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Manifestations of attentional lapses in evoked potentials during performance of the auditory condensation task

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Introduction

Here we try to address the question which ERP parameters may be identified as correlates of occasional spontaneous errors related to failures in information processing in alert non-clinical subjects. Tasks described in literature usually use distractors or competing tasks, which make participants distract their attention from the target stimuli ("induced" errors). The current study was designed to investigate spontaneous errors made by participants in the absence of any distractors or any overt competing tasks. Relying on the set of behavioral data (Dyson and Quinlan, 2003; Thompson, 1994), we can propose that the use of a condensation task, requiring overt behavioral responses and feature binding, seems to be well suited for the study of failures in purposeful responding. The condensation task apparently depends upon higher-order cognitive processes and mimics everyday purposeful human behaviour relying on recognition of various complex stimuli and choice of appropriate responses to them. Thus present study is dedicated to the investigation of the electrophysiological manifestations of occasional attentional lapses leading to errors in feature binding in auditory modality.

Materials and methods

In experiment 1 data were obtained in 56 participants (mean age 20.9±1.3 years). Four brief tones (40 ms, 85 dB) were randomly presented with equal probability. The stimuli could be discriminated by way of conjunction of two distinct features: pitch and noisiness (high pure, high noised, low pure and low noised sounds). Participants were asked to discriminate the stimuli and to respond by pushing one of two buttons. The stimuli used had well discernable differences in their physical parameters. Task performance required the conjunction of the two physical features, thus imposing a high load on attention (Treisman, Gelade, 1980). Each participant was recorded during 5 blocks of trials, each block consisted of 100 trials. Interstimulus interval was 2500 ms ± 500 ms. A behavioral outcome could be a correct response, an error or an omission of the response. Stimulus locked evoked potentials were coherently averaged for each type of response.

In experiment 2 data were obtained in 48 participants. In addition to four stimuli described above, one sinusoidal stimulus was added ("pure" 400Hz tone, duration 40 ms, rise and fall 10 ms).

Response contingencies in the condensation task

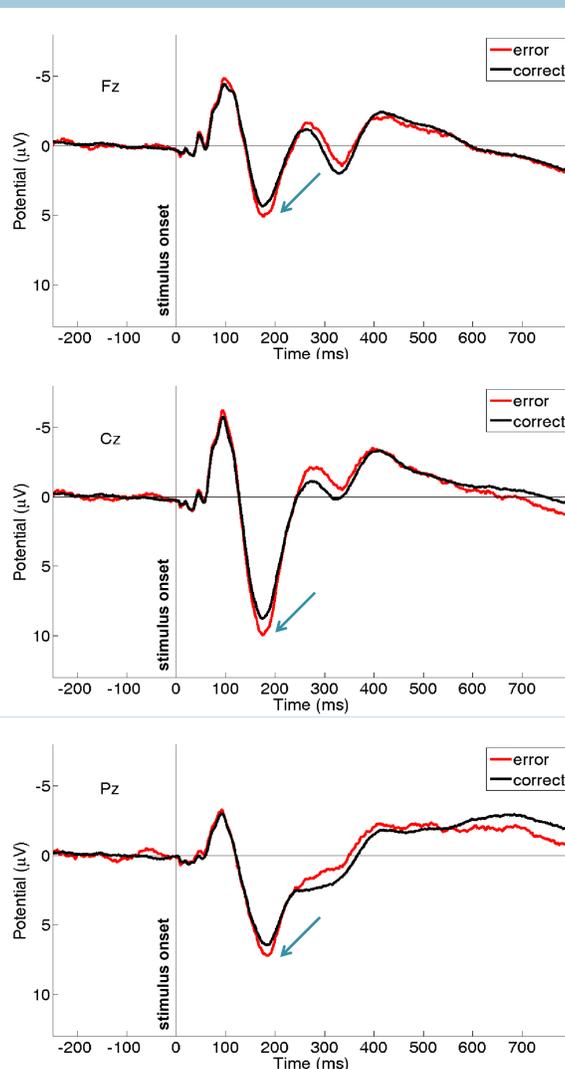
| | Pure | Noised |
|------|--------------|--------------|
| High | Left button | Right button |
| Low | Right button | Left button |

