Emotional Self-Report, Socioemotional Memory,

and Anhedonia in Schizophrenia

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
IAPS	International Affective Picture System
QLS	Heinrichs-Carpenter Quality of Life Scale
NAMI	National Alliance on Mental Illness
NIH	National Institutes of Health
PANSS	Positive and Negative Syndrome Scale
PAS	Physical Anhedonia Scale
RSAS	Revised Social Anhedonia Scale
SANS	Scale for the Assessment of Negative Symptoms
SCID	Structured Clinical Interview for DSM-IV Disorders
WASI	Wechsler Abbreviated Scale of Intelligence
WRAT	Wide Range Achievement Test

SUMMARY

A secondary analysis of recognition memory and clinical data from people with schizophrenia (N = 112) and healthy control participants (N = 118) was carried out to assess the relationship between the capacity to remember stimuli of varied social and emotional content and anhedonia. Across all participants, no significant zero-order correlations were observed between memory ability and anhedonia. Analysis of memory performance revealed a content (social vs. non-social stimuli) by emotional valence (positive vs. neutral vs. negative) interaction, such that among social images, negative ones were remembered most frequently, whereas among non-social images, negative images were remembered least frequently. This pattern did not differ by diagnosis. In a hierarchical multiple regression, after controlling for diagnosis and disease severity, memory for social images explained a significant proportion of variance in anhedonia. Implications for the Strauss and Gold model of anhedonia and the Accessibility Model of Emotional Self-Report are discussed.

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Background

Anhedonia

Schizophrenia is a complex disorder characterized by positive and negative symptom clusters. While positive symptoms such as hallucinations and delusions can often be well controlled with antipsychotic medications, few effective treatments exist to treat negative symptoms, which are associated with a more severe course of illness and poor functional outcome (Rabinowitz et al., 2012). Investigations into the mechanisms that give rise to negative symptoms are critical for the development of more effective treatments and therefore represent an important agenda in schizophrenia research.

Among negative symptoms, anhedonia has long been considered a core clinical feature of the disease. Anhedonia is usually defined as a decreased capacity to experience pleasure (Horan, Kring, & Blanchard, 2006). Yet recent research has shown that this definition may not adequately describe the abnormalities observed in schizophrenia (Kring & Moran, 2008). Two recent meta-analyses show that patients consistently report levels of current positive emotion and arousal that are comparable to healthy controls when exposed to stimuli in a laboratory setting (Cohen & Minor, 2010; Llerena, Strauss, & Cohen, 2012). These studies have used a wide array of stimuli, including complex pictures, sounds, faces, words, and food (Herbener, Song, Khine, & Sweeney, 2009; Horan, Green, Kring, & Nuechterlein, 2006; Kring, Kerr, Smith, & Neale, 1993). These results imply that anhedonia should no longer be viewed as a diminished capacity to experience pleasure (Strauss & Gold, 2012).

Despite in-the-moment emotional responses that are comparable to healthy controls, patients do report reduced pleasure compared to controls when assessed through prospective and retrospective reports (Strauss, Wilbur, Warren, August, & Gold, 2011). This seemingly paradoxical discordance between current and noncurrent reports of emotion has received

increased attention in recent years (Strauss, 2013). Recent work on the nature of these discrepancies has focused on the reporting format used to assess them. To begin to understand how these discrepancies might come about, it is important to review the various measures with which the construct is assessed. The various instruments currently used to assess anhedonia in schizophrenia will therefore be reviewed here.

Current feelings. Assessments of current feelings ask participants to report how they are feeling "right now" or "in this moment". As mentioned above, patients report current positive emotional responses that are similar to healthy controls when exposed to stimuli in a controlled setting. Studies using real-world experience sampling have shown similar results (Gard, Kring, Gard, Horan, & Green, 2007; Oorschot et al., 2013). A recent meta-analysis, however, showed that patients report more current *negative* feelings in response to positive, negative, *and* neutral stimuli (Cohen & Minor, 2010). Because of this, some have suggested that anhedonia is at least in part a reflection of an increase in baseline negative emotionality (Cohen, Najolia, Brown, & Minor, 2011; Horan, Green, Kring, & Neuchterlein, 2006; Strauss & Herbener, 2011)

Noncurrent feelings. Reports of noncurrent feelings consist of retrospective, trait, hypothetical, and prospective reports. Across assessment instruments of this type, patients report less pleasure than healthy controls (Horan, Blanchard, Clark, & Green, 2008). These instruments will be reviewed in detail below.

Retrospective self-reports. Widely used semi-structured clinical interviews, such the Scale for the Assessment of Negative Symptoms (SANS) and the Heinrichs-Carpenter Quality of Life Scale (Heinrichs, Hanlon, & Carpenter, 1984), use a retrospective self-report format to assess negative symptoms, including anhedonia. The interviewer asks questions such as "What did you do for fun over the last two weeks? How did that make you feel?"

