Journal of Psychopathology and Behavioral Assessment (2020) 42:714–724
https://doi.org/10.1007/s10862-020-09818-3

Learning the Affective Value of Others in Schizophrenia: Examining the Role of Negative Symptoms and Cognitive Deficits

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Published online: 9 June 2020

Abstract

Prior research has examined the hypothesis that negative symptoms, such as anhedonia and lack of motivation, are caused by impaired memory for positive or rewarding experiences. Results have been inconsistent and less work has examined memory for socially-relevant information. The current study employed a repeated measures design to assess immediate and delayed recall of valenced material among 50 individuals with schizophrenia or schizoaffective disorder and 25 demographically-matched controls. We examined the contribution of negative symptoms and cognitive deficits to the recall of positive material on two different tasks: 1) recall for valenced words and 2) the associative learning of valenced social acts paired with facial stimuli. Results indicated that for the word list recall task, individuals with schizophrenia recalled fewer negative words during the immediate recall phase than controls. On the social affective learning task, individuals with schizophrenia, compared to controls, demonstrated poorer learning of positive social behavior associations. Within individuals with schizophrenia, cognitive impairment, but not symptoms, was related to poorer performance on both tasks. In controls, symptoms reflecting deficits in social motivation and pleasure (but not cognitive functioning) were associated with poorer performance in learning associations with positive social behaviors on the affective learning task. Findings suggest that poor learning and recall of positive information in schizophrenia is particularly salient for social stimuli and that reduced recall of social information in schizophrenia is related to general cognitive ability but not negative symptoms. Implications for findings and future directions are discussed.

Keywords Schizophrenia · Affective learning · Negative symptoms · Emotional memory · Cognition

Negative symptoms of schizophrenia are characterized by deficits in motivation and pleasure (anhedonia) as well as diminished expressivity, and they contribute to profound social and functional impairments (Blanchard et al. 2017; Blanchard and Cohen 2006; Kring et al. 2013; Rocca et al. 2014). Given that the capacity to experience pleasure is intact in schizophrenia (e.g., Cohen and Minor 2010; Kring and Kring and Elis 2013), it has been suggested that impaired memory for pleasurable or rewarding activities might contribute to the diminution of goal-related behavior and, over time, increased negative symptoms (Herbener 2008; Herbener et al. 2007; Horan et al. 2006; Lepage et al. 2007).

At the diagnostic level, several studies suggest that the performance of individuals with schizophrenia is characterized by a failure of positively valenced material to enhance memory (Herbener 2008; Herbener et al. 2007; Koh et al. 1981) and an intact memory for negative stimuli (Calev and Edelist 1993; Herbener et al. 2007). However, some work has indicated that the diminished recall is not specific to positive material but is evident across both positively and negatively valenced material (Lakis et al. 2011). Other studies have found that individuals with schizophrenia, in comparison to healthy controls, display similar recall or recognition of emotional material (Horan et al. 2006; Koh et al. 1976; Mathews and Barch 2004; Olsen et al. 2015; Sergerie et al. 2010). At least one study has found differences across recognition and recall tasks as Hall et al. (2007) reported that, within individuals with schizophrenia, recognition memory was not enhanced by emotional stimuli but that there was evidence of enhanced recall of both positive and negative valenced material. Perhaps one reason for these discrepant findings is that

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the delay period between initial learning and later recall has not been long enough as several researchers have found enhanced memory for negative stimuli and reduced memory for positive stimuli when delay periods are twenty-four hours or greater (Dieleman and Roder 2012; Herbener et al. 2007). This may then lead to the recalling of previously enjoyable activities as less pleasurable than they actually were (Horan et al. 2006).

Focusing on negative symptom correlates of valenced or emotion-related memory, results are again quite variable with limited evidence for negative symptoms of any type being differentially related to the recall or recognition of positively valenced material. Hall et al. (2007) reported that increased overall negative symptoms were related to decreased recall for neutral scenes and decreased recognition of both neutral and negative scenes. Mathews and Barch (2004) found that greater blunted affect was correlated with decreased improvement of memory for highly arousing positive and negative words. Olsen et al. (2015) found that in females with schizophrenia self-reported trait social anhedonia was related to poorer recognition memory of pictures irrespective of the valence of images. Jang et al. (2016) reported that individuals with schizophrenia who have high self-reported motivation and pleasure deficits made more recognition errors for positive facial stimuli than controls. Other researchers have failed to find an association between negative symptoms or trait anhedonia and various assessments of emotion-related memory (Harvey et al. 2009; Horan et al. 2006).

It is unclear why there are such variable associations between emotion-related memory performance and negative symptoms. Small samples with low power could contribute to null findings (the above studies correlating negative symptoms and memory had clinical samples ranging from 20 to 33 participants). Task differences including stimuli (e.g., words versus photos), the methods of testing memory (recognition versus recall; immediate versus delayed; recall of material versus recall of subjective experience) as well has how symptoms are assessed may be relevant. In terms of stimuli, past studies have employed word lists (Mathews and Barch 2004), food and films (Horan et al. 2006), and pictures with human and nonhuman content (Hall et al. 2007; Herbener et al. 2007).

