



# Anticipated pleasure for positive and negative social interaction outcomes in schizophrenia

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## ABSTRACT

While recent research suggests that people with schizophrenia anticipate less pleasure for non-social events, considerably less is known about anticipated pleasure for social events. In this study, we investigated whether people with and without schizophrenia differ in the amount and updating of anticipated pleasure over the course of repeated interactions as well as the influence of emotional displays. Thirty-two people with schizophrenia and 29 controls rated their anticipated pleasure over the course of repeated interactions with smiling, scowling, or neutral social partners that had either positive or negative outcomes. Compared to controls, people with schizophrenia anticipated a lower amount of pleasure during interactions with smiling, but not neutral social partners that had positive outcomes. However, the groups did not differ in the amount or updating of anticipated pleasure during interactions that had negative outcomes. Both groups anticipated more pleasure over the course of repeated interactions with smiling partners and less pleasure over the course of repeated interactions with scowling partners compared to interactions with neutral partners. We discuss how less anticipated pleasure for interactions with smiling social partners may be linked to difficulties in social engagement among people with schizophrenia.

## 1. Introduction

Whether meeting a friend for coffee or looking forward to seeing family around the holidays, many people anticipate pleasure from positive social encounters. Unfortunately, people with schizophrenia may not anticipate as much pleasure from the social world as those without schizophrenia. Indeed, people with schizophrenia often report less anticipated pleasure for future positive events compared to people without schizophrenia (Kring and Elis, 2013). However, nearly all of this research has focused on anticipated pleasure for non-social events. Less is known about anticipated pleasure for social events among people with schizophrenia, even as deficits in social engagement and social functioning are common (e.g., Robertson et al., 2014). In this study, we investigated anticipated pleasure for social interactions with either positive or negative outcomes, and whether emotional displays during social interactions might be associated with anticipated pleasure.

Recent work in affective and clinical science has parsed the experience of pleasure into consummatory (in the moment) and anticipatory components (e.g., Kring and Caponigro, 2010; Kring and Elis,

2013). Studies assessing consummatory social pleasure have found that people with and without schizophrenia reported similar positive affect following a social role-play (Aghevli et al., 2003) as well as when around other people in daily life (Oorschot et al., 2011). This is especially important as positive appraisals about past social interactions has been shown to predict the likelihood of future interactions among people with schizophrenia, suggesting that intact consummatory social pleasure may play an important role in promoting social engagement (Granholm et al., 2013). Further, a recent study examining the motivation for daily goals set by people with and without schizophrenia found that goals set in both groups were equally motivated by a desire for relatedness (Gard et al., 2014a). Despite behavioral evidence of intact consummatory social pleasure, studies using self-report measures, most commonly the Social Anhedonia Scale (SAS; Eckblad et al., 1982), have found that people with schizophrenia report less pleasure than controls from social activities (e.g., Blanchard et al., 1998; Horan et al., 2006). This discrepancy may be explained by that fact that self-report measures, like the SAS, require participants to generate a mental representation of a hypothetical situation and then rate their pleasure experience, which creates an additional cognitive demand. Studies in

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the lab or in daily contexts, on the other hand, ask participants to rate their pleasure experience during or immediately after an actual experience or stimulus, likely reducing the cognitive demand for generating and maintaining a mental representation.

Studies of anticipated pleasure have largely focused on self-reported pleasure from future sensory and non-social events using the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006). In a review of 23 studies using the TEPS, about half found that people with schizophrenia reported less anticipatory pleasure than controls (Frost and Strauss, 2016). Like the SAS, the TEPS also require participants to generate a mental representation of future events in order to rate anticipated pleasure, which likely creates an additional cognitive demand. In a study that assessed anticipated pleasure in daily life, Gard et al. (2007) found that, compared to controls, people with schizophrenia anticipated less pleasure for goal-directed activities. However, in a later study, Gard and colleagues found that people with schizophrenia reported *greater* anticipated pleasure daily life activities (Gard et al., 2014b). Methodological differences may account for these discrepancies: in the early study, participants responded to pages; in the later study, participants talked to an experimenter over the phone. In the lab, Wang et al. (2015) found that compared to controls, people with schizophrenia anticipated less pleasure for cues indicating potential monetary rewards. Edwards et al. (2015) asked people with and without schizophrenia to rate their anticipated pleasure for cues corresponding to positive images at high and low intensity levels. Relative to their rating of consummatory pleasure, people with schizophrenia anticipated greater pleasure for cues indicating low intensity stimuli and anticipated less pleasure for cues indicating high intensity positive stimuli. In sum, self-reported anticipated pleasure using the TEPS is the most commonly used approach, and the findings are mixed. Although there are fewer lab and daily life studies, on balance, these studies have more consistently found that people with schizophrenia anticipate less pleasure for future positive events.

