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Individuals with psychometric schizotypy show similar social but not physical anhedonia to patients with schizophrenia

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ABSTRACT

Very few studies have examined physical and social anhedonia across the spectrum of schizophrenia. In the present study, we recruited three groups of participants ($n=84$ in each group): patients with schizophrenia, schizotypy and non-schizotypy as assessed by the Schizotypal Personality Questionnaire (SPQ). All participants completed the self-reported trait anhedonia scales (the Revised Physical Anhedonia Scale and the Social Anhedonia Scale). The clinical symptoms of schizophrenia patients were assessed using the Positive and Negative Syndrome Scale (PANSS) and the Scale for Assessment of Negative Symptoms (SANS). We found that the three groups differed in both physical and social anhedonia. The schizotypy group reported higher levels of physical anhedonia than the non-schizotypy group, and the patient group reported higher levels of physical anhedonia than the schizotypy group. For social anhedonia, the non-schizotypy group differed significantly from both the schizotypy and the patient group, while no significant difference was found between the last two groups. Our findings show that individuals with schizotypy exhibits similar social but not physical anhedonia compared with patients with schizophrenia, which further suggests that decreased pleasure experiences in the social environment may be a valuable target for identification and early intervention in high-risk populations.

1. Introduction

Anhedonia, the reduced capacity to experience pleasure in normally pleasurable situations, has been considered a vulnerability indicator for the development of schizophrenia (Rado, 1953; Meehl, 1962). Although studies have reported reduced pleasure experiences measured by self-reported scales in schizophrenia patients (Blanchard et al., 1998; Burbridge and Barch, 2007) and individuals at-risk of schizophrenia spectrum disorders (Chan et al., 2012; Shi et al., 2012), very few studies have examined trait anhedonia across the schizophrenia spectrum. The Chapman scales are commonly used instruments in capturing trait anhedonia, which assess the defect of pleasure experiences in two aspects: physical and social anhedonia (Chapman et al., 1976). The Revised Physical Anhedonia Scale (Chapman and Chapman, 1978) assesses reduced pleasure experiences related to physical stimuli, such as pleasures of eating, feeling, sex, smell, and sound. In contrast, the Revised Social Anhedonia Scale (Eckblad et al., 1982) assesses diminished pleasure experiences from social environments, such as interaction with other people and talking or exchanging expressions of feeling. Both scales have been translated into other languages to assess anhedonia in different cultural contexts, with established reliability and validity (Chinese version: Chan et al., 2012; French version: Assouly-Besse et al., 1995; Spanish version: Fonseca-Pedrero et al., 2009; German version: Burgdorfer and Hautzinger, 1987).

High levels of trait anhedonia, in both physical and social aspects, have been consistently reported in patients with schizophrenia (Blanchard et al., 1998; Burbridge and Barch, 2007) and their biological relatives (Katsanis et al., 1990). Furthermore, longitudinal studies have found that reduced self-reported anhedonia are stable across different stages of illness in schizophrenia patients (Blanchard et al., 2001; Horan et al., 2008; Herbener and Harrow, 2002; Loas et al., 2009). Previous work has shown that

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anhedonia is also present in non-clinical samples. In particular, individuals with schizotypy exhibited higher levels of social and physical anhedonia than individuals without schizotypy (Chan et al., 2012). The word "schizotypy" we used in the present study refers to schizotypal features such as magical thinking, odd behaviour and speech, constricted affect and so on in non-clinical populations. Although the reduced pleasure experiences in schizophrenia patients and psychometrically defined high-risk individuals have been found in previous studies, there is a lack of direct comparison between healthy controls, individuals with schizotypy, and patients with schizophrenia. Katsanis et al. (1990) examined physical and social anhedonia in three groups: psychiatric patients, their first-degree relatives and healthy controls. They found that both patients and relatives showed higher levels of anhedonia, and patients scored higher than relatives. To the best of our knowledge, no study has examined trait anhedonia across the schizophrenia spectrum, covering patients with schizophrenia, psychometric schizotypy and non-schizotypy controls. Thus, the primary purpose of the present study was to examine the levels of both types of trait anhedonia in schizotypy and non-schizotypy individuals as well as schizophrenia patients.