Given that negative symptoms include social affiliative deficits (e.g., social anhedonia, asociality), it may be informative to more closely examine the association between these negative symptoms and learning and memory of socially-relevant information. In particular, individuals use behavioral information to guide their responding to other individuals in their environment. Impressions of others in our social environment are strongly influenced by behaviors we come to associate with those individuals (Bliss-Moreau et al. 2008). Work by Todorov et al. (2007) finds that people can learn information about others quickly with only a few pairings of pictures of faces with behavioral descriptions. Behavior-based information that is associated with individuals results in the formation of impressions concerning the affective value of others and whether social approach is warranted or if avoidance or withdrawal is justified. Bliss-Moreau et al. (2008) have found that individuals' impressions of the affective value of others can be altered based on the pairing of neutral faces with sentences describing social behavior that is either positive, negative, or neutral. Of particular relevance to the social motivational deficits of negative symptoms, Bliss-Moreau et al. (2008) found that non-clinical individuals higher in extraversion were more likely to categorize neutral faces as positive when they were previously paired with a positive behavioral act. These findings show that individual differences in affiliation may be tied to the formation of impressions concerning the positive affective value of others. This line of research suggests the potential utility of exploring the association of negative symptoms in schizophrenia, particularly those related to social motivation and pleasure, and the diminished ability to learn the positive affective value of others based on behavioral information.

A final consideration in examining the variable findings of prior studies concerns how negative symptoms have been measured. There are potential limitations with some negative symptom instruments (Blanchard et al. 2011), including their problematic reliance on behavioral indicators of social success versus assessing the experiential and motivational deficits that are core to definitions of negative symptoms. Further, some prior memory studies in schizophrenia have used either a total score of negative symptoms (Hall et al. 2007) or have only reported on one facet of negative symptoms such as blunted affect (Mathews and Barch 2004). Given that negative symptoms are comprised of two distinct facets with one reflecting motivation and pleasure and another representing diminished expressivity (Blanchard and Cohen 2006; Blanchard et al. 2017; Horan et al. 2011; Kring et al. 2013) it is important to assess both of these facets when examining correlates of negative symptoms. Prior research has indicated that the two negative symptom domains may be differentially related to external correlates with motivation and pleasure symptoms more strongly associated with functional impairment and quality of life (Blanchard et al. 2017; Rocca et al. 2014).

Lastly, given that cognitive impairment among individuals with schizophrenia can be rather profound (i.e., up to 2.5 standard deviations below those of healthy controls), particularly with regard to verbal memory, attention, processing speed, and executive function (Bratti and Bilder 2006), it will be important to ensure that group differences on the two memory tasks are not due to broad cognitive impairment in the schizophrenia group. Therefore, a brief measure of general cognition was added to the study battery to examine any impact of global cognition on our findings.

Current Study

The present study examined emotional memory and learning among individuals with schizophrenia and demographically matched healthy controls. We sought to improve over past studies with a larger clinical sample, the use of an enhanced measurement of both facets of negative symptoms, and the assessment of memory in two different contexts involving 1) valenced verbal encoding and retrieval of words using a previously employed task (Mathews and Barch 2004) and 2) the associative learning of valenced social acts paired with photos of faces. We examined memory in both short-term and 24-h delay testing, and we explored the contribution of psychiatric symptoms and cognitive ability to affective memory performance. We hypothesized that 1) in comparison to healthy controls, participants with schizophrenia would recall fewer positive words on an incidental encoding, recall, and recognition task, which would be more pronounced after a 24-h delay, 2) in comparison to healthy controls, participants with schizophrenia would exhibit decreased positive affective learning involving valenced social acts paired with neutral faces, which will be more pronounced after a 24-h delay, and 3) more severe negative symptoms involving social motivation and pleasure would be related to decreased recall of positive stimuli across both memory tasks.

Methods

Participants

Participants were 50 individuals with schizophrenia (n = 28) or schizoaffective disorder (n = 22) recruited from several outpatient community mental health clinics and 25 controls. While most effect sizes between controls and schizophrenia patients in the cognitive domain tend to be large, the research on effect sizes in the affective memory domain is scarce. Similar to the cognitive domain, we hope to find a large effect size. Thus, using α of 0.05 and power of at least 0.80 to detect an effect size of approximately .50, power analysis indicates that the sample size of the schizophrenia group should be 50.

Inclusion criteria were: age 18–65; English proficiency; and clinically stable (for the schizophrenia group). Exclusion criteria were: any co-occurring DSM-IV Axis I disorder; DSM-IV substance abuse within the past month or dependence within the past 6 months; inability to provide informed consent; history of intellectual disability; history of significant head trauma; or neurological disease. Additional exclusion criteria for controls were: self-reported history of psychiatric disorder, and currently taking psychiatric medication.

