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Research Paper

The Role of Cognitive Control in Paranormal Beliefs: A Study Based on Performance in Go/No-go Task

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ABSTRACT

Introduction: Cognitive control plays a role in human behavior and mental processes and affects paranormal beliefs. This study aims to investigate the role of cognitive control in paranormal beliefs using the go/no-go task.

Methods: A total of 92 people were selected based on low, middle, and high scores in the revised paranormal belief scale (R-PBS) and assigned to 3 groups. The groups included 30 severe paranormal believers (13 females with a mean age of 25.3 years), 31 mild paranormal believers (14 females with a mean age of 26.4 years), and 31 skeptics (16 females with a mean age of 25.8 years). All participants were tested on the go/no-go task. A multivariate analysis of variance was conducted with the given groups (severe paranormal believers, mild paranormal believers, and skeptics) as the independent variable and the go/no-go subscales scores as dependent variables.

Results: The findings showed a significant difference between the mean scores in errors of go ($F_{(2, 89)}$=7.20, P=0.01), errors of no-go ($F_{(2, 89)}$=11.81, P=0.01), and reaction time ($F_{(2, 89)}$=21.46, P=0.01) between the groups.

Conclusion: The severe and mild paranormal believers had lower accuracy and slower reaction times than the skeptics group. Therefore, severe paranormal believers and mild paranormal believers had a weakness in all go/no-go subscale scores. This finding suggests that paranormal beliefs may be related to poor cognitive control.

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Highlights

- Believers show weak cognitive control.
- Skeptics perform better in accuracy and reaction time.
- Paranormal beliefs linked to poor cognitive control.

Plain Language Summary

This study explores why some people strongly believe in paranormal phenomena while others don't. This study investigated the connection between cognitive control (our ability to manage thoughts and behavior) and paranormal beliefs. They found that individuals with stronger paranormal beliefs had poorer cognitive control, as they made more errors and had slower reaction times compared to skeptics. However, it's important to note that this study doesn't prove causation; it only highlights a potential link that needs more research. Understanding this connection is important because it helps us grasp why some people are more prone to believing in paranormal events. It also opens up avenues for studying how cognitive control affects human behavior and thinking. In conclusion, this study provides valuable insights into the relationship between cognitive control and paranormal beliefs, contributing to our understanding of human behavior and belief systems. More research can further deepen our knowledge of why people hold different beliefs and how cognitive processes influence those beliefs.

1. Introduction

Paranormal beliefs refer to beliefs, entities, practices, and processes that contradict the basic limiting principles of science (Tobacyk, 2004). Paranormal beliefs are determined by asking individuals how often they think about paranormal experiences. Examples include ghosts, witches, amulets, omens, rituals, astrology, psychokinesis, and extrasensory perception (i.e. telepathy, precognition, and clairvoyance) (Lindeman & Svedholm, 2012). Individual differences in cognitive-perceptual bias make people susceptible to paranormal beliefs (Irwin, 2009; Narmashiri et al., 2017, Narmashiri et al., 2018; Narmashiri et al., 2023b). For instance, it associates paranormal beliefs with a strong tendency to make mistakes in decision-making (Riekki et al., 2013; Van Elk, 2013), the perceptual bias in obscure categories (Lindeman & Aarnio, 2007; Lindeman et al., 2015), and dependence on intuitive thinking compared to analytic thinking (Pennycook et al., 2012; Prike et al., 2017). Studies show that decision-making and cognitive biases in people with paranormal beliefs result from cognitive impairment (Irwin, 2009). Accordingly, paranormal believers do not have the necessary cognitive skills and abilities (van Elk, 2017).

Belief in paranormal phenomena is associated with various cognitive failures, including errors in probability reasoning (Rogers, 2015; Rogers et al., 2018). Dagnall et al. (2017) believed that this issue strongly favors paranormal believers to recognize and perceive accidental events. On the other hand, some studies have reported the prevalence of intuitive thinking in paranormal beliefs (Prike et al., 2017) and the reduction of paranormal beliefs by analytical-rational thinking (Gervais & Norenzayan, 2012; Pennycook et al., 2012). However, the difference between analytical-rational thinking and intuitive thinking in reasoning and interpreting events is controversial (De Neys & Van Gelder, 2009). The fundamental questions are whether analytical-rational and intuitive processes compete for dominance over one another or whether there is a specific mechanism for regulating these reasoning processes. A mechanism that may involve suppressing intuitive thinking in the tendency to paranormal beliefs is cognitive control (Riekki, 2014).

