Impaired ability to imagine future pleasant events is associated with apathy in schizophrenia

RAFFARD, Stéphane, et al.

Abstract

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Reference

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Impaired ability to imagine future pleasant events is associated with apathy in schizophrenia

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ABSTRACT

Recent research has established that schizophrenia patients have difficulties envisioning the future. Although mental simulations have a clear adaptive value, little is known about the function of simulating future episodes, particularly emotional events. The aim of this study was to explore the relationships between apathy and future projection in schizophrenia. Twenty-five schizophrenia patients and 25 healthy controls were asked to imagine pleasant and unpleasant episodes that might happen to them in the future. Verbal descriptions were scored for specificity, and participants also completed the Memory Characteristics Questionnaire, which assesses phenomenal characteristics of imagined future events. Apathy was assessed with the Lille Apathy Rating Scale and the apathetic/social withdrawal item of the Positive and Negative Syndrome Scale. Results showed that schizophrenia patients’ pleasant and unpleasant imagined future events were less specific and contained fewer phenomenal characteristics (e.g., amount of sensory details) than those of controls. In the schizophrenia group, difficulties imagining future pleasant events, and particularly poor self-referential information for future pleasant events, were significantly associated with apathy, even after controlling for working memory. These results suggest that episodic future thinking impairments, especially for future events of pleasure, may partly underlie the motivational deficits characteristic of schizophrenia.

1. Introduction

Mental time travel refers to the capacity to remember past personal experiences and to project oneself into possible future events (Tulving, 2005); it is considered as a key component of personal goal planning (Klein et al., 2010). The ability to remember the personal past and the ability to imagine the future are intimately related, insofar as imagining the future involves the capacity to associate and flexibly recombine elements extracted from the past in order to generate a coherent and plausible new event (Schacter and Addis, 2007). The constructive nature of mental time travel allows healthy individuals to mentally shape a future specific event in detail, that is, a unique episode that will occur at a specific time and place. Furthermore, mental simulations of the future give rise to the subjective feeling of pre-experiencing the future; that is, they allow people to “preview” events and to “pre-feel” the emotions, pleasures and pains those events will produce (Gilbert and Wilson, 2007).

It has been suggested that this capacity to momentarily disengage from the immediate environment in order to contemplate hypothetical future events has a clear adaptive value in daily life and plays a fundamental role in future-oriented decision-making and particularly Goal-Directed Behavior (GDB) (e.g., D’Argembeau et al., 2011). Among other things, this ability to imagine possible future events increases behavioral flexibility and fosters more effective plans to achieve goals (Boyer, 2008), guides decision-making (Bechara and Damasio, 2005), allows the consideration of potential consequences prior to acting (Boyer, 2008), favours emotion regulation (Taylor et al., 1998), effectively attenuates temporal discounting (i.e., the propensity to devalue rewards with a delay before delivery; Benoit et al., 2011), and supports initiative, planning and GDB (D’Argembeau et al., 2011). These data suggest that mental simulation of future events may increase motivation and prompt people to concretely plan GDB (e.g., anticipating the positive or negative consequences of a future event may increase motivation to act). Difficulties with future projection could thus...
contribute to reduced GDB, by hindering planning for achieving goals. To date, very few studies have investigated the links between mental time travel and GDB in neurological and psycho-pathological disorders. The objective of the present study was therefore to explore the relationships between apathy – defined as a reduction in GDB (Levy and Dubois, 2006) – and the ability to project oneself into the future in schizophrenia.

Apathy is a common symptom in schizophrenia and is associated with executive deficits, impaired working memory (Faerden et al., 2009), slowed information processing (Roth et al., 2008) and episodic memory deficits (Roth et al., 2004). As for mental time travel, recent studies have revealed that schizophrenia patients were impaired both at remembering the past and at imagining future events (e.g. D’Argembeau et al., 2008). More specifically, individuals with schizophrenia are less able to project themselves into future specific episodes (D’Argembeau et al., 2008), and their autonoetic awareness of their own future is reduced (de Oliveira et al., 2009). Interestingly, some studies have suggested that personal goals are closely related to the construction of episodic future events (e.g. D’Argembeau and Mathy, 2011). However, these studies do not consider the valence of the imagined events and their role in apathy.

