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Socially relevant affective learning in psychosis: Relations to deficits in motivation and pleasure and cognitive ability

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ABSTRACT

Negative symptoms are common in psychotic disorders and significantly contribute to functional impairment. Deficits in reward processing and memory have been implicated as important factors which contribute to negative symptoms, leading to speculation that deficits in learning and memory of socially relevant information may be particularly important. Previous work has also found poorer learning of positive social behavior associations in psychotic disorders, but limitations have prevented an examination of symptom correlates of this diminished learning. In the present study, we used an updated social affective learning task to examine whether diminished accuracy in learning the affective value of others was related to motivation and pleasure negative symptoms as well as cognitive deficits. Results indicated that participants were able to use both positive and negative behavioral information to generate accurate socially evaluative perceptions. Results also demonstrated that reduced accuracy of learning from positive behavioral information was related to greater motivation and pleasure symptoms and cognitive deficits, including working memory, while reduced accuracy of learning from negative behavioral information was only related to cognitive deficits across multiple domains. When controlling for cognition, motivation and pleasure symptoms were no longer related to positive affective learning, but working memory remained related to learning when controlling for motivation and pleasure symptoms. These findings underscore the role of diminished positive affective learning in negative symptoms and suggest that poorer learning of the positive value of others may be one pathway through which cognitive deficits lead to reduced reward anticipation, defeatist performance beliefs, and negative symptoms.

1. Introduction

Negative symptoms are common in psychosis with up to 60 % of individuals with psychotic disorders presenting with clinically significant negative symptoms (Correll and Schooler, 2020). Motivation and pleasure deficits are a major facet of negative symptoms (Blanchard et al., 2017; Kring et al., 2013; Marder and Galderisi, 2017) and contribute to both social and functional impairment (Blanchard et al., 2017; Moe et al., 2021; Rocca et al., 2014). Despite the clinical significance of negative symptoms, they remain an unmet therapeutic need (Fusar-Poli et al., 2015; Kirkpatrick et al., 2006) and the mechanisms which contribute to their emergence and persistence remain incompletely understood (Fulford et al., 2018; Moran et al., 2022).

Motivation and pleasure deficits have been frequently examined from the perspective of diminished benefits derived from social affiliation (Blanchard et al., 2024) and altered reward processes (Fulford et al., 2018; Strauss et al., 2014). Conjectured reward deficiencies may arise from a diminished anticipatory reward response (Dowd and Barch, 2012; Esslinger et al., 2012; Grimm et al., 2012; Kaliuzhna et al., 2020; Moran et al., 2019), decreased responding to reward receipt (Zeng et al., 2022), and impairments in reward learning (Culbreth et al., 2023; Dowd et al., 2016; Merchant et al., 2024).

Beyond reward processes, deficits recalling pleasant experiences have been proposed to play an important role in undermining the anticipation of future pleasure and subsequent reduced approach motivation (Gold and Strauss, 2012; Kring and Caponigro, 2010). Consistent with the hypothesized role of recall, a recent meta-analysis (Pillny et al., 2022) found moderate associations between episodic memory deficits and both motivational and expressive negative symptoms. Another meta-analysis found broad, nonspecific associations

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between cognitive impairment and both facets of negative symptoms (Au-Yeung et al., 2023). Other research examining memory has sought to determine if there is a more specific emotional memory deficiency related to positively valenced stimuli. Findings from various paradigms have been inconsistent. Some results have indicated a relation between anhedonia or motivational symptoms and recall of positive stimuli (Jang et al., 2016; Whearty et al., 2024) while other studies have not (Hall et al., 2007; Harvey et al., 2009; Horan et al., 2006).

