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Diminished humour perception in schizophrenia: Relationship to social and cognitive functioning

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ABSTRACT

This study attempted to confirm that humour recognition deficits previously found in schizophrenia are specific to the condition and not attributable to other parameters such as depression or anxiety. Secondarily, we explored any possible cognitive or social functioning correlates to humour recognition deficits. A total of 60 participants (20 outpatients with schizophrenia, 20 psychiatric control participants and 20 control participants) underwent a 64-question humour task in addition to a battery of standard cognitive tests and Social Functioning Scales. In order to compare the three groups of participants, we conducted an analysis of variance (ANOVA) and post-hoc *t*-tests on neuropsychological measures, social functioning measures, and the primary outcome, humour recognition. The schizophrenia group showed significant and substantial deficits in humour recognition compared to the healthy control group, $t(38) = 5.1$, $P < 0.001$, ES = −1.55 and the psychiatric control group, $t(38) = 3.6$, $P = 0.001$. In the schizophrenia group, humour recognition correlated positively with general intellectual functioning (NART) $r = .45$, $P = 0.04$, social reasoning (WAIS-III Comprehension) $r = .54$, $P = 0.01$, executive functioning (WCST-CC) $r = .69$, $P = 0.001$ and social adjustment ratings (SASS scores), $r = .54$, $P = 0.02$. These findings support the assertion that humour recognition deficits in schizophrenia are specific to the condition and not attributable to other factors such as depression or anxiety. Furthermore, humour recognition deficits in schizophrenia may perhaps be preferentially associated with deficiencies in set shifting and semantic cognition.

1. Objectives of the study

The capacity to perceive humour represents a specialized higher-order cognitive ability, reliant on both intellectual and social proficiencies. Exploring the cognitive underpinnings of humour could perhaps help elucidate the precise nature of higher-order intellectual functions and their possible role in psychopathological conditions. Prior studies have implicated humour perception deficits in schizophrenia (Corcoran et al., 1997; Polimeni and Reiss, 2006a). Therefore, possessing a better understanding of humour perception deficits may enhance our understanding of the core cognitive impairment associated with schizophrenia.

A humorous stimulus has the ability to instigate a brief multi-second period of reflexive laughter and concomitant feelings of pleasure. Even without a laughter response, people are generally aware when others are attempting to be funny. A good sense of humour can enhance psychological well-being and enrich social relationships (Graham, 1995; Kelly, 2002; Larsen and Zvjezdana, 2008; Thorson et al., 1997). Humour may even impart modest physiological benefits such as boosting immunity (Bennett et al., 2003; Martin, 2001). A few evolutionary theorists have explored the potential raison d'être of humour and laughter (Polimeni and Reiss, 2006b; Vaid, 1999; Weisfeld, 2006). Most of these evolutionary hypotheses concentrate on humour's general ability to enhance social cooperation (Polimeni and Reiss, 2006b; Jung, 2003).

Since Ancient Greece, philosophers and scientists have pondered the elemental characteristics of laughter and humour (Bremmer, 1997). Humour theories have generally emphasized one of three essential themes: (1) humour reflects a set of incongruous conceptualizations, (2) humour involves repressed sexual or aggressive impulses and (3) humour elevates social status by expressing superiority or saving face. Veatch has perhaps put forward the most precise formulation of humour (Veatch, 1998). Veatch incorporates the established premise that humour contains two incongruous elements. However, in Veatch's formulation, one element is socially acceptable while the other violates or contradicts the "subjective moral order". Veatch defines this moral order

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as the "rich cognitive and emotional system of opinions about the proper order of the social and natural world". Thus, humour purportedly contains a set of two or more incongruent ideas with one of these elements violating an established social norm.

About a half-dozen fMRI experiments have attempted to locate anatomical areas associated with humour perception in normal subjects (Bartolo et al., 2006; Goel and Dolan, 2007; Mobbs et al., 2003; Moran et al., 2004; Reiss et al., 2008; Samson et al., 2008; Wild et al., 2006), while one fMRI study has done so in subjects with schizophrenia (Marjoram et al., 2006). The most recent studies have yielded relatively consistent results. Although no two studies display identical activation patterns, a general outline is beginning to emerge. For example, in a recent representative study, the left temporal–parietal junction, left anterior temporal lobe and left inferior frontal cortex seemed to be preferentially activated during humour processing (Samson et al., 2008). Utilizing event-related fMRI, Goel and Dolan (2007) attempted to reveal greater specificity around the various components of humour. Their experiments suggest that humour-induced frontal-temporal activations represent the juxtaposing of mental sets whereas ventral medial prefrontal cortex activity may reflect the affective experience associated with humour appreciation. Furthermore, Goel and Dolan propose that the experience of a social norm violation, a key element of humour according to Veatch (1998), produces activations in four cerebral areas – left orbital frontal cortex, right posterior temporal gyrus, left cuneus and right amygdala.