Conclusion

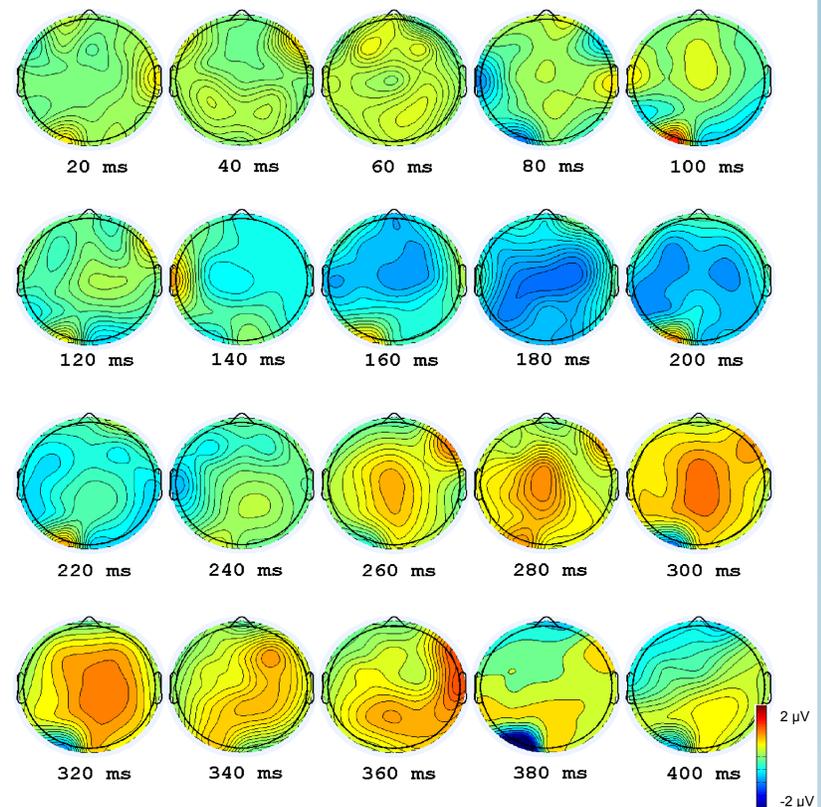
Taken independently, N2 effect, observed in the second experiment, hints at possible deterioration of cognitive control (Botvinick et al., 2001) preceding errors. Current evidence suggests that increased P2 reflects discontinuation or suppression of information processing (Melara et al., 2002). We can speculate that enhanced P2 is a reflection of some processes in the auditory cortex which leads to premature termination of signal information processing, and consequently to failures in the behavioral response. This process may be similar to the "rejection positivity" described by Alho et al. (1987). Another possible explanation, suitable for both experiments, is the presence of a superimposed wave, which leads to a negative shift of the ERP preceding correct responses and thus affects both N2 and P2 amplitudes. The nature of this wave is probably similar to the processing negativity (Näätänen, 1978) reflecting shifts in the attentional state of the subjects.