Measures

To confirm eligibility and diagnostic status, participants completed the Structured Clinical Interview for DSM-IV (SCID-I/P; First et al. 1996). Negative symptoms were assessed via the Clinical Assessment Interview for Negative Symptoms (CAINS; Kring et al. 2013), a 13-item semi-structured interview consisting of two factors: Expression (EXP; 4 items tapping affective flattening and alogia) and Motivation and Pleasure (MAP; 9 items tapping asociality, avolition, and anhedonia). Given our interest in social affiliative deficits specifically, we computed an additional Social Motivation and Pleasure (SMAP; 4 items) score from the CAINS – this focuses on items related specifically to social relationships and excludes MAP items related to work, school, and recreation. Higher scores indicate greater negative symptom severity. To measure psychiatric symptoms, participants also completed the 24-item Brief Psychiatric Rating Scale (BPRS; Ventura et al. 1993) to assess positive symptoms and the Calgary Depression Scale for Schizophrenia (CDSS; Addington et al. 1992) to assess depressive symptoms.

The incidental encoding, recall, and recognition task (Mathews and Barch 2004, 2006) is a paper-and-pencil memory task for both valenced and neutral word stimuli. The stimuli consisted of ten neutral (NEU) words, 10 positive high arousal (PHA) words, 10 positive low arousal (PLA) words, 10 negative high arousal (NHA) words, and 10 negative low arousal (NLA) words that were matched on word frequency and length. Participants were told that they would be rating words on how they make them feel. Using the Self-Assessment Manikin (SAM; Lang 1980), participants rated each word on valance and arousal through a 5-point Likert scale. After completing this incidental-encoding phase, there is a surprise recall trial, during which each participant had three minutes to write down every word he or she remembered from the 50-word list. This was immediately followed by a recognition phase in which participants were read a series of 100 words one a time, with 50 words being form the incidental-encoding task and 50 new words of the same valence and arousal proportions randomly intermixed – note that while we retained the recognition phase to maintain similar word exposure used by Mathews and Barch (2006) we did not analyze recognition performance as current hypotheses focused on recall. Participants returned 24 h after the first assessment session to again write down as many words as they could remember in three minutes.

The affective learning task (Bliss-Moreau et al. 2008) assesses rapid learning of valenced social stimuli and consists of three phases: a learning phase, a post-learning judgment phase, and a delayed judgment phase. During the learning phase, participants viewed 60 face-sentence pairs and were instructed to remember the pairings by imagining each person performing the behavior described by the corresponding sentence. The original task (Bliss-Moreau et al. 2008) only included Caucasian faces. Given that a large proportion of participants from our clinical recruitment sites are African American, we replaced half of the Caucasian faces with African American faces from the same face database (Minear and Park 2004). The faces included both male (50%) and female (50%) faces. The 60 target faces were each paired with a unique descriptive sentence of a social nature, taken from Bliss-Moreau et al. (2008): 20 faces were paired with positive (e.g., warmly hugged a sibling), 20 paired with negative (e.g., cheated on a spouse), and 20 paired with neutral (e.g., mailed a letter to someone) behavioral descriptors. All of the sentences are social in nature, meaning that they explicitly or implicitly referenced another person. The face-sentence pairs were displayed on the computer screen for 5 s with a 1-s inter-trial interval. Each face-sentence pair was presented four times in a random order. During the post-learning judgment phase, participants were shown the 60 target faces, plus 20 novel faces, and instructed to make quick "snap judgments" of the faces, rating their valence judgment of each stimulus (positive, negative, or neutral) using marked keys on a computer keyboard. Participants returned for a delayed judgment phase 24 h after their initial session.

The Brief Cognitive Assessment Tool for Schizophrenia (B-CATS; Hurford et al. 2011) assesses cognitive ability and is comprised of three tests: trail making test part B (Reitan and Wolfson 1985), category fluency, and digit symbol (Kreiner and Ryan 2001). The B-CATS correlates well with more extensive cognitive batteries (r's ranging from .73 to .86; Hurford et al. 2011). The B-CATS was selected as a time-efficient measure of general cognition given its relatively brief administration time (~10 min), that it taps into several cognitive domains (i.e., executive function, processing speed, verbal fluency, working memory), and that it strongly correlates ($r = 76$) with the gold standard MATRICS battery (Hurford et al. 2018), which has a much larger battery and longer administration time (~65 min). Overall intelligence was estimated using the Full Scale Intelligence Quotient (FSIQ) from the Wechsler Test of Adult Reading (WTAR; Wecshler 2001).

Procedures

This study was approved by the Institutional Review Board. Assessments were administered by trained, master's level interviewers. Participants completed the above measures in a fixed order and they received $50.00 compensation for their time. They were aware that they would return on a second day to finish their assessment; however, participants were not forewarned about the delay recall phases of the two memory tests.

Data Analysis

Analyses were conducted in SPSS 24. One-way analyses of variance (ANOVA) and Person Chi-Squared analyses were used to examine demographic and clinical characteristics across groups. We conducted a $2 \times 3 \times 2$ repeated measures ANOVA with group (schizophrenia vs. control) as a between-subjects factor and word valence (negative, neutral, or positive) and time (immediate vs. delayed recall) as within-subjects factors to assess recall of words. A second $2 \times 3 \times 2$ repeated measures ANOVA with group (schizophrenia vs. control) as a between-subjects factor and sentence valence (negative, neutral, or positive) and time (immediate vs. delayed judgment phases) as within-subjects factors was conducted on the mean proportion of correctly rated trials (i.e., categorizing faces with the valence of the sentence with which they were paired) on the affective learning task. Pearson correlations were conducted to examine the relation between memory for positively valenced information, psychiatric symptoms, and cognitive functioning.

