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journal homepage: www.elsevier.com/locate/schresAnticipated, on-line and remembered positive experience in schizophrenia [☆]Fabien Trémeau ^{a,b,c,*}, Daniel Antonius ^b, John T. Cacioppo ^d, Rachel Ziwich ^a, Pamela Butler ^{a,b}, Dolores Malaspina ^b, Daniel C. Javitt ^{a,b}^a Nathan S. Kline Institute for Psychiatric Research, Orangeburg, NY, United States^b Department of Psychiatry, New York University School of Medicine, New York, NY, United States^c Rockland Psychiatric Center, Orangeburg, NY, United States^d Department of Psychology, University of Chicago, IL, United States

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ABSTRACT

Background: Three temporal stages in the evaluation of positive affect can be identified: anticipation, experience (hedonia) and memory. In schizophrenia, despite research indicating non-impaired hedonic capacities, little is known about anticipation and memory of positive affect. Moreover, the role of positive affect evaluations on motivation has rarely been studied in schizophrenia.

Method: Seventy individuals with schizophrenia and 35 non-patient control participants completed an evocative emotional task consisting of pictures and sounds. Following each presentation, participants rated their hedonic experience. Ratings of pre-test anticipated and post-test remembered pleasures were also obtained. Finally, explicit motivation to repeat the task was assessed.

Results: Compared to control participants, schizophrenia participants demonstrated similar levels of anticipation, hedonia and motivation, as well as significantly increased remembered pleasure. In schizophrenia, affective processes had lower correlations with motivation than in controls, and only remembered pleasure predicted motivation. Moreover, the predictive value of hedonia was significantly lower in schizophrenia.

Conclusions: The affective and cognitive processes involved in the anticipation, experience and memory of positive affective events showed no deficit, and to the contrary, immediately remembered pleasure was higher in schizophrenia. However, important deficits resided in the inter-connectivity between affective evaluations and motivational processes. The major deficit in schizophrenia participants' reward system was not in hedonic experiences but in the translation of pleasurable experiences into motivational states.

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1. Introduction

For Kraepelin and Bleuler affective impairments were cardinal and multifaceted features of schizophrenia. Kraepelin,

for example, noted the centrality of blunted affect and lack of emotional experiences, whereas Bleuler focused more on ambivalence and disconnections between emotions and ideas. Nevertheless, ideal methods for empirically examining these seminal observations remain to be determined. In particular, the concept of anhedonia—the inability to experience pleasure from positive stimuli—has undergone recent revision (reviewed in Trémeau, 2006; Kring and Moran, 2008; Cohen and Minor, in press), with the increasing realization that patients experience a relatively normal intrapsychic emotional life when probed with evocative testing, yet appear anhedonic

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during an interview situation. The present study probes elemental processes underlying the construct of anhedonia in schizophrenia.

Over the last 20 years, considerable progress has been made in the understanding of psychological and neural processes related to pleasure, based in part upon different theories including Decision Theory (Kahneman et al., 1997; Mitchell et al., 1997), Intertemporal Choice Theory (Elster and Loewenstein, 1992), Affective Forecasting Theory (Wilson and Gilbert, 2003), and Reward Theory (Berridge, 2003). Pleasure-related activity cannot be viewed solely as reflecting instant gratification. Rather, three distinct phases must be considered: anticipation of pleasure, experience of pleasure and memory for pleasure. Judgments such as anticipation and memory of pleasure reflect everyday-life complex psychological processes (Weber and Johnson, 2009), and they often rely on intuitions and heuristics (Kahneman, 2003). Therefore, anticipated and remembered pleasures are not the results of a single cognitive process and often lack accuracy. Authors have shown that we anticipate more intense pleasure from future emotional events than we experience when these events unfold (Kahneman, 1999; Loewenstein and Schkade, 1999; Wilson and Gilbert, 2003). Regarding the memory of pleasurable life events, Kahneman (1999) has shown that remembered pleasure is the result of two principal psychological processes. Life events extend over time and are made of instant moments that have their own emotional value. Therefore, remembering the hedonic value of past events requires the capacity to remember and to integrate all these momentary pleasures, and authors have shown that we tend to remember more pleasure than we actually experienced (Kahneman, 1999; Thomas and Diener, 1990). The functional consequences of increased anticipated and remembered pleasure on decision-making are still the subject of debate (Wilson and Gilbert, 2003; Dunn and Laham, 2006). Positive consequences on motivation can be suspected: high levels of anticipated pleasure can enhance motivation and preparation for a future event, and high levels of remembered pleasure can increase motivation to repeat an activity.