Hypothetical self-reports. Other self-reports measures, such as the Chapman Physical and Social Anhedonia Scales (Chapman, Chapman, & Raulin, 1976) ask participants to rate how they think they would feel in a given hypothetical scenario, e.g. "True or False: Although there are things that I enjoy doing by myself, I usually seem to have more fun when I do things with other people". Patients consistently report diminished pleasure using these instruments as well (Horan, Blanchard, Clark, & Green, 2008).

It is worth noting that the hypothetical nature of the Chapman scales could vary from person to person, depending on the extent of that individual's experience with any given item. It could be argued that these reports are retrospective in nature, since past experience almost certainly has some bearing on one's responses. Even so, the Chapman scales are more hypothetical than the SANS or QLS, for example, which ask about specific periods of the recent past. As such, the Chapman scales will be considered hypothetical measures for the purposes of this study.

Trait self-reports. Trait self-reports of emotion are also diminished in people with schizophrenia (Horan, Blanchard, Clark, & Green, 2008). These instruments, such as the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988), ask participants to rate how they feel in general. For example, a typical question might ask, "In general, how happy do you feel?" with responses ranging from 1 [not at all] to 5 [extremely].

Prospective self-reports. Reporting tools of this type ask participants to predict a future emotional response. Several studies have indicated that patients predict lower emotional responses than controls, leading some to conclude that anhedonia in schizophrenia is characterized by deficits in "anticipatory pleasure." In a naturalistic experience sampling study of this type, Gard et al. (2007) asked patients and healthy controls to record what they were

doing and how much they were enjoying it at seven time points each day for seven days. Participants were also asked to record what they were looking forward to doing and how much they expected to enjoy those activities. Patients reported similar levels of pleasure during their daily activities but predicted that they would enjoy upcoming activities less than healthy controls did. The Temporal Experience of Pleasure Scale (Gard et al., 2007) was developed to explicitly assess these differences in consummatory versus anticipatory pleasure. While the finding of reduced anticipatory and intact consummatory pleasure in schizophrenia has been replicated cross-culturally (Chan et al., 2010), contradictory findings have also been reported with this scale in particular (Strauss, Wilbur, et al., 2011).

Accessibility Model of Emotional Self-Report

Strauss and Gold (2012) have drawn on insights from the affective neuroscience literature to explain observed discrepancies between intact current and diminished noncurrent self-reports of emotion. In their accessibility model of emotional self-report, Robinson and Clore (2010) describe four memory systems involved in emotional self-report: experiential knowledge, episodic memory, situation-specific beliefs, and identity-related beliefs. In this model, people are thought to prioritize these sources of information, relying first on that information which is most relevant and available. When reporting current feelings, therefore, individuals tap into experiential knowledge of what they are experiencing in the moment, a task mostly reliant upon working memory. When asked to recall emotional experience retrospectively, however, they access episodic memory stores to re-create a mental image of past experiences. If a sufficiently strong mental representation cannot be formed (either due to a disruption of the episodic memory system or a lack of experiences from which to draw), semantic knowledge, such as situation-

specific or identity-related beliefs, would then be used (e.g. "social interactions are enjoyable" or "I am a generally happy person").

Evidence supporting this model has been found in both people with schizophrenia and healthy control participants. Mitchell, Thompson, Peterson, & Cronk (1997) asked healthy volunteers to rate how much they expected to enjoy an upcoming vacation, how much they were enjoying it during the vacation, and how much that had enjoyed once they returned. They found that people tend to overestimate their level of pleasure prospectively and retrospectively compared to what they actually experience while on vacation. The authors describe this effect as a “rosy view” of describing events. To test the hypothesis that patients and controls show similar patterns of emotional responsiveness, Strauss and Gold (2012) examined correlations among multiple current and non-current reports of anhedonia. Consistent with this view, in both patients and controls, measures of retrospective, prospective, trait, and hypothetical emotional response correlated more highly among with each other than with in-the-moment emotional responses to photographic stimuli.

Taken together, these results indicate that the “emotional paradox” of schizophrenia may not be paradoxical at all. In fact, it may follow quite logically considering that healthy controls also report differences in current emotion when compared to recollections of past and predictions of future emotion (Ito & Cacioppo, 2005; Norris, Larsen, Crawford, & Cacioppo, 2011). Specifically, it seems that healthy people tend to *overestimate* how much pleasure they will experience at future point in time (Gilbert & Wilson, 2007). The deficits observed in schizophrenia may, therefore, stem from a reduction in the overestimation of past and future pleasure that healthy people regularly perform. More studies are required, however, to determine the validity of this claim.

Strauss and Gold (2012) assimilated these findings and presented a novel theoretical framework of anhedonia in schizophrenia. They propose that anhedonia consists of three main components: 1) low pleasure beliefs and a lack of prospective or retrospective overestimation of positive emotion, 2) reduced pleasure-seeking behavior, and 3) elevated negative emotions.