Results

Sample Characteristics

Demographic and clinical characteristics are presented in Table 1. There were no significant differences across groups with respect to age, gender, race, education, and FSIQ. Compared to individuals with schizophrenia, the control group was more likely to be employed and demonstrated better cognitive ability on all subtests of the B-CATS. As expected, the schizophrenia group evidenced significantly greater negative, positive, and depressive symptoms compared to the control group. The schizophrenia group had a wide range of negative symptoms (CAINS MAP: 1–36; CAINS EXP: 0–15; CAINS SMAP: 0–16) as did the control group (CAINS MAP: 1–31; CAINS EXP: 0–7; CAINS SMAP: 0–13).

Word Recall

First, to explore whether the manipulation of word valence and arousal was comparable between the two groups, we examined valence and arousal ratings obtained during the incidental-encoding phase. With regard to valence ratings, a 2-way ANOVA with group as a between-subjects factor and word type (NEU, PHA, PLA, NHA, NLA) as a within-subject factor revealed no main effect of group, $F(1,73) = 1.24$, $p = .37$, or interaction of word type with group, $F(4,292) = 1.11$, $p = .42$. Similarly, for arousal ratings a 2-way ANOVA with group as a between-subjects factor and word type as a within-subject factor revealed no main effect of group, $F(1,73) = 0.97$, $p = .51$, or interaction of word type with

Table 1 Demographic and clinical characteristics

	Schizophrenia ($n = 50$) *M (SD)*	Controls ($n = 25$) *M (SD)*	F or χ^2
Age	49.36 (8.84)	45.84 (11.39)	1.47
Gender			
Male, n (%)	37 (74%)	17 (68%)	0.29
Female, n (%)	13 (26%)	8 (32%)	
Race			
African American, n (%)	47 (94%)	25 (100%)	1.56
Caucasian, n (%)	3 (6%)	0 (0%)	
Education (years)	11.36 (1.71)	12.12 (2.66)	2.23
Employed, n (%)	4 (8%)	8 (32%)	7.14 **
Duration of illness (years)	29.04 (9.99)	–	–
Medication status			
1st Gen Neuroleptic, n (%)	19 (38%)	–	–
2nd Gen Neuroleptic, n (%)	15 (30%)	–	–
Both, n (%)	13 (26%)	–	–
No Neuroleptics, n (%)	3 (6%)	–	–
CAINS			
MAP	14.09 (7.11)	5.33 (6.63)	5.13 ***
EXP	3.7 (3.93)	1.00 (2.06)	3.21 **
BPRS positive	1.93 (0.78)	1.15 (0.17)	4.91 ***
CDSS	2.60 (3.39)	0.40 (0.70)	3.19 **
Estimated FSIQ	88.24 (10.14)	91.60 (12.13)	1.26
B-CATS			
Trails B	167.28 (78.88)	117.08 (77.91)	6.16 *
Category fluency	35.60 (8.54)	42.84 (10.73)	10.05 **
Digit symbol	4.90 (2.23)	6.36 (2.34)	6.89 *

CAINS Clinical Assessment Interview for Negative Symptoms, *MAP* Motivation and Pleasure subscale, *EXP* Expression subscale, *BPRS* Brief Psychiatric Rating Scale, *CDSS* Calgary Depression Scale for Schizophrenia, *FSIQ* Full Scale Intelligence Quotient, *B-CATS* Brief Cognitive Assessment Tool for Schizophrenia

* $p < .05$; ** $p < .01$; *** $p < .001$

group, $F(4,292) = 2.03$, $p = .32$. These findings suggest that the schizophrenia sample and controls provided similar valence and arousal ratings of the words in the incidental-encoding phase.

The mean proportion of words recalled during the immediate and delayed recall phases per group in each valence category with standard errors are presented in Fig. 1. The 2 × 3 × 2 repeated measures ANOVA for the mean proportion of words recalled indicated a main effect of valence, $F(2,144) = 57.78$, $p < .001$, $\eta^2 = .45$. Within-subjects contrasts revealed that negative, $F(1,72) = 92.29$, $p < .001$, $\eta^2 = .56$, and positive words, $F(1,72) = 77.47$, $p < .001$, $\eta^2 = .52$, were recalled more often than neutral words. There was a significant valence by time interaction, $F(2,144) = 8.74$, $p < .001$, $\eta^2 = .11$. Post hoc contrasts indicated a decrease in memory for positive, $F(1,144) = 6.42$, $p < .05$, and negative words, $F(1,144) = 4.85$, $p < .05$, but not neutral words, $F(1,144) = .03$, $p = .861$, after a one-day delay. Results also indicated a trending but non-significant 3-way interaction, $F(2,144) = 3.02$, $p = .05$, $\eta^2 = .04$. To facilitate interpretation of this interaction, the association between group and valence was examined separately for each day. The interaction stems from a significant group by valence interaction during the immediate recall phase, $F(2,146) = 3.37$, $p = .04$, $\eta^2 = .04$, but not for the delayed recall trial, $F(2,144) = 0.85$, $p = .43$, $\eta^2 = .01$. Post hoc contrasts indicated that during the immediate recall phase controls recalled significantly more negative words, $F(1,73) = 6.76$, $p = .01$, than the schizophrenia group, but not more positive, $F(1,73) = 0.36$, $p = .55$, or neutral, $F(1,73) = 0.25$, $p = .62$, words. On the second assessment day, there were no group differences observed for any valence category (*F*s range .003 to 2.95, all *ns*).

