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Real-life Affective Forecasting in Young Adults with High Social Anhedonia: An Experience Sampling Study

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***Background and hypothesis*: Affective forecasting (AF), the ability to forecast emotional responses for future events, is critical for optimal decision-making and mental health. Most previous AF studies were conducted using laboratory-based tasks but overlooked the impacts of real-life situations and social interactions. This study used the experience sampling method to examine real-life AF in young healthy adults and individuals with high social anhedonia.*Study design*: In Study 1, 109 young healthy adults reported anticipated and experienced emotions of personal events for 30 days on mobile phones. In Study 2, we examined real-life AF in 28 individuals with high social anhedonia (HSA) and 32 individuals with low social anhedonia (LSA).*Study results*: In Study 1 (totaling 8031 real-life events), participants anticipated and experienced social events as more positive and more arousing than non-social events, but also with larger AF discrepancy. In Study 2 (totaling 2066 real-life events), compared with the LSA group, the HSA group anticipated less pleasure and displayed a larger valence discrepancy especially for social but not for non-social events. However, the HSA group reported less experienced pleasure for both social and non-social events.*Conclusions*: Using an ecological method for assessing real-life AF, we extended the previous laboratory-based findings to real-life situations. These findings demonstrate the effects of sociality on real-life AF and elucidate the deficit in anticipating social pleasure among HSA individuals, which reflects liability to schizophrenia-spectrum disorders. Altered AF may be a potential intervention target in people with schizophrenia spectrum disorder.**

Key words: affective forecasting; experience sampling; anticipated emotion; experienced emotion; social anhedonia.

Introduction

Affective forecasting (AF) refers to the ability to predict emotional consequences for future events.[1] AF is essential for optimizing decision-making and planning and is involved in motivation and anticipatory pleasure.[2–5] In patients with psychosis, impaired AF contributes to negative symptoms and diminished functioning.[6]

AF can be measured using laboratory-based tasks, which require participants to report anticipated emotions for different experimental conditions or report their anticipated emotions for hypothetical future events.[5,7–12] However, given that both the content factor (ie, mental simulation of future scenarios) and the contextual factor (ie, an individual's emotional state and the environmental factors) could influence AF,[13–16] it is necessary to investigate AF in real-life situations.

Moreover, the majority of AF research focused on the emotional valence of future events,[17,18] but seldom

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studied in effects of "sociality" on AF. Sociality refers to whether an anticipated event involves social interactions, and prospected events could be broadly categorized into social vs non-social events.[10] Previous studies suggested that sociality influences emotional experience and episodic memory, both are fundamental to AF processing. Many studies found that people tend to find experiences more pleasurable in the company of others than in being alone.[19–23] Moreover, recognition accuracy (ie, episodic memory) was found to be higher for images with social content than for those without, suggesting that memories involving social information would have higher accessibility.[24] Based on these findings,[19–24] we speculated that the sociality of prospected events would influence AF. Specifically, people would anticipate more pleasure for future events involving social interactions than those without.

The effects of sociality on AF may also depend on an individual's ability to experience pleasure from social interactions. Anhedonia, the diminished capacity to experience pleasant emotions, is a cardinal feature of schizophrenia.[25] The majority of previous studies found schizophrenia patients having anticipated pleasure deficits,[26–32] while some studies suggested intact anticipated pleasure,[33–37] or higher anticipated pleasure.[38,39] Social anhedonia, a core feature of negative schizotypy, refers to the inability to experience social pleasure,[40] and reflects liability to schizophrenia-spectrum disorders.[41,42] Two previous studies showed that individuals with high levels of social anhedonia (HSA) exhibited anticipated pleasure deficits,[10,43] while 2 other studies reported intact anticipated pleasure in HSA individuals.[17,44]

Empirical findings demonstrated that both patients with schizophrenia[31] and individuals with HSA[10] exhibited social-related impairments in AF. Specifically, they anticipated reduced pleasure especially for social events than controls, but not for non-social events. Since social anhedonia is regarded as a risk factor for developing schizophrenia, investigating individuals with HSA is important for clarifying the early pathological mechanisms of anhedonia before psychosis onset. Nevertheless, no study has investigated real-life AF in individuals with HSA.

Taken together, the extant literature had 2 unresolved issues, ie, it remained unclear whether (1) sociality would influence AF in the real-life setting and (2) the effects of sociality on AF would be absent in individuals with HSA in real-life settings. We aimed to examine the pattern of real-life AF and the effects of social interactions in a non-clinical sample of young adults (Study 1), as well as to compare the real-life AF in individuals with high vs low levels of social anhedonia (Study 2). The ESM is a well-recognized method to measure everyday emotion experience,[45,46] and has unique advantages such as timely measurements of emotional responses and higher ecological validity. We therefore applied the ESM method to measure both anticipated and experienced emotions and treated *anticipated emotion* as the primary variable of interest. In Study 1, we hypothesized that participants would anticipate a higher level of pleasure for future events with social interactions than those without social interactions. In Study 2, we hypothesized that the effects of sociality would be absent in individuals with HSA, and individuals with HSA would display social-related impairment in real-life AF.

Study 1: Real-life AF in Young Adults

Methods

Participants. Using the Monte Carlo simulation method,[47] the sample size required was estimated to be >30, for an alpha level of 0.05, and a power of 0.8 (as detailed in Supplementary Section 1.1). We recruited 173 adults aged 18-30 years via online advertisements from January 2018 to July 2019 among college students in Beijing, China. The inclusion criteria included using a cellphone with an Android system. The exclusion criteria were detailed in the data analysis section. The final dataset comprised 109 participants. Study 1 was approved by the Ethics Committee of the Institute of Psychology, the Chinese Academy of Sciences (H15031). We complied with the ethical standards of the institutional committees on human studies and the revised Helsinki Declaration of 2008. All participants provided written informed consent.

Measures. The Time Master application was developed to measure future-oriented cognition in everyday life, and is applicable to the Android system of mobile phones. For each day, participants created personal events and rated their emotions for these events. First, they input the expected events that would happen on that day, and entered basic information about the expected events, including (1) content, (2) expected start and end time, (3) expected locations, and (4) expected participants (eg, self, family, friends, and non-acquaintance). Then, participants rated their anticipated emotions for the events, including the *anticipated* valence ("Please anticipate how happy/unhappy you would feel when the event happens to you?" 1 = very unhappy; 5 = very happy), anticipated arousal (1 = very peaceful; 5 = very excited), anticipated emotion type (eg, happy, sad, etc.), anticipated intensity (1 = very weak; 5 = very strong), *anticipatory* valence ("As you are anticipating the event to come, please indicate how happy/unhappy you feel." 1 = very unhappy; 5 = very happy), and the importance of the upcoming events (1 = not at all important; 5 = extremely important). In the AF literature, *anticipated* emotion refers to the emotion *expected* to be experienced for future events, while anticipatory affect refers to the *current* emotion during the AF process. Immediately after the occurrence of the events, participants self-initiated an evaluation of the

experienced emotions, including the experienced valence, experienced arousal, experienced emotion type, and experienced intensity. All ratings were made on a 5-point Likert scale.

Procedure. First, participants installed the Time Master application on their personal mobile phones with the assistance of the experimenters. Practice trials of the application were conducted to ensure proper data collection. In the formal assessments, participants created events and rated their emotions for 30 consecutive days. During each day, they were required to create at least 3 events that would happen within that day (preferably including both positive and negative events). During the first 3 days, the experimenters constantly monitored the participants' compliance and sent reminders in order to minimize data loss. Technical support was available throughout the period.