Benoit et al. (2011) suggested that imagining and anticipating an episode of pleasure (e.g., the receipt of a reward) with high emotional intensity and many phenomenological details might constitute an intrinsic source of motivation. It could be then hypothesized that the inability to project oneself into the future, and especially into future episodes of pleasure, may contribute to the existence of apathetic manifestations (e.g., loss of initiative or interest; see Mulin et al., 2011 for the diagnostic criteria of apathy) in schizophrenia. In this regard, it is interesting to consider the concept of anhedonia (characterized by a loss of pleasure) in parallel to apathy. According to Gard et al. (2007), anhedonia can be divided into consummatory (i.e., inability to experience pleasure in current enjoyable activities) and anticipatory (i.e., disturbances in the experience of pleasure related to future activities) anhedonia. Due to the loss of pleasure, anhedonia may contribute to apathetic manifestations (e.g., loss of initiative or interest). In addition, the disinterest and emotional blunting aspects of apathy partly overlap with anhedonia. However, unlike anhedonia, which is mainly restricted to pleasure deficits, apathy reflects a wider range of processes (e.g., planning and prospective memory problems, low self-efficacy beliefs, inability to mobilize effort) related to GDB reduction. Moreover, several studies on anhedonia in schizophrenia showed that patients have anticipatory pleasure deficits but normal levels of positive feelings (i.e., consummatory pleasure) when processing emotional stimuli (see Cohen and Minor, 2010, for a review). This may suggest that patients do not manifest disinterest (a dimension of apathy; see Mulin et al., 2011) in current activities. According to Heerey et al. (2011), anticipatory pleasure deficits in schizophrenia patients could be due to degraded representations of future pleasurable events (e.g., rewards), which might account for their lower likelihood of pursuing pleasurable activities and thus their reduced GDB. Therefore, anticipatory pleasure deficits, connected in part to difficulties projecting into future episodes of pleasure, might affect GDB and explain apathy in schizophrenia.

In this study, we decided to consider the emotional valence of the imagined events and to explore the links between future thinking and apathy in schizophrenia, focusing particularly on future episodes of pleasure. This study aimed (1) to replicate previous findings showing impaired ability to mentally time travel into the future in schizophrenia patients in comparison with healthy participants (D’Argembeau et al., 2008) and to explore the question of whether these deficits generalize to emotional events (both positive and negative); (2) to examine to what extent the capacity to project oneself into the future and apathy are related in schizophrenia, focusing especially on the phenomenal characteristics (i.e., amount of sensory details, contextual information, self- and hetero-referential information) of future episodes of pleasure. It should be noted that the aim of this study was to consider more than just anhedonia: specifically, we focused on GDB reduction, which is the core feature of apathy (Levy and Dubois, 2006; Robert et al., 2009), and its relationships with future projection. Indeed, exactly how the inability to mentally simulate the hedonic consequences of a future event contributes to apathy has not yet been empirically investigated. It was predicted that, (1) relative to healthy participants, schizophrenia patients would report less sense of pre-experiencing future positive and negative events; (2) diminished ability to project themselves into a rich “recollection-like” positive future situation would be positively associated with apathy in schizophrenia patients.

2. Methods

2.1. Participants

Twenty-five individuals (all were outpatients) who fulfilled the DSM-IV criteria for schizophrenia participated in the study. Diagnoses were established using the Structured Clinical Interview for DSM-IV (SCID; First et al., 1996). Patients were in the stable phase of the illness according to the current treating psychiatrist and based on the absence of hospitalizations or changes in housing in the month prior to entering the study. Patients taking antiparkinsonian drugs and benzodiazepines were excluded. Seventeen patients were prescribed atypical antipsychotics (68%) and eight patients were prescribed conventional antipsychotics (32%). The total daily dosage of antipsychotic drugs was equal to 874.2 mg/day in Chlorpromazine equivalents (CP2eq). Severity of symptoms was rated by clinicians who were blind to the patient’s task performance, with the Positive And Negative Syndrome Scale (PANSS; Kay et al., 1987). Exclusion criteria were: (1) known neurological disease, (2) developmental disability, and (3) substance abuse in the past three months. Participants were recruited from the University Department of Adult Psychiatry in Montpelier. The control group consisted of 25 healthy (nine women) participants with no personal lifetime history of any psychosis diagnosis (SCID) and no first-degree relatives with such a diagnosis, who were recruited from the general population. Patients and controls were matched for gender, age (M = 33.60, S.D. = 11.63, vs. M = 34.72, S.D. = 9.10), and education (M = 10.92, S.D. = 1.80, vs. M = 11.68, S.D. = 2.04). Level of depressive symptoms was assessed with the Beck Depression Inventory – II (BDI-II; Beck et al., 1998) (see Table 1 for participants’ characteristics).

2.2. Experimental task assessing future projection

The ability to imagine new future events was assessed with an adaptation of the procedure developed by Hassabis et al. (2007). On the basis of six pictures from the International Affective Picture System (IAPS; Lang et al., 1995) (i.e., three pictures with positive valence matched with three pictures with negative valence),2 participants had to simulate a future event (as had been done previously to assess autobiographical memory in schizophrenia; D’Argembeau et al., 2008; Neumann et al., 2007). In response to each IAPS slide, participants were asked to rate the pleasure experienced in the moment (1 = none, 7 = a lot). Then, they were...

