year-old children's narratives that add new information concerning the language acquisition stage of 9-year-olds.

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## The effects of perceptual distortion, age and proficiency on functional neural activation for sentence processing

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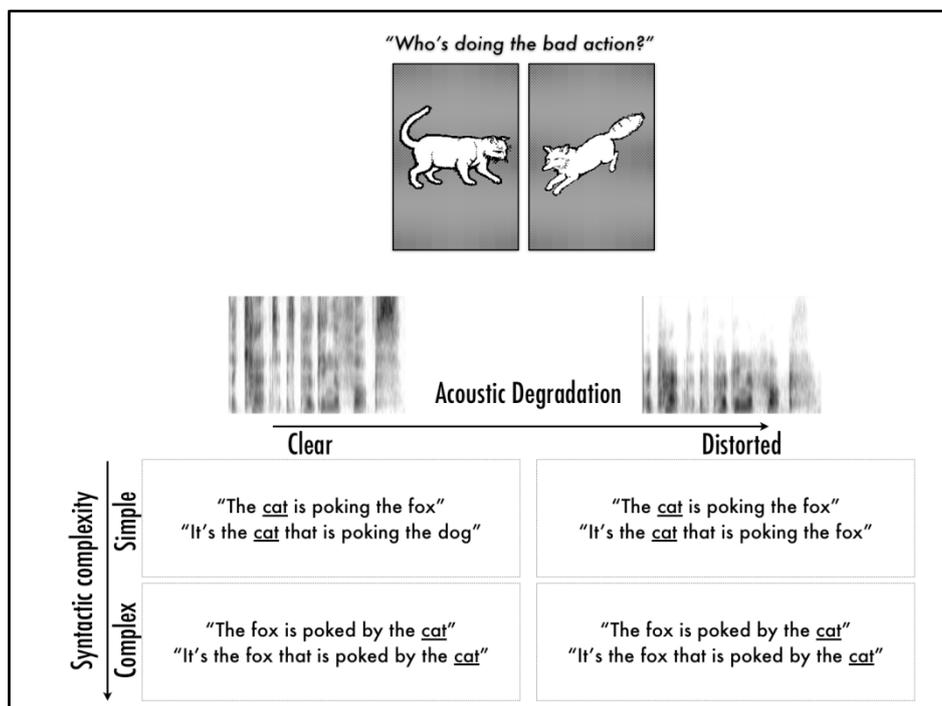
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In the school years, children become proficient language users. They acquire a larger vocabulary, and start to comprehend and use more complex syntactic constructions. During the same developmental period, perceptual, attentional and cognitive abilities are changing. These changes influence children's language comprehension ability. A gradual refinement of syntactic comprehension occurs in tandem with refinements of perceptual and attentional ability. In adverse listening conditions, this trajectory for sentence processing is extended even further (Leech et al., 2007). The functional neural bases of these protracted behavioural changes in language comprehension are not well understood. In adults, syntactic comprehension is associated with activation in a well-defined set of regions. Nonetheless, this activation can vary with relation to sentence complexity and task demands. Only a handful of studies focus on developmental differences in syntactic comprehension (Nunez et al., 2011; Yeatman et al., 2010). These studies focus on neural effects related to syntactic complexity alone. However, despite children's everyday exposure to noisy and distracting environments (such as classrooms/ playgrounds), the effects of perceptual/attentional factors on neural activation for language remain largely unexplored.

**Figure 1.** Schematic of the experimental design

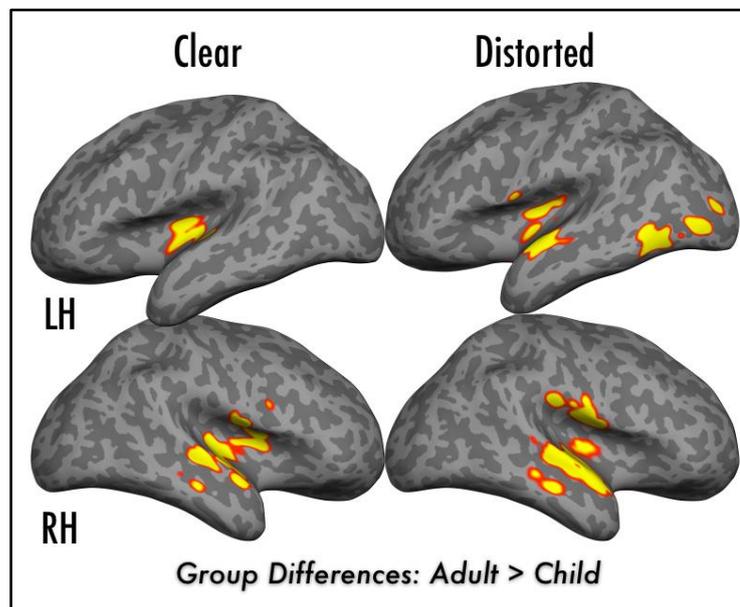


We compared school-age children (7-13 year olds, N = 32) and adults (N = 18) to characterise developmental differences in the neural activation for sentence comprehension. In our fMRI task, participants had to identify the agent of a sentence. Sentence complexity as well as perceptual/attentional demands were modulated. Complexity was modulated by using simple (active/ subject clefts) and more complex sentences (passives/ object clefts). Perceptual/attentional

demands were increased by introducing speech compression plus low-pass filters (Dick et al., 2001). To identify potential interactions, we explored the relationships between neural activation, age, and performance on a range of auditory-motor behavioural tasks.

All listening conditions elicited activation in the superior temporal and inferior frontal regions in both groups. Perceptual distortion was associated with decreased activation in the superior temporal regions in adults and children. On the other hand, increased syntactic complexity was associated with activation over the superior temporal gyrus and the inferior frontal gyrus. Although overall patterns of activation were similar in response to changes in syntactic complexity and perceptual degradation, group differences over temporal regions were observed when comparing children/adults. These indicate that the functional organisation of language comprehension in school-age children is still undergoing change.