Data Analysis. All participants ($n = 173$) completed the 30-day real-life AF assessments, with 13389 events recorded. Three types of time points were extracted, namely (1) the *anticipation time,* ie, the time point when participants made the prediction of anticipated emotions for a future event; (2) the *expected start time,* ie, the estimation of the time when a future event would happen; and (3) the *evaluation time*, ie, the time when participants evaluated the experienced emotions of a finished event. Events were deemed invalid if the anticipation time was later than the expected start time. Events would also be excluded if the experienced emotion was not reported by the participants. Moreover, based on the criteria in previous ESM studies,[29,48] participants were excluded if they completed less than 33% of the required events (30 events).

The final dataset comprised 109 participants and 8013 events. The events were further categorized as non-social (in which the participant had involved him/herself in the events) and social events (in which the participant involved other people). The AF discrepancy was calculated as the absolute difference between the anticipated emotions and experienced emotions,[18] generating the valence discrepancy (eg, valence discrepancy = |anticipated valence—experienced valence|) and the arousal discrepancy (eg, arousal discrepancy = |anticipated arousal—experienced arousal|). A larger discrepancy indicated a larger deviation between the anticipated emotion and the experienced emotion.

We fitted the linear mixed-effects models using the *lme4* package (version 1.1–31) and R studio (version 4.2.2).[49] Details are shown in Supplementary Materials (Section 1.2). The sociality (social vs non-social events) had fixed effects in the model. The outcome variables included anticipated valence, anticipated arousal, experienced valence, experienced arousal, valence discrepancy, and arousal discrepancy. We reported the standard regression coefficient (β) and its 95% confidence intervals (CI), as well as effect size (*Cohen's d*) and its 95% CI. To test the robustness of our findings, repeated analyses for anticipated emotions including all the valid events (with and without experienced emotions) were conducted. Sensitivity analyses were conducted to clarify the covariate effects of sex, age, length of education, time intervals (For anticipated emotions: hours between the anticipation time and the expected start time. For experienced emotions, valence discrepancy and arousal discrepancy: hours between anticipation time and evaluation time), and importance of expected events.

Table 1. Descriptive Results of Demographic Information and Real-life Affective Forecasting Indices in Study 1 and Study 2

	Study 1	Study 2	
	Participants ($n = 109$)	HSA ($n = 28$)	LSA ($n = 32$)
	Mean (SD)	Mean (SD)	Mean (SD)
Demographic information			
Sex (male:female)	28:81	7:21	11:21
Age (years)	21.25 (2.15)	20.00 (2.13)	19.69 (1.67)
Length of education (years)	15.03 (2.02)	13.71 (1.58)	14.13 (1.68)
Estimated IQ	–	126.11 (7.00)	122.13 (7.58)
Number of events	73.51 (21.80)	36.96 (8.98)	32.22 (7.08)
Real-life affective forecasting			
Anticipated valence	3.46 (0.32)	5.43 (0.35)	5.84 (0.50)
Anticipated arousal	2.69 (0.47)	4.17 (1.16)	4.79 (1.12)
Heart rate	–	76.51 (9.46)	77.28 (11.70)
Experienced valence	3.43 (0.34)	5.59 (0.46)	6.00 (0.53)
Experienced arousal	2.75 (0.47)	4.18 (1.11)	4.88 (1.17)
Valence discrepancy	0.40 (0.20)	0.89 (0.33)	0.77 (0.29)
Arousal discrepancy	0.44 (0.21)	0.97 (0.36)	0.80 (0.34)

Abbreviations: HSA = individuals with high social anhedonia; LSA = individuals with low social anhedonia.

Results

In the final dataset (109 participants, 8031 events), the average number of events per participant was 73.51 (SD = 21.80, range = 30-115). Participants' characteristics and the real-life AF indices are shown in Table 1. Participants created different events, such as playing, chatting, meeting, working, studying, and going to a hospital. Moreover, 42.58% of the events were anticipated as social events (see Figure 1).

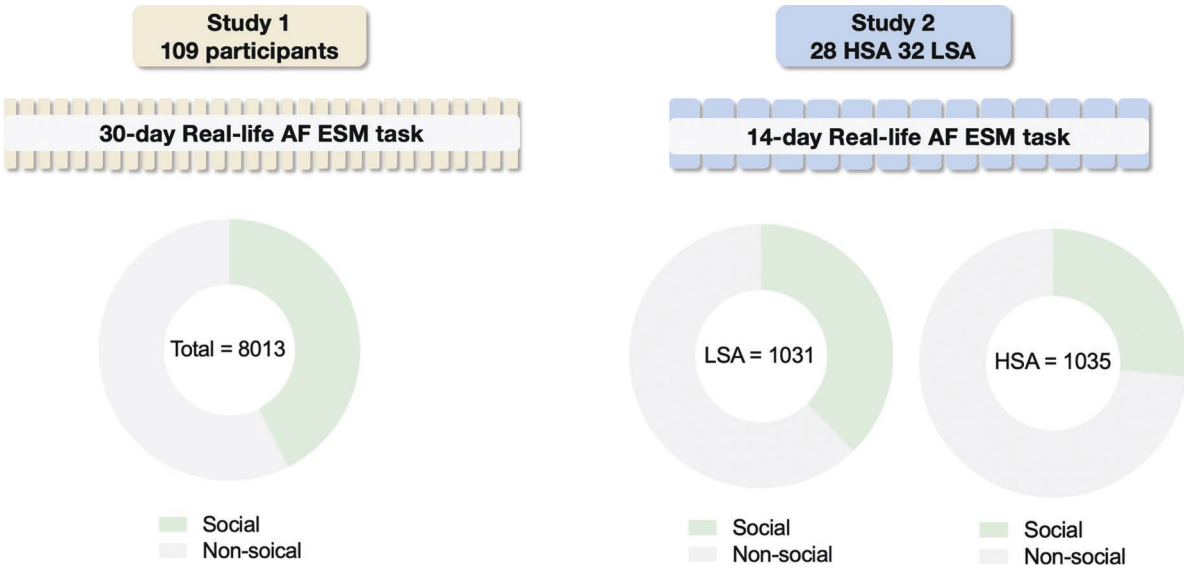

Figure 1. The research framework of Study 1 and Study 2. HSA = individuals with high social anhedonia; LSA = individuals with low social anhedonia.

As shown in Figure 2 and Supplementary Table S1 (109 participants, 8031 events), sociality was a significant predictor for all outcomes. Compared with non-social events, social events were rated as more positive (anticipated valence: β (95% CI) = 0.30 [0.23, 0.36], *Cohen's d* (95% CI) = 0.34 [0.26, 0.41], $P < 0.001$; experienced valence: $P < 0.001$), more arousing (anticipated arousal: $P < 0.001$; experienced arousal: $P < 0.001$), and had larger AF discrepancy (valence discrepancy: $P = 0.022$; arousal discrepancy: $P = 0.041$). Further analysis of the direction of AF discrepancy showed that participants tended to underestimate the actual level of arousal for non-social events, but not for social events (see Supplementary Section 1.3 and Figure S1).

Moreover, we repeated the same analyses on anticipated emotions including those without experienced ratings, and the significant results for anticipated emotions (9544 events) remained similar (see Supplementary Table S2). After controlling for the covariates, the significant results in Supplementary Table S1 remained similar. Moreover, social events were also rated as more positive for anticipatory valence (see Supplementary Section 1.4).