Social Cognition

Thus far, we have described the purported relationships between semantic, episodic and working memory in self-reports of anhedonia. Yet memory deficits represent just a single component of the myriad cognitive deficits associated with schizophrenia. Particularly, deficits in social cognition may particularly influence the severity of social anhedonia. It is now well established that people with schizophrenia often have difficulty perceiving and processing social cues such as facial and vocal emotional expression (Gur, Keutmann, & Gur, 2010) as well as more complex social interactions. These deficits also likely contribute to poor social functioning (Couture, Penn, & Roberts, 2006). These findings can be viewed in the context of broader neurocognitive deficits in the disorder, which are also well known (R. W. Heinrichs & Zakzanis, 1998). Among these, deficits in episodic memory are among the areas of greatest impairment (Reichenberg & Harvey, 2007) and are also associated with poor clinical and functional outcomes (Green, Kern, Braff, & Mint, 2000).

In recent years, particular emphasis has been given to the role of emotional memory in schizophrenia and its relationship to clinical symptoms (Herbener, 2008). It is now well established that healthy people remember emotionally salient stimuli better than non-emotional stimuli. This emotional memory boost is diminished in people with schizophrenia. For example, while patients display memory deficits overall, they show a particularly blunted memory enhancement for positively valenced emotional images compared to healthy controls (Herbener,

Rosen, Khine, & Sweeney, 2007). Since social stimuli contain great capacity for emotional salience, it follows logically that there could be important implications in the way people with schizophrenia remember social stimuli, yet no studies to date have examined memory for social versus non-social stimuli in this population. The proposed research also addresses this gap in the schizophrenia literature.

Hypotheses

Strauss and Gold model of anhedonia. The proposed research will evaluate several specific hypotheses predicted by the Strauss and Gold (2012) model by examining the relationship between episodic memory and retrospective and hypothetical self-reports of anhedonia in both people schizophrenia and healthy controls.

Hypothesis 1. In people with schizophrenia, retrospective reports of pleasure (i.e. Item 17, "Anhedonia," Heinrichs-Carpenter Quality of Life Scale) will correlate more highly with recognition memory performance than hypothetical self-reports (i.e. Chapman Anhedonia scales) since, according to the accessibility model of emotional self-report, retrospective reports and recognition performance rely more heavily on episodic memory, while anhedonia scores rely more heavily on situational and/or identity beliefs.

Social cognition. In addition, the proposed research will examine the relationship between memory for social versus non-social images and anhedonia.

Hypothesis 2. Consistent with previous literature on broad cognitive deficits in schizophrenia, we hypothesize that patients will recollect both social and non-social images more poorly than healthy controls.

Hypothesis 3. Extending previous work showing that patients display a poorer memory for positive images relative to healthy people (Herbener et al., 2007), we hypothesize that

healthy control participants will remember social stimuli better than non-social stimuli, but that this social stimulus advantage will be diminished in people with schizophrenia. This represents a potentially novel finding.

Hypothesis 4. Finally, we hypothesize that impairment in memory for social stimuli will predict social anhedonia among people with schizophrenia. If people with schizophrenia have a specific deficit for remembering social stimuli, they would default to broad, identity-related beliefs. If people with schizophrenia have low pleasure beliefs about themselves, as some previous research suggests, this should, in turn, lead to lower reports of pleasure on the Chapman scale. We expect to see this effect even after controlling for potential confounding variables, such as age, sex and overall memory performance.

Methods

Overview

This study consisted of secondary data analyses of a recognition memory task and clinical scales in a sample of people with schizophrenia spectrum disorders and healthy control participants. In the first part of the study, stimuli from the memory task were re-coded as either social or non-social and measures of memory discrimination and bias were calculated. In the second part of the study, memory performance and clinical scales data were analyzed to test the specific hypotheses of the Strauss and Gold model of anhedonia outlined above. In addition, the relationship between social memory and clinical symptoms were examined.

Participants

People with schizophrenia spectrum disorders were recruited at the University of Illinois at Chicago through ads in the community, special interest websites (e.g. National Institutes of Health [NIH] and the National Alliance on Mental Illness [NAMI]), and physician referral. Forty-eight patients met DSM-IV criteria for schizophrenia; 7 met criteria for schizoaffective disorder. All were clinically stable outpatients at the time of the study with at least a 4-week history of stable medications. Healthy control participants were recruited through ads in public places (e.g. public transit and supermarkets). Healthy participants were screened to exclude for a history of head trauma with loss of consciousness, current substance abuse, and neurological or systemic disease.

The original sample consisted of 55 patients with schizophrenia spectrum disorders and 63 healthy control participants (N = 118). To exclude mental retardation as an explanatory factor in this study, only participants with IQ greater than 70 were included in the final analysis. Five patients with IQ < 70 and one patient with no IQ score available were excluded. In addition, one patient was excluded during analysis of the recognition memory data due to performance that

was well below chance level, indicating a possible confusion of the response choices. Demographics of the final sample (N = 112) are shown in Table 1. Two-tailed t-tests of age, premorbid intelligence (Wide-Range Achievement Test) and IQ scores and a chi-squared test of gender indicated no significant differences between groups. For these and all subsequent analyses, an a priori significance threshold of .05 was selected.

