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Review article

The relationship between fluid intelligence and sustained inattentional blindness in 7-to-14-year-old children

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ABSTRACT

Previous researches have shown that people with higher fluid intelligence are more likely to detect the unexpected stimuli. The current study systematically explored the relationship between fluid intelligence and sustained inattentional blindness in children. In Experiment 1, we measured one hundred and seventy-nine 7-to-14-year-old children's fluid intelligence and sustained inattentional blindness. The results showed that fluid intelligence was negatively related to sustained inattentional blindness only in 7-to-8-year-old children. In Experiment 2, we explored sustained inattentional blindness in sixty children with high Raven's scores. We found that compared with children who have average Raven's scores aged 11-to-12 years old, children with high Raven's scores were unable to better avoid sustained inattentional blindness. In general, this research implies that the relation between fluid intelligence and sustained inattentional blindness is weak. Fluid intelligence could predict sustained inattentional blindness only when children do not have enough perceptual capacities to complete the primary task.

1. Introduction

People usually fail to see a distinctive but unexpected object when they focus on some other things. This phenomenon is termed as inattentional blindness (IB) (Mack & Rock, 1998; Simons & Chabris, 1999). It is universally occurred and has been frequently cited as causal in human errors (Hannon & Richards, 2010). This pervasive aspect of visual perception has important implications for safety procedures, such as those about aircraft driving, traffic loading and medical treatment (Chabris, Weinberger, Fontaine, & Simons, 2011; Murphy & Greene, 2016; Hugheshallett et al., 2015). However, this phenomenon does not happen to every participant in a certain condition: some people will notice the unexpected stimulus whereas others will not. In other words, there are individual differences in the propensity to have IB.

Various studies have largely focused on investigating some individual characteristics which may associate with IB in recent years (e.g., Bredemeier & Simons, 2012; Grossman, Hoffman, Berger, & Zivotofsky, 2015; Hannon & Richards, 2010; Kreitz, Schnuerch, Gibbons, & Memmert, 2015; O'Shea & Fieo, 2014; Seegmiller, Watson, & Strayer, 2011; Zhang, Zhang, He, & Shi, 2016). These researches could be classified into two aspects. One aspect is to investigate which domain expertise may relate to IB (Drew, Võ, & Wolfe, 2013; Furley, Memmert, & Heller, 2010; Memmert, 2006) and the other aspect mainly focused on what general cognitive abilities are connected with IB (Hannon & Richards, 2010; Richards, Hannon, & Derakshan, 2010; Richards, Hellgren, & French, 2014; Bredemeier & Simons, 2012; Kreitz, Furley, Memmert, & Simons, 2015; Seegmiller et al., 2011; O'Shea & Fieo, 2014; Zhang et al., 2016).

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According to Lavie's Perceptual Load Model (1995), the processing level of task-irrelevant stimuli largely depends on the level of task perceptual load. The ability to deal with irrelevant stimuli is available only when the perceptual load of the task is insufficient to consume all available capacities. The results from the domain expertise convey the information that people who have the domain skills are less completely occupied in the perceptual load by the primary task and it is more possible for them to have the available capacities to process the irrelevant stimuli in the corresponding domain (Drew et al., 2013; Furley et al., 2010; Memmert, 2006). These cases supported the available capacity hypothesis. However, the result of the relationship between general cognitive abilities and IB is mixed.

The bulk of the researches on working memory and IB showed contrary results (e.g. Beanland & Chan, 2016; Bredemeier & Simons, 2012; Kreitz, Furley, Simons, & Memmert, 2016; Richards et al., 2010, 2014). The researches of participants within a large age span and without practice trials before the critical one, showed significant correlation between working memory and IB, while the studies with young participants having more than one practice trial before the critical one, indicated no significant relationship between them. It implies that the relationship between working memory and IB depends on the age range of the participants and the experimental paradigm. In other words, participants who have higher working memory capacity are more likely to detect unexpected events only in certain conditions.