Discussion

Study 1 examined the real-life AF performance and the influence of social interactions in a non-clinical youth sample. Overall, participants anticipated and experienced emotions as more pleasurable and arousing for social events than for non-social events, and the AF discrepancy for social events was larger than that for non-social events.

When predicting emotions for their own personal events in the real-life context, participants would expect more happiness and excitement, if social interactions were involved in the prospected events. This finding extended the previous results of experienced pleasure[19–23] to real-life AF context. How participants forecasted future emotions would largely depend on how they experienced and remembered similar events.[1] Our findings supported the notion that sociality could influence anticipated and experienced emotions.

We also examined the difference between predicted and experienced emotions. Participants had larger AF discrepancies in estimating the valence and arousal of future social events than the non-social events. To our knowledge, no previous research has compared AF discrepancy in social vs non-social events, and our findings revealed that participants were less accurate in predicting emotions for future events that involved social interactions than those not. The larger discrepancy observed for future social events may be attributable to the "focalism errors" during AF. When people evaluate their emotions, they often ignore other important events/factors which may influence their future emotions,[50] a phenomenon called "focalism errors." Moreover, social events are usually associated with a higher chance of co-occurring events/factors than non-social events. Therefore, participants might have overlooked more unexpected events/factors that could happen during future social rather than non-social events and thus might exhibit higher discrepancy in predicting their emotions for social than non-social events. Moreover, social events are more prone to emotional contagion, which might further exacerbate AF discrepancy. Emotional contagion refers to the phenomenon where emotion can spread rapidly among individuals in a group setting.[51,52] While the impact of emotional contagion would be minimal

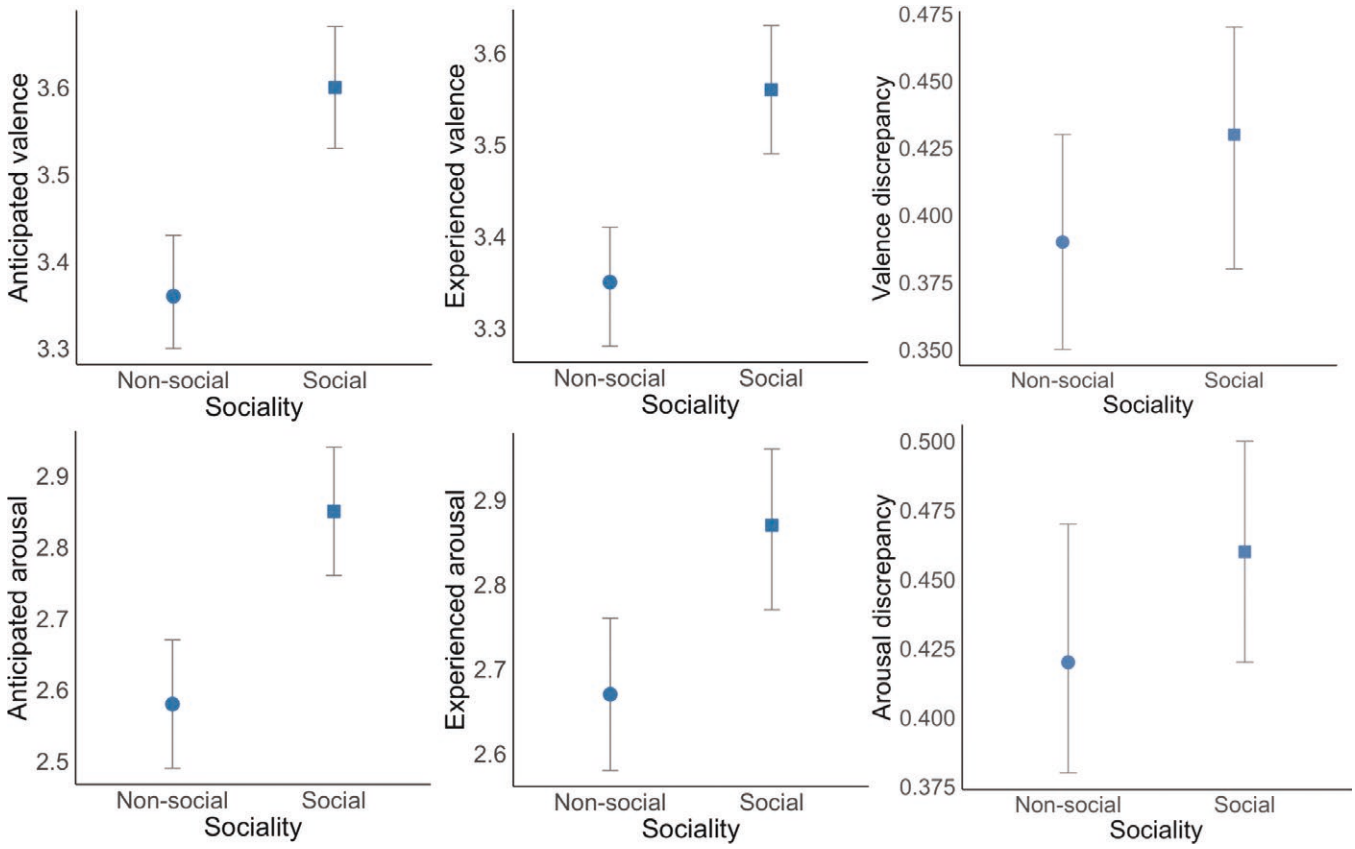

Figure 2. Estimated marginal means of outcomes when comparing social and non-social events (Study 1). Estimated marginal means ± 95% CI derived from linear mixed-effects models.

during affective forecasting, it could largely influence an individual's actual emotional experience of social events (but not non-social events), thus exacerbating the larger AF discrepancy in social events compared to non-social events.

Study 2: Real-life AF in Individuals With High Social Anhedonia

Methods

Participants. We recruited 1322 students online from a local university from November 2021 to January 2022 in Shanghai, China. They completed 2 screening questionnaires online, ie, the Chinese version of the Chapman social anhedonia scale[53,54] and the Chapman infrequency scale.[55] We selected the participants based on the criteria in a large-sample study.[56] Specifically, participants who scored ≥ 20 on the CSAS were deemed the high social anhedonia (HSA) group; and those who scored ≤ 11 were deemed the low social anhedonia (LSA) group. Detailed information on CSAS and other exclusion criteria are shown in Supplementary Materials (Section 2.1).

The Monte Carlo simulation[47] estimated the required sample size to be >49, for an alpha of 0.05 and a power of 0.8 (Supplementary Section 2.2). A total of 70 participants (32 HSA and 38 LSA) completed the real-life AF task. The final dataset comprised 60 participants (28 HSA and 32 LSA) and 2066 events. Exclusion criteria were detailed in the data analysis section. Study 2 was approved by the Ethics Committee of the Institute of Psychology, the Chinese Academy of Sciences (H21043). We complied with the ethical standards of the institutional committees on human studies, and the revised Helsinki Declaration of 2008. All participants provided written informed consent.