**Figure 2.** Adults show greater activation than children do for clear speech > rest and distorted speech > rest



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## Recognizing environmental sounds in complex sound scenes: Change over the school years

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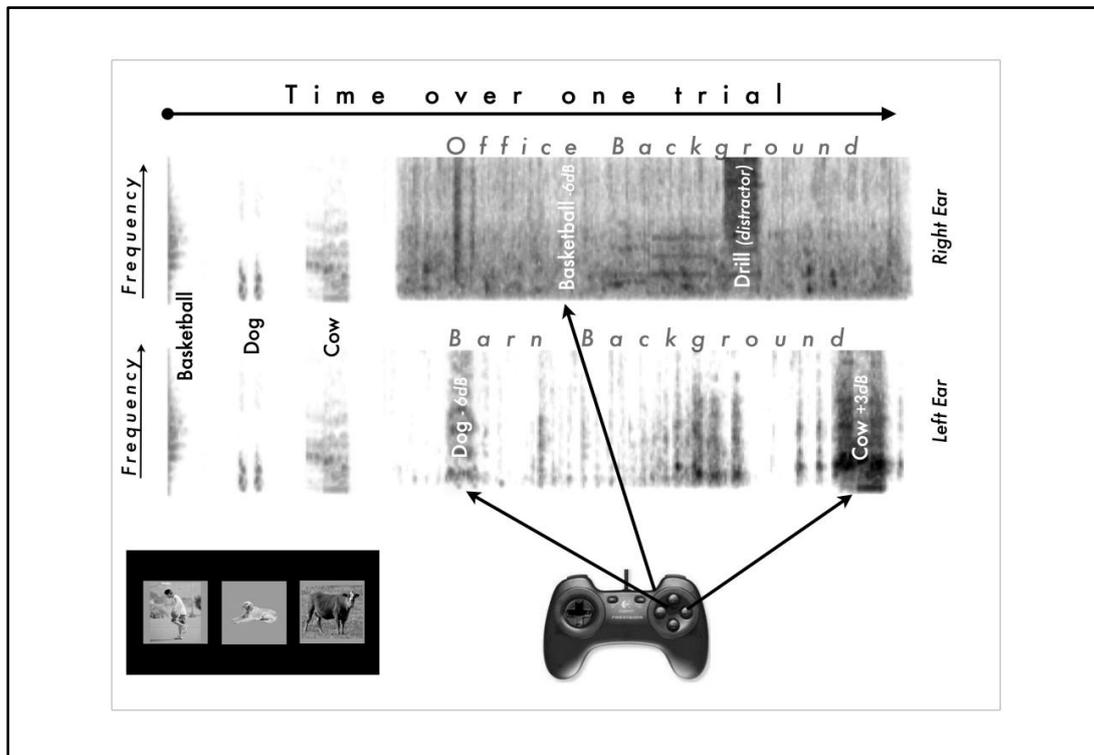
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In schoolrooms, playgrounds, city streets, and video arcades, hearing children must learn to isolate meaningful auditory cues in complex and dynamic listening environments to succeed scholastically and socially. The current study investigated the development of children's skills in detecting and identifying ecologically relevant sound objects within naturalistic listening environments, using a non-linguistic analogue of the classic 'cocktail-party' situation (Leech et al., 2009). Typically developing children aged seven to 12.5 years (N= 91) completed a closed-set identification task in which brief, commonly encountered environmental sound objects were presented at varying signal-to-noise levels. To simulate the complexity of real-world acoustic environments, target sound objects were embedded in either a single, stereophonically presented scene, or in one of two different scenes, with each scene presented monophonically to a single ear (see Figure 1). Each sound object was either congruent or incongruent with the auditory context, e.g. a 'cow moo' presented in a barn versus in a restaurant scene. Children's performance was compared to that of 46 young adults (Leech et al., 2009).

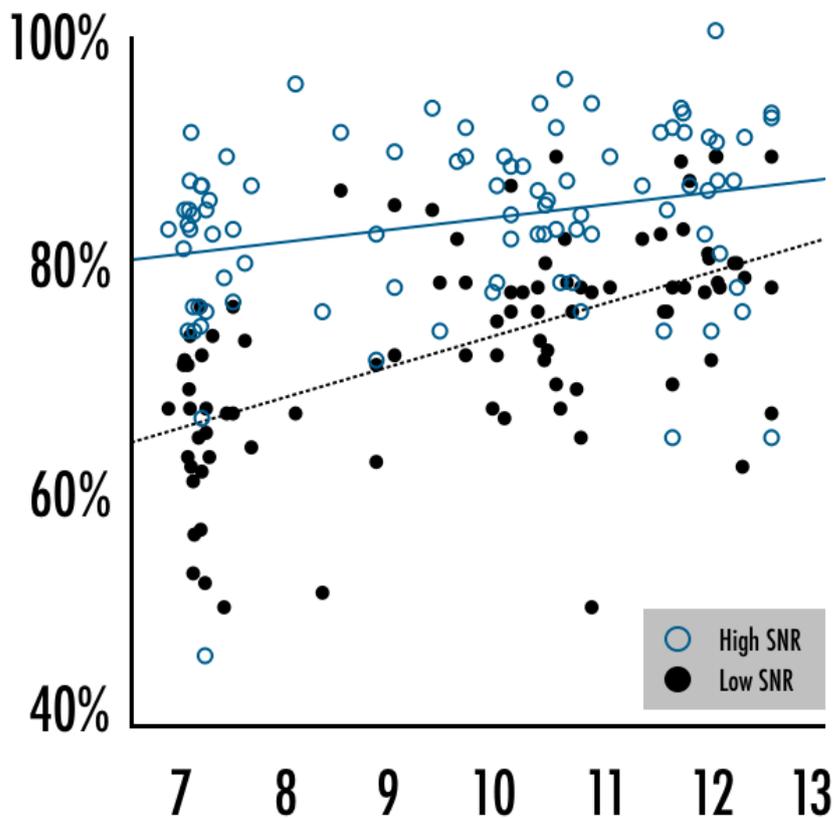
**Figure 1.** Schematic of experimental design



