Psychiatry Research 268 (2018) 288–296

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

A direct examination of the cognitive underpinnings of multitasking abilities: A first study examining schizophrenia

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ARTICLE INFO

Keywords:
Executive function
Psychosis
Multi-tasking
Ecological validity
Real world functioning
Neurocognition

ABSTRACT

Many real world activities are complex and require multitasking abilities. However, the nature of these abilities remains poorly understood, and in particular in schizophrenia. The aim of the present study was to provide a better understanding of such abilities with the help of a newly developed computerized tool, the Computerized Meeting Preparation Task (CMPT). Fifty-seven individuals with schizophrenia and 39 healthy controls completed the CMPT and an extensive cognitive battery. Patients were also evaluated with a series of clinical measures. During the CMPT, participants are asked to prepare a room for a meeting while, at the same time, dealing with interruptions, solving problems, and remembering prospective memory instructions. The CMPT was found to significantly differentiate patients and healthy controls for several variables. Results also showed that multitasking abilities were related to a large array of cognitive functions and, in particular, to those associated to executive functioning. These relations were not explained by the presence of a general cognitive impairment. Finally, a double dissociation between multitasking abilities and performance on standard cognitive tests was observed. Altogether, these results underline the importance of evaluating multitasking abilities in schizophrenia as it allows detecting cognitive difficulties that cannot be identified by standard cognitive tests.

1. Introduction

Many real world activities are of a multitasking nature that is, they involve different and integrated cognitive processes and take place in an unstructured context. To date, previous studies demonstrated that multitasking abilities are essential for real world functioning (Bulzacka et al., 2016; Laloyaux et al., 2014; Shallice and Burgess, 1991). However, due to an absence of suitable assessment tools, these abilities have been largely unexplored in the literature. As a consequence, many issues remain unexplored such as the cognitive underpinnings of multitasking abilities.

According to Burgess (2000), multitasking activities are characterized by eight main features: (1) many tasks have to be completed; (2) the realization of the tasks require interleaving; (3) due to cognitive or physical constraints, only one task can be performed at a time – for this reason, everyday life multitasking activities are different from the dual task paradigm in which participants are instructed to perform two tasks at the same time; (4) unforeseen interruptions/unexpected outcomes can occur; (5) the realization of the different tasks requires delayed intention (prospective memory); (6) the different tasks vary in terms of priority, difficulty, and duration; (7) the targets of the tasks are defined by the person; (8) and there is no minute-by-minute performance feedback during the tasks. Standard cognitive tests, however, do not possess these characteristics as they are designed to assess one cognitive function in a well-structured and controlled environment (e.g., office setting). Moreover, there is evidence of a double dissociation between standard cognitive measures and multitasking abilities – at least in brain-injured patients (Burgess et al., 2009). That is, patients may present impaired multitasking abilities, yet preserved performances on standard cognitive tests and vice versa. Such results suggest that brain processes underpinning multitasking abilities are independent from those supporting standard cognitive tests (Burgess et al., 2009).

Multitasking abilities are particularly relevant for many clinical populations and especially for patients with schizophrenia as they

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https://doi.org/10.1016/j.psychres.2018.06.060
Received 12 December 2017; Received in revised form 14 May 2018; Accepted 27 June 2018
Available online 26 July 2018
0165-1781/

encounter many difficulties in real world functioning (American Psychiatric Association, 2013). To date, no previous studies have directly examined multitasking abilities using a task that reflects all the characteristics of multitasking activities in psychiatric populations, including in schizophrenia.

Nevertheless, a previous study (Semkovska et al., 2004) suggested (albeit indirectly) that patients encounter difficulties of a multitasking nature. Semkovska et al. (2004) compared the performance of patients with healthy controls during three observation-based real world tasks: (1) choosing a three-course menu, (2) shopping for the missing ingredients, and (3) cooking a meal. Results showed that, for each of the three tasks, patients performed worse than controls, especially for the cooking task, which possessed a number of multitasking characteristics. In the patient group, performance on the cooking task was found to be related to executive functions, episodic memory, and selective attention. However, only a limited number of cognitive functions in relation to multitasking abilities were explored. Also, the study did not examine if broader cognitive functions such as processing speed and working memory have an influence on multitasking abilities. Indeed, in schizophrenia, these broader cognitive functions have been found to be two major deficits that can have an important influence on other, more specific cognitive functions (Dickinson et al., 2008; Silver et al., 2003). Finally, several authors (Larøi and Van der Linden, 2013; Raffard and Bayard, 2012) claim that schizophrenia is highly heterogeneous in terms of cognitive impairments. However, this heterogeneity has never been examined in regard to multitasking abilities by, for example, identifying different profiles.