Given the centrality of social affiliative deficits in negative symptoms, we have suggested the importance of examining the learning and memory of socially relevant information (Dwyer et al., 2020). Healthy individuals use behavioral information to guide responses to others in social environments and social impressions are influenced by the behavior of others (Bliss-Moreau et al., 2008; Hackel and Mende-Siedlecki, 2023). This social affective learning informs decisions on appropriate social engagement and warranted withdrawal (Bliss-Moreau et al., 2008). Previous research has demonstrated that pairing pictures of unfamiliar faces with social behavioral descriptions or socially-relevant biographical information is sufficient to impact evaluative perceptions of those faces (Falvello et al., 2015; Suess et al., 2013).When faces with neutral expressions are paired with positive behavioral descriptors they are subsequently perceived more positively (Bliss-Moreau et al., 2008) or more trustworthy (Falvello et al., 2015). In contrast, when such faces are paired with negative behavioral (Bliss-Moreau et al., 2008) or negative socially-relevant biographical information (Suess et al., 2013) they are perceived more negatively. Finally, trait extraversion can facilitate the formation of positive evaluations of neutral facial pictures that were paired with a positive behavioral act (Bliss-Moreau et al., 2008). Thus, healthy individuals demonstrate social affective learning using unfamiliar faces paired with social-relevant information and this learning is facilitated by individual differences.

We have previously examined if motivation and pleasure deficits are related to the diminished ability to learn the positive affective value of others based on behavioral information (Dwyer et al., 2020). At both immediate and delayed recall, individuals with schizophrenia displayed poorer learning of positive social behavior associations compared to controls. Contrary to expectations, only cognitive impairment, and not negative symptoms, was related to poorer performance in individuals with schizophrenia. However, in non-clinical controls social motivation deficits, but not cognitive ability, were related to poorer learning of positive social behavior associations. This initial test of the relation between affective learning and negative symptoms was limited by floor effects in the social affective learning task, potentially demonstrating that the task was too difficult for individuals with psychosis due to the cognitive deficits typical in psychotic disorders (Dwyer et al., 2020). Since performance on both negative and neutral trials was no different than chance in this study in both the schizophrenia and control groups, we were limited in our ability to detect symptom level correlates of affective learning. Thus, it remains unclear whether diminished social affective learning in psychosis is related to motivation and pleasure deficits and whether their potential contribution is independent of cognitive impairment.

Here, we examined the relation between social affective learning, negative symptoms, and cognitive deficits. We sought to improve upon our previous research by utilizing a revised social affective learning task (see section 2.3 below), updated to improve performance and avoid previously observed floor effects (Dwyer et al., 2020).

To better understand the potential role of affective learning in motivation and pleasure deficits, the current study utilized a dimensional approach to psychopathology consistent with the National Institute of Mental Health's Research Domain Criteria (RDoC; Cuthbert, 2022; Kozak and Cuthbert, 2016) and the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2017). To capture a broad range of symptomatology, social motivation, and social functioning, the current sample includes both clinical participants with a history of psychosis and non-clinical community participants. This aligns with previous work identifying negative symptoms as a transdiagnostic construct existing on a spectrum from healthy to clinically significant, both in and outside of clinical psychosis (Strauss and Cohen, 2017). Additionally, the current study utilized a validated cognitive battery allowing for a comprehensive assessment of cognitive functioning. We hypothesized that: 1) participants would demonstrate learning of positive and negative social stimuli utilizing an updated social affective learning task, 2) diminished learning of positive social stimuli would be associated with more severe motivation and pleasure deficits and cognitive impairment, 3) relations between negative symptoms and social affective learning would remain when controlling for cognition.

2. Methods

2.1. Participants

Participants ($N = 111$) represented a mixed transdiagnostic sample including individuals diagnosed with a psychotic disorder ($N = 90$) and non-clinical controls ($N = 21$). The current study is part of a larger program of research examining behavioral, cognitive, and neural contributors to affiliative deficits in psychosis (Blanchard et al., 2024; Savage et al., 2024). General inclusion criteria included being 18–60 years old, English fluency, and normal or corrected-to-normal vision. General exclusion criteria included an inability to provide informed consent, lifetime intellectual, developmental, or neurological disorder, lifetime history of significant head trauma, moderate or severe substance use disorder in the past 6 months or mild substance use disorder in the past month, and standard MRI contraindications (e.g., non-MR compatible medical implants). Inclusion criteria for clinical participants also included a lifetime psychotic disorder (e.g., schizophrenia) or affective disorder with psychotic features (e.g., bipolar disorder with psychotic features) and clinical stability (i.e., no inpatient hospitalizations in the past 3 months, no changes in psychoactive medication in the past month). Additional inclusion criteria for community participants included absence of any current psychiatric diagnosis or medications and absence of any lifetime diagnosis of psychotic or mood disorders.