Results revealed a gradual developmental trajectory in which identification accuracy increased as a function of age, particularly in trials with low signal-to-noise ratios (see Figure 2). Children's performance was most accurate when sound objects were incongruent with the background scene

(a contextual 'pop-out' effect), and when objects were presented in a single background scene. The presence of two backgrounds disproportionately disrupted children's identification performance relative to previously tested adults, and reduced children's sensitivity to contextual cues, resulting in an attenuation of the pop-out effect. These results (Krishnan et al., 2013) show that successful identification of familiar sound objects in complex auditory contexts is the outcome of a protracted learning process, with children reaching adult levels of competence after a decade or more of experience.

**Figure 2.** Illustration of the interaction effect of age, denoted on the x-axis, with SNR condition (low/ high); accuracy is denoted on the y-axis. The black circles represent children's response rates in the low SNR condition, and the blue circles represent response rates in the high SNR condition. The black and blue lines indicate best fit with age for low and high SNR conditions



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## **How the cognitive system supports the development of complex narrative abilities in children**

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Prior narrative research examining the development and acquisition of story schema by young children reveals that by about 8 years of age, most children are typically able to tell complete stories, i.e. stories that include setting and contextual information, and a main episode, including goal formation by the protagonist, an attempt to achieve the goal and a subsequent consequence (Stein & Glenn, 1979; Stein & Albro, 1997). Acquisition and expertise in this narrative domain is a relatively late and protracted phenomenon relative to other language domains such as vocabulary or acquisition of simple syntactic structures. As one example, a recent study found that 4 and 5 year olds scored on average 7 out of 14 points on a prompted comprehension measure that required recall and reasoning about discrete story components (Khan, Nelson & Whyte, in press). Furthermore, the complexity of narratives – in terms of number of events included, the causal connectedness of the stories comprehended and produced, and coherence of the narrative generated by children –also continues to develop through late childhood until about 12 years of age (Trabasso & Nickels, 1985). So, it becomes evident that not only are narrative abilities continuing to develop throughout early and late childhood, but also that there is incredible variation in terms of the complexity of narratives comprehended and produced by children even within the typically developing spectrum.

According to a Dynamic Systems perspective (Nelson et al., 2004; Thelen & Smith, 1994; Sporns, 2011), children who make rapid progress in their narrative abilities relative to their peers are also more advanced in terms of their cognitive development – particularly in terms of the kinds of complex cognitive processes that they can perform. This prediction is based on the number of component processes that need to be successfully coordinated when, for example, producing a complex narrative. These component processes would include: setting the goal of linking and integrating all of the story elements in a coherent manner, retrieving the appropriate semantic information, syntactic structures, and morphological features that would express the causal links between various story elements and also indicate the characters' motivations and reactions, as well as monitoring and flexibly adjusting the narrative while it is being produced. Furthermore, it is important to note that not only do all of these processes need to be coordinated into one coherent system, but they also need to be deployed at incredibly rapid speed for coherent production. Thus, it is predicted that cognitive tasks requiring complex coordination of multiple cognitive processes will help best account for variance in narrative production and comprehension abilities in children relative to other language domains.

The current study is the first to empirically test this theoretical assumption and examine how a differentiated set of multiple cognitive skills, including phonological short term working memory, and executive functions (EF) including inhibitory control processes, speeded processing, planning, goal setting and management, goal-directed search and retrieval, monitoring, shifting, coordination, and attentional flexibility pattern together in their contributions to preschool aged children's language abilities. The participants in the current study include 84 typically developing children between the ages of 3.5 and 6 years.

A stepwise regression using a backward elimination approach was used to identify the best cognitive predictor models accounting for the most significant amount of variance in these language outcomes: narrative production, narrative comprehension, complex syntax, simple syntax, vocabulary comprehension, and vocabulary production. Results indicate that both narrative production and comprehension are supported by the more complex EF skills involved in the Dimensional Change Card Sorting task and by a spontaneous semantic category production task (the two most complex tasks in our cognitive assessment battery). This is in contrast with the lack of predictive power of both of these complex EF tasks when examining vocabulary production and comprehension abilities. Additionally, distinct patterns of cognitive contributors were found for narrative production vs. comprehension, indicating that faster speed of processing was more beneficial in a production context, but that more efficient monitoring and updating skills were particularly important when reasoning about a narrative that had just been heard. These results overall show that children who are better able to coordinate and deploy higher order EF functions in turn demonstrate higher levels of performance on both the complex EF tasks and complex language tasks.

**Table 1.** Results of multiple regression analysis with narrative production as the outcome variable.

Predictor	Beta	t	p
Processing Speed - Simple EF	-.18	-1.81	.075
Tower of Hanoi Planning - Simple EF	.22	2.24	.028
Card Sorting & Switching - Complex EF	.27	2.68	.009
Verbal Fluency - Complex EF	.21	2.00	.049

**Table 2.** Results of multiple regression analysis with narrative comprehension as the outcome variable.

Predictor	Beta	t	p
Tower of Hanoi Planning - Simple EF	.16	1.75	.083
Sentence Completion Recall Span - Simple EF	.30	2.92	.005
Card Sorting & Switching - Complex EF	.27	2.73	.008
Verbal Fluency - Complex EF	.18	1.78	.079

Future theoretical and empirical work is needed to understand how various conditions, including levels of cognitive readiness and functional connectivity, as well as social, motivational, and contextual factors are related to the development of complex narrative skills in children. Future work will examine how the cognitive architecture supports language processing in older children. Few rigorous narrative intervention studies have been conducted with older children, and this will also be a promising avenue of scientific inquiry. Cumulatively, this type of research helps us increase our knowledge of theoretical mechanisms supporting language development, and also holds great promise for language remediation and training work with children.