While there have been several studies of consummatory social pleasure, there have been fewer studies of anticipated pleasure in the social domain. To date, only one study (Engel et al., 2016) investigated anticipated pleasure for social events in schizophrenia. In this study, people with and without schizophrenia were assigned to either a social inclusion (positive outcome) or social exclusion (negative outcome) condition in a computer game (Cyberball) and then asked to make a single rating of anticipated pleasure about being included or excluded from the upcoming game. In the inclusion condition, people with schizophrenia reported less anticipated pleasure than controls. No group differences were found in the exclusion condition.

In the current study, we sought to extend our understanding of anticipated pleasure in several ways. First, while the Engel et al. study (2016) found group differences in the amount of anticipated pleasure for positive outcomes based on one rating, they did not take advantage of the multiple trials in the game to also assess the extent to which people with schizophrenia *updated* anticipated pleasure based on the outcomes of experiences. Studies have consistently found that people with schizophrenia have comparative difficulties in using rewarding non-social (e.g., Gold et al., 2012; Strauss et al., 2014) and social outcomes (e.g., Campellone et al., 2016) to update subsequent decision-making, and as a result may be less likely to make decisions that result in future rewarding outcomes. We reasoned that people with schizophrenia will have difficulty using a positive social interaction outcome, such as a pleasant conversation with a friend, to update their anticipated pleasure for the next interaction, and as a result be less inclined to seek out a future interaction.

Second, for common sense reasons, most studies of anticipated pleasure have focused on positive events or outcomes, leaving open the question of whether deficits in anticipated pleasure are specific to positive outcomes. While people typically do not anticipate pleasure for negative outcomes, such outcomes may lessen anticipated pleasure. For example, a stressful meeting with a co-worker may lessen anticipated

pleasure for the next work meeting. We reasoned that investigating anticipated pleasure for interactions with positive and negative outcomes would allow us to assess whether deficits in anticipated pleasure among people with schizophrenia are specific to positive outcomes, or also extend to negative outcomes. Indeed, evidence from Engel et al. (2016) suggests that deficits in anticipated social pleasure may be specific to positive social outcomes, consistent with studies using negative, non-social (Gold et al., 2012; Strauss et al., 2014) and social outcomes (e.g., Campellone et al., 2016) to update decision-making to avoid future negative outcomes.

Another factor that may influence anticipated pleasure in social interactions are emotional displays, which convey a social partner's feelings and intentions during an interaction (e.g., Keltner and Kring, 1998; Van Kleef, 2009). Smiles have been shown to activate brain regions associated with the anticipation of reward (Rademacher et al., 2010) and facilitate learning from rewarding outcomes (Heerey, 2014). Scowls, on the other hand, signal rejection (e.g., Heerdink et al., 2015) and for others to keep their distance (Marsh et al., 2005), and as such may be associated with less anticipated pleasure in social interactions. Even though people with schizophrenia have difficulties accurately labeling emotional displays (e.g., Kohler et al., 2010), other evidence suggests people with schizophrenia implicitly use the information conveyed in emotional displays to guide subsequent behavior (e.g., Hooker et al., 2011; Kring et al., 2014; Campellone et al., 2016). Thus, people with schizophrenia may be able to implicitly use the information signaled by emotional displays to guide anticipated pleasure in social contexts.

### 1.1. Present study

We tested three hypotheses and one exploratory aim. First, based on the Engel et al. (2016) study, we predicted that people with schizophrenia would anticipate less pleasure than controls from social interactions with positive, but not negative outcomes. We then explored group differences in the updating of anticipated pleasure over the course of repeated interactions with positive and negative outcomes. Second, given recent evidence (Hooker et al., 2011; Kring et al., 2014; Campellone et al., 2016), we predicted that people with schizophrenia would not differ from controls in their anticipated pleasure for social interactions with smiling and scowling social partners. Third, we predicted that anticipated pleasure for social interactions with positive, but not negative outcomes would be associated with social functioning among people with schizophrenia. To explore whether the association between anticipated pleasure and social functioning was influenced by social partner emotional displays, we also conducted these correlations separately for social partners with emotional (smile/scowl) and neutral displays.