Measures. Similar to Study 1, participants in Study 2 anticipated emotions using the Samply application before the event and evaluated their experienced emotions after the event happened (see Supplementary Section 2.3). However, Study 2 participants rated their emotions on a 9-point Likert scale, for enhancing the sensitivity of measurements. Moreover, recent research showed that heart rate varied with emotion,[57] and employed smartwatches[58] or smartphones[59] to measure heart rate in AF research, we followed this method to additionally measure participants' heart rate, which provided an objective index other than self-report formats for anticipated emotions.[17,44,60] We asked participants to

measure their heart rates using their own smartwatches or other applications on their mobiles, immediately after they reported the anticipated emotions. Additionally, participants in Study 2 were required to report the current emotions, importance, anticipated effort level, familiarity, probability of expected events, anticipatory emotions, and the imaginary details of future events.

Procedure. Participants installed the Samply application and completed the practice trials with the assistance of the experimenters. In the formal assessments, participants created events and rated their emotions using the Samply software for 14 consecutive days. Similar to Study 1, participants were required to create at least 3 events that would happen within that day. Likewise, during the first 3 days, participants' compliance was monitored, and experimenters would send reminders. Technical support was available throughout the period.

Data analysis. In total, 70 participants completed the real-life AF task and created 2839 events. Similar to Study 1, events were excluded if the anticipation time was later than the expected start time and lacked the experienced emotions. According to the criteria in previous ESM studies,[29,48] participants were excluded if they completed less than 33% of the required events (14 events). After data cleaning, the final dataset comprised 60 participants (28 HSA; 32 LSA) and 2066 valid events.

Data analyses were conducted using the SPSS 22. Group differences in demographics, number of valid events and the ratio of social events were examined using the independent sample *t*-test and χ^2 test. The definition of social events and AF discrepancy were the same as in Study 1. For the data on heart rate, we deleted the event if this data is missing or value > 3SD of the mean.

Similar to Study 1, linear mixed-effect models were used to estimate the predictive effect of factors on real-life outcomes (Supplementary Section 2.4). The interaction between sociality and group was defined as fixed effects. The outcomes included anticipated valence, anticipated arousal, heart rate, experienced valence, experienced arousal, valence discrepancy, and arousal discrepancy. We reported the standard regression coefficient and its 95% CI, as well as the effect size (*Cohen's* f^2) and its 95% CI. In addition, we conducted Spearman correlations to examine the relationship between anticipated emotions and heart rates.

To test the robustness of the findings, we repeated the analyses for anticipated emotions and heart rate by including all the valid events (with and without experienced emotions). Sensitivity analyses were conducted to clarify the covariate effects of current emotions, ie, sex, age, length of education, estimated IQ, time intervals, importance, familiarity, and probability of expected events.

Results

In the final dataset (60 participants; 2066 events), the average number of events per participant was 34.43 (SD = 8.30, range = 14-61). Participants' characteristics and real-life AF indices are shown in Table 1. The HSA and LSA groups did not differ in sex ratio, age, length of education (*Ps* > 0.05), but the HSA group had a higher estimated IQ ($t_{(58)}$ = 2.10, *P* = 0.040) and created a greater number of events ($t_{(58)}$ = 2.29, *P* = 0.026) than the LSA group. We explored the responding activity and found a downward tendency in the number of events throughout the study (see Supplementary Section 2.5 and Figure S2).

Among all the events (28 HSA participants and 32 LSA participants; 2066 events), 32.14% were anticipated as social events. The ratio of social events was significantly lower in the HSA group than in the LSA group (HSA: 26.57%; LSA: 37.73%, χ^2 = 29.50, *P* < 0.001, see Figure 1). For anticipated and experienced emotions, the 3 most frequent types of emotion were *calm, happy, and upset* (see Figure 3A and Supplementary Table S3). Compared with the LSA group, the HSA group anticipated less frequently *happy* emotion ($t_{(58)}$ = –2.64, *P* = 0.011) and more frequently *upset* emotion ($t_{(58)}$ = 2.14, *P* = 0.036), and they experienced less frequently happy emotion ($t_{(58)}$ = –3.31, *P* = 0.002).

Anticipated Emotions and Heart Rates. Among 60 participants and 2066 events, Figure 4 shows the descriptive results of outcomes; Supplementary Table S4 shows the results of linear mixed-effects models. For anticipated valence, the LSA group (with reference to the HSA group, β = 0.20 [0.01, 0.38], *P* = 0.032, f^2 = 0.26 [0.05, 0.60]) significantly predicted higher anticipated valence. Sociality is not a significant predictor (β = 0.13 [–0.14, 0.21], *P* = 0.772, f^2 = 0.22 [0.03, 0.59]). The interaction between sociality and group was a significant predictor for anticipated valence (β = 0.32 [0.09, 0.56], *P* = 0.009, f^2 = 0.15 [0.01, 0.47]). Specifically, compared with the LSA group, the HSA group anticipated lower levels of pleasure, and this reduction was larger for social events ($t_{(55)}$ = –4.12, *P* < 0.001, *Cohen's d* = 0.56 [0.29, 0.84]) than non-social events ($t_{(57)}$ = –2.20, *P* = 0.032, *Cohen's d* = 0.21 [0.02, 0.41]). The LSA group reported higher anticipated valence for the social events than the non-social events ($t(54)$ = –4.45, *P* < 0.001, *Cohen's d* = 0.38 [0.21, 0.56]), while the HSA group reported similar anticipated valence for the social and non-social events ($t(52)$ = –0.36, *P* = 0.723, *Cohen's d* = 0.03 [–0.16, 0.23]). For anticipated arousal, the social events received higher ratings than the non-social events (*P* < 0.001), but the main effect of the group (*P* = 0.051) and the interaction between the group and sociality (*P* = 0.760) were not significant.

For 1782 events with valid data of heart rate, the main effect of sociality was significant, with the social events having a faster heart rate (*P* = 0.001). The main effect of