In patients with schizophrenia, deficits in humour appreciation have been consistently demonstrated (Bozikas et al., 2007a; Corcoran et al., 1997; Polimeni and Reiss, 2006a; Tsoi et al., 2008). To determine humour impairment, these research groups have utilized different humour measurements – each with its own specific strengths and limitations. Using a 128-item humour questionnaire, our group previously reported a rather large effect size of 1.94 between patients with schizophrenia and healthy controls (Polimeni and Reiss, 2006a). This result suggests that humour deficits in schizophrenia are not trivial and could perhaps help elucidate the underpinnings of altered cognition in schizophrenia. Thus, humour could serve as a sort of probe to explore the cognitive inner-workings of schizophrenia. As our grasp of humour improves, both at the psychological and brain level, so perhaps can our understanding of schizophrenia.

The primary purpose and unique aspect of our study was to directly test the specificity of the previously identified humour deficit in schizophrenia using a psychiatric control group in addition to healthy controls. A positive result would suggest that humour recognition deficits do not reflect general psychiatric experiences (e.g., disruptions to one's social interactions and day-to-day patterns, entering the mental health care system, and receiving psychiatric treatment) or general emotional turmoil (e.g., symptoms of depression or anxiety). Our secondary purpose was to administer a battery of wide-ranging cognitive tests and Social Functioning Scales with the hope of detecting potential associations with humour impairment. This could perhaps implicate the most salient cognitive components underlying impaired humour recognition in schizophrenia, as well as exploring real world outcomes of humour impairment. The latter possibility is related to the known association of cognitive deficits with poorer outcomes in schizophrenia (Bowie et al., 2006; Danion et al., 2007; Hamaoui et al., 2006), and humour being a higher order form of cognition.

2. Methods and materials

A total of 60 participants were recruited by newspaper or poster advertisements and word of mouth at the Health Sciences Centre, Winnipeg. Ethical approval for the study was obtained from the local Research Ethics Board. After a full explanation of the study, participants agreed to take part by way of written informed consent and were provided a $50 stipend. General inclusion criteria were that all participants had to be fluent in English and between the ages of 18 and 65. General exclusion criteria were a history of head injury, mental retardation, epilepsy or other neurological disorder and a Folstein's Mini-Mental State Exam (MMSE; Folstein et al., 1975) score of less than 28. Testing took between 2 and 4 h. Table 1 describes and compares the demographic characteristics of the three participant groups: schizophrenia, clinical control, and healthy control.

The schizophrenia group consisted of 20 outpatients. A diagnosis of schizophrenia by *DSM-IV-TR* criteria (APA, 2000) was confirmed by one of two Psychiatrists (J.P.R. and J.P.) using the Mini International Neuropsychiatric Interview (M.I.N.I. 5.0.0; Sheehan et al., 1998). In addition, clinical assessments were conducted, using the Positive and Negative Symptoms of Schizophrenia Scale (PANSS; Kay et al., 1987), Calgary Depression Scale for Schizophrenia (CDSS; Addington et al., 1992), and Hamilton Depression Inventory (HAM-D; Hamilton, 1960). All 20 patients were taking antipsychotic medication at the time of testing (18 atypical, 1 typical, 1 both typical and atypical). Mean chlorpromazine equivalent dose of antipsychotic medication was 358 mg/day (SD 390 mg/day). HAM-D scores fell within the normal to mildly depressed range of 0–13.

The clinical control group consisted of a total of 20 treated and relatively stable psychiatric outpatients with a diagnosis of either a primary depressive or anxiety disorder. A primary depressive or anxiety disorder using *DSM-IV-TR* criteria was confirmed by one of two Psychiatrists (J.P.R. and J.P.) using the Mini International Neuropsychiatric Interview (M.I.N.I. 5.0.0; Sheehan et al., 1998). Each clinical control group participant was assessed using the HAM-D. Clinical control group participants were excluded if they scored above 18 on the HAM-D, in order to avoid cognitive deficits associated with severe depression. Eighteen of the 20 participants in the psychiatric control group had described a recent history of appreciable dysphoria (i.e., depressive disorder, adjustment disorder with depressed mood, post-traumatic stress disorder).