## 2. Methods

### 2.1. Participants

Thirty-two people meeting DSM-IV-TR (American Psychiatric Association, 2000) criteria for schizophrenia ( $n = 20$ ) or schizoaffective disorder ( $n = 12$ ) and 29 healthy controls were recruited from outpatient mental health clinics and community advertisements. We calculated our sample size using G\*Power software (Faul et al., 2007), using the effect size from Engel et al. (2016) as a basis for estimating the sample size. Participants were between the ages of 18 and 60, had no history of neurological disorders or serious head trauma, were fluent in English, had an estimated IQ > 70, and did not meet criteria for depression, mania, hypomania, or substance abuse in the past month or substance dependence in the last six months. Participants received \$15 per hour for their participation in the study. Twenty-nine people in the schizophrenia group were taking medications; of these, 26 were taking atypical anti-psychotics.

## 2.2. Clinical assessment

Diagnoses were confirmed using the Structured Clinical Interview for DSM–IV (SCID-I/P; First et al., 2002a), and the absence of diagnoses for the control group was confirmed using the SCID non-patient version (SCID-I/NP; First et al., 2002b). We assessed negative symptoms using the Clinical Assessment Interview for Negative Symptoms (CAINS; Kring et al., 2013), and general symptoms using Brief Psychiatric Rating Scale (BPRS; Lukoff et al., 1986). Given that the CAINS is a newer assessment instrument, we compared the scores for each CAINS subscale to those from the validation paper that contained a large, diverse, and representative sample of people with schizophrenia ( $n = 162$ ; Kring et al., 2013). The current sample was very similar to the validation study sample on both the Motivation and Pleasure (MAP, Means: 15.0 and 14.2) and Expressivity scales (EXP, Means: 5.7 and 4.9). Functioning in the areas of work, self-care, family relationships, and social networks was assessed with the Role Functioning Scale (RFS; McPheeters, 1984).

## 2.3. Social interaction task – modified trust game

After providing informed consent, participants played a modified version of the Trust Game (Campellone et al., 2016) created using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) and presented on a laptop computer. Instructions were designed to be self-explanatory and participants completed the task alone in a quiet testing room.

During the game, participants interacted with four simulated social partners, each identified by name and a dynamic 5 s video of them expressing either an emotional (smile or scowl) or neutral facial display (see Fig. 1). After seeing the partner's name and display, participants were asked to rate the amount of pleasure they anticipated from the forthcoming outcome of this interaction by entering a number on the keyboard that corresponded to a 1 (not at all) to 5 (very much) scale presented on the screen. Next, participants decided how many points to send to this partner, choosing an amount between 0 and 10 on the keyboard. The amount of points sent by the participant was then quadrupled, increasing the total number of available points. At this point, the social partner returned anywhere between 0 and 40 points to the participant.

Participants interacted with each simulated social partner 10 times for a total of 40 trials. Interactions between participants and simulated social partners were conducted entirely using the computer monitor and keyboard and the only information that participants were provided about each social partner was their name, display, and the interaction outcome. The total amount of points a participant received did not accumulate across trials and was reset after each interaction. The order of interactions was pseudo-randomized so that participants never interacted with the same partner on consecutive trials.<sup>1</sup>

## 2.4. Social interaction outcomes and displays

Social interaction outcomes were predetermined so that two social partner interactions resulted in *positive* outcomes (average return was equal to double the amount of points sent) and the other two social partner interactions resulted in *negative* outcomes (average return was equal to half the amount of points sent). For the two social partners with whom interactions resulted in positive outcomes, one exhibited a dynamic smile and the other exhibited no emotion (i.e., neutral display). For the two social partners with whom interactions resulted in negative outcomes, one exhibited a dynamic scowl and the other no

emotion. Each social partner exhibited the same display for all interactions. Thus, ratings of anticipated pleasure reflected the degree to which participants anticipated enjoying the social partner's decision to either honor (positive interaction outcome as indicated by more points returned on average) or reject (negative interaction outcome as indicated by fewer points returned on average) the trust placed in them.