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## **Describing complex pictures as a method of eliciting speech samples from children aged 5 to 10: Syntactic characteristics of the speech of Polish children**

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The poster presents a method of eliciting speech samples (Haman & Smoczyńska, 2010; Smoczyńska & Haman, 2014) devised for children aged from 5 to 10. The purpose of proposing a new eliciting technique that could be used with young school children was to obtain short, possibly uniform, yet syntactically and lexically rich samples of monologic speech, which could be used to assess the level of language competence.

The problem with language samples obtained in dialogic situations (such as free play dialogues and interviews; Evans & Craig, 1992) is that they contain uncontrollable variability due to adult's use of open-ended questions and proposals ('What do we do now?', 'What is your favourite game and how do you play it?', 'How was your birthday?' and the like). This makes the comparisons between performance of different children highly problematic. In contrast, the use of monologic samples of language referring to a pictorial stimulus offers an advantage of eliminating this variability (Ely et al., 2000). Monologic samples of language reported in the literature, typically involve some kind of narrative, where stories are elicited with a set of pictures. Many scholars use wordless picture books such as 'Frog Story' (Berman & Slobin, 1994) or short films, as Chafe's (1980) 'Pear Story' as stimuli. In order to analyze texts collected in this way, complex systems were elaborated, such as Strong's (1998) Narrative Assessment Procedure (SNAP), Heilmann et al.'s (2010) Narrative Scoring Scheme (NSS), Justice et al.'s (2006) Index of Narrative Microstructure (INMiS). Recently new tests were constructed that serve to assess various aspects of developing narrative competence. These are: Gillam & Pearson's (2004) Test of Narrative Language (TNL), and Dorothy Bishop's (2004) Expression, Reception and Recall of Narrative Instrument (ERRNI). These instruments provide highly standardized elicitation techniques for collecting texts as well as procedures of analyzing them both on macrostructural and microstructural levels (Hughes, McGillivray & Schmidek, 1997). However, the emphasis is put on the acquisition of story grammar by children. This is why most methods (with the exception of INMiS) explore mainly macrostructural features of the text. If our purpose is to simply assess the level of language production, a narrative text is not an ideal sample, for two reasons. First of all, it usually has a quite limited lexical content, which does rarely provide sufficient information about the actual level of the child's vocabulary. Second, its syntactic analysis may be unnecessarily demanding, as it cannot be limited to the microstructural level, but has to refer to a number of relevant macro-structural aspects of the text.

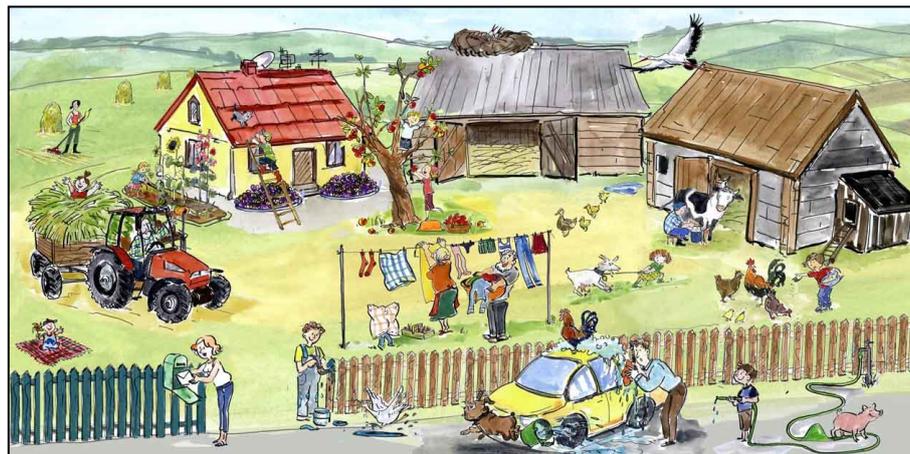
We have therefore decided to elicit complex speech using pictures that do not present a temporal sequence of events. We chose to use large pictures presenting complex scenes, where many actions and events happen simultaneously. Due to the large size of the pictures (8 x 16 inches), the method was called PANORAMA (Haman & Smoczyńska, 2010). Currently THE PANORAMA comprises two pictures: THE PARK and THE FARM. (The third one, called THE KITCHEN was dropped after pilot studies, as it did not yield results comparable to the other two). Each scene, depicted on a panoramic picture, presents a dozen of individuals, adults and children, as well as some animals, performing a number of actions, both in parallel and interactively. Objects and actions for the pictures were selected on the basis of frequency of corresponding nouns and verbs (Polish frequency lists of child's and child directed speech were used). Several events are interrelated, so as to elicit complex syntax. Events are depicted in a vivid, dynamic way, with the artist using subtle humour to make the task more enjoyable and attractive for the child. A revised version of the method called THE PARK & THE FARM PICTURE DESCRIPTION TASK (Smoczyńska & Haman, 2014) was recently

created, which involved slight changes in the scenarios and setting of elements, based on previous results. Additional booklet versions of the two pictures were created for children younger than 5.

**Figure 1.** PANORAMA Picture Description Task: THE PARK (Haman & Smoczyńska, 2010) © University of Warsaw



**Figure 2.** PANORAMA Picture Description Task: THE FARM.(Haman & Smoczyńska, 2010) © University of Warsaw



In the research we report here, children were told to look at the picture, without sharing it with the allegedly naive examiner, and asked to describe the scene for her/him. The description of both pictures by children aged 5 to 10 took ca. 5 minutes. The texts produced were audio-recorded, then transcribed in CHAT format (MacWhinney, 2000), including hesitations, false starts and repairs, as well as examiner's interventions. After the texts were segmented, according to a uniform procedure, a number of quantitative measures, both syntactic and lexical were calculated, such as number of words (tokens) used, number of clauses, MLU in words, number of complex sentences, lexical diversity measured by the number of different words, nouns and verbs (both types and tokens). A qualitative analysis of the lexicon and syntax, especially of the complex sentences, may be also performed.

