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Development and Verification of a Two-Interval, Forced-Choice Infant Behavioral Testing Procedure

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Abstract

The purpose of this study was to develop and validate a two-interval forced-choice (2IFC) infant psychophysical test procedure. Infants (7- 9 months) and young adults were tested to determine the number of trials required to achieve a criterion of 80%-correct detection of a 50-dB SPL noise band presented in quiet. Fewer trials were needed to reach the criterion than reported in previous studies using a single-interval procedure. Following training, an adaptive, 2-down, 1-up procedure was used to estimate hearing sensitivity (Levitt, 1971) for a subgroup of listeners. Estimates for adults were lower in the 2IFC compared to a single-interval procedure. Estimates for infants in the present study were similar to the infants tested by Werner and Boike (2001). These results suggest that using a 2IFC procedure is feasible and efficient while also controlling for both examiner and listener response bias.

Hypotheses

1. The 2IFC procedure is feasible for use with infants and adults.
2. Fewer trials are needed to train infants to an 80%-correct criterion using the 2IFC compared to single-interval procedures.
3. Adult thresholds are lower with the 2IFC observer-based procedure than an observer-based, single-interval procedure.

Background and Rationale

Current behavioral methods used to test infants in the clinic or laboratory can be influenced by response bias on the part of the listener and/or the examiner. Visual Reinforcement Audiometry provides some protection against examiner bias when control trials are used, but does not account for listener bias. Olsho et al. (1987) developed a single-interval, observer-based procedure for infant testing in the laboratory in which the examiner does not know whether or not a signal is presented on a given trial. Although examiner bias is controlled using this procedure, listener bias remains a potential issue that can limit comparisons in adaptive threshold estimates between infants and adults.

Specifically, adults are more conservative listeners than infants (e.g., Leibold & Werner, 2006).

Infant-adult differences in response bias are an issue when thresholds are estimated adaptively because they can result in differences in d' at threshold between the two age groups. The specific objective of this study was to develop a procedure that controls for both examiner and listener response bias by using a two-interval forced-choice (2IFC) paradigm in which the examiner is blinded to the interval containing the signal.

| | Infants | Adults |
|-------------------------|---------|--------|
| Werner & Boike (2001) | .25 | .01 |
| Leibold & Werner (2006) | .26 | .03 |
| Dasika et al. (2009) | .21 | NA |

Table 1: Average infant and adult estimates of the proportion of incorrect responses for catch trials are provided for three previous studies that used a single-interval, observer-based procedure.



Number of trials required to reach criterion on training using the 2IFC task

Listeners: Eleven infants (7-9 mo) and fifteen adults (20-26 yr) with no risk factors for hearing loss participated. All listeners passed screening tympanometry on each test date.

Stimuli: The signal was a 500-ms, 50-dB SPL broadband noise (low-pass filtered at 6000 Hz) presented in the sound field (45 degrees to the left of the listener, 0 degrees elevation).

Procedure: Based on an observer-based psychophysical procedure developed by Olsho et al. (1987), a two-interval, forced-choice (2IFC) was used to estimate the number of trials needed to reach an 80% training criterion for the noise band in quiet. The signal was randomly presented during one of two 500-ms temporal windows, separated by an interstimulus interval of 300 ms. The examiner was blind to which interval contained the signal and made their decision based solely on the listener's behavior. The examiner received feedback on a computer monitor after every trial regarding which temporal window contained the signal. Criterion was achieved when the observer correctly responded on eight of the last 10 consecutive trials.

Results: Ten infants reached the criterion in a single session, with infants requiring an average of 10.9 trials (range= 8-17 trials). All fifteen adults reached criterion in the minimum number of trials.