It is now commonly accepted that working memory is positively related to fluid intelligence (Coloma, Rebolloa, Palaciosa, Juan-Espinosa, & Kyllonenb, 2004; Engle, Tuholski, Laughlin, & Conway, 1999; Kyllonen & Christal, 1990). Possessing high intelligence improves the likelihood of having a large working memory capacity. There were few studies on fluid intelligence and IB at present, but compared with the relationship between working memory and IB, the conclusions of the two studies were relatively consistent. O'Shea and Fieo (2014) investigated the relationship between fluid intelligence and IB in elder people. They found that a higher score on the Raven's Advanced Progressive Matrices Test was significantly associated with lower incidences of IB. A recent study, which compared IB rates between the children with high Raven's scores and mainstream ones, showed that the children who had greater general intelligence were more likely to detect the unexpected stimuli (Zhang et al., 2016). These results seem to indicate that higher fluid intelligence improves the likelihood of avoiding IB.

To the best of our knowledge, there are only two studies that have focused on the relationship between fluid intelligence and IB. O'Shea and Fieo's (2014) research is a preliminary study. They only employed 36 elder people. Therefore, the conclusion is rather limited. Even if Zhang et al., 2016 research employed more participants in children, they treated fluid intelligence score just as a standard of division (gifted or ungifted). The index of fluid intelligence score has not received systematic analysis, and only one age group was explored. Considering that age might be the impact factor for this relationship just like working memory and IB, we would like to test this relationship in different age groups in 7-to-14-year-old children. Moreover, since sustained IB paradigms are more realistic than static IB paradigms, we applied Motion Task, a classic sustained IB paradigm in the current study.

Fluid intelligence played a pivotal role in many cognitive abilities (Daneman & Carpenter, 1980). Series of researches show that people who have a higher fluid intelligence score can process information faster (Cheng et al., 2004; Kranzler, Whang, & Jensen, 1994; Zhang, Shi, Luo, Zhao, & Yang, 2006; Zou, Shi, Yun, & Fang, 2003) and focus attention more effectively (Cowan, Fristoe, Elliott, Brunner, & Saults, 2006; Johnson, Im-Bolter, & Pascual-Leone, 2003; Schweizer, Moosbrugger, & Goldhammer, 2005; Shi et al., 2013). If the hypothesis of available capacity is to be verified from the perspective of individual differences, then researchers should test whether people who have greater perceptual capacities are more likely to be aware of unexpected stimuli or not. What's more, if fluid intelligence can be used to reflect individual perceptual capacities, there may be a negative correlation between fluid intelligence and IB.

2. Experiment 1

Researches on the developmental studies of IB suggest that the rate of IB in children decreases with age in childhood (Memmert, 2006, 2014; Remington, Cartwright-Finch, & Lavie, 2014). The existing developmental studies have supported the hypothesis of available capacity, but the latest findings of the study of Motion Task to check the individual differences of adults' IB have shown that the individual differences of IB seems unstable (Kreitz, Furley et al., 2015). So, what is the outcome of the difference in the development of IB in children with Motion Task, and what is the relationship between IB and fluid intelligence in children of different ages? The problem will be tested in this experiment.

2.1. Methods

2.1.1. Participants

One hundred and seventy-nine children participated in the present study. They were recruited from two schools, one in Beijing and the other in Shenyang, China. Eight participants were deleted as whose accuracy of counting task in inattentional trial were less than two standard deviations of average value in their age group (7-to-8-year-old: 3; 9-to-10-year-old: 3; 11-to-12-year-old: 2). These participants did not focus well on the primary task according to their bad performance on the primary task and therefore, these data were invalid. One other participant was deleted due to the computer error. After exclusion of the nine participants, different age groups' information of the total valid 170 participants shows as below (Total participants, Male participants, mean age ± SD): 7-to-8-year-old (47, 23, 7.40 ± 0.54), 9-to-10-year-old (39, 18, 9.56 ± 0.60), 11-to-12-year-old (40, 23, 11.33 ± 0.47), 13-to-14-year-old (44, 21, 13.13 ± 0.62).

All the children had normal or corrected normal vision and they were all right-handed. All of them had no cognitive neurological disorders. All the children did not have any clinical or subclinical symptoms that might affect their performance, and they did not