Clinical Assessment

All participants were diagnostically assessed using the Structured Clinical Interview for DSM Disorders (SCID). In addition, all participants were assessed for social and physical anhedonia using the Revised Social Anhedonia Scale (RSAS; Eckblad & Chapman, 1982) and the Physical Anhedonia Scale (PAS; Chapman & Chapman, 1978). The RSAS is a 40-item scale that measures pleasure derived from interpersonal interaction. The PAS is a 61-items scale measuring the extent to which pleasure is derived from the five senses.

Table 1

Demographics

	SZ (n = 49)		HC (n = 63)		
Characteristic	*M (SD)*	*n*	*M (SD)*	*n*	Group Differences
Age (years)	36.4 (11.2)		38.3 (11.1)		*ns*
WRAT IQ	95.1 (14.3)		97.3 (11.6)		*ns*
WASI IQ	97.5 (17.6)		100.9 (12.7)		*ns*
Female		23		31	*ns*
Male		26		32	

WRAT: Wide Range Achievement Test

WASI: Wechsler Abbreviated Scale of Intelligence

Two additional scales were used to assess patients only. Clinical symptoms were assessed using the Positive and Negative Syndrome Scale (PANSS; Kay, Fiszbein, & Opler, 1987). This 30-item scale measures consists of 3 subscales that measure positive symptoms, negative symptoms, and general psychopathology, respectively. Symptoms of the deficit syndrome were assessed using the Heinrichs-Carpenter Quality of Life Scale (QLS; Heinrichs, Hanlon, & Carpenter, 1984), a 21-item semi-structured interview. QLS data was available for 63 out of the 67 patients included in this analysis.

Memory Task

Participants were shown 90 digital photos from the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 2008) with either social or non-social content. Social content was defined as the presence of a human face. Photos were displayed for 3s each in blocks of 10, with 15s delay between blocks. Participants were asked to rate each image on the

intensity of the emotional response it evoked. To allow for incidental encoding, participants were not instructed that they would be subsequently asked to remember the photos. On the next day, participants were shown another set of 126 IAPS photos in blocks containing 7 novel and 7 previously viewed images each. Old and new images were equated on valence, arousal and social content. Participants were asked to indicate by key press whether or not they had seen the photo on the previous day. All participants were compensated financially for their participation.

A previous study using this dataset focused on the emotional valence of the visual stimuli (Herbener, 2007). Stimuli were re-coded to take into account the presence or absence of social content as well. A social stimulus was be operationally defined as an image containing at least one discernible human face. Measures of recognition memory, including Pr as an indicator of discrimination, and Br as a measure of bias, were calculated for each of the resulting six categories of stimuli (3 valence X 2 content). Pr is the accurate recognition rate minus the false positive rate and Br is calculated with the following equation: false positives/[1 – (accurate recognition rate – false positive rate)]. These measures are recommended for assessment of group differences (Snodgrass & Corwin, 1988).

Statistical Analyses

Hypotheses 1. To test the novel hypotheses predicted by the Strauss and Gold model, discrimination memory performance scores for each of the 6 stimulus categories were correlated with scores on Item 17 ("Anhedonia") of the QLS and Chapman Physical and Social Anhedonia scores. Differences between correlation coefficients were tested using the Fisher transformation and then compared using a standardized Z-test. Because the QLS and Chapman scores are coded in opposite directions to indicate more anhedonia, the QLS was reverse scored such that higher scores reflect higher anhedonia.

Hypotheses 2 and 3. To test for overall memory performance deficits and the social stimulus advantage hypotheses, discrimination and bias measures were analyzed using a two (group: patient vs. control) by two (stimulus type: social vs. non-social) by three (valence: positive vs. negative vs. neutral) mixed model analysis of variance (ANOVA) with group as a between-subjects variable and stimulus type and valence as within-subjects variables.

Hypothesis 4. Hierarchical multiple regression was used to test whether social memory deficits predict social anhedonia as assessed by the Chapman scale. Age, sex, overall memory performance, and social memory were entered as predictor variables and social anhedonia was the outcome variable. All variables are continuous measures with the exception of sex, which is categorical with two levels. Diagnosis is the hypothesized dichotomous moderator (schizophrenia vs. control). The first model includes only potential confounding variables age and sex. The second model adds non-social memory performance. The third model adds the predictors of interest – diagnosis and social memory performance. The fourth and final model adds the interaction of diagnosis and social memory performance. An F-test was then performed to test the change in R^2 due to the interaction.

