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Allocating effort and anticipating pleasure in schizophrenia: Relationship with real world functioning

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ABSTRACT

Background: Poor motivation to engage in goal-oriented behavior has been recognized as a hallmark feature of schizophrenia spectrum disorders (SZ). Low drive in SZ may be related to anticipating rewards as well as to poor working memory. However, few studies to date have examined beliefs about self-efficacy and satisfaction for future rewards (anticipatory pleasure). Additionally, few studies to date have examined how these deficits may impact SZ patients' real world functioning.
Method: The present study examined SZ patients' ($n = 57$) anticipatory pleasure, working memory, self-efficacy and real world functioning in relation to their negative symptom severity.
Results: Results revealed that SZ patients' negative symptom severity was related to decisions in effort allocation and reward probability, working memory deficits, self-efficacy and anticipatory pleasure for future reward. Effort allocation deficits also predicted patients' daily functioning skills.
Conclusions: SZ patients with high levels of negative symptoms are not merely effort averse, but have more difficulty effectively allocating effort and anticipating pleasure engaging in effortful activities. It may be the case that continuously failing to achieve reinforcement from engagement and participation may lead SZ patients to form certain negative beliefs about their abilities which contributes to amotivation and cognitive deficits. Lastly, our findings provide further support for a link between SZ patients functional daily living skills their effort allocation.

1. Introduction

Avolition, a decrease in motivated behavior, is one of the most adverse symptoms that individuals with schizophrenia (SZ) experience [1,2]. It begins to impact functioning in the early stages of the illness [1] and significantly affects individuals' involvement in treatment [3,4]. Further, avolition disrupts individuals with SZ ability to function independently, inhibiting pursuit of career goals, socialization and establishment of long-term relationships [2,5,6]. Additionally, motivational difficulties do not typically improve with antipsychotic medications and the side effects of these medications can further reduce drive [7–9]. Lastly, individuals with SZ recognize low motivation as significantly more difficult to tolerate compared with other negative symptoms [10].

The psychological processes underlying avolition are complex [11,12]. It was long suspected that SZ deficits in motivated behavior resulted from a decreased sensitivity to experience pleasure from rewards in the environment [2]. It has been found, however, that SZ patients, even patients with high levels of avolition, have an intact experience of pleasure [13]. Given that SZ patients experience intact reward sensitivity, focus has shifted to examining SZ impairments in anticipating patients' ability to utilize cognitive and affective information (e.g., value of a future reward; probability of attaining a goal or reward) when making choice decisions about exerting effort for a future goal or reward [13].

In terms of reward value, SZ patients may experience an impairment in converting normal hedonic experiences in the moment into motivated behavior because they may experience difficulty in anticipating the value of a reward when making choice decisions [11]. Past behavioral and neuroimaging studies examining reinforcement learning in SZ have found that SZ patients with high negative symptoms are impaired at increasing effortful responses after positive reinforcement, but are able to learn to reduce effort after experiencing aversive consequences [2]. Consequently, avolition may in part be due to learning to reduce effort

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effectively in the absence reward and deficits in learning to increase motivation in response to prior reinforcement [2,14]. Supporting this notion, numerous past studies have found SZ patients have impairments in linking reward value to different stimuli and response alternatives [11,14,15].

Avolition may also be caused by a calculation that the required effort needed to obtain a future reward outweighs the anticipated benefit. Consistent with this hypothesis, previous studies have found deficits in SZ patients' allocation of effort for monetary rewards [16,17] with a greater impairment in patients with high negative symptoms [17] or apathy [16]. Examining both value and effort, Gold et al. [17] contrasted SZ patients with high and low levels of negative symptoms using an effort-cost decision-making computer task. In this task, participants were given the opportunity to exert effort (i.e., button pressing) for low and high value rewards. Patients could either choose the low effort choice for $1, or the high effort choice, which alternated between ($3, $4, $5, $6, and $7). The probability of attaining the reward was either certain (100%) or uncertain (50%) regardless of whether the high effort or low effort balloon was chosen. Results revealed that SZ with low levels of negative symptoms put forth more effort when the reward value increased and the probability of receiving the reward was certain (100%), while SZ patients with high levels of negative symptoms did not.

