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 and 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 (Choudury et al., 2006) and may be less willing to adapt their speech if not directly affected by the communication barrier.

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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).*

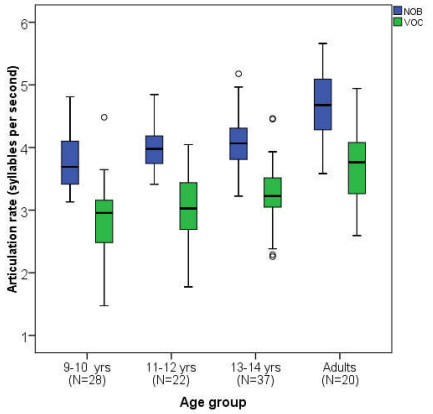

Figure 2: *Vowel F1 range (difference between mean F1 in /i/ and mean F1 in /ae/) and vowel F2 range (difference between mean F2 in /i/ and /O/ for the four age groups as a function of test condition: 'no barrier' (labelled NOB) and 'barrier' (labelled VOC). Formant measurements were made on vowels contained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