Results

Hypothesis 1

We predicted that among people with schizophrenia, retrospective reports of pleasure (i.e. Item 17, "Anhedonia," Heinrichs-Carpenter Quality of Life Scale) would correlate more highly with recognition memory performance than hypothetical self-reports (i.e. Chapman Anhedonia scales). Contrary to our hypothesis, no significant differences were observed in the correlations between memory and Item 17 of the QLS or the Chapman Physical or Social Anhedonia scales for any of the stimulus categories. In addition, no significant correlations were observed when stimuli groups were collapsed across stimulus type. See **Table 2** for the correlation coefficients.

Table 2

Absolute Values of Pearson Correlation Coefficients of Recognition Memory Performance and Clinical Rating Scores

	SZ			HC	
	QLS Item 17 Anhedonia	Chapman Social Anhedonia	Chapman Physical Anhedonia	Chapman Social Anhedonia	Chapman Physical Anhedonia
Social –					
All stimuli	.06	.23	.15	.14	.27
Positive	.23	.28	.24	.03	.25
Neutral	.15	.04	.01	.18	.22
Negative	.00	.17	.15	.12	.33*
Non-Social –					
All stimuli	.00	.03	.05	.09	.23
Positive	.02	.09	.08	.10	.08
Neutral	.00	.06	.12	.10	.21
Negative	.03	.02	.01	.06	.22

*p = .009

Hypotheses 2 and 3

Consistent with Hypothesis 2 (which posited that patients would do more poorly on the task than healthy controls), a main effect of diagnosis, $F(1,110) = 8.39$, $p < .001$, was observed in the predicted direction. In addition, a main effect of content, $F(1,110) = 23.57$, $p < .001$, and a content by valence interaction, $F(2,220) = 20.28$, $p < .001$, were also observed. The content by valence interaction was followed-up across all subjects with the Fisher's Least Square Difference test (see below). Contrary to Hypothesis 3, however, which predicted a different pattern of social and non-social memory for patients and controls, no diagnosis by content interaction was observed, $F(1,110) = 0.81$, *ns*. A linear contrast testing whether schizophrenia subjects demonstrated a different pattern of response to valence than did healthy subjects, was at a trend level $F(1,110) = 2.60$, $p = .11$. Results of the mixed model ANOVA of discrimination memory scores indicated no three-way diagnosis by content by valence interaction, $F(2,220) = 0.29$, *ns.*

Since diagnosis did not interact with any of the other effects in the model, the data were subsequently re-analyzed removing diagnosis as a between-subjects variable. In this model, there remained a significant main effect of content, $F(1,111) = 23.6$, $p < .001$ and a content by valence interaction, $F(2,222) = 20.4$, $p < .001$. Fisher's Least Square Difference post-hoc comparisons indicated that for non-social images, positive stimuli were remembered better than negative ones, whereas for social images, negative images were remembered better than either neutral or positive images. See Figure 1 and Table 3 for details.

Figure 1
Discrimination memory scores by content and valence

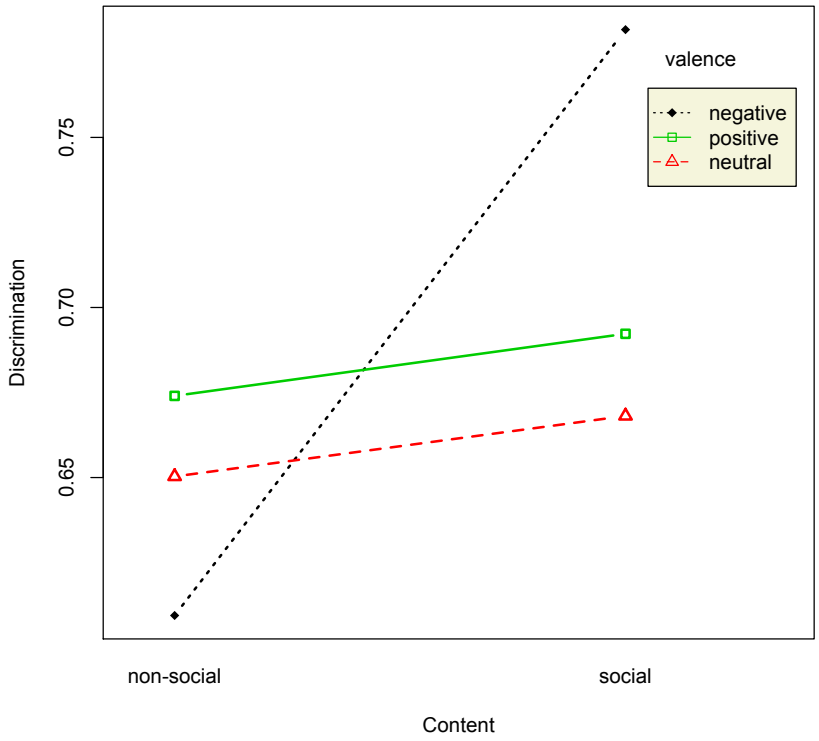

Table 3

Discrimination memory performance scores across all participants

Content	Valence	*M*	*SD*	FLSD
Non-social	Negative	0.61	0.20	
	Neutral	0.65	0.24	a, b, d
	Positive	0.67	0.21	a, c
Social	Negative	0.78	0.25	
	Neutral	0.67	0.29	b, c, e
	Positive	0.69	0.26	d, e

Notes: FLSD: Fisher's Least Square Difference.
Common letter designations indicate non-significant pairwise comparisons,
i.e. two scores with the same letters do not significantly differ from one another.