A total of 20 healthy comparison participants were screened using the Mini International Neuropsychiatric Interview Screen (M.I.N.I. 5.0.0; Sheehan et al., 1998) to rule out any recent or current psychiatric history.

2.1. Materials

2.1.1. Self-report questionnaires

After demographic data was collected, participants filled out the following self-report questionnaires: Social Functioning Scale (SFS; Birchwood et al., 1990); Social Interaction Anxiety Scale (SIAS; Mattick and Clarke, 1998); Revised Social Anhedonia Scale (RSAS; Eckblad et al., 1982); Snaith–Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) and the Social Adaptation Self-Evaluation Scale (SASS; Bosc et al., 1997). The SFS is a self-report questionnaire developed for outpatients with schizophrenia. The SIAS is a self-report questionnaire that measures subjective anxiety during social situations. The RSAS is a true–false questionnaire that measures diminished pleasure derived from interpersonal interactions. The SHAPS measures the present state of anhedonia. The SASS is self-report inventory to assess level of social adjustment.

2.1.2. Cognitive tests

All participants completed the following series of cognitive tests (Table 2): National Adult Reading Test (NART; Nelson and Willison, 1991; Morrison et al., 2000), Wisconsin Card Sorting Test (WCST; Heaton, 1981); Controlled Oral Word Association Test (COWAT; Benton et al., 1983); a category fluency test; Stroop Color-Word

Table 1
Group characteristics including demographics, NART scores and clinical status measures.

Variable	Group			$F/\chi^2/t$	P
	Schizophrenia ($n = 20$)	Clinical control ($n = 20$)	Healthy ($n = 20$)		
Age (years)	42.0 (10.4)	40.6 (11.6)	28.6 (10.8)	$F = 9.0$	<.001[a]
Single to partnered ratio	16:4	8:12	12:8	$\chi^2 = 6.7$	.036[b]
Male to female ratio	17:3	15:5	17:3	$\chi^2 = 0.9$	.6
Education (years)	12.9 (2.0)	13.4 (2.1)	13.4 (1.4)	$F = 0.5$	.6
NART	35.5 (14.8)	40.1 (8.5)	41.0 (9.7)	$F = 1.3$	.3
HAM-D	5.6 (3.8)	11.3 (4.4)		$t = 4.2$	<.001[c]
CDSS	2.4 (2.7)				
PANSS	62.0 (7.4)				

NART: National Adult Reading Test; HAM-D: Hamilton Depression Inventory; CDSS: Calgary Depression Scale for Schizophrenia; PANSS: Positive and Negative Symptoms of Schizophrenia Scale; *P* significance level; Group values are presented as mean (SD) or frequencies.

[a] Healthy participants were younger than each clinical group, $P \leqslant 0.001$, but the clinical groups did not differ from each other age, $P = 0.7$.

[b] The schizophrenia group had more single/divorced participants than the clinical control group, $\chi^2(1, 38) = 6.7$, $P = .02$. No other group comparisons were significant, $P \geqslant .15$.

[c] Clinical control group had higher levels of depression than the Schizophrenia group.

Table 2
Description of neuropsychological tests used, domain assessed, and scores used.

Test	Domain	Test scores used
Trail Making Test A (TMT A)	Speed of processing	Time to completion in seconds
Trail Making Test B (TMT B)	Executive function Inhibitory ability	Time to completion in seconds
Stroop Color-Word Test (Stroop)	Inhibitory control	Total number of correctly named colors in 120 s to a maximum of 112
WAIS-III Digit Symbol-Coding	Working memory speed of processing – sensitive to organic change	Total items correctly coded, scaled for age and gender
WAIS-III Similarities	Verbal reasoning and linking concepts	Total points, scaled for age and gender
WAIS-III Comprehension	Verbal comprehension and societal norms	Total points, scaled for age and gender
WAIS-III Picture-Arrangement	Visual comprehension – recognizing social context	Total points, scaled for age and gender
Controlled Oral Word Association Test (COWAT)	Verbal fluency	Total number of words named, scaled for age, gender, and education
California Verbal Learning Test Second Edition (CVLT-II)	Verbal learning and memory	Total number of words recalled correctly over five learning trials
Category fluency	Speed of verbal processing	Total number of supermarket items named in 60 s
Wisconsin Card Sorting Test (WCST)	Executive function Concept formation Flexibility of abstract thought	Total number of categories completed (WCST-CC) Total number of perseverative errors, corrected for age and education (WCST-PE)

Test (Stroop; Trenerry, 1989); Trail Making Test A and B (TMT-A/B; Reiten, 1971); California Verbal Learning Test-II (CVLT-II; Delis et al., 2000); WAIS-III Digit Symbol-Coding; WAIS-III Picture-Arrangement; WAIS-III Similarities, and WAIS-III Comprehension (Wechsler, 1997).