In the poster, we focus on the developmental characteristics of the samples collected with this method at three data points, namely 5, 8 and 10 year of age. Two sets of data collected in two separate studies of Polish children will be reported.

Study 1 (Smoczyńska & Szczerbiński, 2011) is a longitudinal follow-up study of former late talkers (LT) and their typical language development (TLD) controls who were asked to describe THE PANORAMA pictures (Haman & Smoczyńska, 2010) twice: at the age of 8 and 10. Results of this were presented in Smoczyńska (2012). Here we report the data of the control group of 38 TDL children only, and explore developmental changes observed between 8 and 10.

Study 2 is based on a sample recently collected using the new version of the method (Smoczyńska & Haman, 2014) from preschoolers (aged 5) and school-aged children (aged 8) living in two regions of Poland (South-West Silesia and North-East Podlasie). The original purpose of the study was to explore potential dialectal variation of Polish language that should be taken into account before a larger normalisation study of the method is run. This aspect, however, will not be taken into account here. Instead, we will look at syntactic differences between children from both age groups (40 children in each age group).

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## **Development of auditory attention: Distractibility and conflict resolution**

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Increasing evidence suggests top-down cognitive factors, especially auditory attention, are vital for good listening skills (Moore, 2011) and may even be critical for language acquisition and processing (Fischler, 1998). The Test of Attention in Listening (TAIL) has been developed as a behavioural test to identify components of auditory attention (Zhang, Barry, Moore & Amitay, 2012) whereby two pure tones were presented sequentially to the same or different ears, and of either the same or different frequency. The TAIL provides a measure of involuntary orientation to task-irrelevant information (i.e. distraction) -listeners are asked to attend to the frequency of the sound and ignore the location (or vice versa). This is calculated as the difference between the task-irrelevant information being different and the same within the sound pair. Furthermore, a measure of conflict resolution (i.e. executive control) is provided based on the ability to resolve a response conflict. This is calculated as the difference between the task-relevant and -irrelevant information being incongruent and congruent within the sound pair, using reaction time as the primary performance measure (Eriksen & Eriksen, 1974; Petersen & Posner, 2012; Posner & Petersen, 1990).

Although evidence suggests adult listeners are able to use spatial cues, frequency has been shown to dominate ear presentation during the perceptual organisation of sounds (Deutsch, 1975; Woods, et al., 2001). In addition, tones above discrimination thresholds that are closer together in frequency are harder to discriminate (Bregman, 1978; Näätänen et al., 1980; Woods et al., 2001). Whilst this is also true in children, their discriminatory ability was shown not to be as good as adults, but continues to develop until the age of nine (Jensen & Neff, 1993; Duell & Anderson, 1967). However, how this ability relates to aspects of auditory attention has not been investigated.

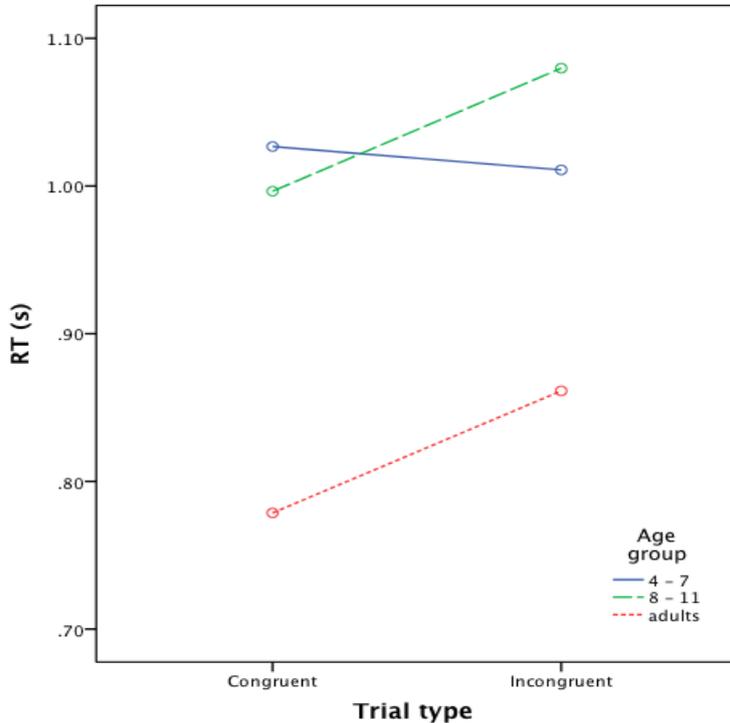
This study investigated how auditory distractibility and conflict resolution, as measured by the TAIL, changed with age. Specifically, we manipulated the perceptual discriminability of the TAIL's attend-frequency task by varying the frequency difference of the sound pair. Thirty-nine younger children (18 males, 21 females) aged 4-7 (mean = 6.15; SD = .95), 29 older children (14 males, 15 females) aged 8-11 (M = 9.53; SD = .95) and 21 adults (7 males, 14 females) aged 17-29 (M = 21.27; SD = 3.30) were tested on the frequency-relevant task of the TAIL with a spaceship game interface. Within the game the listeners were told that they were lost in space and had to listen out for their rescuers. If they heard their rescuers, responding to their call for help with the same frequency, they were to send up fireworks. However, if they heard aliens, responding to their call for help with a different frequency, they were to blow the aliens up. Therefore whilst the listeners were to respond to whether the frequencies of the two tones were the same or different (task-relevant information), they were to ignore any changes in the location (task-irrelevant information).