Social partner emotional displays consisted of dynamic, 5 s video clips of actors from the Amsterdam Dynamic Facial Expression Set (ADFES; Van der Schalk et al., 2011). The actors received instruction from coaches trained in the Facial Action Coding System (FACS; Ekman et al., 2002). We chose 4 actors (2 men, 2 women), with one member of each gender expressing an emotion and the other expressing no emotion (i.e., a neutral display). Pairing of social partner gender and emotional display was counterbalanced so that half the sample within and across groups saw a male actor scowling and female actor smiling while the other half saw a male actor smiling and female actor scowling. The male and female videos were comparably rated by an independent sample ( $n = 12$ ) of healthy adults on attractiveness, trustworthiness, and emotional intensity.

## 2.5. Statistical analysis plan

For our hypotheses and exploratory aim about group differences in the amount and updating of anticipated pleasure as well as the impact of emotional displays, we modeled changes in anticipated pleasure over the course of repeated social interactions using two, separate linear mixed effects regression models: one for interactions with positive outcomes and one for interactions with negative outcomes. A mixed-effect regression model can accommodate the nesting that occurs in the repeated measurement of the same people over time by modeling the random distribution of individual differences in level (random effect for intercept) and change over time (random effect for slope). These random effects are mixed with standard fixed-effects or model predictors, which yield a single regression coefficient for the sample (e.g. group status). We included the following fixed effect model predictors of anticipated pleasure ratings over the course of repeated social interactions with positive and negative outcomes: group (schizophrenia, control), emotion (smile/scowl, neutral), time (repeated social interactions). We also modeled all possible higher order interactions.

Within these models, a significant group main effect would indicate a group difference in the amount of anticipated pleasure while a significant Group  $\times$  Time interaction would indicate that people with and without schizophrenia differed in their updating of anticipated pleasure over the course of repeated interactions. A Group  $\times$  Emotion interaction, on the other hand, would indicate that people with and without schizophrenia differed in their anticipated pleasure for interactions with social partners with emotional and non-emotional displays. Model analyses were conducted using the lme4 package in R version 3.1.0. For significant effects, we reported unstandardized beta coefficient estimates, standard errors, and effect sizes (Cohen's  $d$ ). For significant main and interaction effects, we tested conducted follow-up tests of simple effects using independent (for between subject effects) or paired samples  $t$ -tests (for within subject effects).

To investigate our third hypothesis, we computed correlations between the Social Network subscale of the RFS and the average ratings of anticipated pleasure for social interactions with positive and for interactions with negative. In addition, within each interaction outcome condition, we separately presented correlations for each social partner (emotional/non-emotional display).

## 3. Results

Demographic and clinical information is presented in Table 1. Participant gender, education, age, and estimated full-scale IQ were not significantly different between people with and without schizophrenia nor were they related to any study variables. Among people with

<sup>1</sup> The focus of this article is on anticipated pleasure, results from the decision-making component of this study and an additional reversal learning phase, are published elsewhere (see Campellone et al., 2016).