Another aim of this study was to examine the association between negative symptoms and self-reported anhedonia scores. Contrary to expectation, most previous studies found insignificant correlations between trait anhedonia and clinical ratings (such as SANS, PANSS or BPRS) in patients with schizophrenia (Blanchard et al., 2001; Horan et al., 2006, 2008). We believe that this may be due to the emphasis on observation of decreased engagement in social activities in clinical ratings when greater involvements in social interaction does not necessarily mean stronger pleasure experiences. Furthermore, clinical interviews usually only cover a relatively short time period, which may not capture anhedonia fully (Loas et al., 2009).

In addition, previous studies have found that trait anhedonia may be related to age and gender, which could be potential confounders when we compare groups on trait anhedonia. For example, males have been consistently found to have higher scores on the Chapman Anhedonia Scales in previous studies (Freedman et al., 1998; Kwapil et al., 2008), while age has also been found to be negatively correlated with physical anhedonia both in schizophrenia patients and their relatives (Katsanis et al., 1990). In the present study, we also examined the associations between these variables and trait anhedonia within each group and took them as covariates in subsequent analyses if necessary.

We hypothesized that both types of trait anhedonia are present in both patients with schizophrenia and non-clinical populations, with schizophrenia patients showing the highest level of anhedonia, non-schizotypy group showing the lowest level and schizotypy group in the middle. Significant correlations between clinical ratings on negative symptoms and trait anhedonia scores in patients, and significant correlations between the negative dimension of the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991) and social anhedonia scores in non-clinical sample were expected.

2. Methods

2.1. Participants

Our study included three groups of participants: a clinical group of patients with schizophrenia, and two groups without mental disorder but with different levels of schizotypal features (the schizotypy and non-schizotypy groups). Participants with schizophrenia ($n=84$, mean age=32.6 years, S.D.=14.5, 64 males) were recruited from hospitals in Beijing, Guangdong, and Hong Kong. All of them met the ICD-10 (WHO, 1993) diagnostic criteria for schizophrenia. The duration of illness (DOI) ranged from one month to 41 years, with a mean DOI of 11.4 years (S.D.=12.6). All except three of the patients with schizophrenia were treated with second generation antipsychotic medications. The mean chlorpromazine equivalence was 330.21 mg (S.D.=196.81). To select participants with and without schizotypal features (schizotypy vs. non-schizotypy groups), we first asked 872 college students from three universities in Beijing and Shanghai to complete the SPQ (Raine, 1991). Participants whose scores were at the top tenth percentile were recruited into the schizotypy group ($n=84$). Next, we randomly chose an equal number of participants among those scoring at the bottom 50% and recruited them into the non-schizotypy group ($n=84$). The schizotypy group consisted of 26 males and had a mean age of 19.1 years (S.D.=1.1). The non-schizotypy group consisted of 33 males and had a mean age of 18.7 years (S.D.=0.9). The three groups differed significantly in age ($F(2,249)=74.88$, $p<0.001$) and gender ($\chi^2=38.97$, $p<0.001$), an effect that was driven by the difference between the patient group and the other two groups (age: patients vs. schizotypy: $p<0.001$; patients vs. non-schizotypy: $p<0.001$; and schizotypy vs. non-schizotypy: $p>0.05$; gender: the patients' group had more males than the other two groups: patients vs. schizotypy: $p<0.001$; patients vs. non-schizotypy: $p<0.001$; schizotypy vs. non-schizotypy: $p>0.10$).

