Anticipatory biasing of visuospatial attention in deaf adults

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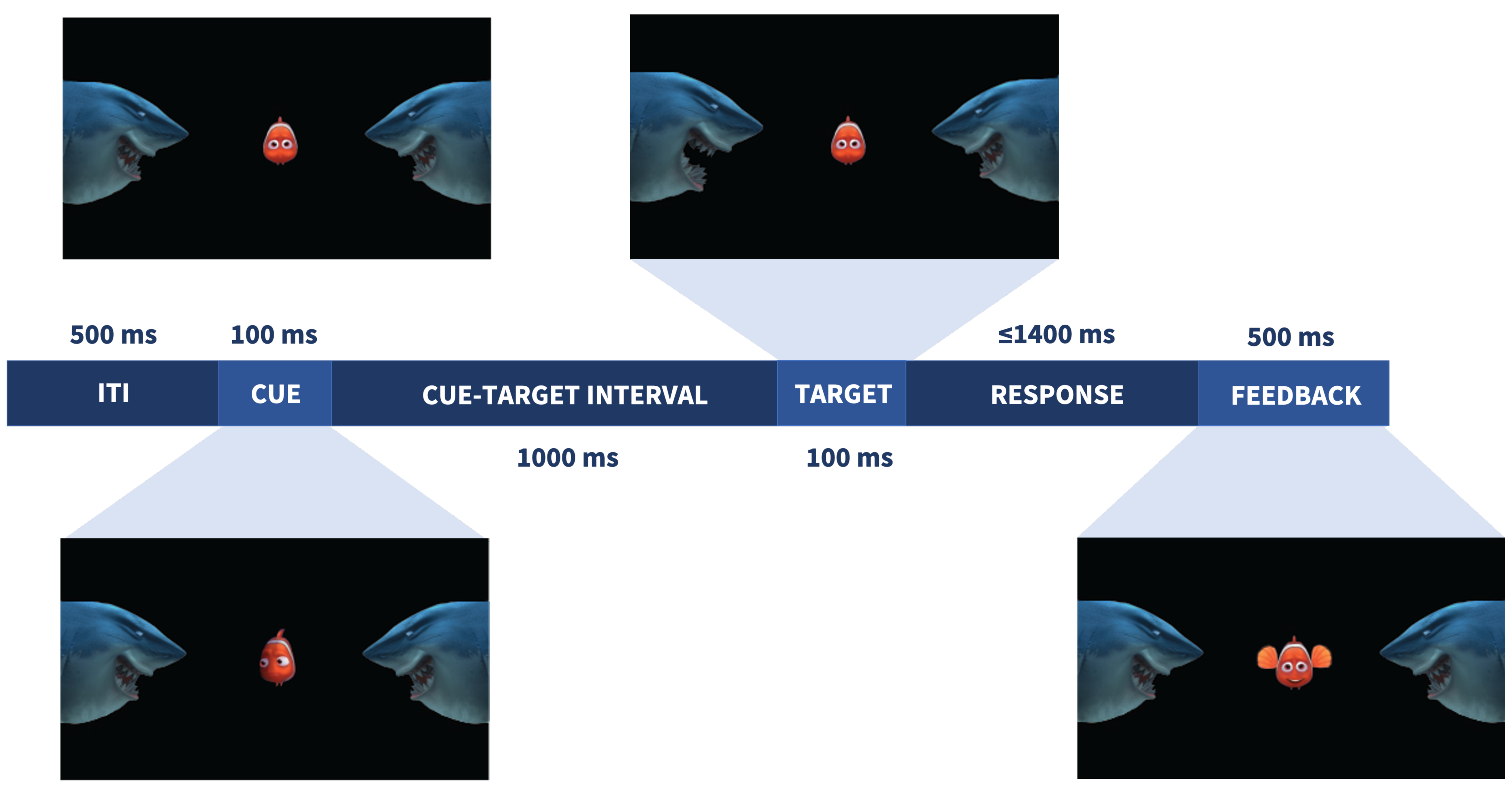
Highlights