Still another factor contributing to motivation deficits in SZ is impairment in patients' working memory ability [18–20]. It has been suggested that avolition may be related to difficulties in recalling significant parts of an experience needed to establish an internal representation of a reward [11,14]. The ability to maintain and utilize mental images from prior rewarding experiences has been shown to be impaired in SZ [2]. This is consistent with studies that find SZ patients have difficulty recalling past rewarding experiences from autobiographical memory, as well as imagining a positive personal future [21].

Lastly in terms of real world functioning ability, motivational deficits may play a key role in causing impairments in SZ daily living ability [12,19,22,23]. Barch et al. [12] found, for example, that individuals with SZ who made fewer hard task choices had high avolition scores, while individuals with SZ who made more high effort choices had better community and work functioning. These findings highlight an important link between effort allocation and independent living skills.

In the present study, we employed a validated behavioral measure of motivation [17] to examine individuals with SZ effort allocation based on value of reward, cost or effort of reward, reward anticipation and reinforcement learning, working memory, and to clarify how beliefs regarding self-efficacy and expectations about future reward, contribute to avolition. We were also interested in examining how decisions about effort relate to daily functioning skills. It was hypothesized that individuals with SZ with high levels of negative symptoms would make fewer high effort choices when the reward value was highest and the probability of receiving the reward was certain compared to individuals with low levels of negative symptoms. We also predicted that individuals with SZ with more negative symptoms would be less likely to make high effort choices after receiving a reward in the uncertain conditions in subsequent 50% conditions compared to individuals with SZ with low levels of negative symptoms.

We hypothesized that participants' poor working memory and negative psychological beliefs regarding self-efficacy and satisfaction of future rewards, independent of negative symptoms, would help explain disparities in effort allocation. Finally, we predicted difficulties related to making high effort choices when the condition had the greatest pay off and had a certain probability of return would be related to individuals with SZ's everyday functional skills.

2. Materials and method

2.1. Participants

Fifty-seven individuals residing in psychiatric inpatient units at hospitals in the New York metropolitan area were recruited for participation. All patients were over 18 years of age and met DSM-IV [24] diagnostic criteria for schizophrenia or schizoaffective disorder. Participants were excluded from the study if they were unable to understand or give voluntary written consent to participate in the IRB approved study, or if they had an intellectual disability or any disorder of the central nervous system.

2.2. Measures

2.2.1. Diagnostic measure

Diagnostics Interview for Genetics Studies (DIGS) [25] was conducted on all study patients to ascertain psychiatric diagnoses. Trained raters completed sections assessing major depression, mania/hypomania, and psychosis that was validated during consensus meetings with senior staff.

2.2.2. Symptom measures

Scale for the Assessment of Negative Symptoms (SANS) [26], Scale for the Assessment of Positive Symptoms (SAPS) [27] are scales used to measure the severity of negative and positive symptoms in individuals with schizophrenia. Based on the Gold et al. [17] method, a median split was computed with individuals' total SANS scores (split score = 35), dividing the groups into a low-negative symptom group (LOW-NEG) and a high negative symptom group (HI-NEG).

2.2.3. Cognitive measures

The Wide Range Achievement Test-Third Edition (WRAT-3) [28], Reading Decoding Subscale is considered a valid estimate of premorbid intelligence due to its irregular word-reading component. In this task, participants were asked to read words aloud in increasing difficulty, and trained administrators rated them on their pronunciation. WRAT reading decoding scores have been shown to provide an accurate measure of premorbid functioning level [29].

The Wechsler Memory Scale-Third Edition (WMS-III) [30] Digit Span and Letter-Number Sequencing subscales measure working memory and attention and were used to evaluated individuals with SZ's working memory abilities [31]. In the WMS-III Digit Span task participants were asked to reiterate a string of numbers immediately after they were read aloud and the digit strings increased in length as the task progressed. This task involved a forward condition where participants were told to repeat the digits back in the same order and a backward condition where participants were required to reverse the sequence. In the WMS-III Letter-Number Sequencing task, a letter-number sequence was said aloud out of order, and the participant was asked to properly order the letters and numbers by saying the numbers first in order from low to high and then the letters in alphabetical order. Scores on both WMS-III scales are summed together to create a composite working memory score.

2.3. Effort assessment

The Effort-Cost Computation Task [17] assessed skill in effort-based decision-making by offering participants a choice of two rewards. The rewards required different amounts of effort, which was operationally defined as key presses on a computer keyboard. The high effort decision/choice required 100 button presses, while the low effort decision required 20 button presses. On every trial,