The frequencies of the two tones were set at 20 (easy condition) and four (hard condition) semitones apart in separate counterbalanced blocks. To keep within the range of the TAIL when the tones were 20 semitones apart and in order to have the same number of possible tones in each condition, the tones were calculated outward from the middle frequency (1716.50Hz) of the range previously used in TAIL (576.18 to 6187.50Hz) (Zhang et al., 2012). Therefore, there were six possible tone pairs in each condition. The inter-stimulus interval (offset to onset) was fixed at 300ms.

Preliminary results indicate that adults and children show similar levels of distractibility on reaction times and error rates no matter the semitone difference within the sound pair. However, the younger children were significantly less conflicted than older children and adults in their time to respond to sound pairs 4 semi tones apart (the hard condition), yet made no more errors than the older age groups. Furthermore, as shown in Figure 1, whilst the younger children are no slower at

responding to incongruent trials than they are to congruent trials, the older children and adults are significantly faster at responding to the congruent trials compared to the incongruent trials.

**Figure 1.** Reaction time of each of the age groups to respond to congruent and incongruent trials when the frequency of the sound pair was 4 semitones apart.



These results could be explained by developmental differences in how conflict is resolved across multiple sources to reduce sensory uncertainty (i.e. integrating speech pitch and location to determine the speaker of a group) (Brandwein et al., 2011; Nardini, Bedford, & Mareschal, 2010). Adults and older children automatically 'fuse' information within a modality (i.e. the task-relevant and task-irrelevant information) (Hillis et al., 2002; Nardini et al., 2010). This can lead to a loss in the ability to judge the individual components of the task and so struggle with incongruent conditions (Ernst, 2005). However, younger children did not automatically 'fuse' the different pieces of information within a task. Therefore, they are less conflicted and more able to detect sensory discrepancies (Hillis et al., 2002). This effect may be crucial for understanding the developmental trajectory of speech perception skills.

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## **Spelling long vowels and consonants in children with learning difficulties including those with mild intellectual disability: Results from 8th and 11th grade students**

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Learning to spell requires children to rely on several advanced language skills, including phonological, morphological and orthographic knowledge (Harris, Perfetti, & Rickles, 2013; Reed, 2012; Young-Suk Kim et al., 2013). Among other important competencies, the acquisition of these skills is built upon accurate speech perception capabilities and strategies. During dictation exercises, children acquiring Hungarian spelling need to be equipped with effective language-specific listening skills to successfully identify and record short vs. long speech sounds on the basis of durational cues and other acoustic features.

The vowel inventory of Hungarian includes five pairs of vowels where members of the pairs differ primarily in their duration, although slight differences in formant values are also observed. The average duration ratio of short vs. long vowels is 1:2. Two additional vowel pairs differ in duration but their members also differ substantially acoustically. The consonant inventory of Hungarian includes 24 consonant pairs with short and long consonant (geminate) members (Zajdó, 2007). Overall, the differentiation of short and long vowels and singleton/geminate consonants is important for understanding Hungarian speech since it often distinguishes semantic units. Obviously, recording short vs. long vowels and singleton consonants vs. geminates accurately constitutes an important spelling skill.

Previous research has demonstrated that even 9.5 months old typically developing infants are capable of correctly identifying language-specific phonemic obstruent lengths on the basis of contrasting durational cues (Sato, Kato & Mazuka, 2012). Thus, listening to durational cues during speech processing is a capability that develops early in children reared in a language community that uses duration phonologically. Typically developing Hungarian-speaking children seem to acquire the discrimination and correct identification of speech sounds (both vowels and consonants) with contrasting phonological length by the age of 7;0 years (Gósy, 2005). Therefore, by the time typically developing children learn to write, it is mostly the limitations in grafomotor skills used for writing (Pontart et al., 2013) and the additional cognitive load that stems from the process of learning to write itself that challenge children. Nevertheless, Hungarian-speaking typically developing children write long speech sounds with considerable success by the time they are in 8th grade (Orosz, 1977), indicating successful linking of the speech perception, word recognition and spelling processes.