2.2. Procedures

All groups were assessed using two self-reported scales capturing trait anhedonia. The Chinese versions of the Social Anhedonia Scale (CSAS) and the Physical Anhedonia Scale (CPAS) were adapted from the English version of the Chapman scales (Chapman and Chapman, 1978; Eckblad et al., 1982). The CPAS contains 61 True–False items with higher scores indicating more severe physical anhedonic experiences. The CSAS contains 40 True–False items and higher scores indicate less pleasure from social interactions. After the standard translation and back-translation process, the Chinese versions of both scales have been shown to have good reliability (see Chan et al., 2012 for details on the adaptation of these measures in Chinese). The inverse correlations between both physical and social anhedonia scales and the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006), which was developed to assess pleasure experiences, suggest that the Chapman Anhedonia Scales have good construct validity (Chan et al., 2012). In our sample, both the Cronbach's alpha coefficients for the CPAS and CSAS were 0.85.

Participants with schizophrenia were interviewed using the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) and the Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1982). The PANSS consists of 16 items that make up three subscales (positive, negative and general) and measures the severity of clinical symptoms of schizophrenia. The SANS consists of 24 items that assess five symptom complexes: affective flattening, alogia, avolition-apathy, anhedonia, and attentional impairment. We used the *subscale score* for each symptom complex and the *summary score* to indicate the severity of each symptom complex and negative symptoms as a whole, respectively.

The Schizotypal Personality Questionnaire (SPQ) (Raine, 1991) was used to screen participants with and without schizotypal features. It was developed based on the DSM-III-R criteria for schizotypal personality disorder and has been commonly used as an instrument to capture schizotypal traits in the general population. The SPQ consists of 74 items, including nine traits: idea of reference, excessive social anxiety, odd beliefs or magical thinking, unusual perceptual experiences, odd or eccentric behaviour, no-close-friends, odd speech and constricted affect. The three-factor structure of the Chinese version of the SPQ includes the cognitive-perceptual, the interpersonal and the disorganized factors, and has been found to have good reliability and validity (Chen et al., 1997). In our sample, the Cronbach's alpha coefficient for the whole scale was 0.95, and 0.69 to 0.86 for the nine traits.

Questionnaire administration was conducted in a group format for the non-clinical sample. For the clinical sample, schizophrenia patients were approached by the researchers individually. The total administration time was about 20–30 min. The clinical ratings were conducted by trained psychiatrists who were the treating clinicians of the patients. All participants gave written informed consents prior to testing. The present study was approved by the ethics committees of the Institute of Psychology, the Beijing Huilongguan Hospital, Shantou Mental Health Centre in Guangdong Province and Castle Peak Hospital in Hong Kong.

2.3. Data analysis

On all items of the Chapman scales, we found nine missing values and we used the medians scores of the participants' group to replace these missing values. Before group comparisons, we examined the gender effect on trait anhedonia by independent sample t tests and age effect by Pearson correlation analyses within each group. The results showed that males reported higher levels of social anhedonia than females in both the schizophrenia group and the schizotypy group (p *values* <0.05); while females reported higher levels of physical anhedonia than males in the non-schizotypy group ($p<0.05$). We did not find any significant correlations between age and trait anhedonia scores in all three groups ($p>0.10$). However, since both age and gender have been reported in previous studies to affect scores on the anhedonia scales and there were significant differences in age and gender ratio for the three groups in our study, we performed the MANOVA without covariates and also took age and gender as covariates in subsequent

Table 1
Demographic information, symptoms severity and trait anhedonia scores.