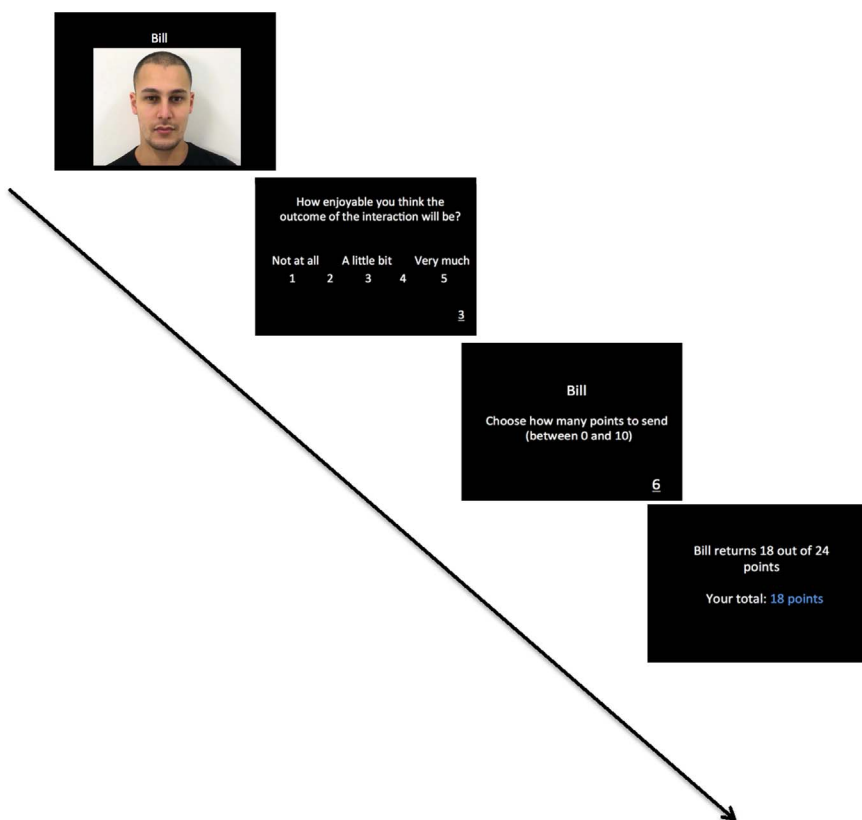


Fig. 1. Example of a task trial. Participants first saw a dynamic clip and name of a social partner. Next, participants rated their anticipated pleasure for the outcome of the social interaction. Then, participants decided how many points to send to that partner and saw the outcome of the interaction, which showed the number of points returned by the social partner.

Table 1  
Demographic and clinical variables.

	Schizophrenia (n = 32)	Controls (n = 29)
Age	47.5 (11.9)	46.2 (10.7)
Education	14.7 (2.6)	15.3 (1.8)
Parental Education	14.7 (2.5)	13.3 (3.3)
Sex (M/F)	17/15	14/15
WTAR	105.4 (13.0)	106.1 (9.9)
BPRS Total Score	46.5 (13.7)	–
CAINS		
MAP scale	15.0 (5.7)	–
EXP scale	5.7 (3.7)	–
RFS		
Work	4.2 (2.0)	–
Self-Care	5.5 (1.2)	–
Family	4.9 (1.9)	–
Social Networks	4.7 (1.7)	–

WTAR = Wechsler Test of Adult Reading, Scale; BPRS = Brief Psychotic Rating Scale; CAINS = Clinical Assessment Inventory for Negative Symptoms; MAP = Motivation and Pleasure; EXP = Expressivity, RFS = Role Functioning Scale.

schizophrenia, neither negative symptoms nor general symptoms were associated with anticipated pleasure for interactions with positive (CAINS MAP:  $r(32) = -0.28, ns$ , CAINS EXP:  $r(32) = -0.20, ns$ , BPRS:  $r(32) = 0.01, ns$ ) or negative outcomes (CAINS MAP:  $r(32) = -0.02, ns$ , CAINS EXP:  $r(32) = -0.09, ns$ , BPRS:  $r(32) = -0.10, ns$ ). Further, people with schizophrenia and schizoaffective disorder did not differ on any clinical variables or task performance, and we thus refer to this group as the schizophrenia group. There were no gender differences within either group for the amount of anticipated pleasure for interactions with positive and negative outcomes. Finally, there were no significant interactions between participant and social partner gender.

### 3.1. Positive social interaction outcomes

We did not find support for our first hypothesis or exploratory aim as the linear mixed effects regression model for interactions with positive outcomes revealed no group differences in either the amount or the updating of anticipated pleasure. However, we found partial support for our second hypothesis regarding group differences in the impact of emotional displays on anticipated pleasure. Specifically, we found a significant main effect of emotion that was qualified by both significant Time X Emotion interaction (see Fig. 2a). Thus, while anticipated pleasure varied from interaction to interaction, both groups similarly used the information conveyed by a smile to update anticipated pleasure over the course of all 10 repeated interactions. The Group X Emotion interaction was also significant (see Fig. 2a). Specifically, compared to controls, people with schizophrenia anticipated a lower amount of pleasure from positive outcome-interactions with smiling social partners,  $t(59) = 1.99, p = 0.05, d = 0.37$ , but not neutral social partners,  $t(59) = 0.29, p = 0.78$  (see Fig. 2a). No other effects were significant ( $p's > 0.11$ ).

### 3.2. Negative social interaction outcomes

Our results from the linear mixed effects regression model for interactions with negative outcomes revealed no group differences in the amount and updating of anticipated pleasure, consistent with expectations. In addition, the groups did not differ with respect to the impact of emotional displays on anticipated pleasure over the course of repeated social interactions (see Table 2). However, similar to our findings for interactions with positive outcomes, we found a significant emotion main effect that was qualified by a significant Time X Emotion interaction. Unpacking this Time X Emotion interaction, we found that both people with and without schizophrenia anticipated less pleasure over the course of repeated interactions with scowling,  $t(59) = 2.10, p = 0.04, d = 0.53$  compared to neutral social partners,  $t(59) = -0.59,$