2.2. Measures

To confirm eligibility and diagnosis, all participants completed the Structured Clinical Interview for DSM-5, Research Version (SCID-5-RV; First et al., 2015). Clinical participants completed the mood and psychotic disorder modules while community participants completed a SCID-5 screener and relevant modules. Interviews were conducted by Master's level interviewers supervised by doctoral-level clinical psychologists.

Negative symptoms were assessed via the Clinical Assessment for Negative Symptoms (CAINS; Kring et al., 2013), a 13-item semi-structured interview consisting of two factors: Expression (EXP) and Motivation and Pleasure (MAP). For hypothesis testing, CAINS-MAP was used as the primary measure of social motivational deficits. Research in psychosis has found CAINS-MAP scores relate to impaired social functioning (Blanchard et al., 2017) and diminished social affiliation in laboratory settings (Mccarthy et al., 2018).

A brief version of the Revised Social Anhedonia Scale (RSAS; Reise et al., 2011) was used to measure self-reported social anhedonia. The RSAS is a 17-item measure derived from the Revised Social Anhedonia Scale (Eckblad et al., 1982).

To measure psychiatric symptoms over the past week, participants completed the 24-item Brief Psychiatric Rating Scale (BPRS; Ventura et al., 1993). Previously established factors were used to calculate scores for positive symptoms, depression/anxiety symptoms, and agitation (Kopelowicz et al., 2008).

Cognitive abilities were assessed using the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive Battery (MCCB; Nuechterlein et al., 2008). The

MCCB is a 10-measure cognitive battery designed for people with psychosis and assesses cognitive performance across 7 domains: speed of processing, attention/vigilance, working memory, verbal learning, visual learning, reasoning and problem solving, and social cognition. The overall composite score was used to capture general cognitive functioning.

2.3. Social affective learning task

The social affective learning task (Bliss-Moreau et al., 2008) assesses rapid learning of valenced social stimuli. Here, a modified version of the social affective learning task was used based on Dwyer et al. (2020). To address concerns about floor effects and to maintain the overall length of the task, the current task reduced the number of faces per condition (positive, negative, neutral) from 20 to 12, increased the duration each pairing was shown from 5 s to 8 s, and, to increase their saliency, modified the sentences to make them personally relevant to the reader (i.e., "held the door open for a boy on crutches" changed to "held the door open for me"). The remainder of the task remained identical to Dwyer et al. (2020).

This task consisted of two phases: a learning phase and a post-learning judgement phase. During the learning phase, participants viewed 36 face-sentence pairs and were instructed to remember the pairings by imagining the person in the image performing the behavior described in the corresponding sentence. The 36 target faces were each paired with a unique descriptive sentence adapted from Bliss-Moreau et al. (2008): 12 faces were paired with positive, 12 paired with negative, and 12 paired with neutral behavioral descriptors (see Table 1). The demographic characteristics of the faces were evenly distributed between the three conditions such that half the faces shown in each condition were female/male sex and half were black/white race. The pairs were presented on a computer screen for 8 s each, with a 1 s intertrial interval, and each pair was presented four times in a random order. Participants were instructed to read each sentence aloud during the learning phase to ensure engagement throughout the task.

Following the learning phase, participants completed the judgement phase. During this phase, participants were shown the 36 target faces without behavioral descriptors along with 12 novel faces not included in the learning phase. Using three buttons, participants were instructed to make quick, "snap judgements" and indicate their impression of each face (positive, negative, or neutral). As soon as they indicated their impression of each face, they were immediately shown the next face. This task demonstrated good internal reliability for accuracy of ratings (α = 0.87).

