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The effect and mechanisms of implementation intention in improving prospective memory performance in schizophrenia patients

Xing-Jie Chen [a,b], Lu-Lu Liu [a,c], Ji-Fang Cui [d], Ming-Yuan Gan [e], Chun-Qiu Li [e], David L. Neumann [f], David H.K. Shum [f], Ya Wang [a,*], Raymond C.K. Chan [a]

[a] Neuropsychology and Applied Cognitive Neuroscience Laboratory, Key Laboratory of Mental Health, Institute of Psychology, Chinese Academy of Sciences, Beijing, China
[b] Department of Psychological and Brain Sciences, University of Massachusetts Amherst, Amherst, MA, USA
[c] University of Chinese Academy of Sciences, Beijing, China
[d] Information Center, National Institute of Education Sciences, Beijing, China
[e] Beijing Huilongguan Hospital, Beijing, China
[f] Menzies Health Institute Queensland and School of Applied Psychology, Griffith University, Gold Coast, Australia

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ABSTRACT

People with schizophrenia (SCZ) have been shown to have prospective memory (PM) deficits. PM refers to the ability to remember to perform delayed intentions in the future and plays an important role in everyday independent functioning in SCZ. To date, few studies have investigated methods to improve PM in SCZ. This study aimed to examine whether implementation intention can improve PM performance and to explore its underlying mechanisms. Fifty people with SCZ and 50 demographically matched healthy controls (HC) participated in this study. Participants were randomly assigned to an implementation intention condition or a control instruction condition. Participants were required to make PM responses when PM cue words appeared while they were undertaking an ongoing task with two levels of cognitive load (1-back or 2-back). Results showed that people with SCZ were impaired in PM, and implementation intention improved PM performances for both SCZ and HC. Implementation intention improved PM performance in SCZ in both the low and the high cognitive load conditions without ongoing task cost, suggesting that implementation intention improved PM remembering in an automatic way. These results indicate that implementation intention may be a beneficial technique for improving PM performances in people with SCZ.

1. Introduction

Schizophrenia (SCZ) is a mental illness associated with significant neurocognitive dysfunctions (Heinrichs and Zakzanis, 1998; Roitman et al., 2000), and memory deficit is one of the core impairments (Loughland et al., 2007; Saykin et al., 1994; Weiss and Heckers, 2001). Substantial evidence has been accumulated to suggest that people with SCZ suffer from severe prospective memory (PM) impairments (e.g., Ordemann et al., 2014; Shum et al., 2004; Wang et al., 2008a, 2008b, 2009).

PM refers to forming an intention and then carrying it out after a delay without external reminders (Einstein and McDaniel, 1990). It plays an important role in people's daily life, such as keeping an appointment, or taking medicine on time. The PM intention needs to be realized at a particular time (time-based PM), when an event appears (event-based PM), or when an activity is completed (activity-based PM) (Einstein and McDaniel, 1990; Kvavilashvili and Ellis, 1996). Impaired PM has been shown to significantly affect quality of daily life (Doyle et al., 2012). Studies have shown that people tend to experience more PM failures than retrospective memory (RM) failures (Crovitz and Daniel, 1984; Terry, 1988).

PM ability has been shown to be related to medication adherence and social functioning in SCZ (Lam et al., 2013; Twamley et al., 2008; Zogg et al., 2012). In addition, previous studies have suggested that the PM deficits in people with SCZ may be related to several processes including slow recognition of cues (Kondel, 2002), inefficient high-level encoding of cues, intentions and the links between them (Twamley et al., 2008), and difficulties in intention encoding and shifting attention between the ongoing and PM tasks (Chen et al., 2016).

Implementation intention is a technique originally proposed by Gollwitzer (1993,1996, 1999) to help people to achieve their goals. A meta-analysis showed that implementation intention had a positive effect on people's goal attainment (Gollwitzer and

* Corresponding author.
E-mail address: wangyazsu@gmail.com (Y. Wang).

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Sheeran, 2006). This is also true for people with mental health problems as revealed by a meta-analysis (Toli et al., 2015). More recently, implementation intention has been used as a technique to improve PM performance (e.g., Chasteen et al., 2001; Liu and Park, 2004). Implementation intention is an encoding strategy in the form of "if situation Y is encountered, then I will initiate the goal-directed behavior X" (Gollwitzer, 1999; Gollwitzer and Sheeran, 2006). It contains an "if" part and a "then" part. In a typical PM experiment, participants are engaged in an ongoing task during which PM cues appear. When the PM cues appear, participants need to make PM responses. During a PM task, the "if" part of implementation intention specifies the situation that PM cues appear and when a response is needed. The "then" part identifies the exact response to realize the PM intention. Implementation intention is believed to facilitate the detection of critical cues and the initiation of actions, and it affects both attention and memory processes (Wieber et al., 2015). All these cognitive processes are necessary to PM processing. A number of studies have shown that implementation intention could improve PM performances effectively in various populations, including healthy participants (Chen et al., 2015) and some clinical and sub-clinical populations with PM deficits (Chen et al., 2014; Grilli and McFarland, 2011; Kardiasmenos et al., 2008; Khoyratty et al., 2015; Kretschmer et al., 2014).