Given Mathews and Barch's (2004) findings regarding similar patterns of recall as a function of arousal for both patients and controls, we explored the role of arousal in the

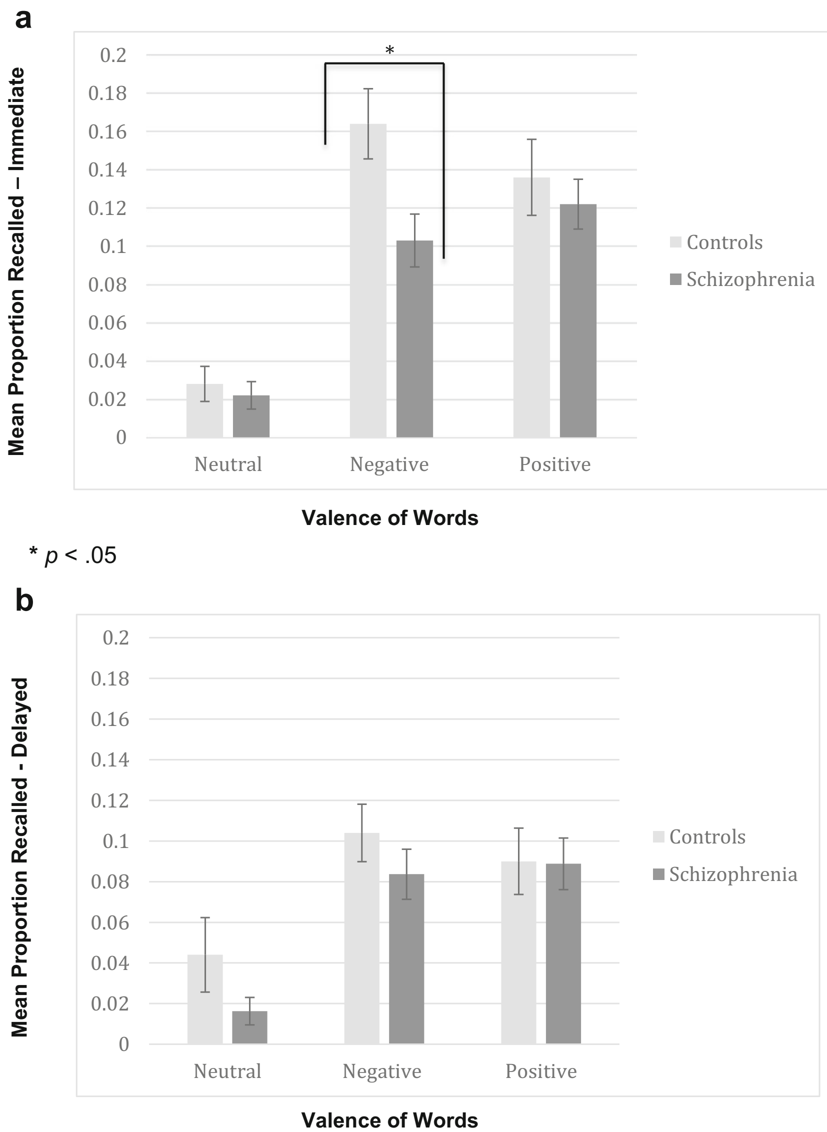

Fig. 1 Proportion of words recalled on emotional memory task. **a** Graph depicting recall of words during the immediate recall phase. **b** Graph depicting recall of words during the delayed recall phase, * $p < .05$

group differences on immediate recall of negatively valenced words by conducting post hoc independent sample *t*-tests. In our study the schizophrenia sample recalled significantly fewer low, $t(73) = 2.38$, $p = .02$, but not high, $t(73) = 1.77$, $p = .08$, arousal negative words than controls.

Affective Learning

The mean proportion of correct valence judgments in each condition (negative, neutral, positive) for each group with standard errors during the immediate and delayed post-learning judgment phases are presented in Fig. 2. Of note, due to program errors, two control participants and four schizophrenia participants did not have usable data, and thus have been excluded from the affective learning task analyses.

To explore the effects of group, valence and time, we conducted a $2 \times 3 \times 2$ repeated measures ANOVA for the mean proportion of correctly rated trials (i.e., categorizing faces with the valence of the sentence with which they were paired). There were significant main effects of time, $F(1,65) = 4.81$, $p = .03$, $\eta^2 = .07$, and valence, $F(2,130) = 27.67$, $p < .001$, $\eta^2 = .29$; however, the main effect of group was not significant, $F(1,65) = 2.52$, $p = .12$, $\eta^2 = .03$. The main effect of time reflected a decline in recall performance over the delayed recall interval. Importantly, the main effect of valence was tempered by a significant 2-way group by valence interaction, $F(2,130) = 5.09$, $p < .01$, $\eta^2 = .07$. The 3-way interaction of group by valence by time was not significant, $F(2,130) = 0.87$, $p = .42$, $\eta^2 = .01$. In order to fully explore the group by valence interaction, post hoc contrasts indicated that across days controls made more correct positive judgments than the schizophrenia group, $F(1,65) = 11.33$, $p < .01$, though not more correct negative, $F(1,65) = 0.04$, $p = .85$, or neutral, $F(1,65) = 2.91$, $p = .09$, judgments.