	Schizophrenia patients ($n=84$)		Schizotypy ($n=84$)		Non-schizotypy ($n=84$)		$F/t/\chi^2$
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Age	32.6	14.5	19.1	1.1	18.7	0.9	74.88, $p<0.001$
Gender (male:female)	64:20		26:58		33:51		38.97, $p<0.001$
Education (years)	11.50	2.53	12.49	0.84	12.34	0.65	9.40, $p<0.001$
Anhedonia							
CPAS	21.69	8.95	17.21	7.20	12.19	5.23	27.19, $p<0.001$
CSAS	13.61	6.48	11.08	4.74	4.33	2.90	60.95, $p<0.001$
PANSS							
Positive	10.65	3.80	–	–	–	–	–
Negative	14.07	6.60	–	–	–	–	–
General	24.94	6.09	–	–	–	–	–
Total	49.66	12.83	–	–	–	–	–
SANS							
Affective flattening	4.19	3.99	–	–	–	–	–
Alogia	2.68	2.94	–	–	–	–	–
Avolition-apathy	3.62	3.14	–	–	–	–	–
Anhedonia	3.58	3.39	–	–	–	–	–
Attentional impairment	1.26	1.58	–	–	–	–	–
Summary score	4.40	3.53	–	–	–	–	–
SPQ							
Cognitive perceptual	–	–	19.47	4.27	7.19	3.44	20.54, $p<0.001$
Interpersonal	–	–	16.99	4.58	3.63	3.21	21.87, $p<0.001$
Disorganized	–	–	10.06	2.39	2.51	1.52	24.43, $p<0.001$
Total	–	–	46.52	6.20	13.33	5.89	35.57, $p<0.001$

Note: CPAS: Chinese version of Physical Anhedonia Scale; CSAS: Chinese Version of Social Anhedonia Scale; PANSS: The Positive and Negative Syndrome Scale; SANS: The Scale for the Assessment of Negative Symptoms; SPQ: Schizotypal Personality Questionnaire.

MANCOVA. Lastly, among the patients with schizophrenia, we calculated Pearson correlations between the PANSS/SANS scores and trait anhedonia. For the non-clinical participants, we calculated Pearson correlations between scores on the SPQ and trait anhedonia. All statistical analyses were conducted using SPSS 19.0.

3. Results

Table 1 shows the descriptive statistics on the measures used in the study for each group. To examine the differences between the three groups on physical anhedonia and social anhedonia, we first conducted a MANOVA. The results showed that the effect of group was significant (Wilk's lamda=0.588, F (4,496)=37.73, $p<0.001$, partial eta squared=0.233). Follow-up univariate statistics indicated that the effect of group was significant in both physical anhedonia (F (2,249)=35.72, $p<0.001$; partial eta squared=0.223) and social anhedonia (F (2,249)=79.44, $p<0.001$; partial eta squared=0.390). On both physical and social anhedonia scales, patients scored higher than both the schizotypy (p *values* <0.01) and the non-schizotypy groups (p *values* <0.001); with the schizotypy group scoring higher than the non-schizotypy group (p *values* <0.001) (Fig. 1).

To control for the effect of age and gender, we performed a MANCOVA (co-varying with age and gender). The results showed that the effect of group was significant (Wilk's lamda=0.642, F (4,492)=30.48, $p<0.001$, partial eta squared=0.199). Follow-up univariate statistics indicated that the effect of group was significant in both physical anhedonia (F (2,247)=27.19, $p<0.001$; partial eta squared=0.180) and social anhedonia (F (2,247)=60.95, $p<0.001$; partial eta squared=0.330). The schizotypy group reported higher levels of physical anhedonia than the non-schizotypy group ($p<0.001$), and the patient group reported higher levels of physical anhedonia than the schizotypy group ($p<0.01$). For social anhedonia, the non-schizotypy group differed significantly from both the schizotypy and the patient group ($p<0.001$), while there was no significant difference between the last two groups ($p>0.10$). The results also showed that the effect of gender was significant (Wilk's lamda=0.962, F (2,246)=4.80, $p<0.01$) and univariate analysis showed that the effect of gender was significant in social anhedonia scores (F (1,247)=8.85, $p<0.01$), but not in physical anhedonia ($p>0.10$). The effect of age was not significant ($p>0.10$).