Hypothesis 4

A hierarchical multiple regression approach was used to analyze the relationship between social memory and social anhedonia. See Table 4 for a summary of the regression models and standardized regression coefficients. In Model 1, potential confounding variables of age and sex were regressed against social memory scores. Neither predicted a significant proportion of variance in the outcome. In Model 2, non-social memory was added as a predictor. It too did not predict a significant proportion of variance in social anhedonia. In Model 3, the main predictors of interest, diagnosis and social memory, were added. In this model, social memory significantly predicted social anhedonia (B = - 0.33, SE = 0.14, p = .017), whereas diagnosis demonstrated only a trend effect (B = 0.36, SE = 0.19, p = .064). These results indicate that even after controlling for overall disease severity and diagnosis, social memory predicts a significant proportion of unique variance in social anhedonia. In the final model (Model 5), a diagnosis by interaction term was added to assess whether the effect of social memory on social anhedonia was different for patients and controls. This interaction term was non-significant.

Table 4

Standardized Regression Coefficients of Predictors of Social Anhedonia

	Model 1	Model 2	Model 3	Model 4
Age	-0.15	-0.19	-0.18	-0.18
Sex: Male	0.28	0.23	0.23	0.23
Non-social memory		-0.15	0.15	0.15
Social memory			-0.33*	-0.37*
Diagnosis: SCZ spectrum			0.36	0.36
SCZ * social memory				0.08
R-squared	.05	.07	.16	.16

* $p < .05$

Discussion

This study examined the relationship between recognition memory and anhedonia from the perspectives of both social cognition and the Strauss and Gold model of anhedonia. Two main findings were observed. First, after controlling for non-social memory, social memory predicted a significant additional proportion of variance in social anhedonia among people with schizophrenia. Secondly, among both patients and controls, negative social images were recalled better than neutral or positive images, whereas negative non-social images were recalled more poorly than neutral or positive non-social images.

We hypothesized that, in patients, retrospective reports of pleasure would correlate more highly with recognition memory performance than hypothetical self-reports (Hypothesis 1). Contrary to these hypotheses, when considered in isolation, social and non-social recognition memory performance did not correlate significantly with either retrospective or hypothetical reports of pleasure in either group. (See below for discussion of Hypothesis 4, in which the effect of social memory was examined after regressing out the effect of non-social memory). Hypotheses 1 was predicated upon the idea that recognition memory scores would correlate at least moderately with clinical scores. This turned out not to be true.

There are a number of factors that could lead to the low levels of association observed. The retrospective reporting format used a single item taken from a larger measure of negative symptoms, which likely leads to a low reliability of this measure. Another possible explanation is that anhedonia arises from a process that is truly unrelated to memory systems. It is also possible that a subtle relationship between the two exists, but the clinical or cognitive measures used are not sensitive enough to measure it accurately.

The results of the analyses of the recognition memory task by social content and valence partially replicate previous findings. In support of Hypothesis 2, and consistent with previous findings, patients performed more poorly on the memory task overall than healthy controls. We also found that social content and emotional valence of stimuli influenced memory, which is also consistent with previous literature. A trend effect of a diagnosis by valence interaction (Hypothesis 3) is also consistent with a previous finding of a failure of positive, but not negative, stimuli to enhance memory in schizophrenia, suggesting that part of the difference captured in the analyses of valence alone were influenced by differential responses to valenced social content. It is worth noting, too, that while some of the data used in this study overlap with previously published findings (Herbener, Rosen, Khine & Sweeney, 2007), the sample used in this study is larger.

Our results support Hypothesis 4, which predicted that, after controlling for non-social memory and demographic variables, memory for social images would predict a significant additional proportion of variance in social anhedonia. The lack of a diagnosis by social memory interaction may indicate that a similar pattern is ongoing in both healthy people and those with schizophrenia. If episodic memory is indeed contributing to social anhedonia scores in both people with schizophrenia and healthy controls, this would seem to go against the Strauss and Gold model.