Results, experiment 1

ERPs



Difference (correct-error) map

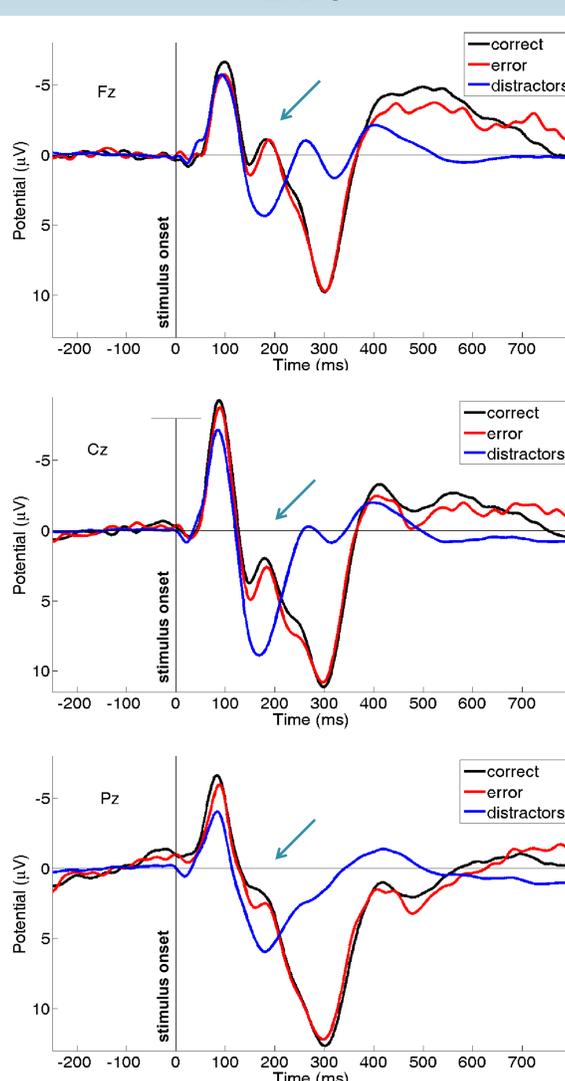


N1 does not change, P2 amplitude is higher in case of errors, N2 and P3 are not pronounced, no differences found within their time windows

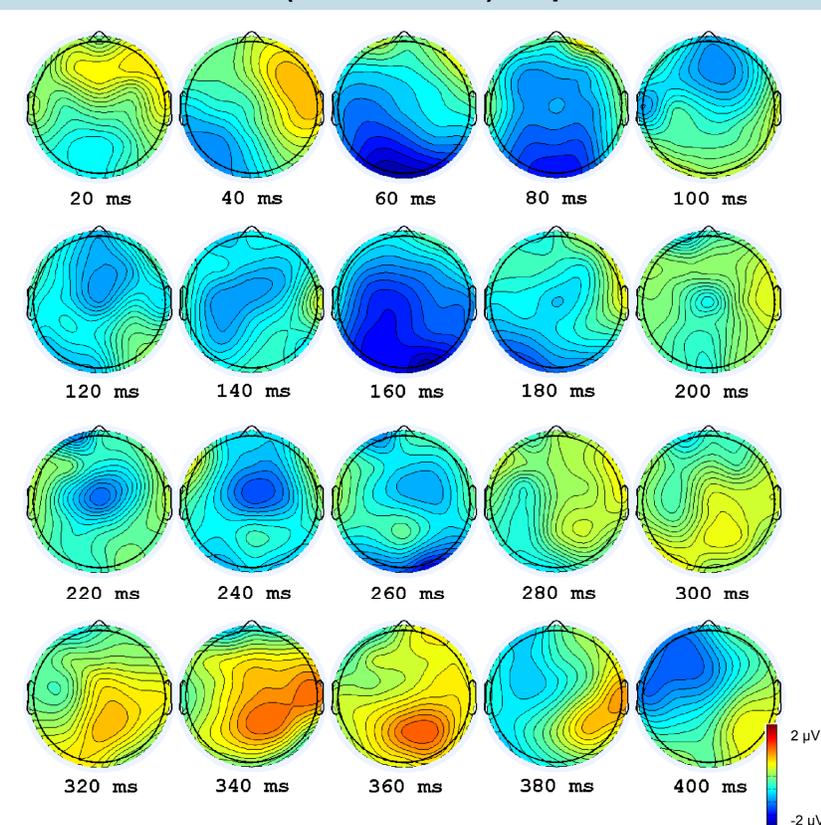
For more details of experiment 1 results you are welcome to download the working paper at <http://www.hse.ru/data/2012/12/28/1304052706/06PSY2012.pdf>

Results, experiment 2

ERPs



Difference (correct-error) map



N1 remains the same, P2 amplitude is slightly higher in case of errors (still not significant), N2 amplitude is higher for correct responses, P3 remains the same

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