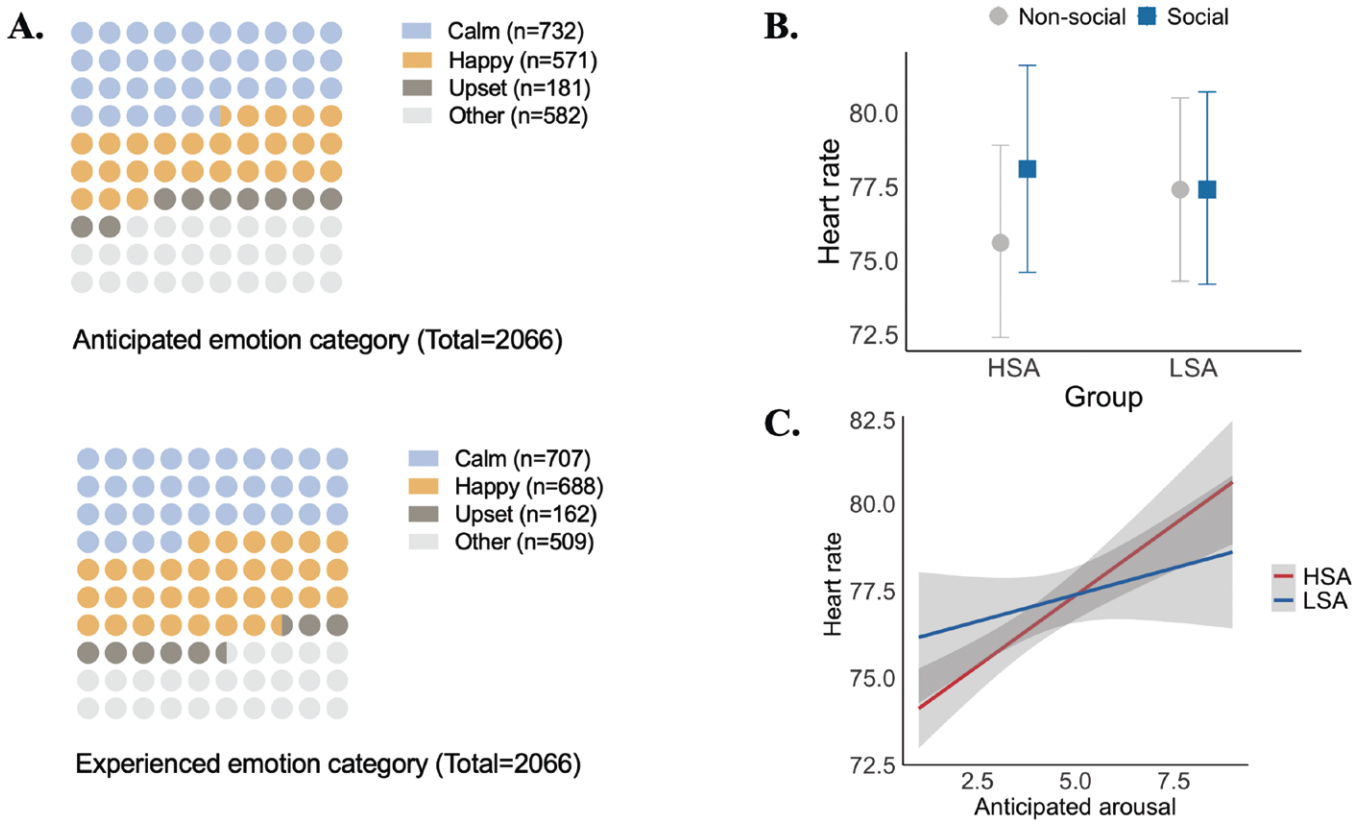

Figure 3. Results for Study 2. (A) anticipated and experienced emotion category; (B) estimated marginal means of heart rate when comparing social and non-social events between high vs low social anhedonia individuals; (C) correlation between anticipated arousal and heart rate. Estimated marginal means ± 95% CI derived from linear mixed-effects models. HSA = individuals with high social anhedonia; LSA = individuals with low social anhedonia.

the Group was not significant ($P = 0.438$). The group-by-sociality interaction effect was significant ($P = 0.018$, see Figure 3B), showing that the HSA group had higher heart rates for the social events than the non-social events ($t_{(44)} = –3.42$, $P = 0.001$, *Cohen's* $d = 0.35$ [0.14, 0.56]), while the LSA group reported similar heart rate for the social and non-social events ($t_{(48)} = –0.07$, $P = 0.946$, *Cohen's* $d = 0.01$ [–0.19, 0.20]). As shown in Figure 3C, the heart rate was positively correlated with anticipated arousal in the HSA group ($r = 0.15$, $P < 0.001$) but not in the LSA group ($r = 0.03$, $P = 0.321$). The heart rate was not significantly correlated with anticipated valence in either the HSA group ($r = –0.02$, $P = 0.514$) or the LSA group ($r = –0.04$, $P = 0.211$). No significant difference was found between the measurement methods of smartphones and smartwatches (Supplementary Section 2.6).

Experienced Emotions and AF Discrepancy. For experienced emotions (60 participants and 2066 events), the social events (vs non-social events) and the LSA group (vs HSA group) predicted higher experienced valence and arousal (*Ps* < 0.043), but the interaction between sociality and group was nonsignificant (*Ps* > 0.841). Specifically, compared with the LSA group, the HSA group reported lower experienced pleasure both in social ($t_{(55)} = –2.31$, $P = 0.025$, *Cohen's* $d = 0.30$ [0.04, 0.57]) and non-social events ($t_{(57)} = –2.69$, $P = 0.009$, *Cohen's* $d = 0.28$ [0.07, 0.49]). The LSA group ($t_{(49)} = –3.75$, $P = 0.001$, *Cohen's* $d = 0.32$ [0.15, 0.48]) and the HSA group ($t_{(53)} = –4.51$, $P < 0.001$, *Cohen's* $d = 0.34$ [0.19, 0.49]) both reported higher experienced pleasure for social than non-social events.

For AF valence discrepancy (60 participants and 2066 events), the effect of sociality ($P = 0.107$) and group ($P = 0.511$) was not significant, but the interaction between sociality and group was a significant predictor ($P = 0.049$). Compared with the LSA group, the HSA group reported a larger valence discrepancy for social events ($t_{(51)} = 2.92$, $P = 0.005$, *Cohen's* $d = 0.30$ [0.09, 0.51]), but not for non-social events ($t_{(57)} = 0.66$, $P = 0.511$, *Cohen's* $d = 0.07$ [–0.14, 0.28]). Further analysis indicated that, for inaccurate estimated events, the HSA group tended to underestimate the valence and arousal for social events, but not for non-social events (see Supplementary Section 2.7 and Figure S3). For AF arousal discrepancy, no significant predictors were found (*Ps* > 0.093).

Sensitivity Analysis. We conducted repeated analyses on anticipated emotions and heart rate, by including those events without experienced ratings. We found that the significant results for anticipated emotions (2153