Cognitive control leads to controlling inappropriate or unwanted responses in individuals and is an essential aspect of executive functions (Friedman & Miyake, 2004). Studies have shown a relationship between paranormal beliefs and poor cognitive control (Lindeman & Svedholm, 2012; Riekki, 2014; Wain & Spinella, 2007; Narmashiri et al., 2023a), whereas strong cognitive control reduces it (Aron et al., 2004; Pennycook et al., 2012). Besides, it relates weakness in cognitive control to intuitive thinking (Moutier & Houdé, 2003), schizophrenia (Nigg, 2000), and religious and obsessive-compulsive disorder (Dewhurst & Beard, 2003), which are closely related to paranormal beliefs and experiences (Brugger

& Mohr, 2008; Lindeman & Aarnio, 2007; Wiseman & Watt, 2006). Reducing cognitive control increases paranormal beliefs (Hood, 2009).

Thus, cognitive control decreases across a range of cognitive domains overlapping with supernatural beliefs, such as schizophrenia (Lesh et al., 2011) and is associated with decreased activity in the dorsolateral prefrontal cortex (DLPFC) (Lesh et al., 2013) and the right inferior frontal gyrus (rIFG) regions (Lindeman et al., 2012). Since the DLPFC and rIFG regions are related to the neural network of cognitive control, this neural network function is defective in paranormal believers. Studies have shown that DLPFC and rIFG regions are related to the inhibition mechanism (Braver et al., 2009; Chiew & Braver, 2013). In this regard, in a study, Lesh et al. (2013) showed that the DLPFC region of individuals with primary schizophrenia did not have significant activity during cognitive control tasks compared to the control group, while the DLPFC region activity of the control group increased. In addition, Fassbender et al. (2014) showed that people with schizophrenia had lower cognitive control scores than the control group. Besides, Lindeman et al. (2012) showed that the rIFG region has an intense skepticism compared to paranormal believers. Concerning previous studies and the relationship between brain regions with cognitive control in paranormal beliefs, this study aims to investigate whether poor cognitive control is associated with a tendency to a variety of supernatural beliefs and an increase in beliefs.

2. Materials and Methods

Study participants

The participants were selected from the students who had not previously participated in the study of paranormal beliefs. All participants were full-time university students of psychology. The age of participants ranged from 19 to 35 years (Mean±SD 28.0±11.9), and formal education ranged from 9 to 20 years (Mean±SD 14.8±1.6). A total of 92 people were selected based on mean low, middle, and high scores on the revised paranormal belief scale (R-PBS) (Tobacyk, 2004). They were classified into 3 groups: Severe paranormal believers, mild paranormal believers, and skeptics. In other words, participants who attained a high mean score on the R-PBS were considered the severe paranormal believer's group (first group). Also, participants who obtained the middle mean score on the R-PBS were considered the mild paranormal believers group (second group). Finally, participants who scored low mean on the R-PBS were considered the skeptics group (third group). This process produced 30 severe paranormal believers (13 females with a mean age of 25.3 years), 31 mild paranormal believers (14 females with a mean age of 26.4 years), and 31 skeptics (16 females with a mean age of 25.8 years).

Study measurement

All participants were tested on the go/no-go pictorial task (Fillmore et al., 2006). In this test, two-colored rectangles (green and blue) were presented horizontally and vertically as a stimulus to the participants. They were then asked to respond only to the green rectangle and ignore the blue one and not consider whether the rectangle was horizontal or vertical when answering. In other words, researchers asked the participants to press the space bar on the laptop keyboard when presenting the green rectangle, both horizontally and vertically. Otherwise, the participants should not press any key. In this test, the person in the go-green rectangle position should respond to the stimulus as soon as possible by providing an actuator. Another stimulus was presented after providing the first stimulus in the other position (no-go-blue rectangle). With the presence of the second stimulus, the person should refuse to answer. Two types of positions (go-green rectangle and no-go-blue rectangle) were randomly assigned to one pictorial task. An individual's ability to control their response in the second position indicates control. The following sub-scales were used for analysis: Error (go), errors (no-go), and reaction time.

3. Results

A multivariate analysis of variance (MANOVA) was conducted with the group (severe paranormal believers, mild paranormal believers, and skeptics) as the independent variable and the go/no-go subscales scores as dependent variables. The MANOVA was significant as the differences between the means on the subscales (Table 1). The findings show a significant difference between the mean scores in errors (go) ($F_{(2, 89)}$=7.20, P=0.01), errors (no-go) ($F_{(2, 89)}$=11.81, P=0.01), and reaction time ($F_{(2, 89)}$=21.46, P=0.01) between the groups. In other words, the severe and mild paranormal believers had lower accuracy and slower reaction times than the skeptics group. Therefore, severe paranormal believers and mild paranormal believers had weaknesses in all go/no-go subscale scores.

4. Discussion

This study aimed to investigate the comparison of cognitive control in groups with severe, mild, and skeptic paranormal beliefs in the go/no-go task. The findings

Table 1. Task performance in groups

Variables	Mean±SD			MANOVA	
	Group Condition				
	Severe Paranormal Believers	Mild Paranormal Believers	Skeptics	F	P
Errors (go)	0.077±0.081	0.080±0.066	0.026±0.04	7.20	0.01
Errors (no-go)	0.116±0.121	0.026±0.038	0.053±0.03	11.81	0.01
Reaction time	493.780±88.266	406.431±58.655	393.562±49.841	21.46	0.01

Reaction time is in ms.

