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A working memory task reveals different patterns of impulsivity in male and female college students

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ABSTRACT

Impulsivity is an important personality trait that affects people's lives every day. Because of the complicated structures and various measurements of impulsivity, the conclusion that whether there were gender differences on impulsivity remained controversial. In our study, we used delay discounting and probability discounting to measure impulsive choice and employed stop signal reaction time task (SSRT) to measure impulsive action within the same subjects. No inherent gender differences were found, either on impulsive choice or on impulsive action. However, after adding a working memory (WM) task, we found an interaction between gender and WM: males made more impulsive choices in the delay discounting task, but females remained no change, and this only occurred when the reward amount was large; in the SSRT, the males showed better inhibitory control under the WM load condition, but females did not. These results demonstrate that gender difference does not exist on impulsivity biologically, but the increased working memory load could affect the gender's sense of delay gratification and the ability of inhibitory control differently. These findings can contribute to the studies of gender differences on impulsivity and draw attention to the need for further research that gender factors should be considered more carefully when exploring the effects of working memory.

1. Introduction

1.1. Impulsivity

Impulsivity, often refers to "actions that are poorly conceived, prematurely expressed, unduly risky, or inappropriate to the situation and that often result in undesirable outcomes" (Daruna and Barnes, 1993). Although there is no consensus on a single definition of impulsivity, normally, researchers consider impulsivity as a multi-dimensional construct, which includes impulsive choice and impulsive action (Dalley et al., 2011). The impulsive choice is generally defined as a preference for the smaller immediate reinforcement rather than the larger delayed reinforcement, and is typically assessed by the delay discounting task. Otherwise, risk-taking also has been considered as an important component of impulsive choice (Holt et al., 2003), and could be assessed by the probability discounting task in which subjects make choices between the smaller certain reinforcement and the larger probabilistic reinforcement (Green and Myerson, 2004; Logue, 1988). Impulsive action, refers to the ability to inhibit a response that has already been initiated, in other words, the ability to stop (Eagle et al., 2008), and is often assessed by the stop signal reaction time task (SSRT), continuous performance test (CPT), and the GO/NO GO task. More commission errors and longer stop signal reaction time are representative of greater impulsive action (Ohmura et al., 2012).

1.2. Gender and impulsivity

On the basis of the large amount studies on impulsivity, our first interest is in whether a gender difference in impulsivity exists. Since there are so many stereotypes and prejudices about women's ability for reasonable decision-making and motor control (Baron-Cohen, 2004), we feel it necessary to address the question cautiously and find solid experimental evidence to evaluate the truth. Hitherto, the answers from previous psychological research have been rather ambiguous. Studies by social scientists, which are conducted through questionnaires, suggest that males are more impulsive than females and give the reason that girls and boys are socialized differently in the patriarchal and gender-stratified social systems—males are more encouraged to be impulsive (Constance

Abbreviations: SSRT, stop signal reaction time; WM, working memory; SSD, stop signal delay.

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and Katherine, 2007). However, behavioral tasks and questionnaires probably measure different constructs, and possibly even unrelated components of impulsive behavior (Reynolds et al., 2006). Therefore, in our study, we focused our concern on the results of objective behavioral methods that are generally used by psychologists.

With regard to the impulsive choice related to delay gratification, the results have been somewhat inconsistent. Mischel and Underwood are considered the first to report that preschool girls were more willing than boys to wait for the larger rewards (Mischel and Underwood, 1974). A large online experiment (including 1019 subjects) examining gender differences in time preference also found that men were less patient than women and chose more the immediate reward, which showed more impulsiveness (Dittrich and Leipold, 2014). However, some research garnered contrary results which showed that the discounting rates of females were steeper than males (Beck and Triplett, 2009; Reynolds et al., 2006). In addition, some studies also support the idea that no gender difference exists in impulsivity (Logue and Anderson, 2001; Reynolds et al., 2003). Besides, although there are some research discussing the gender difference in risk-taking decisions (Harris et al., 2006; Hatfield-Eldred et al., 2015), few studies have been conducted by the probability discounting task.