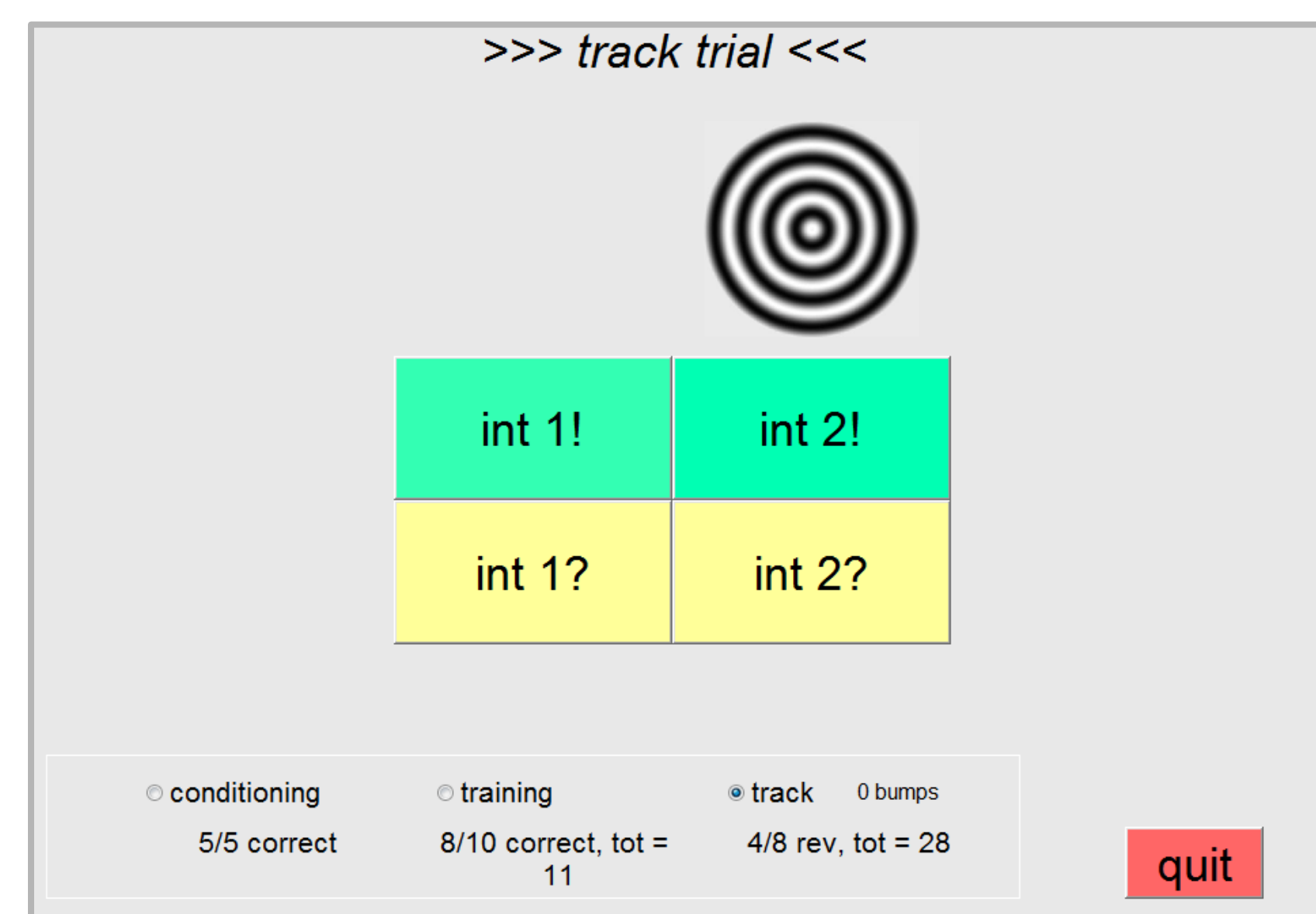


FIGURE 1: A screenshot for one trial using the two-interval, forced-choice psychophysical test procedure.

