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Echo suppression and sound localization in 2- to 3-year old children

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INTRODUCTION

- The “precedence effect” (PE) is an auditory phenomenon that suppresses echoes in reverberant environments. For young children the PE is important because children gain their initial social and educational experiences in noisy, complex auditory environments such as playgroups and preschools.
- The PE is not fully developed in 18-month-old children (Litovsky, 1997). Improvement occurs by age five, however children still perform more poorly than adults on precedence effect tasks (Litovsky, Godar, 2010).
- Using the Reaching for Sound (RFS) methodology we hope to learn about toddler’s performance on PE tasks.

SUBJECTS

Subject	Age [Months]
CVI	26
CVE	30
CUX	30
CUQ	31
CUR	31
CVB	32
CUS	36
CUW	37
CVD	37
CVG	38
CVA	40
CUU	44

Figure 1

- Native English speakers
- Typically developing
- No history of hearing loss
- No medical complications at birth
- Reported no illness at the time of testing

N=12

μ=34.3 months

METHODS

- Testing Apparatus: All testing was conducted at the Waisman Center. The testing apparatus (Figure 2) had nine holes spaced 15° apart from -60° to +60°. A speaker was behind each of the nine holes.

Figure 2

- Task: For each trial a reinforcer (a toy, snack or sticker) was placed above the testing apparatus at 0°. The carrier phrase, “I’m hiding under,” was then presented from the 0° speaker. Next, the experimenter behind the apparatus drew the toy behind the curtain as the stimuli was presented. It was the task of the child to reach into the hole the stimuli was played from, where the reinforcer would be waiting behind the hole’s cover for them to grab.
- Stimuli: The carrier recording was a female voice stating, “I’m hiding under,” prior to stimuli presentation. The stimuli were three 250-ms white noise bursts presented at a rate of four per second at random levels between 56-64dB SPL.
- Three experimenters were involved in testing. Experimenter 1 presented the stimuli and reinforcer. Experimenter 2 sat next to the subject and encouraged responses when needed. Experimenter 3 ran the testing program from the control room.

FAMILIARIZATION

Familiarization was done to teach the children the Reaching for Sound (RFS) task. A toy of the child’s choosing was placed above the puppet show stage (Figure 3). An experimenter then read the carrier phrase, “I’m hiding under,” before placing the toy behind the curtain to obstruct the child’s view. Next, the experimenter simulated the task stimuli.

Figure 3

The child would then reach through the stage curtains to reveal the toy. This taught the children to focus on the toy in front of them and reach for the toy after they heard the stimuli.

PROTOCOL

Visit 1- Single Source:

- Discrimination: For this task only two locations, symmetrically distant from 0°, were possible. This was a right/left discrimination task and was used to train the children prior to localization testing.
- The stimuli were first presented at ±60° and if the child completed the task with 4/5 trials correct, then testing was conducted at ±30° followed by ±15° (Clark, 2014, see Figure 5). Reaching 4/5 correct at ±15° was required in order to advance to the localization task.
- Localization: For this task 8 locations were used and the child’s task was to identify the correct location on each trial. Testing was conducted on 16 trials for all children, with an additional 8 if a child appeared to be motivated and interested in additional testing.

Figure 4: Localization task being performed

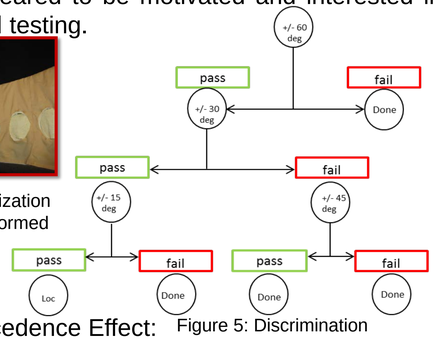


Figure 5: Discrimination

Visit 2- Precedence Effect:

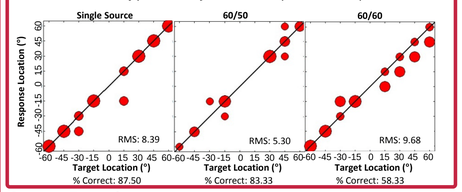
- Localization: The PE stimuli were a “leading” sound and a replica of that sound, delayed by 5 ms (“lagging”). The lagging sound was always presented from the front (0°), while the leading sound varied in location. The intensity of the lagging sound was either 60 dB (equal intensity to the leading sound) or 50 dB (10 dB less intense than the leading sound).

PREDICTIONS

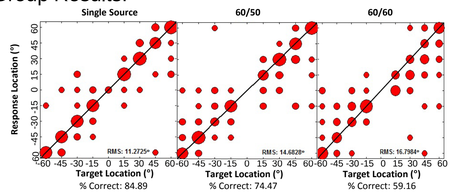
- Performance will be best for the single source, followed by lead-60/lag-50 dB, with the most difficult condition being lead-60/lag-60.
- Effect of age was predicted such that younger subjects would perform more poorly on the tasks. In particular, it was expected that with an increase in age children would perform more similarly on the PE task and the single source task. This was expected because prior studies have shown closer performance between 18-month-old and five-year-old children on single source tasks than on PE inducing tasks (Litovsky, 1997; Litovsky, Godar, 2010).

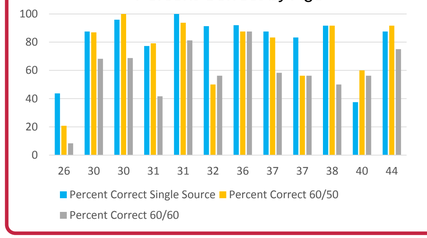
RESULTS

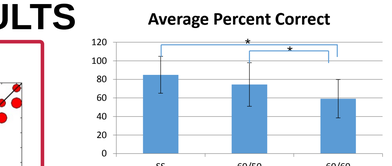
Results from a typical subject: CUW (37 Months)



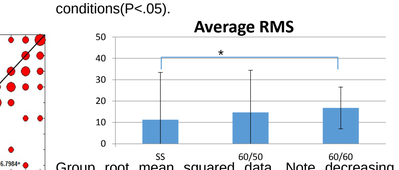
Group Results:



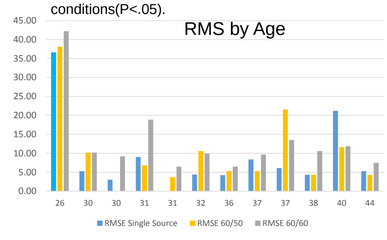




Group percent correct data. Note decreasing performance through the three conditions. Using a repeated measures ANOVA, significant differences were found between single source and 60/60 conditions as well as between 60/50 and 60/60 conditions(P<.05).



Group root mean squared data. Note decreasing precision through the three conditions. Using a repeated measures ANOVA, a significant difference was found between single source and 60/60 conditions(P<.05).



CONCLUSIONS

- 2- to 3-year olds, a group difficult to test with behavioral measures, are capable of performing localization tasks that induce the precedence effect when using the Reaching for Sound method (Litovsky et al, 2010).
- While all children performed well on the single source and 60/50 conditions, older children performed better than younger children when the lead and the lag sounds were at the same level (60/60 condition), which may suggest precedence effect is a skill that is still developing at this age.

REFERENCES

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