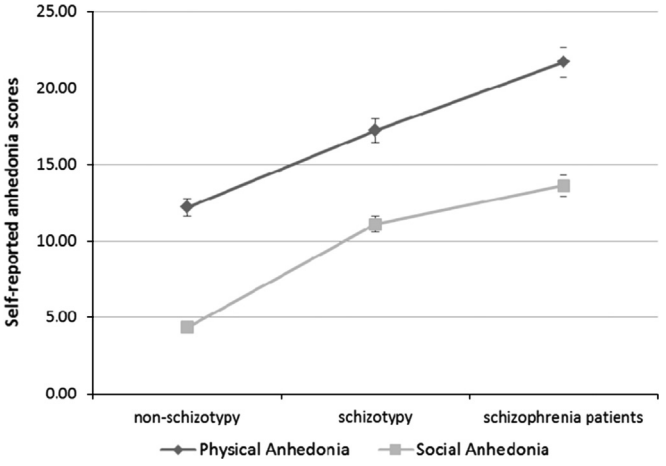

Fig. 1. The comparisons on physical and social anhedonia among non-schizotypy, schizotypy and schizophrenia patients' group. The results from MANCOVA showed that the effect of group was significant. Follow-up univariate statistics indicated that the effect of group was significant in both physical anhedonia and social anhedonia. The schizotypy group reported higher physical anhedonia than the non-schizotypy group, and the patients' group reported higher physical anhedonia than the schizotypy group. In regards to social anhedonia, the non-schizotypy group differed significantly from both the schizotypy and the patients' group with no significant differences found between the last two groups.

Next, we calculated the correlations between self-reported anhedonia and PANSS/SANS ratings in the patient group. There was no significant correlation between physical anhedonia and clinical ratings on all PANSS and SANS items. However, self-reported social anhedonia correlated significantly with PANSS negative ($r=0.23$, $p<0.05$), PANSS general ($r=0.26$, $p<0.05$), PANSS total ($r=0.26$, $p<0.05$) scores, as well as the SANS avolition-apathy ($r=0.23$, $p<0.05$) subscale scores and the SANS summary score ($r=0.22$, $p<0.05$). The correlation between social anhedonia scores and the SANS anhedonia subscale scores was marginally significant ($r=0.21$, $p=0.061$). Since gender was found to be a confounding factor in prior analyses, we conducted partial correlations between anhedonia and clinical ratings controlling for gender. The results showed that there was no significant correlation for self-reported physical anhedonia score. However, the associations between social anhedonia score and PANSS general psychopathology score ($r=0.27$, $p<0.05$), and PANSS total score ($r=0.25$, $p<0.05$) were still significant.

We then calculated the correlations between SPQ scores and trait anhedonia in both the schizotypy and the non-schizotypy groups with and without including gender as a covariate (see Table 2). In both groups, trait anhedonia correlated significantly with negative subclinical traits, including the SPQ interpersonal factor and the SPQ subscales such as “constricted affect” and “no close friends”. At the same time, in the schizotypy group we found negative correlations between trait anhedonia and the cognitive perceptual factor of the SPQ, which measures attenuated positive symptoms. This negative correlation was also observed between trait anhedonia and some SPQ subscales, such as “ideas of reference”, and “unusual perceptual experiences”.

4. Discussion

In the present study, we examined the levels of trait social and physical anhedonia across the schizophrenia spectrum and also explored the associations between trait anhedonia and symptoms. First, we found that the schizotypy group and patient group exhibited higher levels of physical anhedonia than the non-schizotypy group. In addition, after controlling for the effect of gender, the schizotypy group exhibited a similar level of social anhedonia as patients with schizophrenia, both of which were higher than the non-schizotypy group. Secondly, clinical symptoms assessed using the PANSS and the SANS moderately but significantly correlated with self-reported social anhedonia in the patient group, but this was not the case for physical anhedonia. Thirdly, we found significant correlations between trait anhedonia and negative symptoms in both the schizotypy and the non-schizotypy groups. We also found significant negative correlations between trait anhedonia and positive symptoms in the schizotypy group.