2.1.3. Humour task

The humour task consists of 64 black and white single frame comics. Cartoons were derived from four popular artists (Herman, Far Side, Ziggy and Bizarro). Potentially ambiguous or offensive cartoons were removed. Thirty-two of the comics were altered so that the original, humorous caption had been replaced by a non-funny, yet contextually relevant caption. The other 32 comics were in their original form and randomly interspersed between the altered cartoons. Each cartoon was placed on a separate page in a 64-page binder. Participants were instructed to judge each comic as either original or altered. The 64-question humour task is the shorter version of a previously described 128-question humour task (Polimeni and Reiss, 2006). The instructions also emphasized that participants were *not* to judge whether they found the comic amusing, but whether the comic was in its original form and *intended* to be funny.

We evaluated the consistency of responses among the 64-items across our three groups of participants using Cronbach's alpha. We qualitatively re-examined any items that had negative or near zero correlations in the item-to-total evaluations. We concluded that four of the items were potentially ambiguous in their status as original or altered. Two of these comics were altered and two were original comics. After dropping these four comics, the humour recognition measure contained 60 items and showed good internal consistency with a Cronbach's alpha of 0.83. Each participant's humour recognition score was the number of correct responses out of 60. For supplementary analyses, we estimated false positive (false alarm) and false negative (missed acceptances) scores out of 30. False positives were based on the number of comics falsely identified as original and intended to be funny. False negatives were estimated based on the number of original comics falsely rejected as modified and not intended to be non-funny.

2.1.4. Analysis

To compare the three groups of participants, we conducted an analysis of variance (ANOVA) and post-hoc *t*-tests on the cognitive measures, the social functioning measures, and the humour recognition outcomes. To test for potential cognitive associations underlying the humour recognition deficits in the schizophrenia group, we tested for correlations between the cognitive measures and the humour scores for the schizophrenia group. We also ran a group comparison for humour recognition ANCOVA statistically controlling for demographic group differences, the NART, and primary cognitive correlates of humour recognition.[1] To examine the associations between the humour recognition responses and social

[1] We excluded covariates that were highly correlated (i.e., 0.8) with stronger humour recognition predictors to avoid confounding the ANCOVA.

Table 3
Group comparisons on a battery of neuropsychological functioning measures.

Task	Schizophrenia group	Clinical control group	Healthy control group	$F(3, 57)$	P	Effect size (sz-hc)
Equivalent scores between groups						
Category fluency	23.4 (6.5)	23.1 (7.5)	22.1 (5.3)	0.2 [b]	.8	0.22
COWAT	42.9 (10.9)	41.5 (9.2)	46.3 (11.3)	1.1[b]	.4	−0.31
WAIS-III Similarities	8.9 (1.9)	9.8 (2.1)	10.3 (2.3)	2.4	.1	−0.66
Healthy group > each clinical group						
TMT A	52.4 (29.1)	39.2 (20.4)	26.4 (11.5)	7.3	.002[1]	1.18
TMT B	124.6 (53.6)	100.5 (69.7)	59.1 (31.5)	7.6	.001[5]	1.49
CVLT-II	43.4 (9.8)	47.8 (9.4)	54.9 (10.5)	6.8[b]	.002[1]	−1.13
WAIS-III Picture-Arrangement	6.8 (2.5)	9.0 (2.5)	11.2 (2.6)	14.9	<.001[2]	−1.73
WCST-PE	64.2 (30.5)	91.3 (11.0)	110.1 (29.0)	15.3[c]	<.001[2]	−1.54
Stroop	85.0 (24.5)	100.2 (19.2)	120.2 (22.2)	12.4[a]	<.001[2]	−1.50
Schizophrenia < each control group						
WAIS-III – Digit Symbol-Coding	5.7 (1.7)	8.8 (2.1)	10.4 (3.5)	18.4[b]	<.001[3]	−1.73
WCST-CC	3.0 (2.1)	4.8 (1.7)	5.2 (1.6)	7.7[c]	.001[3]	−1.19
WAIS-III Comprehension	7.6 (2.0)	8.6 (2.3)	9.8 (2.0)	5.3	.008[4]	−1.08