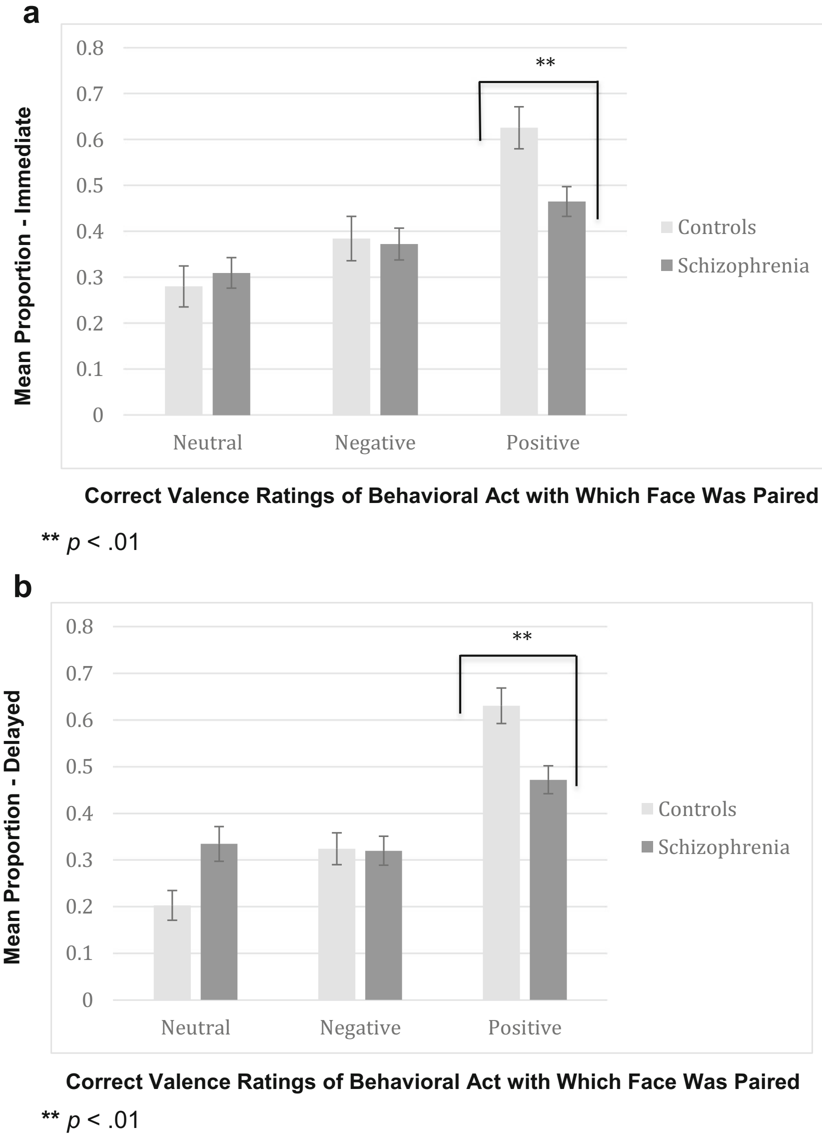

Fig. 2 Mean proportion of correct categorizations on the affective learning task based on valence of behavioral act with which face was paired. **a** Graph depicting correct valence judgments during the immediate judgment phase. **b** Graph depicting correct valence judgments during the delayed judgment phase. $p < .01$, ** $p < .01$

Symptom and Cognitive Functioning Correlates

Symptom and cognitive functioning correlates of recall of positive words and positive affective learning and are shown in Table 2. In the schizophrenia group, immediate and delayed positive minimal affective learning and recall of positive words were not significantly correlated with negative symptoms. We also conducted post hoc analyses in the schizophrenia group to examine if positive symptoms or depression might have been associated with positive affective learning or word recall. Neither positive symptoms nor depression (range of *r*s = −.13 to .25) were significantly related to positive affective learning or word recall (*p*s > .05). Based on findings from Mathews and Barch (2004) indicating that within their schizophrenia group immediate (improved) recall of high arousal positive and high arousal negative words were specifically related to the negative symptom of blunted affect, we conducted exploratory post hoc analyses (with Bonferroni correction) to examine correlations between negative symptom ratings and recall for these sub-groups of words. For immediate and delayed recall there were no significant correlations between negative symptoms and high arousal valenced words (*r*s range .04 to −.21, all *ns*).

With regard to cognitive functioning in the schizophrenia group, positive minimal affective learning on both assessment days was not significantly correlated with general cognitive ability (B-CATS). However, affective learning was correlated with estimated IQ, such that schizophrenia participants with higher IQ levels demonstrated better positive minimal affective learning. Within the schizophrenia group, recall of positive words was positively correlated with the B-CATS on both days and FSIQ for the delayed recall trial.

