Auditory feedback perturbation in adults and children

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INTRODUCTION

Auditory feedback important mechanism in speech production [1]
- Perturbation of auditory feedback during speech production elicits a compensatory response in the opposite direction to maintain the intended auditory outcome [2]
- Places an important role in speech motor learning, i.e. the acquisition of speech motor programs [3]
- Auditory perturbation experiments may help to understand early development of auditory-motor integration.

Research question:
- To what extent are children able to compensate for and adapt to auditory feedback perturbation throughout their developmental trajectory?

METHODOLOGY

Participants
- 15 children: 8 female, 7 male; age range 4.1 - 8.7 y/m, mean 5.8 y/m.
- 37 adults: 32 female, 5 male; age range 19 - 29 years, mean 22.4 y.

Procedure
- Stimuli: CVC words /be:r/ (bear), /ve:r/ (feather), /pe:r/ (pear).
- Participants were seated in front of a PC-monitor showing pictures of the target words.
- A bird flying over one of the pictures cued the participant to say the intended word.
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Perturbation paradigm and analysis
- Experimental setup: Real-time acoustic tracking and shifting of F1 and F2 using Matlab-based software package Audapter [5].
- F1 raised 25%; F2 lowered 12.5%.
- Paradigm with 5 phases: Practice - Start - Ramp - Stay - End.
- Length adults and children > 7 y/o: 111 words; children ≤ 7 y/o: 54 words.
- Analysis F1 and F2 were measured from steady-state portions of the produced voices using custom PRAAT-scripts.
- Compensation differences in formant frequencies between the Start and Stay phase. This is a measure of motor learning, the ability to notice and act on the mismatch between the motor command and the corresponding auditory result.
- Adaptation differences between the Start and End phase. This is a measure of the after-effect of change in the motor command, followed by recovery (de-adaptation).
- Statistical analysis: Differences across groups and phases using Linear Mixed Model analysis with fixed factors Group and Phase; random factors Subject; repeated factors Phase; Word; Repetition.

RESULTS

Experiment debriefing
- Previous studies reported participants were unable to notice perturbations.
- In this study, around 60% indicated to have heard something (and some took action).

“Did you hear something odd when listening to your own voice?”
- Yes, noticed manipulations, and acted on it during experiment.
- No, but recalled possible changes after pointing out word manipulations.
- Yes, noticed manipulations during experiment.
- Yes, noticed manipulations, and acted on it during experiment.

Analysis of compensation and adaptation
- Compensation and adaptation across groups
- Group: Children (p = .003), adults (p = .063).
- Age: 7 y/o (p = .005), 11 y/o (p = .003).
- Within-group differences might be due to different strategies; somatosensory to auditory focus [6].

Discussion

Compensation and adaptation across groups
- Stronger effect of compensation for the group of children suggests auditory-motor properties are less ingrained compared to adult speakers.
- Presence of adaptation effects of F1 suggest ramp and stay phase lengths are adequate, even during the shorter program for children.
- Absence of adaptation in F2 for children is possibly due to a high within-group variance.

Developmental effects
- Absence of age-related effects for children may be due to several reasons: lack of data; large within-group variability; or... storage and learning strategies of auditory-motor integration do not change significantly in the age span of 4-8 years?
- Within-group differences might be due to different strategies; somatosensory to auditory focus [6].

Effect of age

Is it possible to detect developmental changes with respect to compensation and/or adaptation?

References


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