Note: Values are presented as mean (SD).
COWAT: Controlled Oral Word Association Test; WAIS: Wechsler Adult Intelligence Scale; TMT A: Trail Making Test A; TMT B: Trail Making Test B; CVLT-II: California Verbal Learning Test Second Edition; WCST-PE: Wisconsin Card Sorting Test-Perseverative Errors; WCST-CC: Wisconsin Card Sorting Test-Categories Completed.
[a] One colourblind healthy participant – degrees of freedom (df) = 2, 56.
[b] One depressed participant incomplete due to time constraints – df = 2, 56.
[c] Missing data for two healthy participants, one participant with schizophrenia, and three participants with depression – df = 2, 51.
[1] Directionally significant mean group performance pattern with Healthy > Clinical Control > Schizophrenia.
[2] Significant mean group performance pattern with Healthy > Clinical Control > Schizophrenia.
[3] Significant mean group performance patterns with Healthy > Schizophrenia and Clinical Control > Schizophrenia Group.
[4] Significant mean group performance pattern with Healthy > Schizophrenia.
[5] Significant mean group performance pattern with Healthy > Schizophrenia and Clinical Control.

functioning measures, we used Pearson correlations among the schizophrenia participants. SPSS software was used for the statistical analyses (SPSS Inc., 2007).

3. Results

3.1. Cognitive performance comparisons

We compared the cognitive performance of the three groups of participants (Tables 1 and 3). The groups did not differ in NART performance, and showed comparable performance in category fluency, a word association task (COWAT), and verbal reasoning (WAIS-III Similarities) (Table 3). This provides evidence that word retrieval and basic verbal processing were relatively functional in the patient groups.

The groups did differ in several specific cognitive processes (Table 3). Patients with schizophrenia performed more poorly than both the healthy and psychiatric control groups on tests of: working memory and processing speed (WAIS-III Digit Symbol-Coding), executive function (WCST-CC), and complex cognitive functions requiring verbal comprehension, working memory, and social reasoning (WAIS-III Comprehension).

3.2. Anhedonia and social functioning questionnaires

We compared the social functioning reports of the participants. As expected, the healthy participants reported significantly less subjective anxiety in their social interactions (SIAS scores), higher social functioning levels (SFS scores), and better social adjustment ratings (SASS scores) than either of the psychiatric groups (Table 4). Although the two psychiatric groups showed general social deficits, they did not show the same pattern of social functioning deficits. The schizophrenia group reported better social adjustment (SASS) and less anhedonia (SHAPS) than the psychiatric control group (Table 4). This is consistent with the psychiatric control group's significantly higher levels of depression (Table 1).

3.3. Humour recognition

To test our primary hypothesis, we compared humour recognition performance among the three groups of participants (Fig. 1) and found significant differences, $F(2, 57) = 13.0$, $P < 0.001$. As predicted, the schizophrenia group showed significant and substantial deficits in humour recognition compared to the healthy group, $t(38) = 5.1$, $P < 0.001$, ES = −1.55. Equally important, was that the schizophrenia group's humour recognition performance was also poorer than that of the psychiatric control group, $t(38) = 3.6$, $P = 0.001$. The psychiatric control group's humour scores did not differ from the healthy control group, $t(38) = 1.2$, $P = 0.23$. Among humour recognition errors, false positive errors ($M = 10.0$, SD = 5.2) were much more common than false negative errors ($M = 6.8$, SD = 4.3), $F(1, 57) = 18.8$, $P < 0.001$. However, there was no error type by group interaction, $F(2, 57) = 1.7$, $P = 0.18$.

For the full sample, the same pattern of group differences was found using an analysis of covariance (ANCOVA) which controlled for age, marital status, NART scores, and the WSCT-CC scores, $F(2, 46) = 5.5$, $P = 0.007$.[2] We ran a third ANCOVA with a fifth covariate depression scores (HAM-D) which was available for the two psychiatric groups. The findings were the same. Participants with schizophrenia produced significantly more humour recognition deficits than the psychiatric control group, $F(1, 24) = 5.0$, $P = 0.035$.[3]

3.4. Humour and clinical measures

Better humour recognition in schizophrenia correlated with less severe clinical symptomolgy (PANSS total score), $r = -.57$, $P = 0.008$, and was unrelated to depressive symptoms (CDSS; $r = -.4$, $P = 0.09$; HAM-D; $r = -.2$, $P = 0.4$). In addition, humour rec-

[2] With the inclusion of an overall WAIS composite score as a second measure of general cognitive functioning, the group differences in humour recognition were the same the healthy group > schizophrenia group, $p < .05$ and psychiatric group > schizophrenia group, $p < .05$ based on directional one-tailed testing.
[3] Due to missing covariate information, the group sample sizes dropped to 14 and 17 for the psychiatric control and schizophrenia group, respectively.

