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Motivation deficits in individuals with social anhedonia

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ABSTRACT

Patients with schizophrenia have been reported to exhibit anhedonia, a reduced hedonic capacity and deficits in motivation for reward pursuit. However, it is unclear whether these deficits also exist in at-risk individuals prone to psychosis or not. The present study compared 26 individuals with social anhedonia and 28 healthy controls using a grip Effort-based Pleasure Experience Task (E-PET). The findings showed that individuals with social anhedonia did not increase their hard task choices with the elevation of reward magnitude and probability while healthy controls did. Higher reward probability and magnitude did not lead to more anticipatory pleasure in individuals with social anhedonia. The mean anticipatory pleasure experience ratings in individuals with social anhedonia were significantly lower than controls. Our results suggest that individuals with social anhedonia already exhibit motivational deficits during reward pursuit.

1. Introduction

Anhedonia is defined as the reduced ability to experience or anticipate pleasure, and avolition is defined as the reduced motivation to expend effort in pursuing pleasure. Both are core features of schizophrenia (Millan et al., 2014), existing in both clinical and non-clinical but high-risk individuals along the schizophrenia spectrum (Li et al., 2016a; Lui et al., 2016; McCarthy et al., 2015; Zou et al., 2015). Among the heterogeneous high-risk populations, individuals with social anhedonia are believed to share considerable symptoms and traits with people with schizophrenia, albeit in milder and attenuated forms (Chapman et al., 1976; Eckblad et al., 1982).

Many previous studies have investigated neurocognitive performances in individuals with social anhedonia (Karcher et al., 2017; Li et al., 2016a, 2016b; Martin and Kerns, 2010; Yin et al., 2015). However, few studies have specifically examined their motivation to pursue rewards and how happy they would feel when thinking of the potential rewards. According to Kring and Barch's model, experiencing pleasure in anticipation of a potential reward would derive one's motivation to expend effort to approach it (Kring and Barch, 2014). Thus, anhedonia and avolition could be conceptualized as two interactive constructs in the reward system (Lee et al., 2015; Thomsen, 2015; Treadway and Zald, 2013; Vignapiano et al., 2016). Several novel behavioural paradigms, such as the effort-based decision-making tasks (Barch et al., 2014; Treadway et al., 2009), have been developed to specifically tap into the interactive operation of the two constructs, and are the desired approach to study pleasure and motivation in the pursuit of rewards in schizophrenia patients (Fervaha et al., 2015; Green et al., 2015; Treadway et al., 2009). In these paradigms, effort-based decision making represents an individual's cost-benefit computation (i.e., the willingness to expend more effort for higher reward magnitude and probability), which further interacts with anticipatory pleasure experiences to affect his/her effort expenditure (Strauss et al., 2014). Contrary to findings that rewards usually are highly motivating for healthy adults (Shigemune et., 2017), recent studies consistently demonstrated that schizophrenia patients, particularly those with prominent negative symptoms, were less willing to expend effort for rewards and experienced less anticipatory pleasure for incoming rewards (Huang et al., 2016; Wang et al., 2015). Using effort-based decision making paradigms, previous studies have suggested that the phenomenon of avolition is related to impaired effort allocation (Barch et al., 2014; McCarthy et al., 2016; Treadway et al., 2015)and abnormal cost-benefit computation (Fervaha et al., 2013; Gold et al., 2013) in schizophrenia patients. This line of research has also been extended to investigate non-clinical but high-risk individuals along the schizophrenia spectrum, such as individuals with social anhedonia. Importantly, one recent study which utilized an effort-based decision-making paradigm have found that individuals with social anhedonia were more likely to

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allocate low and medium effort to obtain rewards (McCarthy et al., 2015). A recent neuroimaging study showed a reduction in activation in the ventral striatum of individuals with social anhedonia when they anticipated gains, compared with controls (Yan et al., 2016). Another laboratory study showed that individuals with social anhedonia had diminished physiological response to evocative stimuli while anticipating rewards (Simons et al., 1982). However, few studies have examined both cost-benefit computation and anticipatory pleasure experiences together in individuals with social anhedonia.

As far as pleasure experience is concerned, Gard et al. (2007) proposed a two-facetted model, consisting of consummatory and anticipatory pleasure (Gard et al., 2007), which are inter-related and interactive. Consummatory pleasure is the 'in-the-moment' pleasure when an individual is receiving rewards. There is evidence to support that individuals who experience low consummatory pleasure are less likely to experience anticipatory pleasure about possible upcoming rewards (Strauss and Gold, 2012; Treadway and Zald, 2013). Therefore, it is important to capture both anticipatory and consummatory pleasure experiences. However, previous findings on individuals with social anhedonia are inconsistent as to whether this high-risk group has diminished consummatory pleasure experiences (Gooding et al., 2002; Martin et al., 2011). Using an improved paradigm addressing the interaction between anticipatory and consummatory pleasure might reconcile previous inconsistent findings.

In this study, we investigated anhedonia and avolition in individuals with social anhedonia using an improved behavioural paradigm capturing the components of motivation, anticipatory pleasure and consummatory pleasure. We hypothesized that individuals with high social anhedonia would exhibit multi-facet impairments of the reward system, based on earlier findings in high-risk populations and schizophrenia patients (Huang et al., 2016; McCarthy et al., 2016, 2015; Waltz and Gold, 2016).