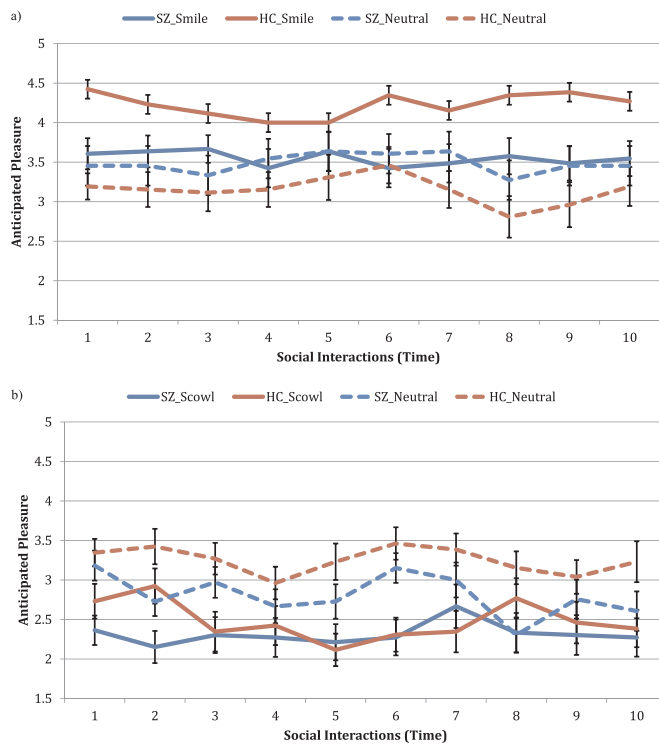


Fig. 2. Anticipated pleasure over the course of repeated social interactions for people with and without schizophrenia. Fig. 2a shows anticipated pleasure for social interactions resulting in positive outcomes with smiling and neutral social partners. Fig. 2b shows anticipated displeasure for social interactions resulting in negative outcomes with scowling and neutral social partners. Note: SZ = schizophrenia, HC = healthy controls.

$p = 0.56$ ,  $d = 0.15$  (see Fig. 2b). No other effects were significant ( $p > 0.32$ ).

### 3.3. Correlations with social functioning

As predicted, we found that the average anticipated pleasure for interactions with positive outcomes was associated with social functioning,  $r(32) = 0.39$ ,  $p = 0.02$ . Examining these associations separately for each social partner, we found that a significant association between anticipated pleasure and social functioning for interactions with smiling social partners,  $r(32) = 0.36$ ,  $p = 0.04$ , but not neutral partners,  $r(32) = 0.32$ ,  $p = 0.07$ . Average anticipated pleasure for interactions with negative outcomes was not significantly associated with social functioning,  $r(32) = 0.30$ ,  $ns$ , nor for either scowling,  $r(32) = 0.08$ ,  $ns$ , or neutral,  $r(32) = 0.32$ ,  $ns$ , social partners.

Table 2

Linear mixed effects regression results for predicted anticipated pleasure during social interactions with positive and negative outcomes.

	Interactions with Positive Outcomes				Interactions with Negative Outcomes			
	B	SE	t	d [95% CI]	B	SE	t	d [95% CI]
Intercept	3.35	0.14	–	–	3.11	0.16	–	–
Time	0.01	0.01	–1.63	0.42 [–0.09 to 0.02]	–0.01	0.01	–1.01	0.26 [–0.76 to 0.25]
Group	–0.10	0.20	–0.49	–0.13 [–0.38 to 0.63]	–0.28	0.22	–1.27	–0.33 [–0.83 to 0.18]
Emotion	0.53***	0.13	4.11	1.05 [0.51 to 1.59]	–0.48***	0.13	–3.71	–0.95 [–1.48 to –0.42]
Group × Time	–0.01	0.01	–0.59	–0.15 [–0.65 to 0.35]	0.003	0.01	0.33	0.08 [–0.59 to 0.42]
Group × Emotion	–0.37*	0.18	–2.09	–0.54 [–1.05 to –0.02]	–0.12	0.18	–0.67	0.17 [–0.33 to 0.67]
Time × Emotion	–0.03*	0.01	–2.49	–0.64 [–1.15 to –0.12]	0.02†	0.01	2.03	0.52 [–1.03 to –0.01]
Group × Time × Emotion	0.01	0.02	0.68	0.17 [–0.33 to 0.68]	0.001	0.02	0.07	0.02 [–0.48 to 0.52]