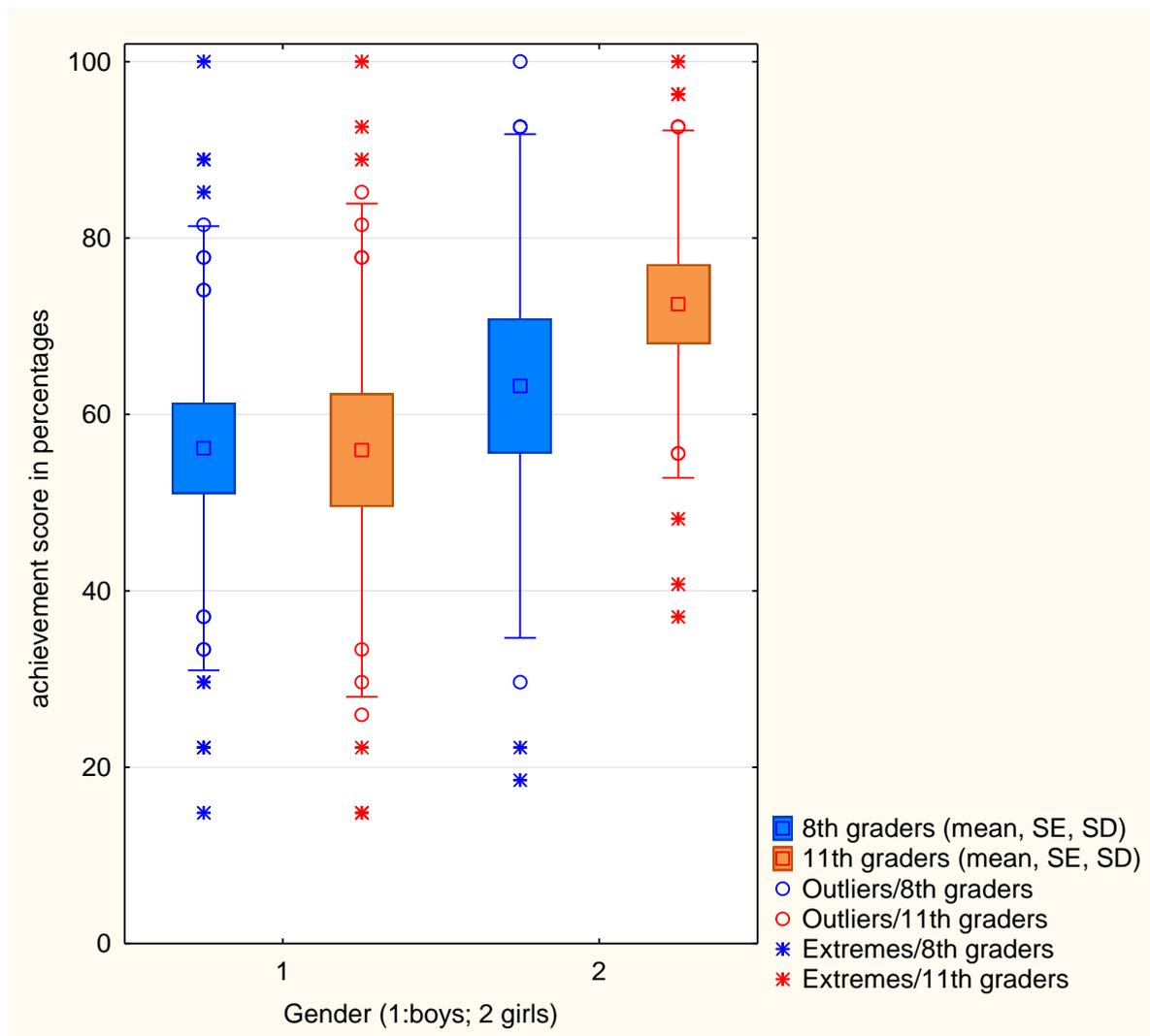
Recent results suggest that children with reading disabilities with or without discrimination problems demonstrate low achievement levels in correct quantity distinctions as reflected by the results of spelling tasks (Pennala et al., 2013). An important question is how children with IQ scores between 50-69 (indicating either mild intellectual impairment or learning difficulties due to being reared in a low socioeconomic status family; henceforth referred to as MIILD) acquire the skill to record phonological length features correctly in writing. Children with MIILD have been shown to acquire linguistic, fine-motor and grafo-motor skills, including those needed for speech production and writing, slower than their typically developing peers. On average, the amount of delay in the acquisition of these skills is 4-6 years.

This cross-sectional study aimed to investigate developmental trends in spelling acquisition in two groups of 76 school-age children, by examining 8th graders ( $n_1=38$ , 14 girls, mean age 15;7 years,  $SD=0;8$  years) and 11th graders ( $n_2=38$ , 19 girls, mean age 19;4 years,  $SD=0;11$  years) with MIILD (with an IQ score range between 50-69, including those with mild intellectual disability). All children

were educated in segregated schools in Northwest Hungary. Students' spelling skills were examined via dictating 14 sentences. Speech material was recorded digitally. On the recording, each sentence was repeated three times with 30 second pauses in-between and played via loudspeakers in classrooms. Students were instructed to record the sentences in writing. Error analysis was carried out by using error matrices.

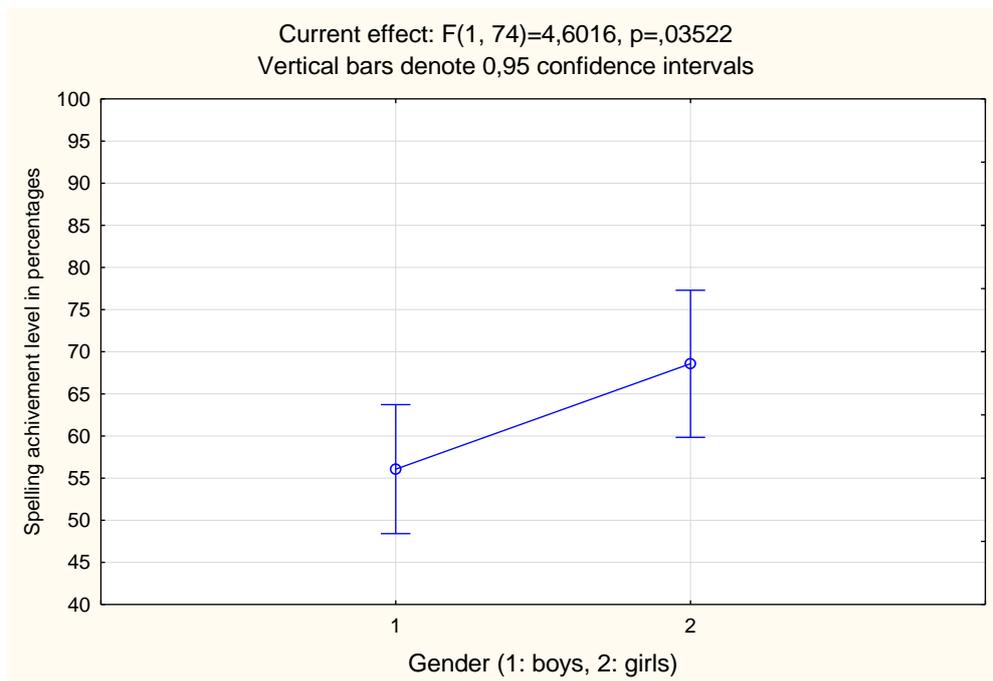
The average achievement levels in 8th grade were 56.17% (SD=25.18) in boys vs. 63.22% (SD=28.55) in girls. In 11th grade, the group means were 55.94% (SD=27.95) vs. 72.51% (SD=19.68) in boys vs. girls, respectively (see Figure 1). Thus, older boys did not exhibit higher achievement levels (one-way ANOVA results for boys:  $F(1,40)=.03$ ,  $p=.86$  (n.s.),  $\alpha=.05$ ). Similarly, no statistically significant change was detected in girls' achievement in the two age groups (one-way ANOVA:  $F(1,31)=2.005$ ,  $p=.16675$  (n.s.),  $\alpha=.05$ ).