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showed a significant difference in cognitive control performance between groups in errors and reaction time. According to the results, the severe paranormal believer has weak cognitive control. Therefore, previous studies with other tasks have shown an inverse relationship between paranormal beliefs and inhibition. Thus, Wain and Spinella (2007) found that paranormal beliefs related inversely to inhibition control with the executive function index. Another study has shown that believers, compared to skeptics, made significantly more errors on all subscales of the Wisconsin card sorting test but were equal in performance on the Stroop task (Lindeman & Svedholm, 2012). Our previous studies support the association of paranormal beliefs with executive brain functions and suggest that frontal brain functions are likely to influence paranormal beliefs (Narmashiri et al., 2022; Narmashiri et al., 2023a).

Lindeman and Svedholm (2012) showed that paranormal believers had poor cognitive control performance based on the Wisconsin card sorting test. However, paranormal believers and skeptics cognitive control performance did not differ significantly in the Stroop task. According to previous studies on the performance of paranormal believers and skeptics in various tasks related to inhibition, different tasks for assessing inhibition do not show the same results. Therefore, it was necessary to use a different task than previous studies to assess inhibition in paranormal beliefs. Hence, this study used the go/no-go task. The result in the present study differed from Stroop's performance in previous studies. The cause of such differences is not entirely exact. Perhaps one of the reasons is the greater sensitivity of the go/no-go task compared to the Stroop task in assessing cognitive control (Macatee et al., 2018). Also, there are conflicting results from the Wisconsin card sorting test, executive function index, and the Stroop test on cognitive control (Dillon & Pizzagalli, 2007; Friedman & Miyake, 2004; Nigg, 2000). Therefore, this study used the go/no-go task to more directly cognitive assessment control. Using the go/no-go task findings may be necessary to explain previous studies because the association of tasks, such as the Stroop and Wisconsin card sorting test, with the inhibitory assessment is challenged (Dillon & Pizzagalli, 2007). Another reason for the differences in the tasks' results may be the complexity of cognitive control and its multidimensionality, making it difficult to evaluate. Besides, it may also refer to related but distinct concepts (Braver, 2012).

Previous findings also support the view that paranormal beliefs are directly related to cognitive control (Nigg, 2000). Although these findings are preliminary, they have an essential role in explaining the causes of the tendency for paranormal beliefs. Also, cognitive control weakness can be explained from different perspectives, such as neural, cultural, and cognitive. According to the neural perspective, inhibition control is one of the essential mechanisms in humans closely related to the DLPFC region (Hampshire et al., 2010). This region may be involved in reducing paranormal beliefs by expanding cognitive control abilities.

According to the cultural perspective, paranormal beliefs from a broad set of beliefs that can exist directly or indirectly in individuals (Narmashiri et al., 2019). Paranormal beliefs appear to stem from other factors, such as culture. Cultural factors may underlie such different findings. However, there may be a tendency for paranormal beliefs to come from each region's particular culture. These differences are rooted in childhood (Preece & Baxter, 2000). They are reduced by training but are related to inhibition that varies between individuals and age. According to the cognitive perspective, the results supported the idea that cognitive inhibition or related cognitive control mechanisms regulate conflicts between intuitive and analytic thinking by downplaying intuitive biases associated with paranormal beliefs.

Hood (2009) has proposed that paranormal beliefs may be latent and re-emerge when inhibition is compromised. Thus, effective regulation of intuitions has an essential role in disbelieving.

Study limitations

This study faced several limitations. Convenient sampling and selection of the sample from university students constituted one of the limitations of the present study. Further investigations with a larger population focusing on other variables related to cognitive inhibition are necessary. In addition, regarding the participation of women in this study, some studies have reported that performance in cognitive tasks associated with the prefrontal cortex might be affected by the levels of estrogen and progesterone hormones. Therefore, future studies are recommended to control the menstrual period of female participants.

5. Conclusion

The results showed that the paranormal believers had lower accuracy in go/no-go trials and slower reaction times than the skeptics group. Therefore, paranormal believers were weak in all go/no-go subscale scores. This finding suggests that paranormal beliefs may be related to poor cognitive control. The present study supports the association of paranormal beliefs with executive brain functions and suggests that frontal brain functions are likely to influence paranormal beliefs."

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Conceptualization, methodology, writing, review and editing: Abdolvahed Narmashiri, Javad Hatami and Reza Khosrowabadi; Software: Abdolvahed Narmashiri and Reza Khosrowabadi; Resources: Ahmad Sohrabi; Supervision: Ahmad Sohrabi, Reza Khosrowabadi and Javad Hatami.

Conflict of interest

The authors declared no conflict of interest.

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