2. Methods

2.1. Participants

Twenty-six individuals with social anhedonia were recruited from the Northern China Electrical University, China. Participants were identified as having social anhedonia, based on their ratings on the Revised Chapman Social Anhedonia Scale (RCSAS) (Chapman et al., 1976; Eckblad et al., 1982), which were administered to 793 undergraduates. The criterion for the social anhedonia group was an RCSAS score of 1.5 standard deviations (*SD*) above the mean score of the undergraduate sample (RCSAS score > 17). Twenty-eight controls were also identified, based on the criterion of an RCSAS score of 0.5 *SD* below the mean score of the undergraduate sample (RCSAS score < 10, Kwapil et al., 1997). Similar methods of recruiting criteria have been used in many other studies (Karcher et al., 2017; Li et al., 2016a; Yin et al., 2015). The two groups were matched in IQ, age, education and gender (see Table 1). The exclusion criteria for all participants were: (1) a personal history of psychiatric disorders; (2) a personal history of neurological disorders; (3) substance abuse; and (4) a family history of psychiatric disorders. All participants provided written informed consent. We obtained Ethics Committee approval.

2.2. Measures

2.2.1. IQ estimation and self-report scales

We used the abbreviated Wechsler Adult Intelligence Scale-Revised (WAIS-R) to evaluate basic cognitive function of participants (Gong, 1992). The Temporal Experience of Pleasure Scale (TEPS) (Gard et al., 2006) was used to assess everyday experiences of anhedonia affecting both the anticipatory and the consummatory facets. The Chinese version of the TEPS (Chan et al., 2012), a 21-item self-report scale, has been found to have a four-factor structure, consisting of the abstract anticipatory, the contextual anticipatory, the abstract consummatory and the contextual consummatory subscales. A higher score reflects better ability to experience pleasure. We also administered the Beck Depression Inventory (BDI) (Beck et al., 1961), a 21-item self-rating scale, to measure participants' depressive symptoms in the past two weeks.

Table 1
Demographic information of all participants.

	HC $N = 26$		SA $N = 28$			
Characteristics	*M*	*SD*	*M*	*SD*	*t/F/Chi-square*	*p*
Gender (% male)	50%		57.4%		1.3	0.25
Age	21.41	1.79	20.92	2.43	0.82	0.42
IQ score	108	7.94	107	7.68	0.69	0.5
Education year	15.07	1.44	14.27	1.39	1.98	0.053
RCSAS	7.5	5.69	16.77	8.23	− 4.84	< 0.001
BDI	4.54	7.55	10.77	8.25	− 2.89	< 0.01
TEPS						
Abs_Cons	20.22	2.58	17.85	3.63	2.76	< 0.01
Con_Anti	19.32	4.4	14	3.91	4.69	< 0.001
Abs_Anti	28.89	3.18	24.6	4.9	4.72	< 0.001
Con_Cons	17.46	3.51	15.19	3.63	2.34	< 0.05

Note: HC, Healthy Control; SA, Individuals with Social Anhedonia; RCSAS: revised Chapman Social Anhedonia Scale; BDI: Beck Depression Inventory; TEPS: Temporal Experience Pleasure Scale; Abs_Cons: abstract-consummatory subscale of TEPS; Con_Anti: concrete-anticipatory subscale of TEPS; Abs_Anti: abstract-anticipatory subscale of TEPS; Con_Cons: concrete-consummatory subscale of TEPS.

2.2.2. Effort-based Pleasure Experience Task

The Effort-based Pleasure Experience Task (E-PET) is a sophisticated paradigm designed to tap into cost-benefit computation, anticipatory pleasure and consummatory pleasure experience (Wang et al., 2015). It is based on the theoretical framework proposed by Kring and Barch (2014). The schematic flow of the E- PET is shown in Fig. 1, which comprise a grip pre-test and a formal test.

We developed a hand dynamometer connected with E-prime software to measure the actual grip force in each participant's dominant hand. The participants were seated in an upright position, with their forearm placed comfortably on the table.

In the grip pre-test, participants were required to grip the handle three times. A thermometer with red filler was presented to visualize the actual grip strength exerted by the participants. We recorded the strongest grip of each participant to calibrate the easy and hard task acceptance level individually (see Fig. 1 left).

In the formal test, participants were allowed to choose between a hard (acceptance grip level: 75% of the strongest grip) and an easy task (acceptance grip level: 25% of the strongest grip) according to the reward magnitude and probability (Fig. 1, middle, A). The participants indicated a hard or an easy task by pressing a button on the grip handle using their thumb without changing their grip position. After making a choice, the participants were required to fulfill the easy/hard task by exerting their grip effort to reach the acceptance level. The actual grip strength assessed in each trial was indicated by a number in kilograms besides the thermometer. The reward will be attributed according to the percentage of the grip above the acceptance level. In easy tasks, participants were eligible to win ¥0.5 or more in the range of ¥0.5 (lower bound) and ¥1 (upper bound) only if their grip strength reached the space between the acceptance level (the solid line) and the strongest grip level (the dotted line) (see Fig. 1 middle, B). The potential reward in each trial was calculated according to the lower and upper bound of the range as follows:

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