These hedonic processes have been studied to some degree in schizophrenia. Using time-sampling methodology, Gard et al. (2007) reported lower anticipated pleasure (the pleasure that subjects anticipate they will have during a future activity [Loewenstein et al., 2001]) in schizophrenia. While time-sampling methodology has ecological validity, it cannot fully differentiate differences in environment from differences in cognition or affective processing. For this, an evocative method is more suited. An evocative study (Horan et al., 2006) reported that schizophrenia participants showed intact episodic memory of the instant pleasures they experienced 4h earlier. However, as discussed above, episodic memory is only one cognitive process involved in the evaluation of remembered pleasure, and the memory of longer pleasurable life events still needs to be investigated in schizophrenia.

Concerning the relationship between hedonia processing and motivation in schizophrenia, two previous studies examined the motivational role of experienced pleasure in schizophrenia. In one study (Gard et al., 2007), participants with schizophrenia reported the same level of instant pleasure from daily life activities but were engaged in these activities less often, suggesting a dysfunctional connection between instant pleasure and goal-directed activities. A second study (Heerey and Gold, 2007) used a laboratory task, and found an

impairment in translating emotional experience into action in schizophrenia. These two studies bring support to the Bleulerian hypothesis of disconnectivity between psychological structures, and especially between pleasure experience and motivation. However, the effects of hedonic anticipation and memory upon motivation still warrant exploration.

In the current study we used an evocative method to study anticipation, experience and memory of pleasure in schizophrenia. In a previous article (Trémeau et al., 2009) we reported on hedonic scores only. In the present study, we extend the sample sizes and report on other affective variables of interest. Because of the scarcity of previous studies on anticipated and remembered pleasure and because previous studies have shown decreased (Trémeau et al., 2008; Prentice et al., 2005) as well as increased (Langdon et al., in press) judgment biases in schizophrenia, we did not make specific predictions. The study, however, was designed to study the association between experienced pleasure and motivation in schizophrenia in an attempt to replicate previous findings (Heerey and Gold, 2007). We also examined the role of anticipation and memory on motivation.

2. Methods

2.1. Participants

The present study was part of a larger study on affective processing in schizophrenia. Subjects included 70 individuals with schizophrenia and 35 non-patient control subjects. Schizophrenia participants were outpatients or inpatients in a research unit at the Nathan S. Kline Institute for Psychiatric Research (NKI), New York. All subjects were English-speaking and between 18 and 65 years of age, and had capacity to give consent. Diagnosis of schizophrenia was assessed using the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1998). Healthy control participants were recruited from the NKI Volunteer Recruitment Pool. They were community subjects who responded to advertisement and volunteered to participate in research studies conducted at NKI. They had no psychiatric history and no psychiatric diagnosis as assessed with the non-patient version of the SCID. The study was approved by the local Institutional Review Board.

2.2. Procedures

One author (JTC) developed a computerized evocative emotional test (Ito and Cacioppo, 2005) which includes 48 pictures from the International Affective Pictures System (Lang et al., 1999), and 48 sounds from the International Affective Digitized Sounds (Bradley and Lang, 1999). Items differ in valence (positive, negative or neutral). Photographs were presented on a 16-inch screen. Participants were instructed to attend to each stimulus for its entire duration (six seconds) and think about how it made them feel. After each item presentation, participants gave two separate intensity ratings: they were asked to rate how positive (first rating) and negative (second rating) they felt from the stimulus, on a 1- to 5-point Likert scale. The presentation order of the two subtests was randomized. The answers were not timed.

