Neural Correlates of Auditory Attention in an Exogenous Orienting Task
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Background

- Inhibition of return (IOR) and facilitation are attentional orienting mechanisms that either enhance or decrease speed and accuracy of response to a target stimulus [1].
- Both effects have been studied in the visual modality, using ERP components such as the N2pc [2].

No previous study has used electrophysiological methods to explore neural basis of exogenous attentional facilitation and IOR in the auditory modality, so in the present study we sought to fill this gap using the N2ac [3] as a neural marker of auditory spatial attention.

Stimuli

- The cue stimulus was a 100 ms monaural tone pip (1000 Hz) presented to either the right or left speaker.

- Trials were either valid (the cue and target were presented from the same speaker), or invalid (the cue and target were presented from different speakers).
- Trials either had a 200ms cue-target interval (CTI) or a 700ms CTI.
- The cue-only trials could also be used to separately examine the activation of the right and left hemispheres in Perceptual Sensitivity.

Methods

- 22 subjects (15 female, mean age=21.45) participated in this study.
- Each subject participated in a single 2.5 hour session.

- Valid Left Short CTI trial

Example trial:

Sequence of events for Valid Left Short CTI trials. Cue stimuli are presented on the left side. The target stimulus (presented on the left side in Valid Left Short CTI) are symbolized by a bold line, with the distractor stimulus (white noise) symbolized by a dotted line. Left and right targets, and short and long CTIs, were equally probable.

Procedure:
- A discrimination task was used to elicit IOR and facilitation.
- Subjects were given two practice blocks.
- Subjects were instructed to press one with their index finger button for target 1, and a different button with their middle finger for Target 2.
- A 100 ms cue was presented on the left side. The target stimulus symbolized by a bold line, with the distractor stimulus (white noise) symbolized by a dotted line. Left and right targets, and short and long CTIs, were equally probable.

EEG Recording:
- 64 equidistant electrodes
- Average mastoid reference
- 500Hz sampling rate, 30Hz low-pass filter
- ERP time-locked to onset of the cue sound (1000Hz) and the target sound (1550Hz or 2100Hz).

References


Future Research

- Further behavioral studies should be conducted in order to fully determine how to elicit both the N2ac and IOR in the same paradigm.
- Including cue-only trials in every experimental block could help to isolate the positive amplitude effect of the invalid 200 condition.
- The cue-only trials could also be used to separately examine the activation of the right and left hemispheres in response to contra- and ipsilateral stimuli, such that the effect of the target is isolated.

Behavioral Results

- Mean RTs for Valid 200, Invalid 200, Valid 700, and Invalid 700 conditions, collapsing across laterality and excluding all incorrect responses. The significant difference between Valid 200 and Invalid 200 is evidence for facilitation.
- These results indicate the typical pattern of behavior for facilitation (significant difference between Valid 200 and Invalid 200).
- The RTs for Valid 700 and Invalid 700 were statistically identical, but the interaction CTI and validity nearly reached significance, indicating a possible trend for IOR.

EEG Results – The N2ac

Conclusions

- The N2ac in the Valid 200 condition had the largest amplitude. Combined with our behavioral results, this shows that facilitation elicits the N2ac.
- The Valid 700 and Invalid 700 conditions elicited the N2ac, but their amplitudes were statistically identical. This indicates that our task did not produce a robust IOR effect.
- We observed no N2ac for the Invalid 200, and this condition elicited the opposite of the normal N2ac effect.
- We found clear behavioral and EEG evidence of facilitation, but only trending behavioral and EEG evidence of IOR.
- We did not find any significant differences in latency.

N2ac Findings

- The N2ac for the Valid 200 condition had the largest amplitude. Combined with our behavioral results, this shows that facilitation elicits the N2ac.
- The Valid and Invalid 200 conditions elicited the N2ac, but their amplitudes were statistically identical. This indicates that our task did not produce a robust IOR effect.
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EEG Results – The N2ac difference waves

N2ac difference waves
- Contralateral-minus-ipsilateral difference waves (averaged across an anterior electrode cluster) for each experimental condition.

N2ac difference maps
- Difference maps showing mean amplitude differences averaged across the 300ms – 400ms time window for each of the four conditions. Electrodes used in data analysis are indicated with small circles.

Discrimination Task Reaction Times

Behavioral results for facilitation and IOR:
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- The RTs for Valid 700 and Invalid 700 were statistically identical, but the interaction CTI and validity nearly reached significance, indicating a possible trend for IOR.