As for the impulsive action, the results are likewise contradicted. There were some findings indicated that no gender differences were found on impulsive action (Fernie et al., 2010; Reynolds et al., 2006; Weafer et al., 2015) and other findings supported the idea that males were more difficult to withdraw the launched actions, both in the teenagers and the children (Liu et al., 2013; Saunders et al., 2008). Conversely, in similar SSRT tasks, there were results showed that females have longer stop signal reaction time or higher percentage of inhibition failures than males, which showed more impulsive action (Colzato et al., 2010; Crosbie et al., 2013; Morgan et al., 2011). However, one more thing should be pointed out about Colzato et al's study that only when women were in the follicular phase, the differences existed.

On the basis of our literature review, we conclude that several reasons could explain the inconsistencies: first, the subjects involved in the previous mentioned studies are varied from a wide range, and the sample differences might account for more than just gender differences. For example, the study conducted by Liu et al. (2013) was among a very young age group (4.5–5.5 years old), and the subjects in the Morgan et al. (2011) was among adults (21.16 ± 2.42 years old). Considering the reason that the participants' ages were related closely to their impulsiveness (Liu et al., 2016; Myerson et al., 2001), it makes sense that the researchers achieved two different results while using the similar tasks. In addition, the gender differences were not always the objective of the researchers' primary design, but were used to compare performance of males and females in specific sample groups, such as alcohol users (Fernie et al., 2010), smokers (Reynolds et al., 2007) or ADHD patients (Crosbie et al., 2013). Because the impulsive response patterns of substance abusers or ADHD patient are quite different form the healthy ones, so the generalization of the conclusions in the particular samples to the general population are in question. Another explanation for the reported conflicting results might be that the construct of impulsivity is multi-dimensional, and its measurement methods are varied; therefore, a more careful investigation is required to obtain a reliable, accurate and unified conclusion.

To our knowledge, no specifically designed study to comprehensively examine gender differences in behavioral impulsivity, especially in young college students, has been performed.

1.3. Working memory and impulsivity

Our second interest is in the relationship between working memory (WM) and impulsivity. Of all the cognitive factors that may be involved in decision-making, WM load has drawn the most attention. WM refers to the cognitive process that maintains and processes information concurrently (Baddeley, 2012). There are proposals which posit that decreased WM capacity can prevent the subjects from making the best choices (Arce and Sanisteban, 2006; Hinson et al., 2003; Jameson et al., 2004). In addition, it has also been suggested that through WM training, it is possible to decrease the delay discounting rate of the substance abusers (Bickel et al., 2011). Alternative results showed that no increased impulsivity was found in the similar experiment (Franco-Watkins et al., 2006). These varied results may be a result of the differing working memory loads used in experiments, and most studies ignored the gender variables (Franco-Watkins et al., 2006; Hinson et al., 2003).

Few studies concentrate on whether males and females respond in the same pattern to the working memory load when they are performing the impulsive-related tasks. Research that used the stoplight task to assess the subjects' risk-taking tendency (this task was a simulation of crossing the road, but the lasting time for yellow/green light varied with a probability), found an interaction between WM and gender, with males being more impulsive in WM load conditions, and females not changing their decision-making patterns under WM load (Hatfield-Eldred et al., 2015).

Hence, we have two goals to achieve in this study: first, to assess whether there are gender differences on impulsivity within the group of college students; second, to investigate how working memory load would influence the impulsivity of males and females, both in the aspects of impulsive choice and impulsive action.

2. Method

2.1. Subjects

The subjects were recruited from universities in China. All the subjects were right-handed and used their right hand to respond. Before starting the experiment, all subjects completed a short questionnaire, in which inquired their demographic information and their gender identity. None of the subjects reported any mental diseases, drug dependence, history of psychiatric illness, brain injury, or gender identity confusion. The subjects were compensated with CNY 30 after finishing the whole experiment. All the subjects provided their informed consent. All the data were analyzed using SPSS 21 software.

2.2. Procedures

2.2.1. Delay discounting

A personal computer was used to present stimuli to the subjects and record their responses. The subjects were tested individually on the discounting tasks and were told to choose between two hypothetical monetary amounts; one was the immediate small amount and the alternative was delayed large amount. Meanwhile, the subjects were instructed to treat the decisions as if they were real-life choices and to feel no restraints in making them.

The procedure was adopted from Holt (Holt et al., 2003), and there were three kinds of large delayed amount: CNY100; CNY1000; and CNY50000. Each subject was shown with seven delays presented in the following ascending or descending order: 1 week, 1 month, 3 months, 6 months, 1 year, 3 years, and 10 years. For each amount condition of the delay discounting task, subjects made six choices at each of the seven delays. The initial small immediate reward was always half of the delayed amount