2.4. Data analytic plan

All analyses were completed using R statistical software version 4.0.2

Table 1
Social affective learning task behavioral descriptors.

Positive
Returned my lost wallet to me.
Gave me directions when I was lost.
Helped me carry a heavy box.
Gave me a nice compliment.
Helped me pick up papers that I dropped.
Gave me a ride to my appointment.
Helped me get up when I fell.
Said I was doing a great job.
Shared the last piece of cake with me.
Made me laugh with a joke.
Bought me ice cream.
Threw me a surprise birthday party.
Negative
Cut in front of me in line.
Made a racist comment to me.
Insulted me for no reason.
Closed the door in my face.
Yelled at me in the street.
Laughed at me when I tripped.
Made a mean comment to me.
Told a lie about me to my friends.
Said he did not like me.
Took money I dropped on the ground.
Fired me from my job.
Hit me when I was not looking.
Neutral
Walked by me on the street.
Sat next to me on the bus.
Lives in my city.
Talked to my neighbor about the weather.
Rode the elevator with me.
Ate lunch when I did.
Stood near me at the stop light.
Was in line behind me at the store.
Walked into the waiting room where I sat.
Bought a lottery ticket after I did.
Asked me for directions to the park.
Borrowed a pen from me.

(R Core Team, 2020). Prior to analyses, descriptive statistics for demographic (Table 2) and symptom assessments (Table 3) were calculated. Next, a 3 × 4 within subjects repeated measures ANOVA with Bonferroni correction was conducted to compare participant rating accuracy (positive, negative, neutral) across stimuli categories (positive, negative, neutral, novel). For our second hypothesis, correlational analyses were conducted to examine whether accuracy in rating both positive and negative social pairings was related to self-reported and clinician-rated negative symptoms and cognitive impairment. Finally, regression analyses were conducted to examine whether significant relations between accuracy in rating positive and negative social stimuli and negative symptoms remained when controlling for cognitive deficits. A post-hoc power analysis indicated 99 % power to detect medium effect size in ANOVA analyses, 91 % power to detect medium effect size in correlational analyses, and 98 % power to detect medium effect size in regression analyses.

3. Results

Performance for the affective learning task is summarized in Fig. 1. A within subjects repeated measures ANOVA with Bonferroni correction revealed a significant interaction effect between stimuli valence and participant rating ($F(2.82,310.71) = 62.27$, $p < .001$). Post-hoc pairwise *t*-tests indicated that positive stimuli were rated positive ($M = 62.39$ %) more frequently than either negative ($M = 14.94$ %, $t = 13.69$, $p < .001$) or neutral ($M = 20.05$ %, $t = 11.20$, $p < .001$) and that negative stimuli were rated negative ($M = 42.42$ %) more frequently than either positive ($M = 30.11$ %, $t = 2.92$, $p = .004$) or neutral ($M = 20.05$ %, $t = 4.35$, $p < .001$). These analyses also indicated that neutral stimuli were rated positive ($M = 46.10$ %) more frequently than either negative ($M = 18.39$ %, $t = 8.32$, $p < .001$) or neutral ($M = 32.43$ %, $t = 2.97$, $p = .004$).

Table 2
Demographic variables (N = 111).