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2 The IAPS slide numbers were 2998, 4640, and 7350 for positive pictures and 6561, 7359, and 9417 for negative pictures.
asked to imagine an event that might plausibly happen in the future in as much detail as possible, as if they were physically present (i.e., “I want you to describe the experience and the surroundings in as much detail as possible using all your senses including what you can see, hear and feel”). Detailed instructions explained that the imagined events had to be new (i.e., participants were explicitly told not to recount an actual memory but instead to create something new), precise and specific (i.e., they had to take place in a specific place at a specific time and they had to last a few minutes or hours but not more than a day). All verbal responses were audiotaped and then transcribed for specificity scoring. After imagining and describing each event, participants had to assess the phenomenological characteristics (sensory details, spatial context, associated feelings) of the imagined future event with seven-point rating scales adapted from the Memory Characteristics Questionnaire (MCQ; Johnson et al., 1988) and modified appropriately for the future projection task in our study. Four experiential indices were computed by averaging responses to the items: (1) an index of sensory details (amount of visual details, sounds and smells/tastes (1 = none, 7 = many)); (2) an index of representation of contextual information (clarity of location, clarity of the spatial arrangement of objects and people, and clarity of the time of day (1 = not at all clear, 7 = very clear)); (3) an index of self-referential information (feeling of the emotion (1 = not clearly, 7 = very clearly)), feelings of pre-experiencing the event when imagining (1 = not at all, 7 = a lot), representation of one’s own behavior, and representation of what one said/would say and thought/would think (one = none, seven = very detailed); (4) an index of other-referential information (representation of the behavior of other people and representation of what other people said/would say (1 = none, 7 = very detailed)) (for the rating scales used in this study, see D’Argembeau and Van der Linden, 2006). Participants also rated the difficulty of constructing an imagined future event (1 = very easy, 7 = very difficult) and the extent to which the constructed representation was similar to an actual memory, in whole or in part (1 = not at all like any memories, 7 = exactly like a memory).

The specificity of each imagined event was assessed by two independent raters who were blind to the participants’ diagnosis status and to the hypotheses of the study. The imagined events were categorized as one of three types (Williams et al., 2000): (1) specific events, defined as personal future events that happen in a particular place and time and last for one day or less (e.g., ‘I imagine it is Christmas Eve, we are at home and my children are giving me a present’); (2) category events, referring to a category of events that occur repeatedly over a period of time (e.g., “I am going to take an apartment and I don’t have many friends, so I think I will often be alone; I see that as a general situation’); and (3) extended events, which correspond to a series of events that last for longer periods of time (i.e., events occurring over more than a day; e.g., “I imagine next summer, my wife and children will be away on holidays for a week and 1 will be alone at home”). Following Baddeley and Wilson’s (1986) method, responses were scored on a scale from 3 to 1, with higher scores reflecting greater specificity. Agreement between the two raters was very good (Kappa = 0.86).

2.3. Apathy and clinical measures

2.3.1. The Lille Apathy Rating Scale (LARS; Sockeel et al., 2006)

The LARS is a semi-structured interview assessing specific components of apathy. This scale includes 33 items, divided into nine domains (i.e., everyday productivity, interests, taking initiative, novelty seeking, voluntary actions, emotional responses, concern, social life, and self-awareness). Except for the first three questions, which are scored on a five-point Likert scale, responses are coded by the clinician on a binary scale (1 = yes/0 = no). The global score ranges from −36 to +36, with a higher score representing a greater degree of apathy. The LARS has been validated in French with 159 patients with probable Parkinson’s disease (Sockeel et al., 2006). However, only exploratory analyses were conducted and, to date, no confirmatory analysis has validated the LARS’s factor structure. Given that our sample was too small to verify the scale’s factor structure or to compute multiple correlations, we decided to consider only the overall score. Note that the alpha for the overall score was good (α = 0.72).

2.3.2. Item N4 of the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987)

The PANSS is a 30-item rating scale designed to be completed by clinically trained research staff at the conclusion of a chart review. Assessments are conducted on a seven-point rating scale (0 = absent, 6 = extreme). Regarding the scale’s factor structure, van der Gaag et al., 2006 highlighted five factors: positive symptoms, negative symptoms, disorganization, excitement, and emotional distress. For the purpose of this study, we focused on the apathetic/social withdrawal item of the PANSS (i.e., item N4: diminished interest and initiative in social interactions due to passivity, apathy, anergy, or avolition), which provides a hetero-measure of apathetic manifestations in schizophrenia patients.
2.3.3. The Beck Depression inventory – II (BDI-II; Beck et al., 1998)

This 21-item scale measures depressive symptoms with a 4-point Likert scale. The total score ranges from 0 to 63, with higher scores reflecting greater depression. Recently, Kirsch-Darrow et al. (2011) proposed a “factor-based” scoring of the BDI-II that disentangles symptoms related to apathy (loss of interest/pleasure factor), depression (dysphoric mood factor) and somatic complaints (somatic factor). In our study, we used this factor structure in order to have a “pure” measure of depression that did not overlap with apathy components.