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

## 4. Discussion

To date, there have been few studies of anticipated social pleasure in schizophrenia. Yet, people with schizophrenia often have lower levels of social engagement, which may be in part reflect diminished anticipated pleasure for social interactions. In this study, we investigated anticipated pleasure for social interactions with positive and negative outcomes among people with and without schizophrenia. To better elucidate the nature of anticipated social pleasure, we investigated both the amount and updating of anticipated pleasure over the course of repeated social interactions. Further, given that social partners often display emotion during interactions, and that emotional displays have been shown to influence anticipated pleasure for non-social outcomes (e.g., Rademacher et al., 2010), we investigated whether social partner emotional displays were associated with anticipated pleasure for social interaction outcomes.

For interactions with positive outcomes, we found that people with schizophrenia anticipated less pleasure than controls, but only during social interactions with smiling partners. Moreover, greater anticipated pleasure for social interactions with smiling partners was associated with better social functioning, pointing to its importance. In most contexts, smiles promote social engagement by signaling that someone is trustworthy (e.g., Scharlemann et al., 2001) and inviting social approach behavior (e.g., Knutson, 1996). Research with healthy people has shown that greater anticipated pleasure is linked to a greater likelihood of engaging in a particular course of action (e.g., Mellers and McGraw, 2001). Therefore, if people with schizophrenia anticipate comparatively less social pleasure from interactions with smiling social partners, then they may also be comparatively less likely to engage in social interactions with smiling social partners.

We did not find group differences in updating anticipated pleasure over the course of repeated interactions with positive outcomes as both groups anticipated more pleasure over the course of repeated interactions with smiling compared to neutral social partners. While exploratory, this finding is important as it suggests that decreases in the amount of anticipated pleasure was not due to difficulties learning from interactions with positive outcomes, but rather a failure to “catch up” to the anticipatory pleasure ratings made by controls. Further, while speculative, this finding also suggests that overcoming barriers to initial social engagement may pose the bigger challenge and that engaging in subsequent interactions may be comparatively easier due to intact updating. Why might people with schizophrenia anticipate a lower amount of pleasure for interactions with smiling partners, but still appear to have no difficulty in updating their pleasure over the course of repeated interactions? One possibility is that engaging in repeated interactions with the same social partners provided participants in both groups the opportunity to calibrate anticipated pleasure for subsequent social interactions, allowing all participants to use previous outcomes to guide their anticipated pleasure. Thus, people with schizophrenia may

have been just as able as controls to use the outcome from a prior positive interaction to bolster anticipated pleasure for subsequent interactions.

Another speculative possibility is that people with schizophrenia may have more accurately predicted their pleasure for interactions with positive outcomes than controls. Research has shown that healthy people often overestimate the amount of pleasure for future positive events (e.g., Wilson and Gilbert, 2005), which has been posited to be adaptive and important for subsequent engagement in motivated behavior in healthy people (Mellers and McGraw, 2001; Greitemeyer, 2009; Miloyan and Suddendorf, 2015). People with schizophrenia, as was shown in the study by Edwards et al. (2015), may in fact underestimate their anticipated pleasure relative to their consummatory pleasure for high intensity positive stimuli. In other words, their anticipated pleasure may more closely approximate the in the moment experience of pleasure, with a possible consequence being diminished drive to engage in motivated behavior. In our study, it may be that interactions with smiling social partners were similar to the highly pleasant non-social stimuli in the Edwards and colleagues study, and that people with schizophrenia may have more accurately predicted (or even underestimated) the amount of pleasure for these interactions. If this is true, smiles may not facilitate social engagement in people with schizophrenia the way that they do in healthy people (e.g., Knutson, 1996). Unfortunately, we did not assess pleasure in response to these interactions and thus cannot compare these two ratings. Future studies should assess both anticipated and consummatory pleasure from social interactions in people with and without schizophrenia to more clearly determine whether group differences in anticipated pleasure amount may reflect an overestimation, underestimation, or potentially a combination of the two.

To determine whether potential deficits in anticipated pleasure were specific to social interactions with positive emotional displays and outcomes, we also investigated anticipated pleasure for interactions with negative emotional displays and outcomes. As expected and consistent with Engel et al. (2016), we did not find group differences in the amount of anticipated pleasure for negative social interaction outcomes. Our design also allowed us to assess the updating of anticipated pleasure over the course of repeated interactions with negative outcomes, and we also found no differences between people with and without schizophrenia. Together, our findings suggest that deficits in anticipated pleasure do not extend to negative social outcomes. Furthermore, our findings of no group differences in anticipated pleasure for negative social outcomes are in line with findings from previous studies that have shown intact use of negative non-social (e.g., Gold et al., 2012) and social (e.g., Campellone et al., 2016) outcomes to inform decision-making among people with schizophrenia. Thus, it appears that using negative outcomes to inform behavior may be a relative strength among people with schizophrenia.

