

Conference Paper

# Conformity and Reaction to Error: An ERPs Study

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## Abstract

This article is devoted to the analysis of cognitive indicators of conformal behavior. It presents the results of the study of EEG-correlates of conformity. The hypothesis of the study is that people who tend to the conformal behavior have a similar way of response on the errors and disagreement with the majority opinion. The experiment involved 20 participants: 11 – nonconformists, 9 – conformists according to tests ('Interpersonal Behavior Circle' by T. Leary and 'Portrait Values Questionnaire' by S. Schwartz). Participants took part in two types of tasks: arithmetic tasks and attractiveness evaluation. After solving the tasks, participants were given feedback about right/wrong decisions in arithmetic tasks, and agreement/disagreement with the majority opinion in the evaluation of people's attractiveness. This study analyzed event-related potentials (ERPs) in the case of error or disagreement with the majority opinion. The results of the study showed the differences in the indicators of bioelectric brain activity between conformal and nonconformal participants after the disagreement with the majority opinion. Conformal participants demonstrate higher amplitude of P300 wave upon presentation of the feedback of the disagreement with the majority opinion. Thus, the conformal behavior in a situation of disagreement with others' opinion accompanied by specific ERP patterns of the brain associated with the correction of behavior.

**Keywords:** conformity, error processing, event-related potentials, P300, error-related negativity

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## 1. Introduction

The phenomenon of conformity described in the middle of the last century, became one of the most popular areas of socio-psychological experimental research at the end of the 20th century. To date many replicas of early studies of conformity supplemented by a study of various factors have been carried out. For instance, in the experiment of

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D. Abrams [1] the influence of belonging to the group on the manifestation of conformity is studied. The results shows that people are more tend to conformal behavior in relation to the group to which they belong. It has also been shown that residents of collectivist countries more often demonstrate conformism in S. Ash's tasks in estimating the length of lines than the residents of individualistic countries [3, 5]. Further studies describe affective aspects of conformity [13, 20]. The experiments demonstrated that under pressure a person not only agrees with false judgments but also 'catch' a general mood adopting the style of the group's behavior.

In the studying of conformity the correlations between the conformal behavior and various personality traits were found, for example, the relationship between conformity and the locus of control is described [10, 11, 16]. As the predictors of conformal behavior the criteria for self-esteem are also declared. It is noted that people who consider internal bases (such as their own competencies) more important for self-esteem are less often demonstrate conformal behavior than those who believe that the external bases of self-esteem (for example, achievements) are more important [2].

Of particular interest in the study of conformity are research of the transfer of decisions made on the basis of the group's opinion to other similar tasks. Moroshkina et al. [22] in their studies examine whether a subject who agrees with the group's opinion on the evaluation of attractiveness of a certain person will evaluate other people by the same criteria of attractiveness.

Thus modern studies of the conformity are conducted within the framework of studying the characteristics of conformal behavior (stability, the possibility of transfer to other situations) and it correlations with different personality traits. However the nature of conformity is still not described, there is no integrity in understanding of the mental properties mediating behavior.

The study of conformity mostly based on the analysis of observable behavior. In the same time modern neuroscience allows to study brain mechanisms of social behavior [8, 19, 21]. For example, classical Ash's experiment was replicated using electrophysiological method and it allowed to describe psychophysiological correlates of conformity [4]. Besides, the relationship was found between conformity and neural correlates of an error [19]. Thus it is important to continue studying the conformity in the context of post-error adjustments. Within the framework of this approach the conformity can be considered as a way of failures avoidance (errors committing).

Post-error behavior is broadly studied in the field of cognitive psychology [6, 7]. The main types of post-errors adjustments are post-error slowing [9], post-error reduction of interference [17], and post-error improvement in accuracy [12]. Notebaert and colleagues [14] suggest that post-error slowing occur after atypical errors and reflect orienting response to an unexpected event. Thus slowing down the following response might be the result of unexpected feedback, even after correct response.

Many studies analyze such event-related potentials (ERPs) as error-related negativity (ERN), feedback-related negativity (FRN) and P300 amplitude to investigate the mechanisms of post-error slowing [13, 18]. Núñez Castellar and colleagues [13] found that post-error slowing correlate with the P300 amplitude. It was shown that higher P300 amplitude occurs after infrequent responses. Wherein error-related negativity and the feedback-related negativity were not correlated with behavioral data. These results support the hypothesis that post-error slowing is caused by attentional orienting to unexpected events.

According to study of conformity we consider that the orienting account should occur after disagreement with the majority opinion for conformists, because it is infrequent event for them. For nonconformists the disagreement with the majority opinion is a typical situation, thus they should not demonstrate the orienting account. The present work is devoted to the studying of psychophysiological indicators of conformity by means of comparison of physiological reactions to the report of an error during solving arithmetic tasks and responses to mismatch with the majority opinion in the evaluation of individuals. The hypothesis of the study is that people who tend to the conformal behavior have a similar way of response on the errors and disagreement with the majority opinion.