The underlying mechanisms of how implementation intention improves PM performance are not clearly understood. To date, three possible mechanisms have been proposed. First, McDaniel et al. (2008) suggested that implementation intention creates a strong link between the PM cues and intentions, and reduces the reliance on cognitive resources in prospective remembering. Therefore, compared with the control PM instruction, implementation intention improves PM performance, but does not reduce ongoing task performance (Breneiser, 2009; Brewer et al., 2011; McDaniel et al., 2008; McFarland and Glisky, 2012). According to this explanation, implementation intention is an automatic process. Second, it has been suggested that implementation intention causes participants to perceive PM tasks as more important (Meeks and Marsh, 2010) such that more cognitive resources are allocated to PM tasks by reducing cognitive resources for the ongoing task (Brewer and Marsh, 2010; Meeks and Marsh, 2010; Smith et al., 2014). According to the explanation, implementation intention is a controlled process. The third proposed mechanism suggests that implementation intention encoding does not automatize PM responses but contains both automatic and controlled processes (McDaniel and Scullin, 2010). Implementation intention can cause people to spontaneously recall the intentions when PM cues appear, but cognitive resources are needed to switch attention from ongoing task to PM task.

To date, there were only a few studies applied implementation intention in SCZ. For example, Brandstätter et al. (2001) suggested that implementation intention can help schizophrenia patients with action initiation. Sailer et al. (2015) showed that implementation intention can help inpatients with schizophrenia to achieve the goal of doing physical exercise. These results indicated that implementation intention may benefit SCZ's cognitive function and goal achievement. Although no study has investigated the effect and mechanisms of implementation intention on PM in people with SCZ directly, implementation intention has been shown to benefit PM performance in some other clinical populations, including early psychosis (Khoyratty et al., 2015), multiple sclerosis (Kardiasmenos et al., 2008), brain injury (Grilli and McFarland, 2011), and autism spectrum disorders (Kretschmer et al., 2014). Khoyratty et al. (2015) recently found that implementation intention improved PM performance in people with early psychosis by making PM responses more automatic (without ongoing task cost). Moreover, Chen et al. (2014) found that implementation intention improved PM performance in individuals with schizotypal personality features. More importantly, they found that implementation intention improved PM performance without ongoing task cost in low ongoing task cognitive load conditions, and with ongoing task cost in high ongoing task cognitive load conditions. These findings suggest that implementation intention may change cognitive resources allocation. In other words, in the high ongoing task cognitive load conditions, schizotypal participants paid more attention to PM tasks while reducing the cognitive resources allocated to the ongoing task (Chen et al., 2014). Based on these findings, implementation intention may help SCZ to improve their PM performances.

In the present study, we aimed to explore the effect and mechanisms of implementation intention on PM in people with SCZ. We manipulated the cognitive load of the ongoing task as in our previous study (Chen et al., 2014). We hypothesized that the PM performance of individuals with SCZ would benefit from implementation intention. We further hypothesized that implementation intention would work differently in individuals with SCZ and HC. Previous studies suggested that people with PM impairment such as individuals with early psychosis and older adults, implementation intention can improve their PM performance without ongoing task cost (Khoyratty et al., 2015; Zimmermann and Meier, 2010). Therefore, for individuals with SCZ, we hypothesized that implementation intention would work in an automatic way (similar to people with PM impairment like early psychosis and older adults). For HC, we hypothesized that implementation intention would improve PM performance in the low ongoing task cognitive load condition automatically but would not improve PM performance in the high ongoing task cognitive load condition based on the results of HC in a previous study (Chen et al., 2014).

2. Method

2.1. Participants

Fifty individuals with SCZ were recruited from the Beijing Huilonguan Hospital. All patients met diagnostic criteria for SCZ according to the Diagnostic and Statistical Manual of Mental Disorders 4th Edition (American Psychiatric Association, 1994), ascertained using the Structured Clinical Interview for DSM-IV (First et al., 1995). Participants were excluded if they had a history of neurological disorders, alcohol/drug dependence, or had received electroconvulsive therapy in the past three months. Clinical symptoms were rated by trained psychiatrists with the Positive and Negative Syndrome Scale (PANSS, Kay et al., 1987). All patients were treated with second generation antipsychotics (e.g., risperidone, quetiapine, aripiprazole). The Abnormal Involuntary Movements Scale (AIMS, Smith et al., 1979) and the Barnes Akathisia Rating Scale (BARS, Barnes, 1989) were used to evaluate medication side effects. Fifty demographically matched (age, gender, and education) HC were recruited from communities in Beijing. All HC did not have a personal or family history of psychiatric illness, neurological disorder, or alcohol/drug dependence.

All participants in the study were right-handed. Their IQs were estimated using the four-subtest short form (information, arithmetic, similarity, and digit span) of the Chinese version of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Gong, 1992). The IQ of SCZ group was significantly lower than that of the HC group ($t=3.53$, $p<0.001$). IQ was not correlated with PM performance and was matched between implementation intention group and control instruction group, thus IQ was not controlled in further analyses. Both SCZ participants and controls were randomly assigned to the implementation intention condition and the