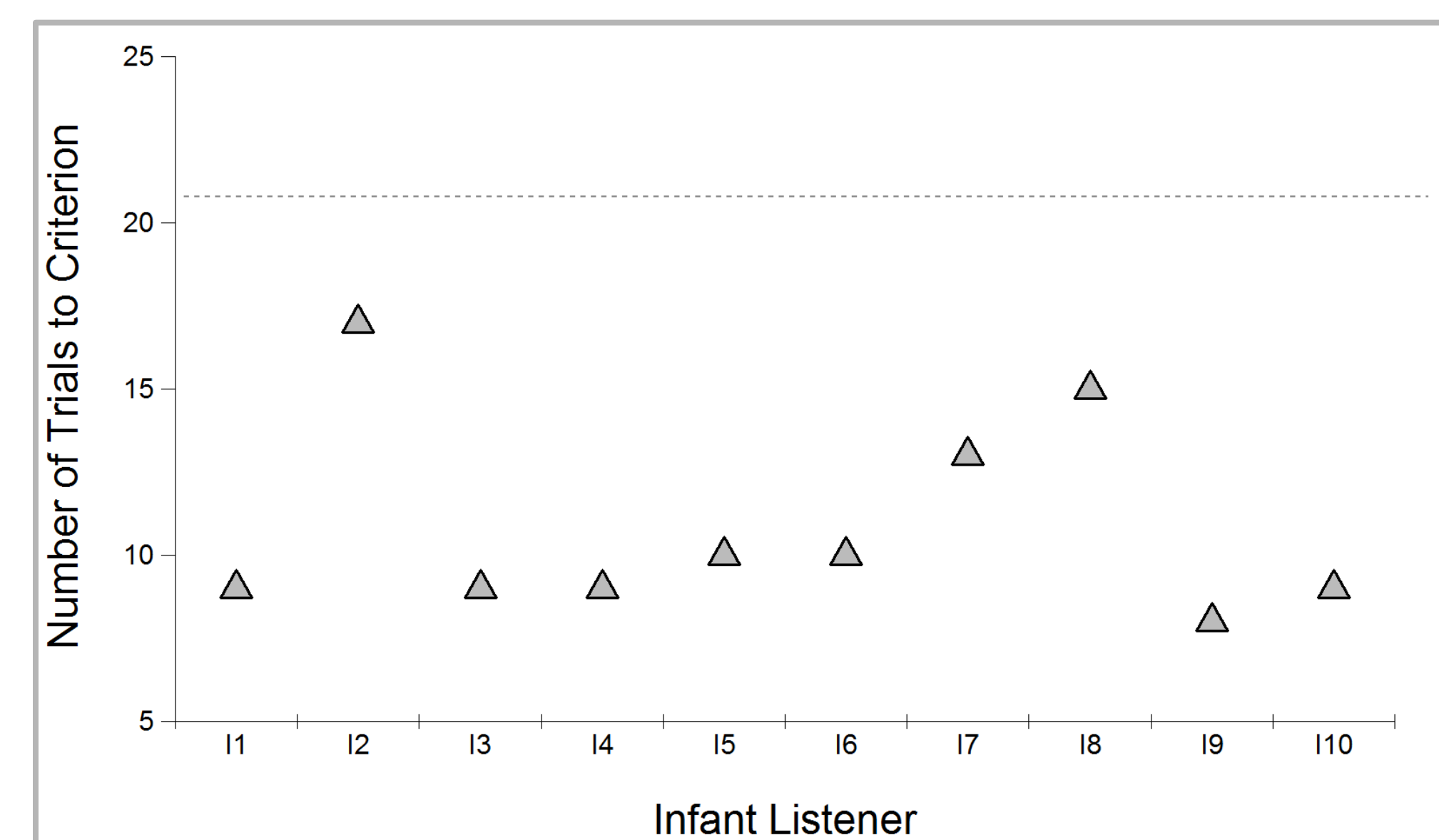


FIGURE 2: The number of trials to reach criterion to achieve 80%-correct detection of a 50-dB SPL noise band presented in quiet is plotted for individual infants (n=10). The dashed horizontal line shows the average number of training trials (21.2) needed for infants to reach criterion in the Leibold and Werner (2006) study using a single-interval, observer-based procedure.

Comparison of detection thresholds estimated adaptively for adults using the 2IFC and single-interval procedures

Listeners: Fifteen normal-hearing adults (20-26 yr) with no risk factors for hearing loss participated.

Stimuli and Procedure: The stimulus and 2IFC procedure were identical to those described above. The single-interval procedure followed the observer-based psychophysical procedure described by Olsho et al. (1987). For both procedures, listeners first completed a training phase when an 80%-correct criterion was reached, and threshold was estimated using an adaptive, 2-down, 1-up stepping rule (Levitt, 1971). For the Yes-No test procedure, the probability of a signal trial was 0.75 and the probability of a no-signal trial was 0.125. For both procedures, the listener received reinforcement after correct responses via the activation and illumination of a mechanical toy. The examiner received feedback on a computer monitor.

Results: Consistent with the results from Marshall & Jesteadt (1986), adult thresholds were lower with the 2IFC procedure, which controls for listener bias. The difference in average threshold was about 2 dB.