Compared to the non-schizotypy group, we found that patients with schizophrenia reported higher levels of both physical and social anhedonia, which is consistent with previous studies. There have been several studies focusing on trait anhedonia in schizophrenia patients and most researchers seem to agree that higher levels of anhedonia are found in this population, which are relatively independent from symptom state and duration of illness (Blanchard et al., 1994, 1998; Herbener and Harrow, 2002; Horan and Blanchard, 2003; Katsanis et al., 1990). In addition, the findings of this study replicated those of previous studies (Chan et al., 2012; Yan et al., 2011) and showed that the schizotypy group reported significantly higher levels of physical and social anhedonia than the non-schizotypy group. Though based on different theoretical models, both the Chapman scales and the SPQ are commonly used instruments in measuring schizotypal features. The multidimensional structure of schizotypy has been established, and it has been suggested that there are at least two dimensions of schizotypy: positive and negative (Vollema and van den Bosch, 1995). The Chapman anhedonia scales and the “interpersonal factor” of the SPQ, which includes items related to “constricted affect”, “social anxiety”, “no close friends” and “suspiciousness”, are both thought to capture the negative dimension of schizotypy. Therefore, it is reasonable that the schizotypy group in our study, who had higher scores not only on the SPQ total, but also on the “interpersonal factor” of the SPQ, reported less pleasure experiences than the non-schizotypy group.

By incorporating schizophrenia patients, schizotypy and non-schizotypy groups, we were able to examine the levels of trait anhedonia across the whole schizophrenia spectrum. The results show that the levels of physical anhedonia in schizotypy lie somewhere in between the non-schizotypy group and patients with schizophrenia. However, the levels of social anhedonia in the schizotypy group were similar to patients with schizophrenia. This suggests that the psychometric-defined schizotypy group in our study exhibited severe trait anhedonia, especially social anhedonia. Previous longitudinal studies have suggested that

Table 2
Pearson correlations and partial correlations (controlling for gender) between trait anhedonia and SPQ scores.

	Non-schizotypy ($n=84$)		Schizotypy ($n=84$)	
	CPAS	CSAS	CPAS	CSAS
Ideas of reference	0.00 (−0.07)	−0.13 (−0.11)	−0.29** (−0.28*)	−0.24* (−0.23*)
Odd beliefs or magical thinking	−0.10 (−0.21)	0.00 (−0.01)	−0.18 (−0.16)	−0.27* (−0.27*)
Unusual perceptual experiences	0.03 (−0.02)	0.14 (0.13)	−0.25* (−0.24*)	−0.28* (−0.27*)
Excessive social anxiety	0.00 (0.00)	0.29**(0.31**)	0.06 (0.08)	0.02 (0.02)
No close friends	0.14 (0.19)	0.37***(0.38***)	0.41*** (0.40***)	0.57*** (0.53***)
Constricted affect	0.24* (0.31**)	0.34** (0.34**)	0.26* (0.25*)	0.23* (0.16)
Suspiciousness	0.24* (0.28*)	0.26* (0.27*)	0.17 (0.17)	0.11 (0.13)
Odd speech	0.09 (0.10)	0.10 (0.12)	−0.23* (−0.20)	−0.25* (−0.21)
Odd or eccentric behavior	0.12 (0.14)	0.02 (0.04)	0.01 (0.02)	0.06 (0.02)
SPQ_cognitive_perceptual	0.00 (−0.07)	0.04 (0.06)	−0.19 (−0.21)	−0.32** (−0.27*)
SPQ_interpersonal	0.16 (0.21)	0.46*** (0.46***)	0.37** (0.36**)	0.39*** (0.35**)
SPQ_disorganized	0.13 (0.14)	0.10 (0.13)	−0.15 (−0.13)	−0.14 (−0.13)
SPQ_total	0.12 (0.08)	0.30** (0.30**)	0.08 (0.03)	0.01 (−0.02)

Note: CPAS: Chinese version of Physical Anhedonia Scale; CSAS: Chinese Version of Social Anhedonia Scale; SPQ: Schizotypal Personality Questionnaire. Partial correlation coefficients are shown in parentheses.