- Recruitment occurred in the greater Rochester, NY area
- Participants included 15 deaf native signers and 20 hearing non-signers
- Deaf participants had a significantly faster reaction time, in agreement with prior research
- Task performance (d-prime) did not differ between groups
- Repeated-measures ANOVA revealed a main effect of hemisphere and an interaction effect between hemisphere and cue direction
- No between-group differences were found

Introduction

Some compensatory plastic changes as a result of limited or no access to audition have been associated with visuospatial processing [1-4]. There is greater recruitment of the posterior parietal cortex (PPC) in deaf native signers compared to hearing non-signers and signers when processing peripheral stimuli [2]. The PPC serves a critical role in the modulation of selective attention and may act as an attentional gate for the visual system due to fast magnocellular inputs and feedback projections onto early visual areas and thalamic nuclei [5-7]. The finding that deaf signers demonstrate greater recruitment of the PPC but similar recruitment of V1-V2 compared to hearing individuals suggests that the enhancement of peripheral attention takes place within higher stages of visual processing. These findings are consistent with the hypothesis that deaf native signers are more efficient at covert shifts of attention to parafoveal and peripheral stimuli. Alpha oscillatory activity (8–14 Hz) in the parieto-occipital area has been identified as an attentional suppression mechanism when distracters need to be ignored. An earlier onset of alpha oscillatory activity could be a potential contributing factor or explanation for these heightened attentional skills.