Within the control group, experiential negative symptoms of specifically a social nature (CAINS social motivation and

Table 2 Symptom and cognitive functioning correlates of positive affective learning and memory

	Schizophrenia				Controls			
	(+) Affective Learning		(+) Word Recall		(+) Affective Learning		(+) Word Recall	
	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
CAINS EXP	-.04	.01	- .15	- .20	- .04	.12	- .32	- .34
CAINS MAP	- .09	.17	- .04	.07	- .35	- .17	- .15	- .17
CAINS SMAP	- .06	.09	- .20	.01	**- .46** *	- .21	- .23	- .13
Estimated FSIQ	**.38** **	**.30** *	.19	**.32** *	.08	.13	**.54** **	**.45** *
B-CATS	.03	.19	**.32** *	**.47** **	.15	.23	.33	.19

CAINS Clinical Assessment Interview for Negative Symptoms, *EXP* Expression subscale, *MAP* Motivation and Pleasure subscale, *SMAP* Social Motivation and Pleasure subscale, *BPRS* Brief Psychiatric Rating Scale, *CDSS* Calgary Depression Scale for Schizophrenia, *FSIQ* Full Scale Intelligence Quotient, *B-CATS* Brief Cognitive Assessment Tool for Schizophrenia, * $p < .05$; ** $p < .01$

pleasure items) were negatively correlated ($r = -.46$, $p < .05$) with immediate positive affective learning (i.e., greater social motivational and pleasure deficits were related to less correct categorization of faces previously paired with positive social behavior). Although nonsignificant, which may be attributable to the smaller sample size in the control group, there were also moderate positive relations between CAINS MAP and immediate positive affective learning ($r = -.35$) as well as CAINS EXP and immediate ($r = -.32$) and delayed ($r = -.34$) positive word recall. No other symptom domains were correlated with immediate or delayed positive minimal affective learning and positive word recall. We also conducted post hoc analyses to examine if positive symptoms or depression might have been associated with positive affective learning or word recall. Neither positive symptoms nor depression (range of rs $= -.29$ to .13) were significantly related to positive affective learning or word recall in controls (ps $> .05$).

Within the control group estimated IQ was positively correlated with both immediate and delayed word recall, though not with minimal positive affective learning. General cognitive functioning (B-CATS) was not significantly correlated with positive affective learning or word recall in the control group; however, the magnitude of the correlation between B-CATS and immediate positive word recall ($r = .33$) was similar to that of the schizophrenia group ($r = .32$).

Discussion

The present study examined the association of negative symptoms and the recall of emotion-related material among individuals with schizophrenia and demographically matched healthy controls. Our first hypothesis that participants with schizophrenia, compared to controls, would exhibit poorer memory of positive words was not supported by our results. The two groups recalled a similar number of positive words across immediate and delayed recall. Valence-enhanced recall for both positive and negative words (compared to neutral) was evidenced in both groups and was more notable during the immediate recall phase than the delayed recall phase; however, an important potential confound is that recall of neutral words was essentially at floor (i.e., .2 words) at both time points. One group difference that did emerge was that controls recalled more negative words on day one than did the schizophrenia group but this group difference was not evident in the delayed recall trial. This finding is not a result of the negative words being perceived as more arousing or negative for the control group as both groups rated these words similarly on valence and arousal.

Focusing on the overall influence of valence on recall, our results do replicate those of Mathews and Barch (2004) indicating that both groups showed enhanced recall for valenced words. The present findings from the word list task demonstrating intact enhanced recall of valenced material in schizophrenia are also consistent with other studies (Horan et al. 2006; Koh et al. 1976; Olsen et al. 2015; Sergerie et al. 2010). The findings are not consistent with prior reports of a selective deficit in the recall of positively valenced material in schizophrenia (Herbener et al. 2007; Herbener 2008). Group differences in overall recall performance on the word list task are not consistent with Mathews and Barch (2004) in that they found overall poorer recall in individuals with schizophrenia than controls. The difference in findings may, in part, be a result of differences in the control groups used in our study compared to Mathews and Barch (2004): the control group in the current study was older (by approximately 10 years) and had less education (high school level versus college-level), and approximately two-thirds of our controls were unemployed.

When examining symptom correlates of memory performance on the word task, our findings are not consistent with prior work (Hall et al. 2007; Jang et al. 2016; Mathews and Barch 2004; Olsen et al. 2015), in that no negative symptom domain was correlated with recall of valenced words. Inconsistent with Mathews and Barch (2004), post-hoc examination of the role of arousal in memory for negative words in our sample revealed that individuals with schizophrenia recalled significantly fewer low, but not high, arousal negative words than controls and negative symptoms were not correlated with recall of arousing words. This suggests that normative enhancement of highly arousing stimuli was intact in our clinical sample, regardless of negative symptom severity.

Our second hypothesis that individuals with schizophrenia would exhibit poorer affective learning for positive social information compared to controls was supported. Consistent with prior research illustrating that there is a memory impairment of positively valenced stimuli in this population (Hall et al. 2007; Lakis et al. 2011), controls correctly categorized faces paired with positive behavioral acts as positive significantly more often than our schizophrenia sample and did so across both immediate and delayed recall. Although we anticipated that the group differences in memory for positive social stimuli would be more pronounced on the second day given prior work (Herbener 2008), results showed that group differences were stable across the two assessments with no differential impairment following the delay. Interestingly, group differences with regard to recall of positive stimuli were found only on the affective learning task and not the word recall task. This highlights that it is particularly within the social realm that individuals with schizophrenia demonstrate an inability to recall positive information and experiences.