## 2. Method

The study included two parts. On the first part 62 participants took part in personality tests: Interpersonal Behavior Circle (T. Leary) and Portrait Values Questionnaire (S. Schwartz). We analyzed the scales scores 'Docile-Dependent' and 'Self-Effacing-Masochistic' of Interpersonal Behavior Circle and scale score 'Conformity' of Portrait Values Questionnaire. The groups of conformists ( $N = 9$ ) and nonconformists ( $N = 11$ ) were formed according to the results of the tests.

On the second part the experiment was conducted using the ERPs method. Participants took part in two types of tasks: 106 arithmetic tasks and 103 photos for attractiveness evaluation. Arithmetic tasks were two-digit numbers, which should be folded

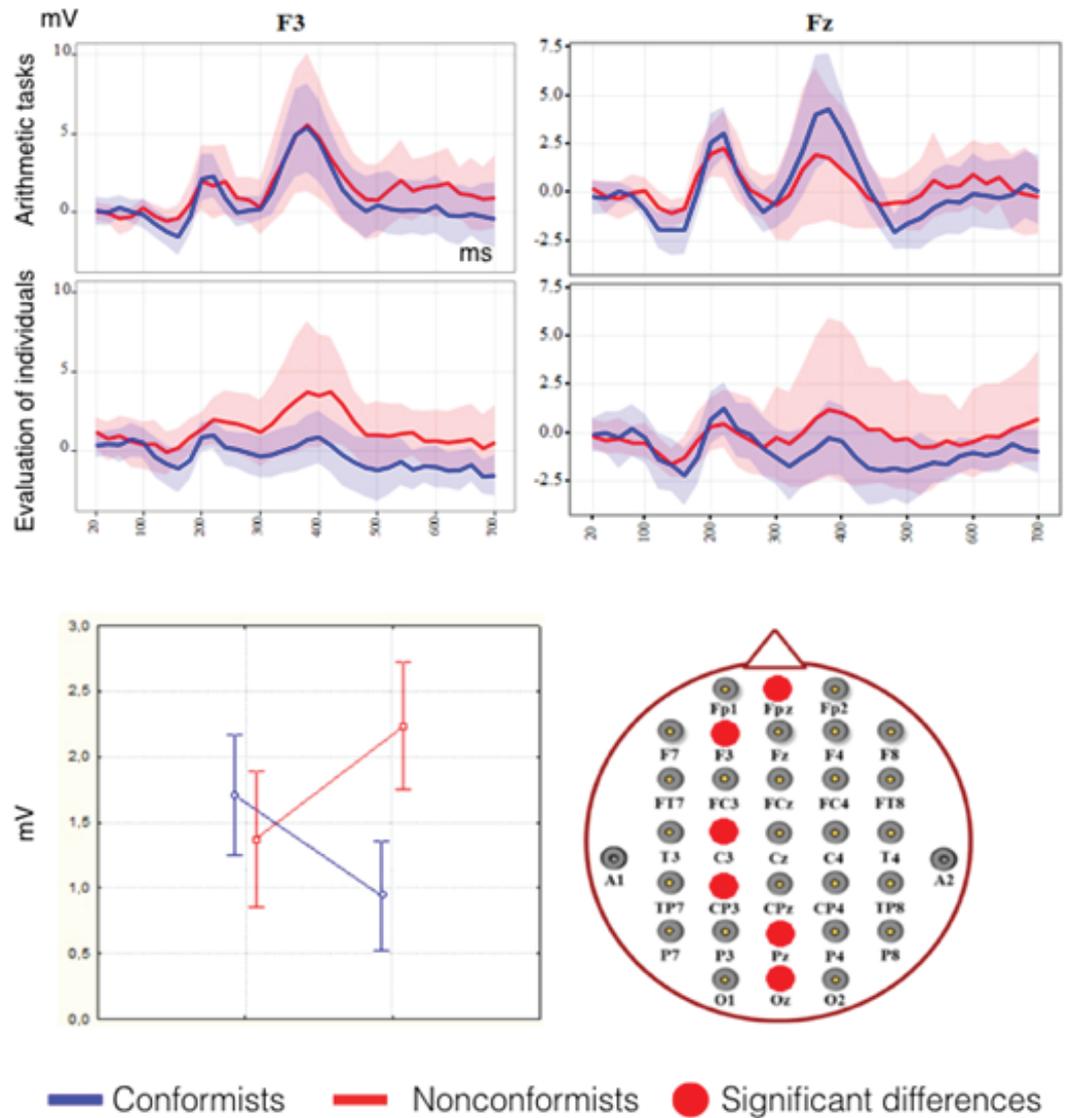
in the mind and choose one of the five answer choices. In the second task photos were presented on the screen, which the subject should assess as attractive or not attractive by pressing a certain key. After solving the tasks participants were given feedback about right/wrong decisions in arithmetic tasks, and agreement/disagreement with the majority opinion in the evaluation of people's attractiveness. Countdown was a green (in the case of the correct answer or agreement with the majority opinion) and red (in the case of error or mismatch) squares of 50x50 pixels, which were presented at the 1000 ms in the center of the screen. This study analyzed ERPs in the case of error or disagreement with the majority opinion. In the analysis ERPs for each test was averaged at least 35 samples.

