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The effects of two types Ebbinghaus visual illusion on changes perception of visual size and brain waves pattern in children with autism: A review of neurocognitive perspective

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Abstract

Introduction: Several studies have examined visual illusion's effect on motor performance and the cognitive task of estimating target size in normal individuals. However, research that has used this approach on the cognitive function of children with autism and the underlying neurological mechanisms has been neglected. According to the neurological approach, the present study aimed to investigate the effects of Ebbinghaus visual illusion on changes in perception of target size and brain waves in children with autism.

Methods: The research was semi-experimental with pre-test and post-test design with three groups (two experimental groups and one control group). The study's statistical population included all right-handed children with autism aged eight-ten years old in Mashhad. Thirty-three children with autism were selected by the available sampling method and randomly divided into three groups of 11 people. The research instruments included visual illusion targets for training and an EEG device for recording brain waves. Analysis of covariance and analysis of variance with repeated measures was used to analyze the data.

Results: Visual illusion significantly affect changes in target size and alpha brain waves so that the larger perceived group was more associated with alpha wave reduction.

Conclusion: Due to the identification of the neural mechanism underlying visual illusion, it can be used as an effective training method in perceptual problems in children with autism.

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Extended Abstract

Introduction

Perception of the size of human vision (The size of Ebbinghaus illusion circles) is not an objective reflection of the physical size of objects; and instead, it is more due to the interaction of external sensory information and internal state. The results show that the processing of visual size illusion is somewhat inherent, and the amount of visual size illusion is related to the inherent activity of the human brain. During awakening, human EEG activity can reflect

cortical functions in the absence of sensory input. One of the EEG waves directly related to visual size perception is the alpha wave; most visual illusion studies have used this wave for their studies. The results of brainwave research on visual illusion have shown that alpha-band suppression is significantly associated with perceptual errors. In other words, the decrease in the alpha wave is strongly associated with the overestimation of the target size in the visual field. This research is more common in the general public and does not include specific individuals such as children with autism. On the other hand, according to the week central cohesion theory, children with autism are not sensitive to visual illusion. However, there are contradictions between the researches in this field. Therefore, the present study's hypothesis is that children with autism are susceptible to visual illusion and the reduction in the alpha wave of the visual area about visual perception can also be generalized to the autistic population.

Methods

According to the predicted goals, the present study was of a quasi-experimental type with pre-test and post-test design with three control and experimental groups. This study included pre-test and post-test stages. A total of 33 children with autism ranging in age from eight to ten years (33 boys; mean age: 9.04, standard deviation 0.75 and right-handed) were selected by available sampling method to participate in the study and randomly selected in the three groups of 11 people was divided (two experimental groups, one control group). The goal used to perceive the target size was Ebbinghaus visual illusion. These goals are perceived as either larger or smaller. Then, the subjects first estimated the central target in the condition without visual illusion. They then performed a throwing 200 throw trial under visual illusion conditions and re-estimated the target size (in the presence of visual illusion). Brain data collection was performed by a 32-channel Mitsar-202 brainwave recording device made in Russia. Besides, data catch channels include O1-O2. Accordingly, the EEG data were measured in two stages: pre-test and post-test. In the pre-test stage, alpha-band activity (8-12Hz) in the O1-O2 region was measured in the two channels. The electrode junction was located in the occipital region. The reason for choosing this area is that this area of the brain has been used to record waves in research on visual error. At the end of the training protocols (200 throw trails with visual and control error conditions), the alpha band activity was measured again in the O1-O2 area. Statistical tests of mixed analysis of variance with repeated measures and analysis of covariance were used to analyze the data.

Results

The study's results in the perceptual task section of the target size revealed that the groups perceived the size of the center circle differently. Overall, these results suggested that training with visual illusion has affected perceptual task changes in target size; because there was a significant difference between the research groups in estimating the target size. Thus, when the center circle was surrounded by smaller circles, its perceived size was larger than when it was surrounded by larger circles, and when the center circle was surrounded by larger circles; its perceived size was smaller than when it was surrounded by smaller circles. Also, the results of the ANCOVA test showed that training with visual illusion has a significant effect on changes in the pattern of alpha brain waves. Also, the results of between-group differences showed that there was a significant difference between the research groups and the visual illusion groups that perceived the target as larger and smaller than the control group, which led to a more significant reduction in the alpha wave from pre-test to post-test. Also, among the visual illusion groups, the larger perceived visual il-

lusion group showed a significant decrease in alpha wave compared to the perceived smaller visual illusion group. Thus, it can be said that a target surrounded by smaller circles, which show a larger target, is more associated with a decrease in the alpha wave of the visual area.