Before each subtask, participants were given a brief description of the task (“you are going to see pictures/photographs that you may find pleasant or not, and you will be asked to rate how pleasant and how unpleasant they make you feel”). Participants were asked to evaluate the degree of pleasure/enjoyment they anticipated from each subtask. Immediately after each subtask, participants were asked to rate the degree of pleasure/enjoyment they had during the task. Hedonic anticipation and memory were rated on a 5-point Likert scale (from “not at all” to “extremely”). In order to rate motivation, participants were asked the following question: “How willing will you be to repeat this task in the future even without being paid for it?” Answers were rated on a 5-point Likert scale (from “absolutely no” to “absolutely yes”). The same researcher conducted the evocative tasks with most participants. Participants were paid \$10 an hour.

2.3. Clinical ratings

Schizophrenia participants were clinically assessed with the following scales: 1) the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987), from which the total scores and the Positive Syndrome subscale scores were used; 2) the modified Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1989), the *Attention* subscale was not used in total scores; and 3) the Montgomery–Åsberg Depression Rating Scale (MADRS) (Montgomery and Åsberg, 1979). All raters and SCID interviewers met reliability criteria, and were blind to study performances.

Table 1

Demographics and clinical characteristics.

	Schizophrenia group	Non-patient control group	Statistic
<i>N</i>	70	35	
Demographics			
Age (in years)	37.7 (SD: 12)	36 (SD: 13)	$F(1, 103) = 0.46$, $p = 0.50$
Percentage of women (number)	16% (11)	20% (7)	$\chi^2 = 0.30$, $p = 0.58$
Education (in years)	12 (SD: 2)	15 (SD: 2)	$F(1, 103) = 55$, $p < 0.0001$
Race/ethnicity: African-American/White/Hispanic/other	37/19/12/2	12/16/6/1	
Clinical characteristics			
Outpatients	14 (20%)	N/A	
Age at first psychiatric hospitalization	22 years (SD: 8.5)	N/A	
Duration of illness	19 years (SD: 10)	N/A	
Number of hospitalizations (number of patients)	Less than 6: 21 From 6 to 20: 37 More than 20: 12	N/A	
Number of months spent in State Hospitals (lifetime)	49 (SD: 71)	N/A	
Diagnostic subtypes	Paranoid: 26 Undifferentiated: 34 Residual: 10	N/A	
Antipsychotic medications	First generation: 3 Second generation: 51 Combined: 16	N/A	
PANSS total score	78 (SD: 16)	N/A	
PANSS positive subscale score	19 (SD: 6)	N/A	
SANS total score (sum of four subscales)	9.5 (SD: 5)	N/A	
Montgomery–Åsberg Depression Rating Scale	4.9 (SD: 5.3)	N/A	

PANSS: Positive and Negative Syndrome Scale.

SANS: Scale for the Assessment of Negative Symptoms.

2.4. Data analysis

Four study variables were defined: anticipated pleasure, hedonia (average pleasantness ratings for all positive stimuli), remembered pleasure, and motivation. Motivation data were obtained for 45 schizophrenia participants and 25 control participants only, as this aspect was introduced later in the study. Only one clinical variable differentiated the subjects who rated their motivation and the subjects who did not. In the schizophrenia group, participants who rated their motivation were on average older than participants who did not (40 years, SD: 11 versus 33 years, SD: 11; $F(1, 69) = 5.9$, $p = 0.02$). Normality was assessed with the Kolmogorov–Smirnov test, and only hedonia followed a normal distribution.

In order to compare groups and to determine the influence of additional variables on each performance score, regression analyses were conducted with generalized linear model analysis (SAS procedure GENMOD). This method is an extension of traditional linear models to handle non-normally distributed observations. For each study variable, a separate regression analysis was conducted. “Diagnostic group” was kept as the principal independent variable. An ordinal multinomial model was used for anticipated pleasure, remembered pleasure and motivation.