Evaluating patients' performance on real world activities has the advantage of high ecological validity. However, observation-based assessments (such as those used in Semkovska et al., 2004) lack standardization as the testing environment may vary from one place to another. Moreover, a series of variables that may affect the performance (e.g., the amount of noise) cannot be controlled. Furthermore, only a limited number of variables can be measured as there are constraints as to how much the observer can note, and it is difficult to obtain precise measures. Finally, measures based on real world activities (e.g., cooking a meal) will also be influenced by participants' previous experiences. That is, a person who is familiar with the evaluated activity will rely less upon his/her executive functions compared to someone who is less familiar with the task, which complicates the interpretation of the results. There is thus a need for standardized tools that are accessible in a clinical setting and that are closely related to real world activities – but that at the same time place participants in an unfamiliar situation.

Recently, Laloyaux et al. (2014) developed a pilot version of a computerized task that takes into account certain characteristics of multitasking activities and places participants in an unfamiliar situation. In this task – the Computerized Meeting Preparation Task (CMPT) – participants are required to prepare a room for a meeting for 5 guests with the help of a list of instructions (e.g., containing the names of the guests, the required objects and participants' desired drinks). Results revealed that patients diagnosed with schizophrenia demonstrated significantly poorer performance on several variables compared to healthy controls (i.e., total time to complete the task, planning score, and respect of the rules). Moreover, CMPT performance was significantly correlated with planning abilities, cognitive flexibility, and real world functioning. Finally, performance on the CMPT significantly predicted up to 50% of real world functioning, whereas the prediction from the standard cognitive measures did not reach significance. However, this pilot version of the CMPT lacked some important characteristics of multitasking activities: it did not include interruptions/unexpected outcomes and prospective memory instructions were not incorporated. Moreover, this study was conducted with a small sample of patients and only explored a limited number of cognitive functions in relation to multitasking abilities. Finally, the authors did not take into account the heterogeneous nature of schizophrenia by, for example, identifying different profiles.

The general objective of the present study was to directly explore the specificity and heterogeneity of multitasking abilities in regards to a large array of other cognitive functions in schizophrenia. In particular, one aim was to explore the cognitive underpinnings of multitasking abilities with the help of an extensive cognitive battery measuring functions that have never been directly explored in previous studies (i.e., source flexibility and time-based and event-based prospective memory). A second aim was to investigate if a double dissociation between standard cognitive measures and multitasking abilities could be observed in schizophrenia. A final objective was to explore the relations between multitasking abilities, symptoms, and real world functioning.

In order to meet these objectives, an improved version of an existing pilot computerized multitasking task (Laloyaux et al., 2014) was developed. The aim was to create a new task that takes into account all the characteristics of multitasking activities (Burgess, 2000) and that overcomes the above-mentioned limitations of existing tools. Indeed, there are several advantages with computerized tasks as they can efficiently place participants in complex, standardized, and unfamiliar situations. Additionally, a large array of variables can be reliably measured in a precise manner.

2. Methods

2.1. Participants

Fifty-seven persons diagnosed with schizophrenia according to DSM-IV (American Psychiatric Association, 1994) criteria were included in the study. Diagnosis was confirmed by the Mini International Neuropsychiatric Interview (Sheehan et al., 1998). Exclusion criteria were: the presence of a current or past neurological diagnosis and/or of other current psychiatric disorders including alcohol or drug dependency [measured with the Alcohol Use Disorders Identification Test (Saunders et al., 1993); and the Drug Use Disorders Identification Test (Berman et al., 2005)], lack of clinical stability, mental retardation (French National Adult Reading Test, fNART; Mackinnon and Mulligan, 2005; Nelson and O'Connell, 1978), absence of familiarity with computers, and major change of medication within one month before testing. Patients' medication dosages were converted into three indexes according to data from the literature (Boily and Mallet, 2008; Gardner et al., 2010; Taylor et al., 2009): benzodiazepine (diazepam equivalence in mg), antipsychotic (olanzapine equivalence in mg), and risk for anticholinergic side effects.

Thirty-nine healthy controls were selected based on their similarities with the patients in terms of sex, age, estimated premorbid IQ (fNART), and number of years of education. Exclusion criteria were the presence of any psychiatric and/or neurological disorder, the absence of familiarity with computers, and having a first-degree relative with schizophrenia. Both samples (patients and healthy controls) were different from those included in Laloyaux et al. (2014).

Familiarity with video games and computers was assessed with a questionnaire created by the authors. The questionnaire is composed of 6 questions asking participants to indicate the last time they used a computer or played with video games, the frequency of using a computer and playing with video games, their level of comfort with the utilization of a computer mouse and finding their way in a virtual environment while playing with video games. Each item was rated on a 4-point Likert scale. A total score of 0 was considered as an exclusion criterion.

All participants provided written informed consent and the project was approved by the local ethics committee. Based on independent Student's *t*-tests (Table 1), there were no significant differences between the two groups for age, education, or cannabis consumption. However, patients were significantly less familiar than controls regarding their degree of familiarity with video games and computers and estimated IQ. Nonetheless, the mean estimated IQ difference was only 4 points, which cannot be considered a clinically relevant difference. Finally,