	Mean *(SD)* or *n* (percent)
Age (years)	43.77 (12.36)
Sex	
Male	68 (61.3 %)
Female	43 (38.7 %)
Race	
Black/African American	74 (66.7 %)
White	28 (25.2 %)
Asian	4 (3.6 %)
More than one race	4 (3.6 %)
Unknown or not reported	1 (0.9 %)
Ethnicity	
Non-Hispanic or Latino	101 (91.0 %)
Hispanic or Latino	9 (8.1 %)
Don't know	1 (0.9 %)
Education (years)	13 (2.43)
Marital Status	
Never married/single	84 (75.7 %)
Divorced/separated	18 (16.2 %)
Married	9 (8.1 %)
Current Employment	
No	77 (69.4 %)
Yes	34 (30.6 %)
Diagnosis	
Schizophrenia	37 (33.3 %)
Schizoaffective Bipolar Type	14 (12.6 %)
Schizoaffective Depressive Type	17 (15.3 %)
Bipolar I with psychotic features	12 (10.8 %)
Major Depressive Disorder with psychotic features	9 (8.1 %)
Delusional Disorder	1 (0.9 %)
No Diagnosis (Healthy control)	21 (18.9 %)
Antipsychotic Medication	
Typical	11 (9.9 %)
Atypical	57 (51.4 %)
Combined (typical and atypical)	9 (8.1 %)
None	12 (10.8 %)
Unknown	1 (0.9 %)

Table 3
Descriptive statistics for symptom and cognitive variables.

	N	Mean *(SD)*	Range
CAINS- Motivation & Pleasure (MAP)	111	11.46 (7.01)	1.00–34.00
BPRS- Positive Symptoms	111	12.36 (5.16)	8.00–31.00
BPRS- Depression & Anxiety	111	8.04 (4.17)	4.00–19.00
BPRS- Agitation	111	7.63 (2.31)	6.00–19.00
RSAS	110	5.73 (4.00)	0.00–15.00
MCCB			
Composite T-Score	105	28.51 (13.94)	5.00–67.00

Note: BPRS = Brief Psychiatric Rating Scale; CAINS = Clinical Assessment Interview for Negative Symptoms; RSAS = The Revised Social Anhedonia Scale-Brief; MCCB = Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive Battery.

Neutral stimuli were also rated neutral more frequently than negative ($t = 4.06$, $p < .001$). Novel stimuli were rated neutral ($M = 56.53$ %) more frequently than either positive ($M = 25.15$ %, $t = 5.99$, $p < .001$) or negative ($M = 15.62$ %, $t = 9.24$, $p < .001$) and novel stimuli were rated positive more frequently than negative ($t = 3.45$, $p < .001$). Additional post-hoc t-tests demonstrated that positive stimuli ($t = 12.29$, $p < .001$) and negative stimuli ($t = 3.65$, $p < .001$) were accurately remembered at above chance rates.

When examining the relation between accuracy of rating positive stimuli as positive and negative symptoms, results indicated that greater MAP ($r = -0.20$, $p = .03$) and RSAS ($r = -0.20$, $p = .04$) were both related to reduced accuracy in recalling positive social stimuli. These results were replicated in analyses using the difference between rating positive stimuli as positive and as neutral (MAP: $r = -0.21$, $p = .02$; RSAS: $r = -0.23$, $p = .01$). Exploratory post-hoc analyses examining the relation between MAP and positive affective learning using a hierarchical model of three subcomponents of MAP (Strauss et al., 2018) were also conducted (Supplementary Table S1). EXP was not related to recalling positive social stimuli accurately ($r = -0.13$, $p = .18$). Regarding the accuracy of rating negative stimuli as negative, neither MAP ($r = -0.04$, $p = .72$), EXP ($r = -0.16$, $p = .09$) nor RSAS ($r = -0.08$, $p = .41$) were related to these ratings. To determine whether the relation with accuracy of rating positive stimuli was unique to negative symptoms, post-hoc correlations were conducted to examine the relation between accuracy rating positive stimuli and depression/anxiety, positive symptoms, and agitation. Results indicated that accuracy was unrelated to any of these symptom domains (*ps* > 0.05).

When determining the relation between accuracy of social affective learning and cognitive deficits, results indicated that greater overall cognitive abilities were related to both positive ($r = 0.22$, $p = .02$) and negative ($r = 0.25$, $p = .009$) social affective learning. Post-hoc analyses examining the relation between accuracy and the seven MCCB cognitive domains indicated that only working memory was related to positive affective learning ($r = 0.27$, $p = .004$). These same post-hoc analyses indicated that several cognitive domains were related to negative affective learning(see Table 4). Correlations between negative symptoms and cognitive domains can be found in Supplementary Table S2.