ERPs registered on 31-channel «Mizar-EEG 202», the electrodes are superimposed on the 10-20 system, monopolar montage, high-pass filter – 30 Hz, low-pass filter – 1.0 (0.16 Hz), notch filter – 45-55 Hz, oculomotor artifacts removed using the ICA. For statistical analysis we used two-factor analysis of variance with repeated measures. In the case of significant differences we applied post hoc Tukey.

### 3. Results

Figure 1 shows ERP's averaged within groups and types of stimuli. A larger amplitude P300 is observed when the error feedback is presented in arithmetic examples in the group of nonconforming subjects. No significant differences were found in the number of errors between the identified groups (conformists:  $M = 47.87 \pm 21.38$ , nonconformists:  $M = 46.11 \pm 12, 92$ ). The P300 amplitude is significantly higher in the group of conformal subjects than in the group of nonconforming subjects. Significant differences were found in 6 electrodes (Figure 1). The largest values of the P300 amplitude of ERPs in response to the discrepancy with the opinion of the majority in conformal subjects were recorded in leads located along the middle line in left-hemispheric frontal and central leads (F3:  $p = 0.001$ ; F3:  $p = 0.001$ ; C3:  $p = 0.037$ ; CP3:  $p = 0.003$ ; FPz:  $p = 0.007$ ; Pz:  $p < 0.001$ ; Oz:  $p < 0.001$ ).

When analyzing the amplitude of P300 in different series of experiments, a large 'variability' was revealed in the group of nonconforming subjects. In this group, a large P300 amplitude was recorded with a feedback about the error (arithmetic tasks) in comparison with the feedback on the discrepancy with the majority opinion (in the evaluation of attractiveness), mainly in the frontal areas (F3:  $p < 0.001$ ; FC3:  $p < 0.001$ ; C3:  $p < 0.001$ ; Fz:  $p < 0.001$ ; FCz:  $p < 0.001$ ; Pz:  $p < 0.001$ ; CPz:  $p < 0.001$ ; F4:  $p < 0.001$ ; F8:  $p < 0.001$ ; FC4:  $p < 0.001$ ; C4:  $p < 0.001$ ; CP4:  $p < 0.001$ ; TP8:  $p < 0.001$ ).



**Figure 1:** Differences in the amplitude of the P300 when presenting feedback about the error and the discrepancy with the majority opinion. Red marked the leads for which significant differences were found (post hoc Tukey), the average values of the P300 amplitude from these leads, confidence intervals of 95%.

Also, the P300 amplitude, depending on the objectivity of the feedback (task type) in the group of conformal subjects. A large P300 amplitude was observed in response to the feedback of the discrepancy with the majority opinion compared with the objective error feedback in the frontal and occipital electrodes (FT7:  $p = 0.002$ ; FPz:  $p = 0.038$ ; Pz:  $p = 0.003$ ; Oz:  $p < 0.001$ ; O2:  $p < 0.001$ ).

## 4. Discussion

The registration of late component P300 (P3b) upon presentation of the feedback of an error can point at the discrepancy between the feedback and the prepared setting. The observed positivity with peak latency of approximately 400 ms is considered by us as a component of the P3b wave of P300, since the presentation of feedback was indicated in the instruction, and the stimuli had fixed contextual significance.

The results of similar psychophysiological indicators of the reaction on the disagreement with the majority opinion and on the error correspond to the data which Klucharev and colleagues [21] described in their study. However due to the grouping the participants to the conformists and nonconformists we found that only for conformal participants a situation of disagreement with others' opinion accompanied by specific ERP patterns of the brain similar to the patterns which register in case of committing errors.

Besides, the results of the study showed that for conformists the reaction to the mismatch with the majority opinion accompanied by higher amplitude of P300, which relates to the conscious appraisal of the stimulus and the behavior correction. We can suppose that higher amplitude of P300 after the feedback about the mismatch with the majority opinion appears as an adaptation to the conflict situation for conformists. For nonconformists the reaction to the feedback about an error in arithmetic task differs from the reaction to the mismatch with the majority opinion. Objective feedback for nonconformists causes the reaction of activation, but subjective feedback is ignored.

## 5. Conclusions

Our data correspond to the results of Núñez Castellar et al. [15] concerning the connection of P300 amplitude with the attentional orienting to unexpected events. Conformal people do not tend to express the opinion which differs from the majority opinion. Thus, we can consider that the feedback about the disagreement with the majority opinion induce the reaction of mismatch with their expectations and the necessity to correct their behavior.

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