Table 4
Group comparisons on anhedonia and social functioning measures.

Measure	Schizophrenia group	Clinical control group	Healthy control group	$F(2, 57)$	P	Effect size (sz-hc)
Superior healthy group performance relative to both patient groups						
SIAS −	33.5 (12.5)	38.25 (12.2)	14.4 (8.6)	25.2	<.001	1.78
SFS +	141.9 (31.0)	135.8 (25.1)	176.5 (18.2)	15.0	<.001	−1.36
Superior healthy group performance to schizophrenia group and superior schizophrenia group performance to clinical control						
SASS +	42.1 (7.2)	33.0 (7.2)	47.5 (5.0)	25.2	<.001	−0.87
RSAS −	12.2 (6.0)	18.6 (8.7)	6.6 (4.3)	16.5	<.001	1.08
Healthy and schizophrenia groups performance comparable and superior to clinical control group						
SHAPS −	.9 (1.2)	3.5 (3.1)	1.5 (1.9)	7.5	.001	−0.38

Note: the "−" symbol denotes that the higher scores on the measure reflect poorer social outcomes, while the "+" symbol denotes that higher scores on the measure reflect better social outcomes. SIS: Social Interaction Scale; SFS: Social Functioning Scale; SASS: Social Adaptation Self-Evaluation Scale; RSAS: Revised Social Anhedonia Scale; SHAPS: Snaith–Hamilton Pleasure Scale.

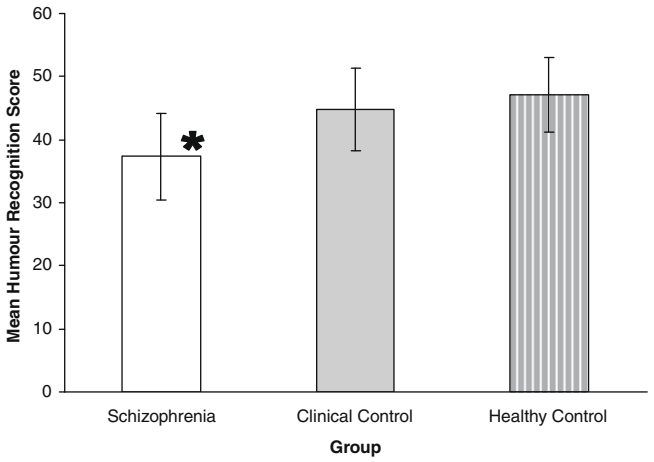

Fig. 1. Mean humour recognition scores by group. *Schizophrenia group performed significantly worse than both control groups on humour task. Schizophrenia group mean = 37.3, SD = 6.8; clinical control group mean = 44.8, SD = 6.5; healthy control group mean = 47.2, SD = 5.9.

ognition scores and use of antipsychotic medication, as measured by chlorpromazine equivalencies, were unrelated, $r = .038$, $P = 0.9$.

3.5. Cognitive correlates of humour recognition

Among the schizophrenia group, humour recognition correlated positively with general intellectual functioning (NART) $r = .45$, $P = 0.04$, social reasoning (WAIS-III Comprehension) $r = .54$, $P = 0.01$ and executive functioning (WCST-CC) $r = .69$, $P = 0.001$. Among patients with schizophrenia, humour recognition did not correlate with basic processing speed (TMT A) $r = -.24$, $P = 0.3$; working memory (WAIS-III Digit Symbol-Coding) $r = .14$, $P = 0.6$; inhibitory ability (TMT B) $r = -.13$, $P = 0.6$; inhibitory control (Stroop) $r = .16$, $P = 0.5$; verbal memory (CVLT-II) $r = .24$, $P = 0.3$; flexibility in abstract thought (WCST-PE) $r = .08$, $P = 0.8$, speed of verbal processing (category fluency), $r = .08$, $P = 0.7$, or verbal fluency (COWAT) $r = .16$, $P = 0.5$. Correlations approaching significance were found between humour recognition and both visual sequencing (WAIS-III Picture-Arrangement) $r = .43$, $P = 0.06$ and verbal reasoning (WAIS-III Similarities) $r = .41$, $P = 0.07$.