Regression analyses examining whether negative symptoms uniquely predicted positive social affective learning when controlling for overall cognition indicated that neither MAP ($t = -1.12$, $p = .26$) nor RSAS ($t = -0.80$, $p = .43$) remain related to accuracy remembering positive social stimuli. Given the relation between positive social affective learning and cognition was largely driven by working memory, post-hoc analyses were run to examine whether negative symptoms would remain related to positive social affective learning when controlling for working memory. Results of these analyses revealed that neither MAP ($t = -1.36$, $p = .18$) nor RSAS ($t = -1.02$, $p = .31$) remained related to positive social affective learning when controlling for working memory. However, the same analyses indicated that working memory remained related to accuracy remembering positive social stimuli when controlling for both MAP ($t = 2.51$, $p = .01$) and

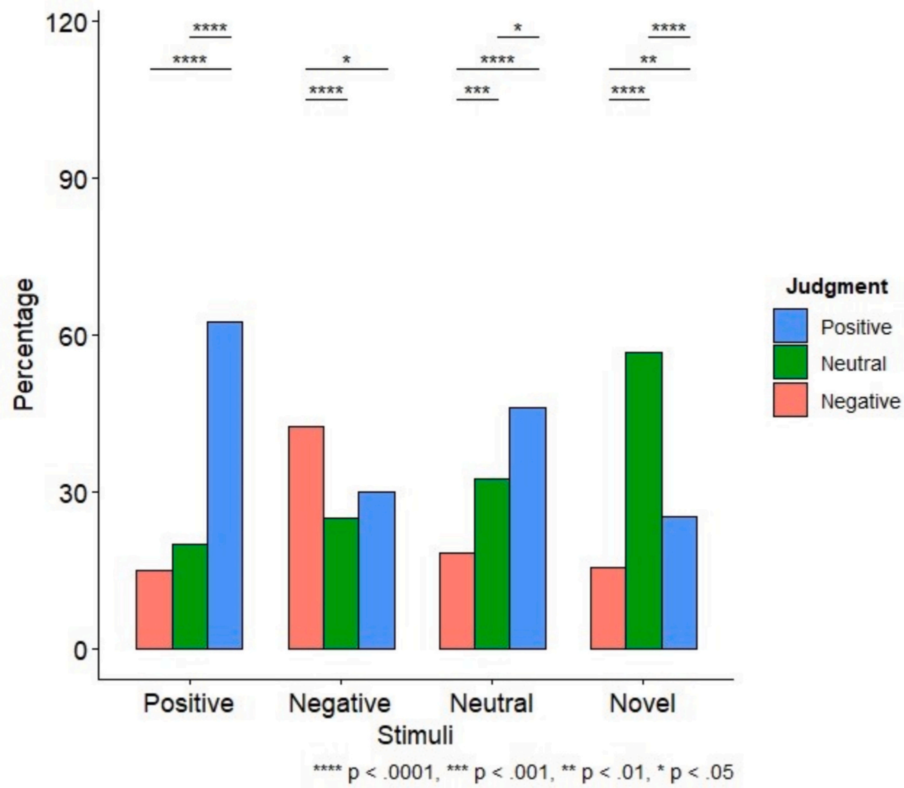

Fig. 1. Affective learning task performance.

Table 4
Correlation results.

	Positive social affective learning accuracy	Negative social affective learning accuracy
CAINS MAP	**−0.20***	−0.04
RSAS-B Total	**−0.20***	−0.08
CAINS EXP	−0.13	−0.16
BPRS Depression/ Anxiety	0.01	−0.02
BPRS Positive Symptoms	−0.15	**−0.19***
BPRS Agitation	−0.04	−0.11
MCCB Composite Score	**0.22***	**0.25***
MCCB Working Memory	**0.27***	**0.20***
MCCB Speed of Processing	0.13	**0.24***
MCCB Attention/ Vigilance	0.09	**0.20***
MCCB Verbal Learning	0.06	0.13
MCCB Visual Learning	0.16	**0.29***
MCCB Reasoning and Problem Solving	0.18	**0.22***
MCCB Social Cognition	0.05	0.05

CAINS MAP = Clinical Assessment for Negative Symptoms Motivation and Pleasure; RSAS-B = Revised Social Anhedonia Scale- Brief; CAINS EXP = Clinical Assessment for Negative Symptoms, Expressivity; BPRS = Brief Psychiatric Rating Scale; MCCB = Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive Battery.