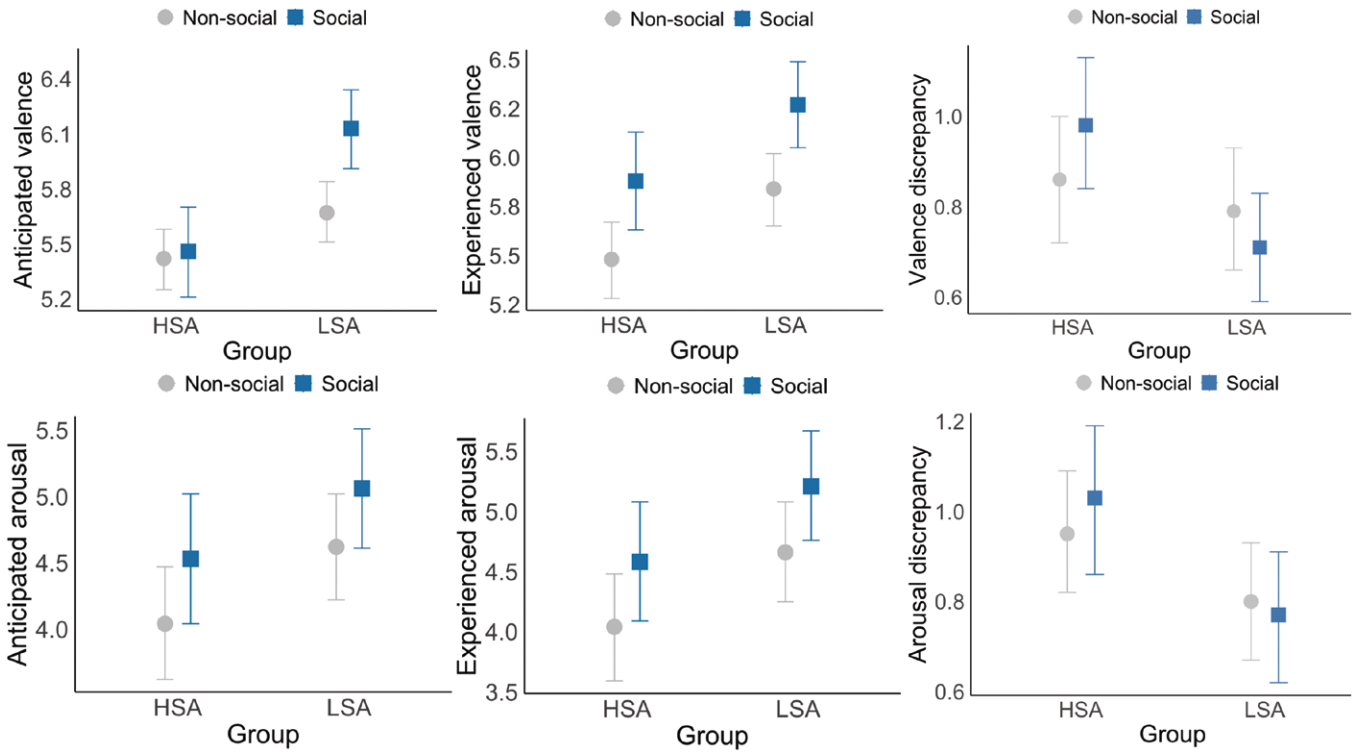

Figure 4. Estimated marginal means of outcomes when comparing social and non-social events between high vs low social anhedonia individuals (Study 2). Estimated marginal means ± 95% CI derived from linear mixed-effects models. HSA = individuals with high social anhedonia; LSA = individuals with low social anhedonia.

events) and heart rate (1859 events) remained similar (see Supplementary Table S5). After controlling for the covariates, the results (see Supplementary Section 2.8) remained largely similar to the results reported in Supplementary Table S4. The linear mixed-effects models of other outcomes can be found in Supplementary Materials (Supplementary Section 2.9, Tables S6 and S7).

Discussion

Study 2 examined the real-life AF in individuals with HSA, who demonstrated social-related impairments in AF, which reflected in several aspects. First, compared to people with LSA, individuals with HSA anticipated less pleasure for future events, but the reduction of anticipated pleasure was larger for social than non-social events. This finding was consistent with previous research using laboratory-based AF task,[10] thus extending the social-related AF deficit of HSA to real-life situations. Second, individuals with HSA displayed a larger valence discrepancy for upcoming social events than the LSA group, but not for non-social events. Further analysis of the direction of discrepancy revealed that individuals with HSA underestimated the level of pleasure they would obtain from future social but not non-social events. Lastly, compared to the LSA group, the HSA group showed reduced willingness to engage in similar future events involving social interactions, but not for non-social future events (see Supplementary Section 2.9). Together, these findings revealed that, in real-life settings, individuals with HSA had social-related impairments in multiple processes relating to AF. Moreover, individuals with HSA created a lower ratio of social events compared to those with LSA. This finding aligned with previous results that individuals with HSA[61,62] and negative schizotypy[63] tended to spend more time alone and had a stronger preference for solitude.

Relative to the LSA group, the HSA group anticipated and experienced reduced pleasure in social events. However, the reduction was larger for anticipated pleasure but smaller for experienced pleasure. This finding was consistent with previous results in schizophrenia patients[64] who showed a larger impairment of non-current social pleasure[25,65] than consummatory social pleasure.[64,66] Our findings revealed for the first time that individuals with HSA also displayed such a phenomenon in real-life situations.

The LSA group reported higher levels of social pleasure than non-social pleasure, both for anticipated and experienced emotions. However, the HSA group reported higher levels of social pleasure for experienced emotions, but not for anticipated emotions. Previous ESM studies on schizophrenia patients also found that patients experienced higher positive affect in social events compared with non-social events.[67,68] An ESM study revealed a more marked increase in positive affect in controls when the level

of pleasantness of having company was high, compared with that in patients with early psychosis.[69] Similarly, our findings showed that, while individuals with HSA were able to experience more pleasure from social than non-social events, they did not anticipate social events as more pleasurable than non-social events. Our findings may be related to the presence of "low-pleasure beliefs"[70] for social events, ie, individuals with HSA underestimated the value of pleasure or even expected negative outcomes of pleasure for social events. The thinking schemata of "low pleasure beliefs" may contribute to diminished anticipated emotions in the HSA group.

General Discussion

Our 2 inter-related ESM studies investigated real-life AF in young adults (Study 1) and individuals with HSA (Study 2) and yielded 2 novel findings. First, sociality influenced both anticipated and experienced emotions, ie, people anticipated and experienced more pleasure in social than in non-social events. Second, while individuals with HSA exhibited social-related deficits in multiple processes of real-life AF, they reported less experienced pleasure for both social and non-social events.

The effects of sociality on AF have significant implications. Humans are social beings, and the ability to process social information is essential for survival and reproduction. However, few studies examined the role of sociality in AF in real-life settings. Our research highlighted the role of sociality in the process of AF and extended effects of sociality from experienced emotions to anticipated emotions. Moreover, our findings on the effects of sociality can advance our understanding of psychopathology. Study 2 further elucidated that sociality did not exert effects on AF in individuals with HSA. Individuals with HSA are at a higher risk of developing psychosis than the general population.[41] Patients of schizophrenia also exhibit a social-related deficit of anticipated pleasure in daily life.[31] The reduced anticipation of pleasure from daily social events, a common deficit observed in both clinical and subclinical samples of the schizophrenia spectrum, could potentially play a crucial role in the early identification and intervention of psychosis. Indeed, it has been argued that AF discrepancy, a component of dysfunctional expectations and an intermediate process between situational cues and consequences, maybe the core element for the maintenance of psychopathology.[71,72] Future studies could further investigate how to restore the effects of sociality in individuals with HSA, as altering dysfunctional expectancies is an important target of psychotherapies.

In Study 2, our findings that individuals with HSA show larger deficits in anticipated than experienced pleasure of social events have significant implications. Such deficits may be related to low-pleasure beliefs for social events and may serve as a potential target for early identification and intervention. For instance, individuals with HSA could be trained to develop higher levels of awareness regarding the deficits of anticipated social pleasure, so that they may self-regulate the inherent tendency of underestimating social pleasure, and in turn, may improve motivation and socialization. Recent advances in mobile technology may offer promising interventions for daily experiences. For instance, audio recordings[73] and smartphone reminders[74] of prior enjoyable social experiences may enhance awareness of daily social pleasure and increase motivation for socialization.

Nevertheless, our investigations have several limitations. First, our research focused on individuals with negative schizotypy. Future studies could explore the characteristics of AF in people with positive schizotypy or patients with schizophrenia. Second, our ESM tasks only invited participants to predict emotions and events prospectively for 24 h, thus limiting the timeframe of AF. Studies on real-life AF for future events with longer temporal distances are needed. Third, our ESM tasks mainly measured self-report emotions, although heart rate was used as a more objective measure of emotional response (Study 2). Future research on real-life AF should include more objective measures of emotional response such as audio recording and GPS-based mobility.[75–77]

Notwithstanding these limitations, the present work is one of the pioneer studies on AF in real-life situations. Together, our findings emphasized the importance of sociality in AF and suggested that the larger deficit of anticipating social pleasure may serve as a target for interventions of social anhedonia. Future studies should further investigate real-life AF in clinical populations and its relationship with anhedonia.

Supplementary Material

Supplementary material is available at the Schizophrenia Bulletin Open online.

Author Contribution

R.-T. Zhang, Y. Gao, and T.-X. Yang contributed equally.

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Competing Interest Statement

The authors declare no competing interest.

References

1. Gilbert DT, Wilson TD. Prospection: experiencing the future. *Science.* 2007;317:1351–1354.
2. Ballance BC, Tuen YJ, Petrucci AS, *et al*. Imagining emotional events benefits future-oriented decisions. *Q J Exp Psychol* 2022;75:2332–2348.