3.6. Social correlates of humour recognition

Humour recognition correlated with several of the social functioning measures among the schizophrenia participants. Better humour recognition correlated with higher social adjustment ratings (SASS scores), $r = .54$, $P = 0.02$, and less subjective anxiety in social interactions (SIAS scores), $r = -.50$, $P = 0.02$. A borderline significant correlation was present between humour recognition and better social functioning (SFS), $r = .42$, $P = 0.07$. Similarly, at a borderline level, humour recognition correlated with the amount of pleasure derived from interpersonal interactions (RSAS) $r = -.45$, $P = 0.06$.[4] No association was found between humour recognition and anhedonia (SHAPS), $r = -.14$, $P = 0.55$.

4. Discussion

A number of studies using different methods have previously demonstrated humour appreciation or recognition deficits in schizophrenia compared to healthy controls. To our knowledge, this is the first study to utilize psychiatric patients (without schizophrenia) as a comparison group. Correspondingly, the patients with schizophrenia performed significantly more poorly than both the healthy and psychiatric control groups. This result implies that humour perception deficits in schizophrenia are the result of specific cognitive deficits related to the condition rather than being due to generic mental health issues associated with persons accessing psychiatric care.

Every method of humour assessment has its own advantages and limitations. One advantage of our humour task is that it is structured as an actual test with definitive answers. Our humour test measures humour recognition as opposed to humour appreciation, the latter of which measures fondness for any particular joke. It can therefore be argued that our humour test primarily measures one's cognitive ability to recognize a humorous statement. A greater affective response could, however, help attune a participant towards the proper cognitive evaluation of whether something is intended to be funny or not. Therefore, humour appreciation cannot be entirely disentangled from the "pure" cognitive component of humour recognition.

In an attempt to better understand the precise nature of humour recognition deficits in schizophrenia, we applied an extensive battery of cognitive tasks to our study protocol. We utilized 12 varied tests (TMT A, TMT B, Stroop Color-Word Test, WAIS-III Digit Symbol-Coding, WAIS-III Similarities, WAIS-III Comprehension, WAIS-III Picture-Arrangement, COWAT, CVLT-II, a category fluency test, NART and WCST) to assess cognitive domains that might preferentially accompany humour deficits in schizophrenia. These neuropsychological tasks represent diverse aspects of higher-order cognition such as working memory, semantic memory, verbal reasoning, visual sequencing and executive functions.

Of all neuropsychological tests, WCST performance (categories completed) demonstrated the greatest correlation with humour recognition in the schizophrenia group, ($r = .69$). Although they did not specifically report WCST categories completed, Tsoi et al., in their study of humour in schizophrenia (Tsoi et al., 2008), simi-

[4] Higher RSAS scores represent less pleasure derived from interpersonal interactions.

larly found that WCST perseverative error scores correlated as well as any other measure they had compared, ($r = -.38$).

WCST performance has been extensively investigated in schizophrenia because appreciable WCST deficits are reliably found in schizophrenia (Arduini et al., 2003; Mohamed et al., 1999). WCST seems to preferentially reflect executive functioning, particularly mental flexibility through set shifting (Braff et al., 1991; Fuster, 1997). WCST deficits in schizophrenia have been found to preferentially predict social skill deficits (Lysaker et al., 1995), negative symptoms (Breier et al., 1991; Nieuwenstein et al., 2001), and measures reflecting poor insight into one's own illness (Shad et al., 2006). Theory-of-mind, a psychological construct related to psychological insight, has also been found to be compromised in schizophrenia (Brune, 2005). Two humour studies have shown some preliminary evidence that jokes preferentially utilizing theory-of-mind themes may be more difficult for many patients with schizophrenia (Corcoran et al., 1997; Marjoram et al., 2005). The postulated fundamental structure of humour – that being the comparison of a social norm to a contrasting congruous–incongruous concept – has the semblance to a set shifting neurocognitive task. Taken together, these findings support the hypothesis that executive functioning deficits may be a major factor underlying social impairment associated with schizophrenia.

A recent study suggested that WCST might be helpful to differentiate bipolar disorder from schizophrenia (Wobrock et al., 2008). Similarly, Bozikas et al. reported that although bipolar patients in remission performed slightly inferior to healthy controls using the Penn's Humor Appreciation Test, the results were statistically insignificant (Bozikas et al., 2007b). It should, however, be acknowledged that a small sample size and type-2 error could account for this non-significant finding.