The interplay between anticipated, experienced, remembered pleasures, and motivation was first assessed with Spearman’s correlation analyses. In order to evaluate the predictive value of these evaluative processes on motivation, multinomial logistic regression analyses with cumulative logit as the link function were conducted with motivation as the dependent variable.

All tests were two-tailed, and the alpha level was set at 0.05.

3. Results

Groups did not significantly differ for age and gender. Individuals with schizophrenia had a lower educational level ($p < 0.0001$) (Table 1).

3.1. Schizophrenia versus control participants

As hypothesized, groups did not differ on hedonia (on-line experience), and schizophrenia participants showed higher remembered pleasure than comparison participants. However, groups did not significantly differ on anticipation, and motivation (Table 2).

Confounding factors were analyzed for each variable. “Channel” (pictures or sounds) and age were never significant factors. Education was a significant factor for experienced pleasure and remembered pleasure. Higher education levels were associated with lower scores in these two variables. For these variables, the significance of group differences did not change after education was entered in the model. Gender was a significant factor for motivation (male participants expressed higher motivation than females), and the interaction factor, gender by group, was significant for anticipated pleasure and remembered pleasure. Pairwise comparison analyses showed that female schizophrenia participants had higher scores than female controls and male schizophrenia participants for anticipated pleasure ($p = 0.0003$ and $p = 0.04$ respectively), and remembered pleasure ($p < 0.0001$ and $p = 0.049$ respectively). As female schizophrenia participants had greater anticipation and memory, and lower motivation than male schizophrenia participants, we further calculated the correlation coefficients between anticipation, memory and motivation for male and female schizophrenia participants separately. Female patients showed higher but non-significantly different correlations than male patients (correlation between motivation and anticipated pleasure: females: $\rho = 0.57$, males: $\rho = 0.30$; and correlation between motivation and remembered pleasure: females: $\rho = 0.54$, males: $\rho = 0.33$).

When Caucasian participants were compared to African-American participants, race was never a significant predictor. In the schizophrenia group, inpatients did not differ from outpatients on any measures. We also looked for an order effect. As participants were more familiar with the testing procedure for the second task, it can be hypothesized that their anticipation differed according to familiarity with task. “Order” and the interaction term, “order by group”, were never significant factors for any study variables.

3.2. Interplay between affective processes

The three affective evaluative stages—anticipation, experience and memory—were significantly intercorrelated with similar magnitude of correlates across groups (Table 3). However, our main interest was in the correlations between motivation and affective processes. In the control group, all three positive affect processes were significantly correlated with motivation. In the schizophrenia group, anticipated and remembered pleasures were significantly correlated with motivation, but not hedonia, showing a near-zero correlation

with motivation (Table 3). As it can be argued that total pleasure (pleasure experienced from positive, neutral and negative stimuli) may be as important as hedonia (pleasure coming from positive stimuli only) in the motivation to repeat an act, we calculated the correlation between total pleasure and motivation. Again the correlation was significant in the control group ($\rho = 0.34$, $p = 0.02$), and near-zero in the schizophrenia group ($\rho = 0.05$, $p = 0.64$).

Ordinal multinomial logistic regression analyses with motivation as the dependent variable showed that anticipated and remembered pleasures were significant predictors ($\chi^2 = 4.4$, $p = 0.04$, and $\chi^2 = 12$, $p = 0.0005$ respectively) for both groups combined. The interaction term, diagnostic group by on-line pleasure, was significant ($\chi^2 = 5.7$, $p = 0.02$), indicating that the predictive value of on-line pleasure was significantly different between groups. When groups were analyzed separately, only remembered pleasure was a significant predictor of motivation in schizophrenia ($\chi^2 = 5.4$, $p = 0.02$). In control participants, experienced pleasure and remembered pleasure were significant predictors ($\chi^2 = 5$, $p = 0.02$, and $\chi^2 = 9.4$, $p = 0.002$ respectively), and anticipation approached significance ($\chi^2 = 3.8$, $p = 0.052$)¹.