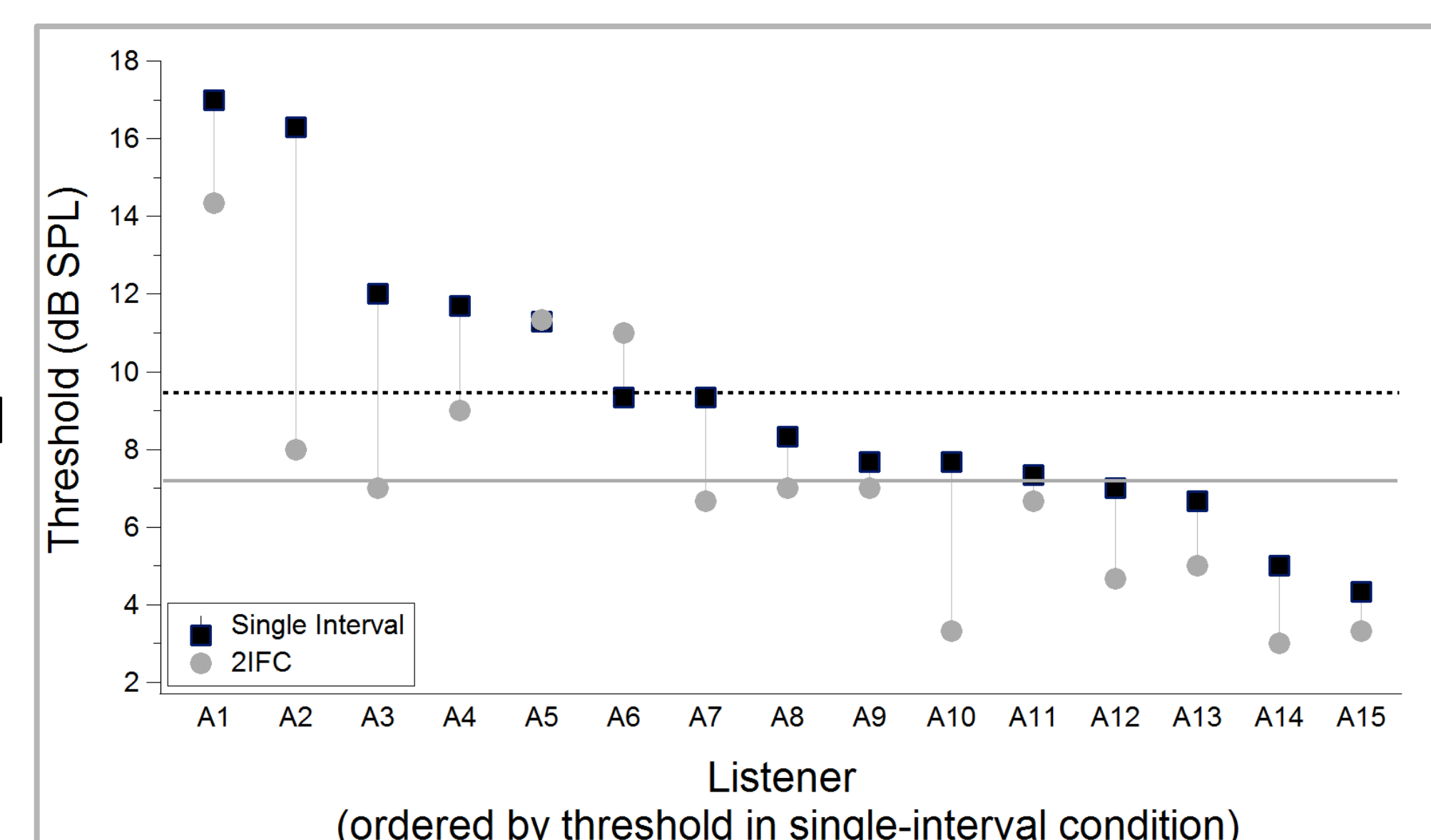


FIGURE 3: Adult thresholds estimated adaptively using the 2IFC and single-interval procedures are plotted. The black dotted line shows average adult threshold for the single-interval procedure (9.397) and the grey solid line show average thresholds for adult listeners tested with the 2IFC test procedure (7.156).

Preliminary estimates of threshold for infants using the 2IFC Procedure

Listeners: Estimates of threshold were obtained for five infants.

Stimuli and Procedure: The stimulus and procedure were identical to that described for adults.

Results: Similar estimates of average threshold were observed for infants tested in the present study and for infants tested by Werner and Boike (2001) who used the single-interval procedure. Average thresholds for adults were lower in the present study using a 2IFC task than estimated by Werner and Boike (2001).