Conclusion

The results of this study showed that children with autism, like normal people and their peers, are sensitive to visual illusion as a cognitive task. These results pose a further challenge to the theory of weak central cohesion. Regarding the neural part, the results showed that visual illusion has significantly affect alpha brain wave changes; this effect was shown to be a more significant reduction in the alpha wave in the group of larger perceived visual illusion. Therefore, the results of this study can be used by people who work with children with autism in the field of perceptual processing. Children with autism are less susceptible to visual errors, which prove the theory of poor central cohesion. Visual errors are used as an accurate and valid tool to diagnose autism. Therefore, according to these results, it is necessary to develop early therapies to strengthen central cohesion in children at risk of autism. Therefore, the current research's results suggest to educators and people with autism that training and intervention with any of the visual conditions can be improved the field of cognitive task learning in children with autism and can be helped to central cohesion of these people. Of course, it should be noted that this research is the first research conducted in this field, and the need for more research with different protocols is felt in these people and other disorders.

Ethical Considerations

Compliance with ethical guidelines

The present study included ethical principles, such as obtaining informed consent, the principle of confidentiality of participants to keep their information confidential, and the coding of participants' names. The study also provided sufficient information on conducting the research. In addition, participants were free to withdraw from the study.

Authors' contributions

Article writing: Mohammad Hossein Zamani; Analysis of statistical findings and scientific and literary editing of the article: Hamidreza Taheri and Alireza Saberi, Brain wave analysis and EEG findings: Majid Qashouni.

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Conflict of interest

The authors of the present article declared that there is no conflict of interest in conducting this research.

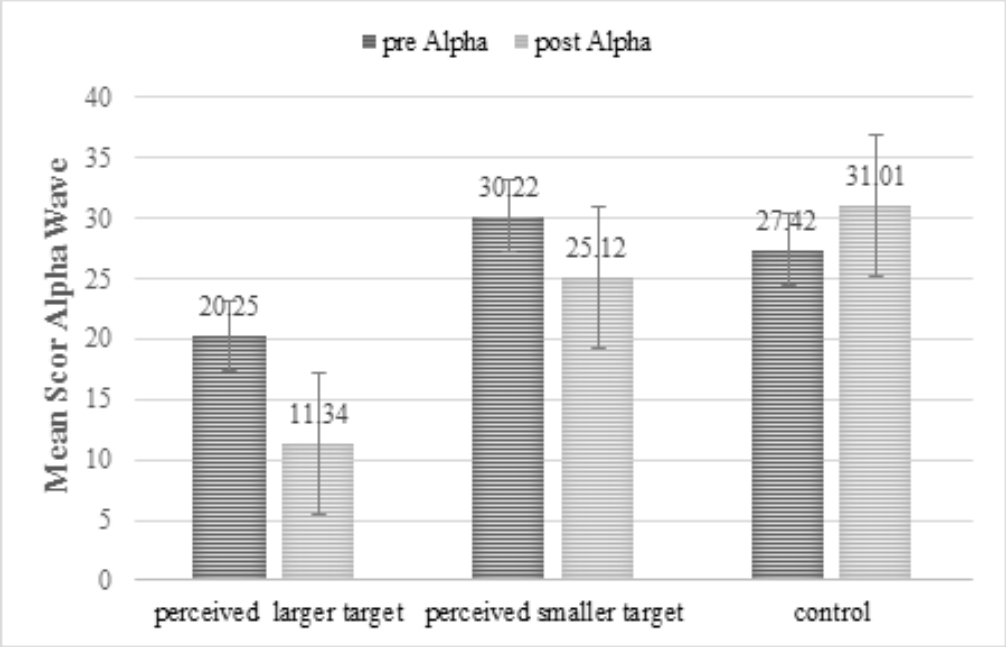

Figure 1. Average alpha wave scores of the visual area before training, after training with visual illusion