3.3. Association with clinical ratings

For the four study variables, scores on the picture and the sound tasks were collapsed in order to obtain one score for each schizophrenia participant. Only motivation scores did not follow a normal distribution, and Spearman's rho coefficients were calculated for this variable. For the other variables, Pearson's correlation coefficients were obtained. Correlation analyses revealed that no study variable significantly correlated with any demographic variable. For psychopathology variables (Table 3), anticipation significantly correlated with PANSS total scores, SANS total scores, and SANS *Avolition/Apathy subscale*. Motivation significantly correlated with SANS total scores, and SANS *Affective Flattening subscale*.

The confounding role of antipsychotic medications was explored in the schizophrenia group. Medication dosages (chlorpromazine [CPZ] equivalency values) did not significantly correlate with any study variable.

4. Discussion

We investigated the experience of pleasure in schizophrenia; its pre- and post-experiment evaluations, and its impact on motivation. The three major findings of our study are: 1) schizophrenia participants did not differ from healthy subjects on anticipation and on-line experience of pleasure, 2) schizophrenia participants had greater remembered pleasure than controls, and 3) motivation was disconnected from hedonia in schizophrenia.

¹ Unpleasantness felt from negative stimuli and ambivalence to positive stimuli did not significantly add predictive value to the model in each group. This is consistent with the idea that evaluative system for Positivity is the primary affective system involved with motivation to repeat an action.

Table 2

Affective evaluations in schizophrenia participants and in healthy control group.

	Schizophrenia participants	Healthy controls	Statistic (GENMOD procedure)	Effect size (Cohen's <i>d</i>)
Anticipated pleasure	3.6 SD: 1.1	3.4 SD: 0.9	$\chi^2 = 3.2$ $p = 0.07$	0.25
On-line pleasure	3.2 SD: 0.8	3.2 SD: 0.7	$\chi^2 = 0.07$ $p = 0.79$	0.04
Remembered pleasure	4.1 SD: 1.0	3.4 SD: 0.9	$\chi^2 = 24$ $p < 0.0001$	0.71
Motivation	3.4 SD: 1.2	3.4 SD: 1.1	$\chi^2 = 0.05$ $p = 0.82$	−0.02

4.1. Anticipation of pleasure

The level of anticipated pleasure did not significantly differ between groups. However, before concluding that anticipation of pleasure is not impaired in schizophrenia, methodological issues and other interpretations need consideration.

In our study, the level of novelty differed between tasks and depended on the order of administration: a short description was given for the first task, whereas for the second task, participants had become familiar with the task procedures, and only the stimuli were unknown to them. This difference in novelty/familiarity raises two issues regarding the interpretation of our results. The first issue concerns the psychological processes involved in anticipation. Anticipating future pleasure relies on emotional memories, self-knowledge and intuitive theories (Robinson and Clore, 2002). Depending on novelty, different strategies can be used. With a completely novel task, it can be expected that subjects resort less to emotional memories

and more to intuitive theories. Therefore a novel task may stress one process involved in anticipation, leaving the possibility of impairment of other psychological processes involved in anticipation. In our study, the novelty of the tasks depended on the order of administration, and no order effect was found for anticipation. Therefore, the absence of anticipation impairment in schizophrenia was not due to the novelty dimension of the tasks. A second issue has to do with contextual effects. Context can affect hedonic evaluations at all levels (Robinson and Clore, 2002): when anticipating, experiencing, remembering and planning. Although all study evaluations were done during the same session in order to limit variations in contextual effects, it can be argued that contextual effects (being with a researcher, being off the psychiatric ward, being paid for participating) played a major role in the anticipation of the first task, and contextual effects may have been more prominent with the first task, as limited descriptive information was given to the participants. Our results showed that anticipation scores did not differ between tasks. Subsequently, although a

Table 3

Correlation coefficients between affective scores and psychopathology.