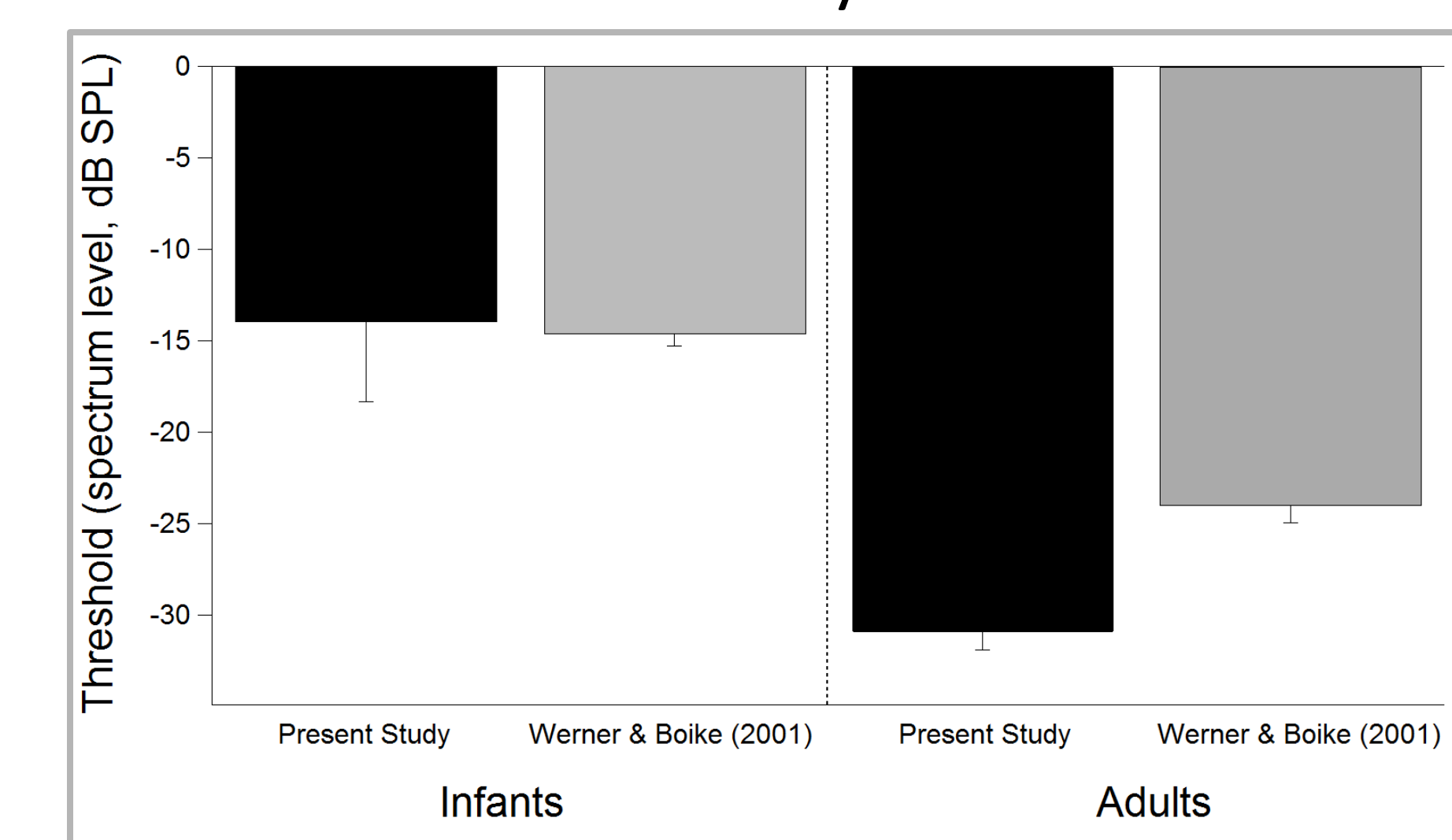


FIGURE 4: Average (± 1 standard error of the mean) thresholds are shown for infants (left) and adults (right). Data for the present study (2IFC) are shown by the black bars, and data from Werner and Boike (2001; single interval) are shown by the grey bars (replotted from their Figure 5 and based on psychometric functions).

Summary

1. The 2IFC procedure is feasible and more efficient for use with infants, reducing the number of training trials related to single-interval procedures.
2. Consistent with previous studies, threshold estimates for adults were lower using the 2IFC compared to a single-interval task.
3. Preliminary data suggest similar threshold estimates for infants across the two procedures.

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