* $p<0.05$.
** $p<0.01$.
*** $p<0.001$.

trait anhedonia could be considered a promising predictor of psychosis. However, it was also suggested that social and physical anhedonia may differ in predictive value. Individuals with high levels of social anhedonia have been shown to be more likely to develop schizophrenia spectrum disorders at follow-up. Kwapil et al. (1998) found that 24% of psychometrically defined social anhedonia high scorers were diagnosed with schizophrenia-spectrum disorders 10 years later, compared to 1% of the control group. Gooding et al. (2005) also found that compared to a control group, high-risk groups with high scores on the social anhedonia scale reported more frequent and more severe psychotic-like experiences five years later. Recently, some behavioural studies have also reported the possible predictive value of anhedonia, especially social anhedonia, not only for the development of psychosis, but also for neurocognitive and socio-emotional dysfunctions (Blanchard et al., 2011; Cohen et al., 2012; Horan et al., 2007; Martin et al., 2012). Our findings add to a small but growing number of studies highlighting the value of social anhedonia as a possible predictor for the development of schizophrenia spectrum disorders.

In contrast, physical anhedonia does not seem to have such predictive value. Physical anhedonia focuses on the reduced pleasure experiences induced by physical stimuli, such as food, sex and settings. Previous studies have suggested that physical anhedonia is associated with attentional deficits and social dysfunction (Freedman et al., 1998), as well as structural and functional brain changes in both schizophrenia patients and non-clinical samples (Harvey et al., 2010, 2007; Lee et al., 2011; Park et al., 2009). For example, physical anhedonia has been associated with the volume of the anterior caudate (Harvey et al., 2007), the posterior cingulate cortex and the precuneus (Lee et al., 2011). An event-related functional MRI study found that physical anhedonia scores were correlated negatively with brain activity at the medial prefrontal cortex during an emotional picture viewing task in both patients and healthy controls, and negatively correlated with the activity of the orbitofrontal cortex and the putamen in schizophrenia patients (Harvey et al., 2010). In summary, these results indicate that physical anhedonia may be a characteristic related to behavioural and brain abnormalities in schizophrenia patients. We speculate that physical anhedonia and its related neurobiological changes may be the consequence following a sustained state of decreased experiential pleasure from the social environment without effective coping. This speculation certainly needs to be validated in future studies.

Besides the group comparisons, we also conducted correlation analyses between trait anhedonia scores and symptoms in schizophrenia or the psychotic-like experiences in non-clinical sample. In schizophrenia patients, we only found that self-reported social anhedonia were positively correlated with some PANSS and SANS scores, including the PANSS negative, the SANS avolition-apathy and the SANS anhedonia subscale scores, although the value of the correlation coefficients were small (0.22–0.26). This is consistent with previous studies reporting that few significant correlations have been found between clinical ratings and self-reported trait anhedonia (Blanchard et al., 2001; Horan et al., 2006, 2008). One possible reason is that, as previous researchers had suggested, clinical ratings are more likely to be dependent on the patients' engagement in social activities, but not their experiences of gaining pleasure (Loas et al., 2009). Based on this, we speculate that pleasure experiences from social interactions may be more observable than physical anhedonia. This may partly explain why we only found significant correlations between social anhedonia and clinical ratings. The significant correlation between the SANS avolition-apathy subscale score and anhedonia score suggests that there may be a conceptual overlap between anhedonia and the avolition-apathy subscale. The reasons underlying these inconsistent findings on the associations between clinical ratings and self-reported anhedonia are still not clear and need to be clarified in the future.