	Schizophrenia participants (<i>N</i> = 70)				Healthy control participants (<i>N</i> = 35)		
	Anticipation	On-line	Memory	Motivation	Anticipation	On-line	Memory
On-line	0.31 $p = 0.0002$				0.28 $p = 0.02$		
Memory	0.49 $p < 0.0001$	0.35 $p < 0.0001$			0.55 $p < 0.0001$	0.42 $p = 0.0004$	
Motivation	0.31 $p = 0.003$	0.01 $p = 0.92$	0.35 $p = 0.0006$		0.44 $p = 0.002$	0.39 $p = 0.007$	0.60 $p < 0.0001$
PANSS total scores	− 0.25 $p = 0.04$	−0.14 $p = 0.26$	−0.03 $p = 0.82$	−0.14 $p = 0.36$			
PANSS positive subscale score	−0.04 $p = 0.73$	0.00 $p = 1$	0.10 $p = 0.37$	−0.11 $p = 0.47$			
MADRS	−0.04 $p = 0.72$	0.02 $p = 0.86$	−0.03 $p = 0.84$	−0.13 $p = 0.39$			
SANS total score	− 0.26 $p = 0.03$	−0.10 $p = 0.43$	−0.01 $p = 0.55$	− 0.31 $p = 0.04$			
SANS affective flattening	−0.19 $p = 0.12$	−0.16 $p = 0.18$	−0.10 $p = 0.40$	− 0.30 $p = 0.05$			
SANS alogia	−0.19 $p = 0.12$	−0.03 $p = 0.80$	−0.04 $p = 0.72$	−0.22 $p = 0.16$			
SANS avolition/apathy	− 0.30 $p = 0.01$	−0.11 $p = 0.39$	−0.10 $p = 0.41$	−0.28 $p = 0.07$			
SANS anhedonia/asociality	−0.17 $p = 0.16$	−0.002 $p = 0.99$	0.02 $p = 0.91$	−0.12 $p = 0.43$			

PANSS: Positive and Negative Syndrome Scale.

SANS: Scale for the Assessment of Negative Symptoms.

MADRS: Montgomery–Åsberg Depression Rating Scale.

In **bold** if $p < 0.05$.

difference in contextual effects between the first and second tasks cannot be ruled out, it can be concluded that contextual effects were negligible or uniformly impacted on study scores.

Anticipation was highly correlated with memory. Similar findings have been reported (Mitchell et al., 1997; Wirtz et al., 2003) and it can partially be explained by the respective nature of these two evaluative processes: evaluation of anticipated and remembered pleasures relies more on cognitive processes than evaluation of on-line pleasure.

4.2. Experience of pleasure

Hedonic experiences are the result of early emotional processes (Frijda, 1999), and in our study schizophrenia participants reported the same level of hedonia as healthy control participants. Similar findings have been reported by most evocative studies (Cohen and Minor, in press; Kring and Moran, 2008), and indicate that schizophrenia subjects' positive emotional reactivity is not impaired.

4.3. Memory of pleasure

Schizophrenia participants remembered greater pleasure than controls. This result is surprising as memory and affective deficits are considered common features of schizophrenia. Our results underlie the fact that outcomes of judgment studies cannot be easily predicted from basic cognition research. Remembering the hedonic value of past events requires the capacity to remember and to integrate all these momentary pleasures. As in other intertemporal choice studies (Kahneman et al., 1993), on-line ratings were obtained by multiple momentary evaluations, and post-test evaluations were obtained just after the completing of each task (which took 20 to 25 min to complete on average). Consequently the memory load was rather minimal in our study. For this reason, the effect of time on remembered pleasure should be further investigated (see Horan et al., 2006; Herbener, 2008). A speculative explanation for increased remembered pleasure in schizophrenia is suggested by our results on motivation: in schizophrenia remembered pleasure is up-regulated in order to compensate for impaired connectivity between affective processes and motivation, leading to similar levels of motivation. Further studies may bring more clarity.

Increased remembered pleasure often lead to biases in preferences and decisions (Kahneman et al., 1997). Increased remembered pleasure may lead people to repeat an activity that actually brought and will bring them little pleasure. "Misguided" decisions may be more significant in schizophrenia, which could give observers an impression of anhedonia.