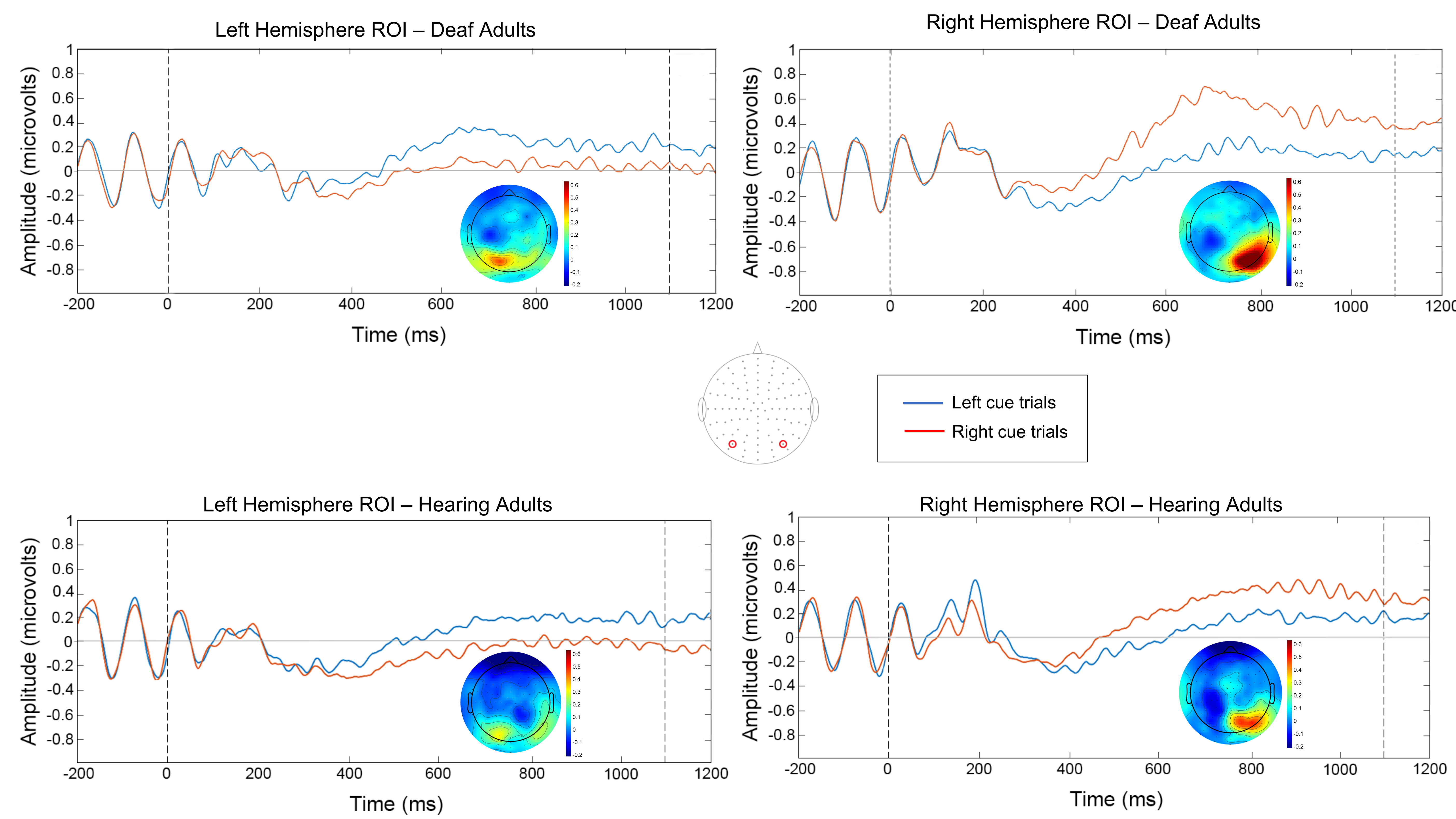


Methods

Hearing non-signers (N = 20) and Deaf native signers (N = 15) were administered an instructional, endogenous visuospatial cueing task (modified Posner cueing task) while wearing a 128-channel electroencephalography (EEG) cap. Visual stimuli were shown on a curved LED monitor using Presentation 20.3. Peripheral stimuli were presented at a visual angle of 18º. Continuous EEG was measured through the ActiveTwo Biosemi electrode system. A 1000-Hz EyeLink eye tracking system was used to ensure strict eye fixation. Two hearing participants were excluded from analysis due to excessive blinking.

The task begins with the intertrial interval (ITI), where all stimuli are static for 500ms. During the cue period, the central stimuli shifts its gaze towards the left or right peripheral stimuli for 100ms. The cue-target interval is 1000ms of static stimuli. The target consists of the left or right stimuli opening its mouth wider for 100ms. The response interval allows the participant to respond to the task for up to 1400ms, if necessary. The task warrants a response only if the cue is valid (e.g., the gaze cue is on the same side as the target stimuli). if the cue is invalid, no response is necessary. The participant is then given feedback on their response for 500ms.

Results



Cue-locked ERPs were derived for leftward cues versus rightward cues. Alpha-band oscillatory activity was characterized in the cue-stimulus interval by the temporal spectral evolution technique (TSE). Cue-locked epochs were bandpass-filtered with a zero-phase Chebyshev II filter with half-amplitude cutoffs at 8-14 Hz. Filtered epochs were then rectified and averaged. 333 ± 34 trials for hearing participants and 342 ± 18 trials survived rejection. Regions-of-interest were generated *a priori* by averaging five electrodes around a central electrode in the parieto-occipital region identified in previous literature. Topographic analysis was conducted to observe the distribution of alpha-band oscillatory activity related to preparatory attention at 750 ms. A repeated-measures ANOVA was performed with the factors of group, hemisphere (left or right), cue direction (left or right), and time window (500-750 ms or 750-1000 ms). The mean amplitude was computed across these time windows and hemispheres. Main effects of hemisphere ($F_{1,33}$=7.97, p < 0.001) and time window ($F_{1,33}$=4.49, p = 0.04) were revealed. There was a significant interaction effect for hemisphere x cue direction ($F_{1,33}$=37.792, p<0.001) and hemisphere x time window ($F_{1,33}$= 10.168, p=0.003). There were no statistically significant differences been group means. Reaction times were compared using an independent samples t-test, yielding a significant difference between deaf (433.3 ± 70.1 ms) and hearing participants (494.8 ± 57.2 ms); t_{33}=2.86, p< 0.01. Task performance was quantified using the sensitivity index, or d-prime. There was no significant difference for d-prime between groups (deaf=3.05 ± 0.54, hearing=2.68 ± 0.68); t_{33}=1.73, p=0.09. Faster reaction times in deaf participants is not explained by the properties of alpha-band oscillatory activity during the cue-target interval of a covert cueing task.