In our non-clinical sample, trait anhedonia was positively correlated with the SPQ “interpersonal factor” subscale scores both in the schizotypy and the non-schizotypy groups, which is consistent with our findings in the group comparisons. Furthermore, we also found negative correlations between SPQ “cognitive-perceptual factor” and trait anhedonia in the schizotypy group, which suggests that participants who scored higher on positive schizotypal features (such as “idea of references”) reported lower levels of anhedonia. In another study, Shi et al. (2012) examined the pleasure experiences of individuals with positive and negative schizotypy and found that individuals with positive schizotypy reported higher levels of pleasure experiences than controls, while individuals with negative schizotypy exhibited less pleasure. These findings suggest that positive schizotypy may also be associated with abnormal emotion processing. For example, previous studies have found that compared to controls, individuals with positive schizotypy showed greater attention to emotion (Kerns, 2005; Berenbaum et al., 2006) and increased subjective emotional arousal (van't Wout et al., 2004). Taken together, these findings suggest that the different dimensions of schizotypy should be considered more carefully in future studies.

As Strauss (2013) had suggested in a recently published paper, in addition to traditional pharmacological treatment, psychosocial interventions should also be used to alleviate anhedonia in patients with schizophrenia in the future. Our findings suggest that there should be distinct interventions targeting different developmental stages along the schizophrenia spectrum. For example, alleviating anhedonia in social interactions and preventing physical anhedonia symptoms may be the more meaningful goals of interventions in high-risk populations. To accomplish these goals, the Social Cognition and Intervention Training (SCIT) developed by Penn et al. (2007), which includes training to improve skills in perceiving emotions, understanding intentions, avoiding attribution biases during the social interaction may be helpful. Empirical findings of interventions using a Chinese version of SCIT in individuals with schizotypy also suggest that this kind of training would be applicable and promising in the Chinese setting (Chan et al., 2010).

It is noteworthy that the scores we reported in the present study in the non-clinical Chinese samples came from two extreme groups, and we were not able to compare our results directly with western samples. However, when we compared the scores of the Chapman Anhedonia Scales in Chinese non-clinical samples from a previous study (Chan et al., 2012) and a Caucasian sample (Kwapil, 1998), we found that the social anhedonia scores were similar for both the Chinese and Caucasian samples. However, the Chinese participants reported higher scores on physical anhedonia than their Caucasian counterparts. This might be due to the fact that some of the physical anhedonia items were related to pleasure derived from sex, which is a taboo in the Chinese society and may not be able to elicit the participants' true responses (Chan et al., 2012). Further studies should be conducted in the near future to specifically examine the cross-cultural differences of reporting anhedonia between Chinese and Caucasian samples.

This study has several limitations. First, we adopted the SPQ to recruit the non-clinical groups but used the Chapman scales to measure anhedonia. Although based on different theoretical models, the two instruments are correlated since they both capture schizotypal traits. In particular, the “interpersonal factor” of the SPQ and the Chapman Anhedonia Scales are both designed to capture the negative traits that resemble negative symptoms. Secondly, we only administered self-reported questionnaires in

the non-clinical samples and did not assess psychotic symptoms to look into the associations between the results from self-reported scales and interviewer ratings. The impairement of self-awareness or insight might be another confounding here which should be considerd in the future. Thirdly, in our study, well-functioning college students were recruited to compare with a clinical sample. A population-based non-clinical sample would improve the matching between samples. A cross-sectional study like ours only provides preliminary evidence for the development of anhedonia along the schizophrenia spectrum. A prospective longitudinal study would better address this issue. Recent studies also found intact pleasure experiences in schizophrenia patients using laboratory-based tasks with immediately emotional response (Horan et al., 2006 for review). Hence, Strauss and Gold (2012) suggested that it might be inappropriate to consider this as a diminished "capacity" of pleasure experiences. Instead, researchers should also consider other aspects of anhedonia in the future, such as the beliefs about non-current feelings or engagement of the pleasurable activities.

In conclusion, this study found individuals with schizotypy exhibits similar social anhedonia as patients with schizophrenia, which further suggests that decreased pleasure experiences in the social environment may be a valuable target for identification and early intervention in high-risk populations.

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