4.4. Motivation

Levels of explicit motivation to repeat a task were very similar between groups, which is consistent with a recent study (Barch et al., 2008) that showed that intrinsic motivation is not impaired in schizophrenia. Consistent with Decision Theory (Wirtz et al., 2003), remembered pleasure was the affective process that had the strongest correlation with motivation. Whereas the correlation between remembered pleasure and motivation was large in the control group, this correlation was only moderate in the schizophrenia group. As motivation and

remembered pleasure were assessed just after the completion of the tasks, it will be important to know whether the predictive value of remembered pleasure remains over time. Moreover the role of remembered pleasure on other kinds of motivation needs further investigation.

Major differences between groups were found in the functional connectivity between positive affect evaluations and motivation. In the control group, all affective evaluations were significantly correlated with motivation; hedonia and remembered pleasure predicted motivation to repeat the task. One striking finding in the schizophrenia group was the near-zero correlation between on-line pleasure and motivation, and the absence of predictive value of hedonia. The pleasure experienced during the tasks did not induce an incentive to repeat these tasks, which is consistent with the Bleulerian hypothesis of disconnectivity between psychological structures. This disconnection between emotional experiences and motivational processes has been reported in a prior study (Heerey and Gold, 2007), and has recently received some support from a neuroimaging study (Waltz et al., 2009). Schizophrenia participants' major deficit was in the translation of pleasurable experiences into motivational states; referred to as "incentive salience attribution" in Reward Theory (Berridge and Robinson, 2003).

4.5. Role of gender

Significant gender differences were found for all variables except for on-line pleasure. Schizophrenia female participants showed greater anticipated pleasure and remembered pleasure, than male schizophrenia participants and female healthy controls. However, female participants showed lower motivation than male participants, which can reflect a primary motivational deficit or a poorly efficient connection between cognition and motivation. This latter explanation of more poorly efficient connection between affective/cognitive processes and motivation was disconfirmed by our post-hoc correlational analyses, favoring the hypothesis of a greater primary deficit in motivation in female patients. However, these results should be interpreted with caution as our number of female participants was quite low, and clinical studies have reported a better global functioning in female than in male schizophrenia subjects (Grossman et al., 2008).

4.6. Limitations

1) Groups differed in education level. The group differences, however, did not change after education was entered into the analyses. 2) All patients were on antipsychotic medications. Although no study variable was associated with CPZ equivalents, the exact role of medications in positive affect processing cannot be fully examined unless unmedicated participants are enrolled. 3) The impact of predictions and anticipation on experienced pleasure is still a subject of debate (Loewenstein and Schkade, 1999). Some authors have argued that asking participants about their anticipated pleasure for an activity increases the pleasure they will experience during that activity. However, it seems that predictions are more influential when the experimenters suggest to the participants how they will feel during the task (Klaaren et al., 1994; Gilbert et al., 2002). The integration of

between-subjects design should be considered in future studies. 4) We measured anticipated pleasure, remembered pleasure and motivation with one item only. Although other studies on anticipation with the general population and with schizophrenia participants (Gard et al., 2007) have also used one item only, it can be argued that the use of multiple items might have added precision to these measures. 5) Little information was given to participants when they had to evaluate their anticipated pleasure for the first task, and one may wonder whether more information could have led to different anticipation evaluations. In our study, more information on the study procedures did not lead to different levels of anticipated pleasures, as no differences between the first task and the second task were found. However, it is still possible that more information on the items content (for example by showing participants practice items before they evaluated their anticipated pleasure) could have impacted on participants' assessments of their anticipated pleasure.

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Contributors

Fabien Trémeau in collaboration with John Cacioppo, Pamela Butler, Dolores Malaspina and Daniel Javitt designed the study and wrote the protocol. Fabien Trémeau, Daniel Antonius and Rachel Ziwich conducted the study and collected the data. Fabien Trémeau and John Cacioppo undertook the statistical analysis. Fabien Trémeau, Daniel Antonius and Daniel Javitt wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflict of interest relevant to this study.

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