Taken together, the results of this study do not support the Strauss and Gold model, at least as it was interpreted in this study. Alternative explanations should also be considered. For example, as mentioned previously, the Strauss and Gold model implies that below some threshold of working memory capacity, responses to hypothetical self-reports of pleasure would be based on broad, identity-related beliefs. Implicit in our hypotheses regarding correlations

between memory scores and clinical scales was the assumption that with stronger working memory, people will report experiencing pleasure with all of the Chapman items. It is plausible, however, that someone could have a strong mental representation of *not* liking a certain activity (e.g. riding in a car with others). If this were to occur in a significant proportion of participants on a significant number of items, one might expect to see the lack of correlation observed here. In addition, if it is true that people with poorer working memory are using identity-related beliefs, responses should correlate not with memory capacity but with the relative positivity or negativity of those beliefs, a phenomenon that could not be directly tested with the measures available for this study. In sum, further investigation is needed to provide more specific evidence for or against the multiple response patterns that are conceivably consistent with the Strauss and Gold model.

The conclusions of this study should be considered in light of significant limitations. The QLS measure of anhedonia is a single item out of a larger scale, and is therefore necessarily less reliable than a full scale would be. Furthermore, recognition memory tasks involving static photos may not be ecologically valid, given that most naturalistic social interactions involve live, animated people. However, the 24-hour delay incidental encoding paradigm does allow for a more naturalistic design than many others that have been used in the literature previously. Ecological validity could also be improved in future studies by using photographs of people who are known to the participant, rather than the nomothetic stimuli used here.

In addition, photographic stimuli often differ from one another on multiple dimensions, only two of which were controlled for in this study (emotional valence and social content). Photos might also differ from one another in the kinds of social and non- social content depicted, brightness, color, and any number of other factors that may influence the rate at which

participants accurately identify them during a recognition memory task. We attempted to limit these effects by balancing the photos along certain dimensions, but it is impossible to balance among every possible variable that could influence the results and thereby provide alternative explanations for the findings observed here.

Cited Literature

Chan, R. C. K., Wang, Y., Huang, J., Shi, Y., Wang, Y., Hong, X., … Kring, A.M. (2010). Anticipatory and consummatory components of the experience of pleasure in schizophrenia: cross-cultural validation and extension. *Psychiatry Research*, *175*(1-2), 181–3. doi:10.1016/j.psychres.2009.01.020

Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1976). Scales for physical and social anhedonia. *Journal of Abnormal Psychology*, *85*(4), 374.

Cohen, A. S., & Minor, K. S. (2010). Emotional experience in patients with schizophrenia revisited: meta-analysis of laboratory studies. *Schizophrenia Bulletin*, *36*(1), 143–50. doi:10.1093/schbul/sbn061

Cohen, A. S., Najolia, G. M., Brown, L. a, & Minor, K. S. (2011). The state-trait disjunction of anhedonia in schizophrenia: Potential affective, cognitive and social-based mechanisms. *Clinical Psychology Review*, *31*(3), 440–8. doi:10.1016/j.cpr.2010.11.001

Couture, S. M., Penn, D. L., & Roberts, D. L. (2006). The functional significance of social cognition in schizophrenia: A review. *Schizophrenia Bulletin*, *32 Suppl 1*, S44–63. doi:10.1093/schbul/sbl029

Gard, D. E., Kring, A. M., Gard, M. G., Horan, W. P., & Green, M. F. (2007). Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. *Schizophrenia Research*, *93*(1-3), 253–60. doi:10.1016/j.schres.2007.03.008

Gilbert, D. T., & Wilson, T. D. (2007). Prospection: Experiencing the future. *Science*, *317*(5843), 1351–4. doi:10.1126/science.1144161

Green, M. F., Kern, R. S., Braff, D. L., & Mint, J. (2000). Neurocognitive deficits and functional outcome in schizophrenia : Are we measuring the "right stuff "? *Schizophrenia Bulletin*, *26*(1), 119–136.

Gur, R. C., Keutmann, M. K., & Gur, R. E. (2010). Understanding emotion processing in schizophrenia. *Die Psychiatrie*, *7*, 217–226.

Heinrichs, D. W., Hanlon, T. E., & Carpenter, W. T. (1984). The Quality of Life Scale: An instrument for rating the schizophrenic deficit syndrome. *Schizophrenia Bulletin*, *10*(3), 388–98. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6474101

Heinrichs, R. W., & Zakzanis, K. K. (1998). Neurocognitive feficit in schizophrenia : A Quantitative Review of the Evidence, *Neuropsychology, 12*(3), 426–445.

Herbener, E. S. (2008). Emotional memory in schizophrenia. *Schizophrenia Bulletin*, *34*(5), 875–87. doi:10.1093/schbul/sbn081

Herbener, E. S., Rosen, C., Khine, T., & Sweeney, J. A. (2007). Failure of positive but not negative emotional valence to enhance memory in schizophrenia. *Journal of Abnormal Psychology*, *116*(1), 43–55. doi:10.1037/0021-843X.116.1.43

Herbener, E. S., Song, W., Khine, T. T., & Sweeney, J. A. (2009). What aspects of emotional functioning are impaired in schizophrenia, *Schizophrenia Research, 98*, 239–246. doi:10.1016/j.schres.2007.06.025.What

