The children's use of tactile and visual information (vs. acoustic information) when learning non-native phonological contrasts

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Learners integrate information from various senses when learning a language. Adult listeners improve their perception and production of non-native phonological categories after being trained with audio-visual stimuli (i.e. seeing lip movements while hearing the acoustic information), compared to audio-only stimuli (Hazan et al., 2006; Ortega-Llebaria et al., 2001), and young children may benefit from visual input too (although the existing evidence is less conclusive for this age range; Erdener, 2007). Haptic (tactile) information is much less studied in relation to how it can contribute to language learning, but the little evidence available is quite promising. To date we know that adult listeners process tactile cues to distinguish between allophonic variants (aspirated vs. unaspirated stops; Gick & Derrick, 2009), and individuals with hearing deficits benefit from phonetic trainings including tactile lip-reading (Plant et al., 2000).

The present study investigates whether tactile and visual information during language learning helps young children to acquire L2 phonological contrasts, compared to when these contrasts are trained only acoustically. Because redundant information found to enhance perceptual learning (Bahrick & Lichter, 2002), we expected that a training including multisensory information (tactile and visual) would be more helpful that an audio-only training.

A total of 45 L1 Catalan (and L1 Catalan/Spanish) 5-year-old children were tested to assess their acquisition of the British English /æ-ʌ/ vowel contrast (e.g. 'cat'-'cut'), which is non-existing in their L1 (Figure 1). First, the children's perception skills were evaluated in a pre-test AX discrimination task, for which we used 24 minimal pairs of monosyllabic CVC words and non-words with voiceless codas (e.g. /ræʃ/-/rʌʃ/). Next, children took part in 3 training sessions in 3 distinct conditions (between-subjects): Audio-Only (AO, repeating orally the English native speaker's production of target non-words), Audio-Visual (AV, repeating orally target non-words while observing their own lip movements displayed on a screen), or Audio-Visual-Tactile (AVT, repeating orally target non-words while observing their own lip movements displayed on a screen and while touching their own lip movements with their fingers) (Figure 2). Finally, the children's perceptive skills were evaluated again in a post-test using the same procedure as in the pre-test.

We used *lmer* models in R to statistically analyzed the data, with Accuracy (d' prime) as the dependent variable, and Training condition (AVT, AV or AO), Time (pretest, posttest), and Word type (word, non-word) as fixed factors (participant and item were set as random factors). Contrary to our expectations, the results showed no main effect of Training condition ($\chi^2(2) = 1.41$, p =. 49), no main effect of Time ($\chi^2(2) = 1.94$, p =. 16), and no interaction between these two factors ($\chi^2(2) = .39$, p =. 82). We found a main effect of Word type ($\chi^2(2) = 77.69$, $p < .001$) by which non-words (Intercept category) were perceived with more accuracy than non-words ($\beta = -2.4719$, SE = .2546, t = -9.707). A visual inspection of our data suggests that children learned (non-significantly) more when trained in the AO condition.

Various reasons can explain our findings. It could be that at this young age intersensory redundancy does not enhance non-native phonological acquisition and, instead, implies too much information coming from too distinct senses. Alternatively, it could be that the training groups were too small to overcome individual variability and thus reveal any possible effect. Finally, it could be that multisensory (phonological) information can only be useful when there is a need to compensate for deficits in auditory perception. More research is needed to confirm any of these explanations. The study of how the various senses interact with each other in the process of learning a new language is one important step further to fully understand this complex, multimodal phenomenon.

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Figure 1. Video frame of the point of maximal visual differentiation in the target contrast. On the left, lip configuration while producing /æ/ in /ræʃ/. On the right, lip configuration while producing /ʌ/ in /rʌʃ/.

Figure 2. Setting during the training task. On the left, the child is repeating the target non-word in the Audio-Only condition. On the middle, the child is repeating the target word in the Audio-Visual condition, where a mirror was placed next to the computer. On the right, the child is repeating the target word in the Audio-Visual-Tactile condition, where the child uses tactile lip-reading while looking himself on the mirror.