**Figure 1.** Group means for spelling achievement of phonologically long speech sounds in percentages in the two genders in each age group



However, the main effect of gender was significant (one-way ANOVA:  $F(1,74)=4.6016$ ,  $p=.03522$ ,  $\alpha=.05$ ) with the average achievement levels at 56.06% (SD=26.12) for boys vs. 68.57% (SD=23.89) in girls. Thus, overall achievement levels in spelling long speech sounds correctly was higher in girls than in boys (see Figure 2). Potential causes of the lack of overall improvement in achievement between 8th and 11th grade and the gender-effect shown here will be discussed.

**Figure 2.** Group means for spelling achievement of phonologically long speech sounds in percentages in the two genders



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## **Specific language impairment from childhood to adolescence: diagnosis, evolution and risks of well-being**

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Specific Language Impairment (SLI) affects 7% of the school aged and about 3% of adult population. SLI (ICD-10 diagnostic codes: F80.1 ja F80.2) is usually diagnosed at the age of four or five and the used diagnostic criteria are -2 standard deviation in language tests and normal performance IQ (pIQ  $\geq$  70). F80.1 is an expressive language disorder in which the child's ability to use expressive spoken language is markedly below the appropriate level for its mental age, but in which language comprehension is within normal limits. There may or may not be abnormalities in articulation. F80.2 is a receptive language disorder in which the child's understanding of language is below the appropriate level for its mental age. In virtually all cases expressive language will also be markedly affected and abnormalities in word-sound production are common.

Symptoms in other behavioral areas are often combined with SLI. Children with SLI experience more emotional and social difficulties than their peers without SLI. In preschool, hyperactivity and attention deficits are commonly present. The presence of SLI in childhood is connected in later adulthood to a greater risk of social maladjustment, permanent unemployment and psychiatric conditions. Also notable reading and writing difficulties are common. According to a recent Finnish study, 26 % of over 30 year old participants with a history of SLI were pensioned and 20 % lived still with their parents.

Symptoms of SLI change when children get older, but difficulties with mother tongue are usually present also in adulthood. Lexicon size is smaller and linguistic working memory is more narrow compared to adults without a history of SLI. Reading and naming take more time and difficulties in spelling are common. SLI impacts individual's choice of schooling and career. It has influence also on social life. Narratives, which are essential in adult conversations, are problematic, including fewer keywords and more inadequate words. In conversations, adults with SLI make undefined questions and give vague answers. Social media with e-mail, Facebook and text messages is harder to use for people with the history of SLI than to their peers without SLI. Written messages in social media show poorer language capacity including more spelling errors, vague expressions and false grammar.

In today's society language skills compose an elemental accomplishment which has broader effects on individual's life than before. Hence, SLI impacts on individual's well-being, but it also has considerable financial effects. It has been estimated that one young adult who is permanently displaced from labor in Finland costs one million euros for the society before the age of 60. More information is needed to recognize the clinical characteristics in early childhood which predict a good prognosis by adolescence or the risk characteristics of negative long-term effects, to provide suitable support means from the beginning for those who are at risk of long-lasting problems.

The presentation will follow the first steps of an investigation which aims at describing the language and combined deficits at the time of the diagnosis of SLI and evaluating their impact on schooling paths, employment and general well-being. The data of the language and combined deficits have been collected from clinical files and the data of participants schooling paths, employment and general well-being will be collected via questionnaires. Participants (N= 203) have been diagnosed at the age of five in 1998 or 1999. At that time in Finland the diagnostic criteria of -2 standard deviation in language tests was based on various clinical assessments, e.g. Reynell Developmental Language Scales and specific parts of ITPA (Illinois Test of Psycholinguistic Abilities). The ICD-10

criteria of normal performance IQ ( $pIQ \geq 70$ ) was valid in 1998 and 1999 and changed to 85 in clinical practice at 2010 along with the Guideline for Specific Language Impairment. The data from clinical files include all notes regarding language and cognitive skills, social and emotional behavior and neurological symptoms. The symptoms concerning speech and language were divided to speech motor, language processing, language comprehension and pragmatic symptom groups. The combined symptoms were divided to attention, interaction, emotional and neurological symptom groups. Cognitive skills were judged by way of language and performance IQs with the participants who had been assessed by a psychologist and had a numeric IQ value mentioned in the clinical file.

According to the preliminary results of the clinical file data (N=100) participants were divided in four groups based on their language and combined symptoms: 1) participants with motor speech symptoms, 2) participants with language deficits, 3) participants with language and motor speech deficits combined with neurological symptoms and 4) participants with pragmatic deficits. In the poster presentation results of the division of language and combined symptoms among all the participants will be presented. 67 participants had a numeric IQ value mentioned in the clinical file. In the F80.1 diagnostic group participants had significantly higher language IQ ( $M=93.78$ ,  $SD=14.38$ ) than participants in the group of F80.2 diagnosis ( $M=70.91$ ,  $SD=18.01$ ) while the performance IQ was quite similar in both groups. It has to be taken into account that standard deviations in language IQ and performance IQ were substantial.

Forthcoming study with the participants, who are now at the age of 19 and 20, will look at their schooling paths, employment situation, social relationships and overall well-being. The preliminary findings of a pilot study indicate that language comprehension difficulties persist to the adolescence and, as in previous studies, participants report difficulties in finding suitable professional schooling and work.

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## NOTES

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