Horan, W. P., Blanchard, J. J., Clark, L. A., & Green, M. F. (2008). Affective traits in schizophrenia and schizotypy. *Schizophrenia Bulletin*, *34*(5), 856–74. doi:10.1093/schbul/sbn083

Horan, W. P., Green, M. F., Kring, A. M., & Nuechterlein, K. H. (2006). Does anhedonia in schizophrenia reflect faulty memory for subjectively experienced emotions? *Journal of Abnormal Psychology*, *115*(3), 496–508. doi:10.1037/0021-843X.115.3.496

Horan, W. P., Kring, A. M., & Blanchard, J. J. (2006). Anhedonia in schizophrenia: A review of assessment strategies. *Schizophrenia Bulletin*, *32*(2), 259–73. doi:10.1093/schbul/sbj009

Ito, T., & Cacioppo, J. (2005). Variations on a human universal: Individual differences in positivity offset and negativity bias. *Cognition & Emotion*, *19*(1), 1–26. doi:10.1080/02699930441000120

Kay, S. R., Fiszbein, a, & Opler, L. a. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*(2), 261–76. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/22420580

Kring, A. M., Kerr, S. L., Smith, D. A., & Neale, J. M. (1993).Flat affect in schizophrenia does not reflect diminished subjective experience of emotion. *Journal of Abnormal Psychology*, *102*(4), 507–517.

Kring, A. M., & Moran, E. K. (2008). Emotional response deficits in schizophrenia: insights from affective science. *Schizophrenia Bulletin*, *34*(5), 819–34. doi:10.1093/schbul/sbn071

Llerena, K., Strauss, G. P., & Cohen, A. S. (2012). Looking at the other side of the coin: A meta-analysis of self-reported emotional arousal in people with schizophrenia. *Schizophrenia Research*, *142*(1-3), 65–70. doi:10.1016/j.schres.2012.09.005

Mitchell, T., Thompson, L., Peterson, E., & Cronk, R. (1997). Temporal Adjustments in the Evaluation of Events: The “Rosy View”. *Journal of Experimental Social Psychology*, *33*(4), 421–48. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9247371

Norris, C. J., Larsen, J. T., Crawford, L. E., & Cacioppo, J. T. (2011). Better (or worse) for some than others: Individual differences in the positivity offset and negativity bias. *Journal of Research in Personality*, *45*(1), 100–111. doi:10.1016/j.jrp.2010.12.001

Oorschot, M., Lataster, T., Thewissen, V., Lardinois, M., Wichers, M., Van Os, J., Delespaul, P., et al. (2013). Emotional experience in negative symptoms of schizophrenia--no evidence for a generalized hedonic deficit. *Schizophrenia Bulletin*, *39*(1), 217–25. doi:10.1093/schbul/sbr137

Rabinowitz, J., Levine, S. Z., Garibaldi, G., Bugarski-Kirola, D., Berardo, C. G., & Kapur, S. (2012). Negative symptoms have greater impact on functioning than positive symptoms in schizophrenia: Analysis of CATIE data. *Schizophrenia Research*, *137*(1-3), 147–50. doi:10.1016/j.schres.2012.01.015

Reichenberg, A., & Harvey, P. D. (2007). Neuropsychological impairments in schizophrenia: Integration of performance-based and brain imaging findings. *Psychological Bulletin*, *133*(5), 833–58. doi:10.1037/0033-2909.133.5.833

Robinson, M. D,, & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 128*:934–960.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: applications to dementia and amnesia. *Journal of Experimental Psychology. General*, *117*(1), 34–50. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2966230

Strauss, G. P. (2013). The emotion paradox of anhedonia in schizophrenia: or is it? *Schizophrenia Bulletin*, *39*(2), 247–50. doi:10.1093/schbul/sbs192

Strauss, G. P., & Gold, J. M. (2012). A new perspective on anhedonia in schiozphrenia. *American Journal of Psychiatry*, *169*, 364–373.

Strauss, G. P., & Herbener, E. S. (2011). Patterns of emotional experience in schizophrenia: Differences in emotional response to visual stimuli are associated with clinical presentation and functional outcome. *Schizophrenia Research*, *128*(1-3), 117–23. doi:10.1016/j.schres.2011.01.010

Strauss, G. P., Robinson, B. M., Waltz, J. A., Frank, M. J., Kasanova, Z., Herbener, E. S., & Gold, J. M. (2011). Patients with schizophrenia demonstrate inconsistent preference judgments for affective and nonaffective stimuli. *Schizophrenia Bulletin*, *37*(6), 1295–304. doi:10.1093/schbul/sbq047

Strauss, G. P., Wilbur, R. C., Warren, K. R., August, S. M., & Gold, J. M. (2011). Anticipatory vs. consummatory pleasure: What is the nature of hedonic deficits in schizophrenia? *Psychiatry Research*, *187*(1-2), 36–41. doi:10.1016/j.psychres.2011.01.012

Watson, D., Clark, L. A, & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–70. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3397865