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Effectiveness of fast mapping to promote learning in schizophrenia

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ABSTRACT

Fast mapping (FM), a process that promotes the expeditious incidental learning of information, is thought to support rapid vocabulary acquisition in young children through extra-medial temporal lobe (MTL) regions. A recent study suggested that patients with MTL damage resulting in profound amnesia were able to learn novel word–image associations using an FM paradigm. The present study investigated whether FM would be an effective strategy to promote learning for individuals with schizophrenia, a severe mental illness associated with compromised MTL functionality. Twenty-five patients with schizophrenia and 27 healthy control subjects completed trials of incidental FM encoding (experimental condition) and explicit encoding (EE, control condition) over the course of three visits spaced one week (±2 days) apart. All participants were evaluated for recognition 10 min after each encoding condition was presented, and again one week (±2 days) later. Results indicate that both groups performed better on the EE recognition trials when compared to FM (p's < 0.05). For the FM recognition trials, both groups performed similarly. However, participants with schizophrenia performed significantly worse on the EE recognition trials than healthy control participants (p's < 0.05). While participants with schizophrenia did not perform significantly worse when assessed for FM recognition, these results do not provide enough evidence to suggest that FM facilitates learning to a greater extent in schizophrenia when compared to EE. Whether FM may benefit a subgroup of patients with schizophrenia remains a focus of further investigation.

1. Introduction

Hippocampal abnormalities are involved in the pathophysiology of schizophrenia, as evident from postmortem and in vivo neuroimaging research studies (Baaré et al. 2001; Csernansky et al., 2002; Goldman et al., 2008; Harrison 2004; Heckers and Konradi 2014; Karnik-Henry et al., 2012; Ongur et al. 2006; Rowland et al. 2010). Compromised hippocampal function contributes to learning and memory deficits commonly observed with this illness, as well as compromised performance on hippocampal-dependent behavioral tasks translated from rodent paradigms (Hanlon et al., 2006; Spieker et al., 2012; Spieker et al., 2013; Titone et al., 2004). Strategies to improve memory function in schizophrenia are of clinical significance, as poor memory function is associated with poorer functional outcomes (Sheffield et al., 2014). One strategy that has shown promise in patients with hippocampal amnesia is fast mapping.

Fast mapping (FM) paradigms were first utilized in the late 1970's by researchers seeking to determine whether young children could formulate lexical representations after limited exposure to novel words (Carey 2010). In research conducted by Carey and Bartlett (1978), an FM paradigm was used to see if the word "chromium" could be added to the vocabulary of children incidentally. Children who participated were asked to hand the researcher a "chromium" tray (the tray was olive green in hue) in a conversational context. The hope was that children would learn that the term "chromium" described the color of the tray. Over half of the children in this study displayed evidence that this term had been added to their lexicon when assessed one week later (Carey 2010). In the context of the current study, FM refers to a method of incidental, exclusion-based learning of a novel word–image pair. A word and two images were shown and based on prior knowledge, participants had to deduce that novel words referred to images they were also unfamiliar with.

FM paradigms have been used to examine whether acquisition of novel word–image pairs can be facilitated for amnesiac patients with hippocampal damage, as FM is thought to be dependent on extra-hippocampal neural structures. Thus far, conflicting results have been reported (Sharon et al., 2011; Smith et al., 2014). In a study by Sharon et al. (2011), four amnesiac patients performed better than chance

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level on the FM task and retained novel word–image associations when assessed for recognition one week later. In contrast, performance level was less than chance when using an explicit encoding (EE) strategy. "New learning" demonstrated by these patients with hippocampal amnesia constituted the first report in amnesia literature of patients rapidly acquiring novel word–image associations using an FM paradigm (Smith et al., 2014).

The goal of this study was to investigate whether FM could be a beneficial learning strategy for individuals with schizophrenia. To our knowledge, this is the first study to investigate the effectiveness of FM in this population as a means of facilitating acquisition of novel word–image pairs. We hypothesized that FM would facilitate learning more effectively than an EE paradigm for the schizophrenia group, but not for the healthy control group.

2. Methods

2.1. Participants

A total of fifty-two participants completed this study. 25 were participants with schizophrenia (16 male, 9 female; mean age = 37.64, age range = 18–58), and twenty-seven were healthy control participants (15 male, 12 female; mean age = 33.59, age range = 18–59). See Table 1 for participant characteristics. All study procedures were approved by the Institutional Review Board (IRB) at the University of Maryland, Baltimore. Participants in the schizophrenia group were evaluated for comprehension of consent documents, and all participants gave written informed consent before study procedures were implemented. Participants were monetarily compensated for their time.