3. Ellis EM, Elwyn G, Nelson WL, Scalia P, Kobrin SC, Ferrer RA. Interventions to engage affective forecasting in health-related decision making: a meta-analysis. *Ann Behav Med.* 2018;52:157–174.
4. Hallford DJ, Farrell H, Lynch E. Increasing anticipated and anticipatory pleasure through episodic thinking. *Emotion* 2022;22:690–700.
5. Lench HC, Levine LJ, Perez K, *et al*. When and why people misestimate future feelings: identifying strengths and weaknesses in affective forecasting. *J Pers Soc Psychol.* 2019;116:724–742.
6. Frost KH, Strauss GP. A review of anticipatory pleasure in schizophrenia. *Curr Behav Neurosci Rep* 2016;3:232–247.
7. Dev AS, Arditte Hall KA, Timpano KR. The relationship between psychiatric symptoms and affective forecasting bias. *J Behav Ther Exp Psychiatry.* 2023;79:101825.
8. Arditte Hall KA, Joormann J, Siemer M, Timpano KR. The impact bias in self and others: affective and empathic forecasting in individuals with social anxiety. *Behav Res Ther.* 2018;106:37–46.
9. Buechel EC, Zhang J, Morewedge CK. Impact bias or underestimation? Outcome specifications predict the direction of affective forecasting errors. *J Exp Psychol Gen.* 2017;146:746–761.
10. Zhang RT, Yang ZY, Wang YM, *et al*. Affective forecasting in individuals with social anhedonia: the role of social components in anticipated emotion, prospection and neural activation. *Schizophr Res.* 2020;215:322–329.
11. Feil K, Weyland S, Fritsch J, Wäsche H, Jekauc D. Anticipatory and anticipated emotions in regular and non-regular exercisers—a qualitative study. *Front Psychol.* 2022;13:929380.
12. Barber SJ, Kausar H, Udry J. Age differences in affective forecasting accuracy. *Psychol Aging.* 2023;38:357–373.
13. Addis DR, Schacter DL. Constructive episodic simulation: temporal distance and detail of past and future events modulate hippocampal engagement. *Hippocampus.* 2008;18:227–237.
14. Gilbert DT, Wilson TD. Why the brain talks to itself: sources of error in emotional prediction. *Philos Trans R Soc Lond B Biol Sci* 2009;364:1335–1341.
15. Luther L, Raugh IM, Collins DE, *et al*. Environmental context predicts state fluctuations in negative symptoms in youth at clinical high risk for psychosis. *Psychol Med.* 2023;53:7609–7618.
16. Schacter DL, Addis DR. The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philos Trans R Soc Lond B Biol Sci* 2007;362:773–786.
17. Moore MM, Chan RCK, Huang J, Martin EA. Affective forecasting and accuracy in social anhedonia: predicted and experienced emotion for a social interaction. *J Clin Psychol.* 2019;75:1684–1700.
18. Shovestul B, Saxena A, Reda S, *et al*. Social affective forecasting and social anhedonia in schizophrenia-spectrum disorders: a daily diary study. *Schizophrenia (Heidelberg, Germany)* 2022;8:97.
19. Gan G, Ma R, Reichert M, *et al*. Neural correlates of affective benefit from real-life social contact and implications for psychiatric resilience. *JAMA Psychiatry* 2021;78:790–792.
20. Monninger M, Aggensteiner PM, Pollok TM, *et al*. Real-time individual benefit from social interactions before and during the lockdown: the crucial role of personality, neurobiology and genes. *Transl Psychiatry.* 2022;12:28.
21. Uziel L, Schmidt-Barad T. Choice matters more with others: choosing to be with other people is more consequential to well-being than choosing to be alone. *J Happiness Stud* 2022;23:2469–2489.
22. Isen AM. Positive affect, cognitive processes, and social behavior. In: Berkowitz L, ed. *Advances in Experimental Social Psychology* Vol. 20. Academic Press; 1987:203–253.
23. Larson R, Csikszentmihalyi M, Graef R. *Time Alone in Daily Experience: Loneliness Or Renewal?* Wiley; 1982.
24. Stewardson CI, Hunsche MC, Wardell V, Palombo DJ, Kerns CM. Episodic memory through a social and emotional lens. *Emotion* 2023;23:961–972.
25. Horan WP, Kring AM, Blanchard JJ. Anhedonia in schizophrenia: a review of assessment strategies. *Schizophr Bull.* 2006;32:259–273.
26. Campellone TR, Kring AM. Anticipated pleasure for positive and negative social interaction outcomes in schizophrenia. *Psychiatry Res.* 2018;259:203–209.
27. Campellone TR, Truong B, Gard D, Schlosser DA. Social motivation in people with recent-onset schizophrenia spectrum disorders. *J Psychiatr Res.* 2018;99:96–103.
28. Gard DE, Kring AM, Gard MG, Horan WP, Green MF. Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. *Schizophr Res.* 2007;93:253–260.
29. Moran EK, Culbreth AJ, Kandala S, Barch DM. From neuroimaging to daily functioning: a multimethod analysis of reward anticipation in people with schizophrenia. *J Abnorm Psychol.* 2019;128:723–734.
30. Painter JM, Kring AM. Toward an understanding of anticipatory pleasure deficits in schizophrenia: memory, prospection, and emotion experience. *J Abnorm Psychol.* 2016;125:442–452.
31. Pillny M, Schlier B, Lincoln TM. "I just don't look forward to anything." How anticipatory pleasure and negative beliefs contribute to goal-directed activity in patients with negative symptoms of psychosis. *Schizophr Res.* 2020;222:429–436.
32. Yan C, Lui SSY, Zou L-Q, *et al*. Anticipatory pleasure for future rewards is attenuated in patients with schizophrenia but not in individuals with schizotypal traits. *Schizophr Res.* 2019;206:118–126.
33. Demmin DL, Mote J, Beaudette DM, Thompson JL, Silverstein SM. Retinal functioning and reward processing in schizophrenia. *Schizophr Res.* 2020;219:25–33.
34. Martin EA, Castro MK, Li LY, Urban EJ, Moore MM. Emotional response in schizophrenia to the "36 questions that lead to love": predicted and experienced emotions regarding a live social interaction. *PLoS One.* 2019;14:e0212069.
35. Pillny M, Hallford DJ, Böge K. The nature of mental imagery and its relationship with amotivational psychopathology in people with schizophrenia spectrum disorders. *Behav Ther.* 2024;55:885–897.
36. Trémeau F, Antonius D, Cacioppo JT, *et al*. Anticipated, on-line and remembered positive experience in schizophrenia. *Schizophr Res.* 2010;122:199–205.
37. Zhang R-T, Yang T-X, Wang Z-Y, *et al*. Anticipated pleasure and displeasure for future social and non-social events: a scale development study. *Schizophr Bull Open.* 2023;4:sgad024.
38. Gard DE, Sanchez AH, Cooper K, Fisher M, Garrett C, Vinogradov S. Do people with schizophrenia have difficulty anticipating pleasure, engaging in effortful behavior, or both? *J Abnorm Psychol.* 2014;123:771–782.
39. Trémeau F, Antonius D, Nolan K, Butler P, Javitt DC. Immediate affective motivation is not impaired in schizophrenia. *Schizophr Res.* 2014;159:157–163.

