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Repetition Positivity and Sound Intensity Changes in Normal Listeners

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Background

Generative models of perception such as predictive coding are used to explain how the brain perceives the world; in these, it is assumed that the brain predicts which sensory inputs will be received through the senses such as hearing and visual and tries to minimize errors within the framework of a hierarchical model (Kumar et al., 2011). Repetition positivity (RP) is a frontocentral positive polarity evoked potential, between 50 and 250 ms post-stimulus that gradually increases with each repetition of a stimulus, and is thought to reflect progressive strengthening of auditory memory and habituation to repetitive stimuli (Baldeweg, 2007, Haenschel et al., 2005). However, little is still known about brain responses that indicate the strength of sensory predictions.

Objectives

The aim of this study is to characterise how RP is influenced by changes in stimulus frequency and intensity, which has not previously been assessed.

Materials and Methods

- Twenty participants with normal hearing were included in the study (10 male, 10 female, median age: 32 yrs, range 18–65), each of whom provided informed, written consent.
- A test paradigm was established which used sequences of isochronous 5 kHz pure tones (300ms duration, 300ms inter-stimulus interval), which change in intensity by 6 dB after every 30 stimuli. Intensity changes were roving, such that an increase would be followed by a decrease, and vice versa. Also, the same procedure was used with the frequency changes too.
- Electroencephalography (EEG) was used to evaluate the response to intensity and frequency changes.
- MATLAB program was used to make the stimulations, and also analyze the EEG responses.
- Participants watched silent films with subtitles during EEG recordings and listened to auditory stimuli via earphones.

Results

Event-related potentials recorded with EEG indicated that intensity and frequency changes are followed by RP. Repetition effects on standards were determined by measuring RP, which continued to increase up until the final (30th) stimulus. We discuss amplitude and latency of RP to intensity changes, along with asymmetries in the effect of intensity increases and decreases. The changes of the RP with the intensity and frequency changes are given on Figure 1.

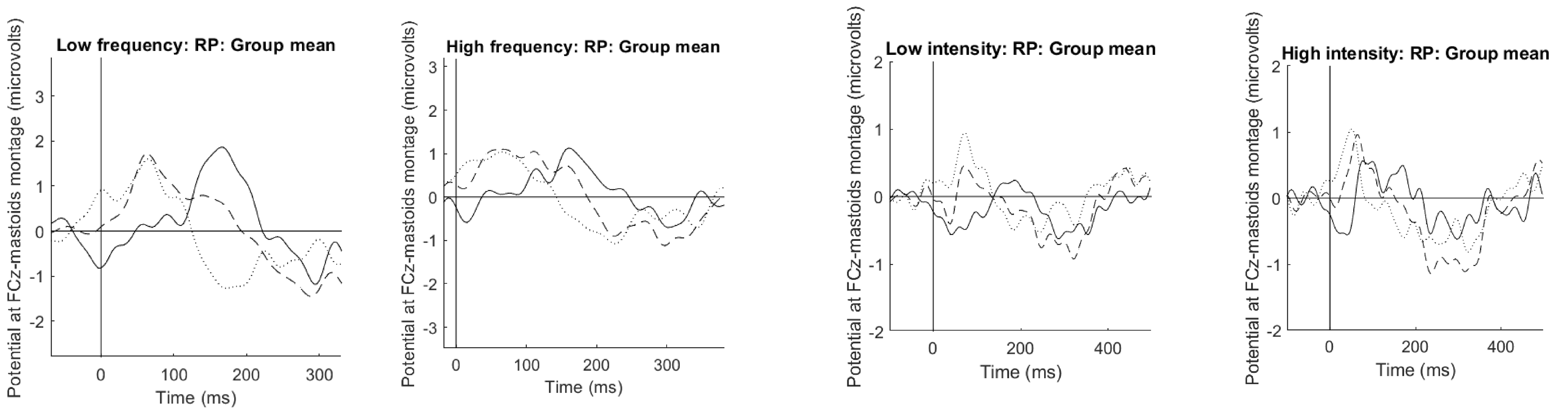

Figure 1: Time course of repetition positivity with frequency and intensity changes. Dotted line indicates stimulus 1 in a series of 30, the dashed line indicated stimulus 30, and the solid line indicates repetition positivity, calculated as the change from the 2nd to 30th stimulus according to a best linear regression fit.

Conclusion

It is concluded that RP robustly follows changes in stimulus frequency, but it is needed more subjects to make a certain decision about the RP with intensity changes. This observation may have great importance in the understanding of a range of common and incompletely understood clinical conditions, and also of fundamentally understanding how the brain habituates to repetitive stimulation, and how frequency and intensity are processed similarly and differently to other sensory attributes in a predictive coding framework. However, it is suggested that the number of the participants should increase to observe the RP waves clearly. Also, further investigations are needed to identify the relationships between RP and hearing and sound tolerance problems.

References

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