* $p < .05$.

RSAS ($t = 2.43$ $p = .02$). Thus, negative symptoms do not uniquely predict positive social affective learning when controlling for cognitive impairment, but deficits in working memory uniquely predict reduced positive social affective learning when controlling for negative symptoms.

4. Discussion

Negative symptoms are common in psychosis and significantly contribute to functional impairment. While research investigating mechanisms behind negative symptoms has examined the role of social reward processing, less research has focused on social affective learning or the relation between social affective learning and negative symptoms. The present study sought to illuminate how social affective learning relates to negative symptoms and determine whether this relation is unique to negative symptoms using an updated social affective learning task.

When examining task performance (Bliss-Moreau et al., 2008; Dwyer et al., 2020), results indicated that individuals across the psychosis spectrum accurately remembered both positive and negative social stimuli using an updated social affective learning task. This contrasts previous work which found immediate affective learning for positive, but not negative, social stimuli (Dwyer et al., 2020). Additionally, novel stimuli in the current study were most often rated as neutral, providing further evidence of affective learning. Taken together, this demonstrates that individuals across the psychosis spectrum can accurately use both positive and negative behavioral information to generate socially-evaluative perceptions of others (Bliss-Moreau et al., 2008; Falvello et al., 2015; Hackel and Mende-Siedlecki, 2023; Suess et al., 2013). Although neutral stimuli were most often rated as positive, it is likely that mere exposure to these stimuli in the absence of valenced social information led to more positive ratings (Carr et al., 2017; Zajonc, 1968). The mere exposure effect has been previously demonstrated in research examining affective learning (Bliss-Moreau et al., 2008). Overall, our updated affective learning task successfully led to learning for both positive and negative stimuli, allowing for an examination of symptom correlates to task performance.

Our examination of symptom correlates indicated that individuals with greater clinician-rated motivation and pleasure symptoms and self-reported social anhedonia were less likely to learn the association between neutral faces and positive social behavior. This pattern did not emerge for negative social stimuli which were unrelated to negative symptoms. Importantly, positive social affective learning was unrelated to other symptom domains (i.e., depression and anxiety, positive psychotic symptoms). Thus, greater motivation and pleasure deficits are uniquely related to diminished recall of positive social stimuli as positive. This finding extends previous research by demonstrating that motivation and pleasure deficits are specifically related to poorer affective learning of positive, but not negative, valenced stimuli. This diminished ability to learn the affective value of others may contribute to reduced social approach in appropriate circumstances, helping explain the emergence and maintenance of negative symptoms over time (Herbener, 2008; Herbener et al., 2007; Horan et al., 2007).

Regarding the relation between social affective learning and cognition, analyses indicated that greater overall cognitive impairment was related to reduced accuracy in remembering both positive and negative social stimuli. Poorer working memory appeared to be particularly important in deficits remembering positive social stimuli while deficiency in several cognitive domains was related to diminished accuracy remembering negative social stimuli. This replicates our previous result that poorer recall of positive social stimuli is related to general cognitive ability in psychosis using a comprehensive cognitive battery (Dwyer et al., 2020) and extends these findings demonstrating that cognitive deficits are related to poorer recall of negative social stimuli. Thus, poorer social affective learning is related to poorer cognition across the spectrum of psychosis.