40. Blanchard JJ, Collins LM, Aghevli M, Leung WW, Cohen AS. Social anhedonia and schizotypy in a community sample: the Maryland longitudinal study of schizotypy. *Schizophr Bull.* 2011;37:587–602.
41. Kwapil TR, Miller MB, Zinser MC, Chapman J, Chapman LJ. Magical ideation and social anhedonia as predictors of psychosis proneness: a partial replication. *J Abnorm Psychol.* 1997;106:491–495.
42. Cohen AS, Couture SM, Blanchard JJ. Social anhedonia and clinical outcomes in early adulthood: a three-year follow-up study within a community sample. *Schizophr Res.* 2020;223:213–219.
43. Yang ZY, Zhang RT, Wang YM, *et al*. Altered activation and functional connectivity in individuals with social anhedonia when envisioning positive future episodes. *Psychol Med.* 2022;52:4058–4066.
44. Xie W-Z, Yan C, Ying X-Y, *et al*. Domain-specific hedonic deficits towards social affective but not monetary incentives in social anhedonia. *Sci Rep.* 2014;4:4056.
45. Murray L, Israel ES, Balkind EG, *et al*. Multi-modal assessment of reward functioning in adolescent anhedonia. *Psychol Med.* 2022;53:1–10.
46. Bartolomeo LA, Raugh IM, Strauss GP. The positivity offset theory of anhedonia in schizophrenia: evidence for a deficit in daily life using digital phenotyping. *Psychol Methods.* 2023;53:1–9.
47. Arend MG, Schäfer T. Statistical power in two-level models: a tutorial based on Monte Carlo simulation. *Psychol Methods.* 2019;24:1–19.
48. Myin-Germeys I, van Os J, Schwartz JE, Stone AA, Delespaul PA. Emotional reactivity to daily life stress in psychosis. *Arch Gen Psychiatry.* 2001;58:1137–1144.
49. Bates D, Machler M, Bolker BM, Walker SC. Fitting linear mixed-effects models using lme4. *J Stat Softw* 2015;67:1–48.
50. Wilson TD, Gilbert DT. Affective forecasting: knowing what to want. *Curr Dir Psychol Sci* 2005;14:131–134.
51. Hatfield E, Cacioppo JT, Rapson RL. Emotional contagion. *Curr Dir Psychol Sci* 1993;2:96–100.
52. Herrando C, Constantinides E. Emotional contagion: a brief overview and future directions. *Front Psychol.* 2021;12:712606.
53. Chan RCK, Wang Y, Yan C, *et al*. A study of trait anhedonia in non-clinical Chinese samples: evidence from the Chapman scales for physical and social anhedonia. *PLoS One.* 2012;7:e34275.
54. Chapman LJ, Chapman JP, Raulin ML. Scales for physical and social anhedonia. *J Abnorm Psychol.* 1976;85:374–382.
55. Chapman JP, Chapman LJ. Reliability and the discrimination of normal and pathological groups. *J Nerv Ment Dis.* 1983;171:658–661.
56. Zhang Y-J, Cheng-Cheng P, Wang Y-M, *et al*. Social brain network correlates with real-life social network in individuals with schizophrenia and social anhedonia. *Schizophr Res.* 2021;232:77–84.
57. Hsueh B, Chen R, Jo Y, *et al*. Cardiogenic control of affective behavioural state. *Nature.* 2023;615:292–299.
58. Nelson BW, Low CA, Jacobson N, Areán P, Torous J, Allen NB. Guidelines for wrist-worn consumer wearable assessment of heart rate in biobehavioral research. *NPJ Digit Med* 2020;3:90.
59. Bae S, Borac S, Emre Y, *et al*. Prospective validation of smartphone-based heart rate and respiratory rate measurement algorithms. *Commun Med (Lond)* 2022;2:40.
60. Engel M, Fritzsche A, Lincoln TM. Anticipation and experience of emotions in patients with schizophrenia and negative symptoms: an experimental study in a social context. *Schizophr Res.* 2016;170:191–197.
61. Brown LH, Silvia PJ, Myin-Germeys I, Kwapil TR. When the need to belong goes wrong: the expression of social anhedonia and social anxiety in daily life. *Psychol Sci.* 2007;18:778–782.
62. Kwapil TR, Silvia PJ, Myin-Germeys I, Anderson AJ, Coates SA, Brown LH. The social world of the socially anhedonic: exploring the daily ecology of asociality. *J Res Pers* 2009;43:103–106.
63. Kwapil TR, Brown LH, Silvia PJ, Myin-Germeys I, Barrantes-Vidal N. The expression of positive and negative schizotypy in daily life: an experience sampling study. *Psychol Med.* 2012;42:2555–2566.
64. Abel DB, Rand KL, Salyers MP, Myers EJ, Mickens JL, Minor KS. Do people with schizophrenia enjoy social activities as much as everyone else? A meta-analysis of consummatory social pleasure. *Schizophr Bull.* 2023;49:809–822.
65. Horan WP, Blanchard JJ, Clark LA, Green MF. Affective traits in schizophrenia and schizotypy. *Schizophr Bull.* 2008;34:856–874.
66. Mote J, Fulford D. Ecological momentary assessment of everyday social experiences of people with schizophrenia: a systematic review. *Schizophr Res.* 2020;216:56–68.
67. Mote J, Gard DE, Gonzalez R, Fulford D. How did that interaction make you feel? The relationship between quality of everyday social experiences and emotion in people with and without schizophrenia. *PLoS One.* 2019;14:e0223003.
68. Oorschot M, Lataster T, Thewissen V, *et al*. Emotional experience in negative symptoms of schizophrenia--no evidence for a generalized hedonic deficit. *Schizophr Bull.* 2013;39:217–225.
69. Fung VSC, Chan JCY, Wong SCY, *et al*. Investigation of momentary negative symptoms in patients with early psychosis in daily life: an experience sampling study. *Psychiatry Res.* 2023;325:115234.
70. Yang Y, Yang ZY, Zou YM, *et al*. Low-pleasure beliefs in patients with schizophrenia and individuals with social anhedonia. *Schizophr Res.* 2018;201:137–144.
71. Rief W, Glombiewski JA, Gollwitzer M, Schubö A, Schwarting R, Thorwart A. Expectancies as core features of mental disorders. *Curr Opin Psychiatry.* 2015;28:378–385.
72. Rizeq J. Affective forecasting and psychopathology: a scoping review. *Clin Psychol Rev.* 2024;108:102392.
73. Minor KS, Marggraf MP, Davis BJ, *et al*. Personalizing interventions using real-world interactions: improving symptoms and social functioning in schizophrenia with tailored metacognitive therapy. *J Consult Clin Psychol.* 2022;90:18–28.
74. Fulford D, Mote J, Gard DE, *et al*. Development of the motivation and skills support (MASS) social goal attainment smartphone app for (and with) people with schizophrenia. *J Behav Cogn Ther* 2020;30:23–32.
75. Fulford D, Mote J, Gonzalez R, *et al*. Smartphone sensing of social interactions in people with and without schizophrenia. *J Psychiatr Res.* 2021;137:613–620.
76. Minor KS, Davis BJ, Marggraf MP, Luther L, Robbins ML. Words matter: implementing the electronically activated recorder in schizotypy. *Personal Disord* 2018;9:133–143.
77. Parrish EM, Depp CA, Moore RC, *et al*. Emotional determinants of life-space through GPS and ecological momentary assessment in schizophrenia: what gets people out of the house? *Schizophr Res.* 2020;224:67–73.