These findings also add to the growing body of work suggesting that in some contexts people with schizophrenia modify their behavior based on the emotional display of another person (e.g., Hooker et al., 2011; Kring et al., 2014; Campellone et al., 2016). In the current study, we extended previous work by simultaneously investigating how people with and without schizophrenia use the information signaled by positive and negative emotional displays to inform the amount and updating of anticipated pleasure. Our results suggest that both groups used the information signaled by smiles and scowls to *update* anticipated pleasure over the course of repeated interactions relative to neutral displays. However, people with schizophrenia appear to have a specific difficulty in using smiles (but not scowls) to inform the *amount* of anticipated pleasure. While speculative given the nature of the interactions in this study, one possibility for this finding is that smiling displays were less rewarding for people with schizophrenia. While work in healthy people has shown that smiles activate reward areas of the brain (e.g., Rademacher et al., 2010), people with schizophrenia often show comparatively less activation in these brain areas during reward

receipt (e.g., Radua et al., 2015). If people with schizophrenia found smiles to be less rewarding, this may have thus influenced their anticipated pleasure for these interactions. However, our results suggest the people with and without schizophrenia found scowls to be similarly un-rewarding.

Our findings have important implications for understanding the nature of decreased social engagement and poor social functioning in schizophrenia. A critical next step of this research will be to expand the investigation of anticipated pleasure for social interactions outside of the lab and into the lives of people with schizophrenia, similar to the approaches taken in previous studies (Granholtm et al., 2013; Oorschot et al., 2013; Gard et al., 2014b). Two key unanswered questions are: 1) whether our findings of intact updating, but decreased amount of anticipated pleasure for positive outcomes is evident in daily life and predict real-world social engagement, and 2) whether a decrease in the amount of anticipated pleasure for social interactions with positive outcomes is due to an underestimation relative to healthy people, as Edwards et al. (2015) work suggests. Answering these questions could inform targeted approaches to promoting real-world social engagement by making people with schizophrenia more aware of a tendency to underestimate their anticipation of pleasure from future social interactions.

As with any study, it is important to acknowledge limitations. First, our study investigated how people with schizophrenia anticipated pleasure over the course of repeated simulated (computer) social interactions with positive and negative outcomes, not actual social interactions. Even though participants interacted with dynamic, virtual social partners, it is not the same as actual people. Future studies ought to extend this work to interactions between people in different social contexts. Second, the outcomes of the social interactions were expressed in terms of points. Future studies might seek to increase the social nature of interaction outcomes, possibly by using emotion displays as outcomes (e.g., Vrticka et al., 2008), or assess anticipated social pleasure in the context of participant's daily lives (e.g., Granholtm et al., 2013). Third, we did not assess consummatory pleasure, nor state positive or negative affect prior to the start of the task, which have been shown to influence the social interaction appraisal in people with schizophrenia (Granholtm et al., 2013). By investigating both pleasure components as well as measuring affect, future studies can determine how these components might independently contribute as well as interact to influence social engagement among people with schizophrenia. Fourth, the pairing of emotional display (e.g., smile/scowl) and outcome (e.g., positive/negative) were always matched, and thus is unclear whether anticipated pleasure would track with social partner emotional display or interaction outcome when these two sources of information are in conflict (e.g., smile and negative outcome). Lastly, while our study extended the investigation of anticipated pleasure in people with schizophrenia by including anticipation of negative events and stimuli, our assessment did not include anticipated *displeasure* from these outcomes, which may be a distinct construct.

In summary, we found that anticipated pleasure for social interactions was largely intact among people with schizophrenia as group differences were limited to the amount of anticipated pleasure for interactions with smiling social partners. Our findings extend the literature on anticipatory pleasure in schizophrenia by showing that the amount and updating of anticipated pleasure, as well as the use of scowls to inform anticipated pleasure for interactions with negative outcomes was the same for people with and without schizophrenia.

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## Contributors

TRC designed the study as well as collected and analyzed the data. TRC and AMK wrote the manuscript.

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