Inclusion/exclusion criteria for the schizophrenia group were as follows: (1) age range between 18 and 60 years, (2) a DSM-IV diagnosis of schizophrenia or schizoaffective disorder, (3) competency to sign an informed consent document, (4) no current substance abuse or dependence, (5) not currently pregnant or nursing, (6) No major medical illness or medication that affects brain structure other than that for schizophrenia. Inclusion/exclusion criteria for the psychiatric control group were as follows: (1) age range between 18 and 60 years, (2) no DSM-IV Axis I disorder as determined by the Structural Clinical Interview for DSM-IV Patient Version (First et al., 2002), (3) no current substance abuse or dependence, (4) not pregnant or nursing, (5) no major medical illness or medication that affects brain structure.

Table 1
Subject demographic characteristics.

	Schizophrenia (n = 25)	Controls (n = 27)
Age (years)	38.76 ± 13.01	33.59 ± 14.91
Gender:		
Male	16	15
Female	9	12
Education (years)	12.68 ± 2.06	14.15 ± 1.75
Race:		
Caucasian	14	13
African American	11	12
Asian	0	1
Biracial	0	0
Hispanic/Latino	0	0
MCCB Overall T-Score	32.24 ± 11.68	43.22 ± 10.66
BVMT Raw	18.04 ± 7.79	22.78 ± 6.25
HVLT Raw	20.84 ± 6.33	25.63 ± 5.62
UPSA-2 (Total)	89.36 ± 15.63	102.85 ± 7.66
Psychiatric Ratings:		
BPRS (total)	38.36 ± 9.66	–
BPRS (positive)	8.24 ± 4.64	–
BPRS (negative)	6.8 ± 2.47	–
BNSS	16.68 ± 10.20	–

MCCB: MATRICS Consensus Cognitive Battery; BVMT used to assess short-term visuospatial memory and HVLT used to assess immediate verbal memory.

2.2. Fast mapping and explicit encoding

Over the course of three visits, each spaced one week (± 2 days) apart, all participants completed computerized tasks of FM and EE. During visit 1, all participants completed a practice FM exercise to become familiar with testing procedures. During the self-paced 10-item practice, two images were displayed on the screen at a time. At the bottom of each screen, a question was presented that pertained to the pair of visual stimuli. Participants were required to select their answer choice using the computer keyboard, and feedback was provided after each response.

After the practice session, self-paced FM encoding began. Forty-eight pairs of images were presented. Just as they had during the practice, participants answered questions pertaining to each pair of visual stimuli. Each novel target stimulus was presented two times during the trial, with different accompanying known stimulus. After a 10 min break, FM target categorization accuracy and recognition accuracy were assessed. Participants were first asked to categorize names of target stimuli from the encoding trials by selecting from mammal, fish, flower, or fruit category answer choices. To assess novel target recognition, participants were then shown three images at a time, surrounding the name of a target novel stimulus in the center of the screen. They were asked to point to or tell the tester which image they felt was the best match. Participants then rated their level of confidence in each recognition response from 1 to 5, where 5 indicated the highest level of confidence.

FM target categorization accuracy and recognition accuracy were assessed for a second time one week (± 2 days) later, at the beginning of visit 2. The delayed recognition assessment was formatted identically to the short-term, 10 min delay one. Upon completion of the memory assessment, participants began the control EE task. For EE, participants were instructed to remember the name of each item they were shown. Forty-eight images in total were shown to participants, and each novel target image–word association was shown twice in a randomized order. Mirroring the FM paradigm, there were 10 min and 1 week (± 2 days) delayed recognition assessments for this condition. Visit 3 comprised of the 1 week delay recognition assessment for target stimuli in the EE task, and completion of all remaining study procedures. See Fig. 1 for task illustrations.

2.3. Neuropsychological and cognitive testing

Neuropsychological assessments of memory and functional capacity were conducted for all subjects. The MATRICS Consensus Cognitive Battery (MCCB) was used to provide a measure of general cognitive function for participant characterization (Green et al., 2004; Kern et al., 2008; Nuechterlein et al., 2008). MCCB sub-tests targeting verbal learning (Hopkins Verbal Learning Test) and visual learning (Brief Visuospatial Memory Test) were of particular interest for comparison to the FM and EE memory tasks. The UCSD Performance-Based Skills Assessment (UPSA-2) was used to measure functional capacity of all participants across five domains: organization/planning, financial skills, communication skills, transportation, and household skills (Green et al., 2011). UPSA-2 is a validated tool created to assess community functional capacity in schizophrenia patients (Green et al., 2011).

2.4. Symptom ratings

Participants in the schizophrenia group were evaluated for positive and negative symptom severity with the Brief Psychiatric Rating Scale (Kopelowicz et al., 2008) and the Brief Negative Symptom Scale (Strauss et al., 2012).