There were no group differences in categorizing faces associated with negative or neutral behavioral acts. Notably, both groups correctly categorized these faces much less frequently than those associated with positive behaviors. The finding of poorer positive, but not negative or neutral, affective learning in the schizophrenia sample may reflect a differential deficit in positive affective learning; however, it is possible that this finding is confounded by test characteristics. Miller et al. (1995) have noted that group differences tend to be larger when task difficulty for free-response tasks is near 50%, as was the case for the positive affective learning condition where accuracy was approximately 50% for positive pairings and closer to 30% for negative and neutral pairings.

The reasons for the lack of learning (i.e., near chance levels) negative associations in the current study are unclear but may relate to sample differences. The affective learning task has only been administered to nonclinical undergraduates at Boston College. In their research on this sample, Bliss-Moreau et al. (2008) consistently found that these participants exhibited minimal affective learning for the positive, negative, and neutral conditions. Differences in demographic factors (i.e., education level, age, gender, and race) may have contributed to our participants viewing the negative sentences differently than young college students. It is possible that in impoverished urban settings, where many of the participants for this study reside, the sentences describing negative behavioral acts are judged differently. Research has shown that urban, low-income African Americans disproportionately reside in neighborhoods that are characterized by poverty, crime, and violence, which increases the likelihood that they will witness community violence (Carlo et al. 2011; Centers for Disease Control and Prevention 2010). Perhaps the largely unemployed African Americans participants in our study were exposed to crime and violence more often than undergraduates in Boston, and thus, sentences such as, “cut in line at the bank,” and “yelled at a bus driver” were not viewed as particularly negative. Future research would benefit from having participants rate all the affective learning task sentences on valence to ensure that that the negative, positive, and neutral behavioral acts are actually perceived accordingly by participants.

It is intriguing that our fourth hypothesis, that more severe negative symptoms would be correlated with poorer associative learning of positively valenced social behaviors paired with faces within the schizophrenia sample, was not supported. Performance on positive recall across tasks and testing sessions was not related to any psychiatric symptom domain in schizophrenia, but rather, was significantly related to cognitive impairments. Although negative symptoms were not related to recall of positive stimuli in the schizophrenia sample, social experiential negative symptoms were negatively correlated with positive minimal affective learning in controls. This result is in line with Bliss-Moreau et al.’ (2008) study which found that individuals who scored high in extraversion evidenced enhanced positive minimal affective learning compared to those who scored low in extraversion. We did not explore individual differences in extraversion in this study; however, our controls who endorsed high motivation and pleasure from relationships with family and friends may also score high in extraversion, given that extraverts often have a preference for engaging in and enjoying social interactions (Costa and McCrae 1980).

Limitations

Although these results are intriguing and help examine affective learning in schizophrenia, there are a number of limitations. First, the study sample was racially homogeneous (being predominantly African-American), middle aged, and mostly male. Examining emotional memory, affective learning, negative symptoms, and the relations among these constructs in other racial groups, younger individuals, or in women (Canli et al. 2002) may yield different results. Second, because the order of the two memory tasks was not counter-balanced, interference effects could have occurred and may not be equivalent between the clinical and nonclinical groups. Third, encoding of material may not have been well balanced between the two memory tasks as the inclusion of a recognition trial for the word list learning test, but not the affective learning task, provided participants a second opportunity to encode the words. Fourth, the we encountered floor effects for both the affective learning task (at least for negative and neutral material) and the word list learning test. For the latter, the marked difficulty of the task reduced the discrimination of the measure, ultimately decreasing our probability of detecting significant associations with negative symptoms and cognition. The affective learning task may have also been too difficult for participants, particularly those with cognitive impairments or low verbal IQ. Future research with the affective learning paradigm might manipulate presentation parameters (e.g., increasing duration of exposure or number of learning trials) or alter content (e.g., using behavioral descriptions that are more engaging) in an attempt to improve performance and enhance the range of accuracy obtained across the valenced categories of social behavior. In line with this, we modified the task to include decreased total number of pairings, increased duration of exposure, and addition self-directed behavioral descriptions to bolster encoding in a currently underway R01.

Concluding Comments

The current study highlights the potential benefit of examining memory for socially relevant information. The group differences that were observed were limited to the social affective learning paradigm. Further, the differential correlates of performance on this task that were observed across groups suggests the need for additional study of how cognitive deficits and individual differences in social affiliation and motivation may contribute to the learning of valenced social information in healthy individuals and clinical samples.

Acknowledgments Preparation of this manuscript was in part supported by a grant from the National Institute of Mental Health (R01MH110462) to Dr. Blanchard.

Author Contributions First author: assisted in executing the study, completed data analyses, and wrote the manuscript. Second and third authors: assisted in executing the study and collaborated in editing the paper.

Compliance with Ethical Standards

Conflict of Interest Kristen R. Dwyer, Melanie E. Bennett and Jack J. Blanchard declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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