

The effect of spectral tilt on infants' discrimination of fricatives

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Abstract

Research on infants' ability to discriminate speech sounds with different directions of spectral tilt can be used to optimise the frequency response of hearing aids being fitted to very young infants. In the current study, infants were presented with a fricative contrast with either a positive or negative spectral tilt, or in unmodified form. The results showed 6-month-olds were able to discriminate the contrast irrespective of the manipulation, while 9-month-olds could only discriminate the contrast in unmodified form.

Index Terms: spectral tilt, infants, speech perception, hearing impairment, discrimination, fricatives

1. Introduction

Fitting infants with hearing aids presents challenges not found with older hearing-aid recipients, one of which is the need to consider that the task for infants is to learn language, while for older recipients, it is merely to understand it. Thus, young hearing-impaired infants need hearing aids which provide the optimal amplification pattern across the speech spectrum. To investigate this, we tested whether normal-hearing 6- and 9-month-olds could discriminate the relatively difficult fricative contrast in the syllables /fa/ - /sa/ which remained unmodified (normal) or had a positive 6dB/octave spectral tilt (higher frequencies amplified, and lower frequencies attenuated) or a negative 6dB/octave spectral tilt (lower frequencies amplified, and higher frequencies attenuated).

2. Method

2.1. Participants

In the final sample of 96 infants, there were 16 6-month-olds and 16 9-month-olds in each of the 3 conditions: Normal speech, Positive tilt, and Negative tilt. Data from 22 infants were discarded due to fussiness or failure to habituate.

2.2. Apparatus and Procedure

Infants sat on their parent's lap facing a computer screen. Each trial began when the infant fixated an attention-getting stimulus for at least 3 secs and ended when they looked away for more than 1.5 secs. The habituation stimulus ('fa') was presented on repeated trials until there was an average 50% decline in looking times over 3 consecutive trials compared to the average of the first 3 trials. Once this criterion was met, 2 no-change control trials were presented, followed by 2 test trials of a novel stimulus alternating with the control stimulus ('sa, fa, sa...'). The dependent variable was average fixation time in each trial type. Infants are said to have discriminated the stimuli if they look longer in test compared to control trials.

2.3. Stimulus Materials

The speech stimuli, 'fa' and 'sa', were filtered from 250-4000Hz, and tilts applied with values of +6dB/octave (Positive) and -6dB/octave (Negative) around a fulcrum of 1000Hz. An unmodified version was also used (Normal).

3. Results

Mean fixation durations during test and control trials were analysed in separate 2 (age) x 2 (trial type) ANOVAs for the Normal, Negative and Positive conditions. The results reveal that 6-month-olds looked longer during test than control trials in all 3 conditions, i.e., they can discriminate /f/-/s/ regardless of tilt type, all $ps < 0.03$. In contrast, 9-month-olds only looked significantly longer in test than control trials in the Normal condition, hence were able to discriminate /f/-/s/ when presented without a spectral tilt, $p < 0.03$.

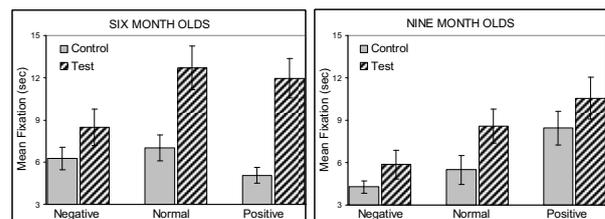


Figure 1: Mean fixation times for 6- and 9-month-old infants in Negative Tilt, Normal Speech and Positive Tilt conditions.

4. Discussion and Conclusions

Infants aged 6 and 9 months can discriminate /f/-/s/ when it is presented in the Normal condition. However, when high- and low-frequency emphasis is applied, only 6-month-olds can discriminate the fricative contrast. We conclude that 6-month-olds are exhibiting a more broad-based sensitivity than older infants because they have not yet attuned to the phonemes of the native language. Hence, they are discriminating fricatives, and other speech sounds, using an acoustic, not phonetic mode of processing [1]. Nine-month-olds, on the other hand, are on the cusp of perceptual reorganization as their native phonemic categories become established, and a new mode of processing speech is emerging. Thus, the older infants cannot discriminate speech sounds distorted by spectral tilt.

5. Acknowledgements

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6. References

- [1] Werker, J.F. and Tees, R.C., "Influences on infant speech processing: Toward a new synthesis", *Annual Review of Psychology*, 50:509-35, 1999.