We found two additional neuropsychological subtests also correlated with humour deficits in schizophrenia – WAIS-III Comprehension ($r = .54$) and the NART ($r = .45$). WAIS-III Comprehension subtest has historically demonstrated appreciable effect sizes between schizophrenia and controls (Mohamed et al., 1999). In broad terms, this test reflects verbal reasoning and social understanding – tasks that would appear to have particular relevance to both humour recognition and social reasoning. While the NART has typically been used as a proxy measure for overall IQ, it too is fundamentally linked to language skills.

Given the social nature of humour, we tested how humour recognition related to social functioning. In the schizophrenia group, higher humour recognition scores were associated with increased social adjustment (SASS scores) and less subjective anxiety in social situations (SIAS scores). Two other Social Functioning Scales, one measuring social functioning across several dimensions (SFS) and the other measuring pleasure derived from interpersonal sources (RSAS), approached significance when correlated with humour recognition in the schizophrenia group. Tsoi et al. (2008) similarly found a substantial correlation ($r = -.40$) with a negatively scored social functioning measure (Life Skills Profile). Our results, in addition to Tsoi et al.'s findings, support an association between social functioning and humour recognition.

In a similarly structured humour study, Bozikas et al. (2007a) reported a number of correlations between a non-verbal humour recognition test and certain cognitive tasks among patients with schizophrenia. However, their results were surprisingly dissimilar as they only found significant correlations to a continuous performance test, the Color-Word Stroop and a Greek verbal fluency test. Furthermore, they found a poor correlation with WCST. Possible reasons for this discrepancy may relate to slightly different approaches to diagnostic confirmation and the use of visual humor in the Bozikas et al. study versus visual–verbal humor in our study.

Fifteen of 20 psychiatric controls had notable symptoms of dysphoria (HAM-D $\geqslant 3$). Nonetheless, diminishment in humour perception did not correlate with measures of perceived pleasure or depression. This lack of any appreciable relationship between humour perception and depressive symptoms has been previously reported (Bozikas et al., 2007a; Tsoi et al., 2008). Additional support for this was found in that scores on the Calgary Depression Scale for Schizophrenia did not significantly correlate with humour recognition in the schizophrenia group.

This study shares the typical limitations associated with many psychiatric pilot studies. First, because this is an exploratory study, we have purposely not utilized a Bonferroni correction for the multiple correlations between cognitive tests and humour performance. Second, given our relatively modest sample size, we may have failed to detect additional underlying relations due to type-2 errors. Despite the modest sample size, a number of schizophrenia-specific significant associations with humour were identified. Third, we did not directly measure IQ in our subjects but estimated intelligence using the NART. In fact, there is some indication that schizophrenia participants in our study may have been less cognitively impaired than most other studies. For example, MMSE scores in our schizophrenia group tended to be higher than most schizophrenia community samples (Ganguli et al., 1998; Moore et al., 2004). However, we do not consider this to be a serious threat to the generalizability of our findings, as we would not expect to find superior humour recognition in a more cognitively impaired schizophrenia population. Fourth, our humour task does not directly take into account the affective component of humour. Other tests, for instance, have sometimes measured laughter responses. Lastly, the effect of medications, especially antipsychotics, could perhaps adversely affect humour appreciation. The sedative or anticholinergic effects of some psychiatric medications can perhaps lessen cognitive performance. However, we did not find a significant correlation between humour recognition and chlorpromazine equivalencies in the schizophrenia group ($r = .04$). Additionally, it could be argued that medication usage might have, in fact, minimized any real differences in humour perception scores between the groups (Daban et al., 2005).

5. Conclusion

We have confirmed, with a large effect size, humour recognition deficits in schizophrenia relative to healthy and psychiatric controls. We concomitantly tested participants with variety of cognitive tasks, Social Functioning Scales and clinical measures. Humour recognition performance in schizophrenia correlated best with social functioning scores, and with semantic cognitive tasks and WCST performance – especially categories completed. Conceivably, set shifting is a core executive function integral to humour and preferentially compromised in schizophrenia. Further studies with larger samples are needed. We suggest neuroimaging investigations and long-term studies evaluating the stability and predictive utility of humour deficits over time. We further propose humour measures be included in cognitive-emotional remediation and/or pharmacological trials to better appreciate the pathophysiology and clinical significance of humour perception deficits in schizophrenia.

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Conflict of interest

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