Contrary to hypothesis, neither clinician-rated motivation and pleasure deficits nor self-reported social anhedonia remained related to positive social affective learning when controlling for cognition, including in analyses controlling for working memory. However, when controlling for motivation and pleasure symptoms, poorer working memory remained related to inhibited recall of positive social stimuli. These findings are consistent with a cognitive model of negative symptoms which posits that cognitive deficits give rise to reduced reward anticipation and defeatist performance beliefs, cascading into disengagement, ultimately resulting in negative symptoms (Rector et al., 2005). Encoding and retrieval processes have been proposed to contribute to expectations of low pleasure that may be inconsistent with real-world experience (Gold and Strauss, 2012) and deficits in working memory also relate to a diminished willingness to exert effort for higher rewards (Barch et al., 2023). Separately, defeatist performance beliefs have consistently been shown to mediate the relation between cognitive deficits and negative symptoms (Campellone et al., 2016; Grant and Beck, 2009; Luther et al., 2024). Given our findings that individuals with poorer working memory are less likely to accurately remember positive social stimuli, this may lead to diminished pleasure anticipation from social engagement and contribute to reduced effort in socially rewarding situations, contributing to the emergence and maintenance of motivation and pleasure deficits over time. This diminished learning may also make appropriate social engagement more difficult, contributing to the defeatist performance beliefs shown to mediate cognitive deficits and negative symptoms.

Thus, the current results expand on prior findings to demonstrate that impairments in working memory contribute to diminished social affective learning associated with positive social behavior. These findings also raise questions about whether diminished affective learning of the positive value of others is a causal pathway by which cognitive deficits lead to the emergence of diminished reward anticipation, defeatist performance beliefs, and motivation and pleasure symptoms. Further longitudinal work and examination of the relations between these variables in clinical high risk and first episode samples will provide additional insight.

Although the present findings enhance our understanding of social affective learning and motivation and pleasure symptoms in psychosis, there are several limitations. While our dimensional approach is consistent with RDoC (Cuthbert, 2022; Kozak and Cuthbert, 2016) and HiTOP (Kotov et al., 2017) recommendations, it limited our ability to examine potential differences between diagnostic subgroups. Additionally, our majority male and majority Black sample limited our ability to explore demographic differences in affective learning and whether demographic characteristics of stimuli interacted with participant characteristics. Future studies should replicate these findings in larger and more diverse samples using more racially diverse social stimuli. Also, while past research has demonstrated that viewing static images paired with socially-relevant information is sufficient to impact social perceptions (Falvello et al., 2015; Suess et al., 2013), the stimuli in this study are limited in their ecological validity and may have relied too much on implicit emotional memory modulation, an area where individuals with psychosis show deficits (Courtenay et al., 2022; Dieleman and Röder, 2013). Studies using dynamic videos or virtual reality may promote more explicit emotional memory modulation and provide additional insight. Additionally, as most of our clinical participants were on a clinically determined stable regimen of psychiatric medications and medication adherence was not assessed, we cannot determine the potential impact of medication on the current findings. Future studies should seek to replicate these findings in medication naïve participants. Finally, while the sentences in our task were modified based on previous research (Bliss-Moreau et al., 2008; Dwyer et al., 2020), participant perceptions of these sentences were not obtained. Future research would benefit from having participants rate the valence of each sentence to ensure accurate perception of the behavioral descriptions.

5. Conclusion

The present findings indicate that both motivation and pleasure symptoms and cognitive deficits are related to diminished memory for positive socially-relevant stimuli. Motivation and pleasure symptoms are uniquely related to impaired social affective learning of positive social stimuli while cognitive deficits appear to diminish social affective learning more broadly. These findings have implications for our understanding of how poorer social affective learning and cognition may contribute to the emergence and maintenance of negative symptoms and suggest that encoding and retrieval of socially-relevant stimuli may be a novel treatment target for negative symptoms in psychosis.

CRediT authorship contribution statement

Ryan D. Orth: Writing – original draft, Project administration, Investigation, Formal analysis, Data curation. **Imani L. Todd:** Writing – review & editing, Visualization, Data curation. **Kristen R. Dwyer:** Writing – review & editing, Software, Methodology, Investigation. **Melanie E. Bennett:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization. **Jack J. Blanchard:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2025.02.003.

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