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Gender Differences in Line Orientation Discrimination

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ABSTRACT

35 healthy subjects (16 males, 19 females) were asked to discriminate the orientation of the gratings having four orientations: Horizontal, vertical, oblique 45° and 135°. No significant behaviour gender differences in performance of orientation discrimination test were observed. Both genders showed a shorter RT for the cardinal orientation recognition in comparison with oblique ones. However, the neural processing of orientations was different across genders. The amplitude of the early ERP components (P100 and N150) measured at early vision posterior areas, demonstrated significant interactions Orientation × Gender. Males display the greater responses to oblique over cardinal orientations which were more significant in the N150 time window while females did not reveal significant differences between the answers elicited by cardinal and oblique orientations. The later ERP components (P300 and Late Negativity) measured at anterior areas did not exhibit distinct gender differences and showed the greater responses to cardinal orientations. The gender specificity of the 'initial classification' of basic and oblique orientations may be considered as one of the possible inherent factors of gender differences in some aspects of visual-spatial tasks performance.

Key Words: Vision; Line orientation; Oblique effect; ERP; Gender

INTRODUCTION

Visual perception critically depends on orientation-specific signals that arise early in visual processing. A large body of animal experiments has examined the mechanisms of orientation detection. The problem of gender influences on electrophysiological correlates of orientation detection has received little emphasis up to now, although numerous data point to the possibility of gender differences in the detection and coding of basic characteristics of visual space. Sex-related differences in visuospatial activity are widely discussed in the literature. As a rule, these are complex, including cognitive components, forms of behaviour, such as navigation, construction, and 3D rotation [1,2]. Sex-related differences in the performance of simpler tasks have received less attention. There are only occasional studies on this theme [3]. We can assume that gender differences in visual-spatial tasks performance to some extent may be related to differences in ability to accurately identify the main spatial axes and deviations from them. The goal of our study was to investigate the influence of gender on orientation sensitivity of the components of the evoked response potentials during line orientation discrimination. We were interested at what stage of orientation processing the gender differences are manifested. Some findings suggest that the gender difference arises early in visual-spatial processing, possibly during encoding.

DESCRIPTION

The study involved 19 females and 16 males with normal vision. Stimuli were black/white gratings of patches of four orientations (0°, 45°, 90° and 135° from horizontal), which were presented in the centre of monitor. The subjects were asked to identify the grating's orientation and press button on a keyboard. The EEG was acquired using a 128-channel system (HydroCel Geodesic Sensor Net, Electrical Geodesics Inc., USA). The data were segmented relative to the test-stimulus onset and were sorted according to the stimuli orientation. The amplitude of components of evoked response potentials P100, N150, P300 and Late Negativity on time window 400 ms-600 ms was measured. It was found, that the components P100 and N150 in the posterior cortex areas, which reflects the early

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sensory processing, exhibited the inverse oblique effect which appeared in the greater response to oblique over cardinal orientations, while the classical effect display a preference for basic orientations [4]. We found that early processing of orientations discover the significant interactions Orientation × Gender. Our results showed that the differences between orientations were more distinct for males than for females, especially in the N150 time window. It is known that this wave is larger in the discriminative-response condition than in the simple-response one, beginning around 150 ms post stimulus while the initial P1 sensory response is the same for simple-response and discriminative-response tasks. In this way our results exhibit the gender dependence of the early stage of 'initial classification' of line orientations. Therefore, we may believe that the females have diverse neural mechanism responsible for the early orientation discrimination. Assumedly it is one of the possible factors determining previously described gender differences in orientation discrimination performance. The later components P300 and the Late Negativity reflect the later stage of information processing in the discrimination of line orientation. The amplitudes of these components were assessed over the central, parietal and frontal electrode groups. As a general remark, it should be noted that these components showed the classic oblique effect with the prevalence of cardinal orientations that was different from the inverse oblique effect at the early stage of orientation processing. The classic oblique effect revealed in the P300 and Late Negativity correlated with behavioural predominance of the cardinal orientations. Our results are in line with the conclusion that the P300 component was modulated by the meaning and significance of the stimulus. Actually, vertical and horizontal orientations that correspond to the fundamental spatial axes evoke the more prominent P300. The Late Negativity as well as the P300 revealed the classic oblique effect. During the later processing stage, determined within time window of the P300 and LN, the gender differences were less distinct than that obtained for the P100 and N150 components. Importantly, for the P300 and Late Negativity the interaction Orientation × Gender was not found. Therefore, in this processing stage the effect of orientation appears to be similar in males and females. The P300 and Late Negativity time windows integrates various simultaneous brain processes such as allocation of attentional resources, estimation of stimulus significance, stimuli congruency, activation of visual object knowledge for a category decision, and cognitive decisions about visual objects. Consequently, there was no distinct gender specificity in the late cognitive orientation processing. Actually, males as well as females demonstrated the similar statistically significant differences between answers evoked by cardinal and oblique orientations. This similarity of operations related to decision making presumably underline the similar performance of orientation discrimination task in males and females. Tentatively the discovered gender differences in early components characteristics may reflect inherent visual processing traits, influencing the different abilities in some spatial tasks performance in males and females.

CONCLUSION

This study explored the gender specificity of electrophysiological correlates of orientation discrimination using event-related potentials. Significant behaviour gender differences in the performance of orientation discrimination test were not observed. Both genders showed a shorter RT for the cardinal orientation recognition in comparison with oblique ones. However, the neural processing of orientations was different across genders. At the posterior areas males exhibited the greater early responses to oblique over cardinal orientations especially in N150 time window. At the same time window females showed no significant differences between the answers elicited by cardinal and oblique orientations. The later components measured at anterior areas did not reveal distinct gender differences and showed the greater responses to cardinal orientations. The gender specificity of the 'initial classification' of basic and oblique orientations may be considered as one of the possible inherent factors of gender differences in some aspects of visual-spatial tasks performance.

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CONFLICT OF INTEREST

The authors declared no potential conflicts of interest for the research, authorship, and/or publication of this article.

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