2.3.4. Letter-number sequencing subtest of the Wechsler Adult Intelligence Scale – III (WAIS-III; Wechsler, 1997)

The Letter-Number Sequencing (LNS) subtest is a measure of verbal working memory and constitutes a good predictor of fluid intelligence (Shelton et al., 2009). We decided to control for working memory, in view of its role in future projection (Heerey et al., 2011) and its association with apathy in schizophrenia (Faerden et al., 2009).

2.3.5. Verbal output measures

To assess “retrieval fluency” and verbal output impairments at a clinical level in individuals with schizophrenia, we used items P2 (disorganization of thought and language) and N6 (lack of spontaneity and flow of conversation) of the PANSS (see Raffard et al., 2010).

2.4. Procedure

Participants were tested individually in a quiet environment. Control participants completed all experimental measures in one experimental session. For schizophrenia patients, the data were obtained in two experimental sessions, completed on two consecutive days. The first day’s session consisted in the same experimental session as control participants. After the future imagination task and the LARS, participants were given the BDI-II. The second session for participants with schizophrenia involved administration of the PANSS. The order in which participants completed the future projection task was counterbalanced according to the valence of pictures. All responses provided in the future projection task were audiorecorded and retranscribed for specificity scoring. It should be noted that only three patients imagined future events that were unrelated to the IAPS content and these three were not included in the study. This indicated that the other participants had understood at least the global content of each image. All participants gave their written consent to participate, and the study was approved by the local Ethics Committee as conforming to the Declaration of Helsinki.

2.5. Statistical analyses

First, exploratory analyses of the data revealed that most of the variables were normally distributed; therefore parametric tests were performed. For each dimensional characteristic and specificity, separate analyses of variance (ANOVAs) were carried out with valence of imagined future events (positive, negative) as within-subject factor and group (patients, controls) as a between-subject factor. An alpha level of 0.05 was used for these analyses. Secondly, partial correlation analyses were computed to assess the relationships between apathy measures (LARS and item N4 of the PANSS) and phenomenal characteristics for positive and negative pictures on the future projection task after partialling out the effect of working memory. Given the number of statistical analyses, and the need to balance the number of type I and type II errors, we calculated adjusted p values with the false discovery rate method for multiple testing (Benjamini and Yekutieli, 2001). This statistical method calls for controlling the expected proportion of falsely rejected hypotheses rather than controlling all falsely rejected hypotheses. Thus, the Benjamini–Hochberg–Yekutieli correction exerts a less stringent control over false discovery than familywise error rate procedures (such as the Bonferroni correction) and improves power to some extent (Narum, 2006). Finally, to control the influence of other factors not specifically related to depression and nonetheless measured by classical clinical inventories such as the BDI-II, we used the factor analysis of the BDI-II proposed by Kirsch-Darrow et al. (2011).

3. Results

3.1. Exploratory analyses

Exploratory analyses of the skewness and kurtosis of each test and scale revealed that most of the data were normally distributed, considering that absolute values for skewness and kurtosis greater than 3 and 20, respectively, are judged to be extreme (Weston and Gore, 2006). Specifically, the results showed that skewness ranged from −0.87 to 2.63 and kurtosis from −1.25 to 12.21.

3.2. Mean ratings and group comparisons

Mean ratings and group comparisons for the demographic data, LNS, apathy measures and BDI-II using independent sample t-tests are reported in Table 1.

The results revealed significant group differences in apathy, as assessed with the LARS ($t(48) = 4.17, p < 0.0001$) and the LNS ($t(48) = −3.41, p < 0.001$). Note that the Cronbach’s alpha for the LARS in the patient group is very good ($\alpha = 0.86$) and that this scale is sensitive enough to assess apathy in our sample. Indeed, the 99%

<table>
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<th>Table 2</th>
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<tr>
<td><strong>Mean ratings for specificity and phenomenal characteristics in control participants and schizophrenia patients as a function of future event valence.</strong></td>
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<tr>
<th>Patients (N=25)</th>
<th>Controls (N=25)</th>
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<tr>
<td><strong>Future events</strong></td>
<td><strong>Positive</strong></td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td></td>
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<tr>
<td>Sensory details</td>
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<td>Contextual information</td>
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<td>Self-referential information</td>
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<td>Other-referential information</td>
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<td>Standard deviations are shown in parentheses.</td>
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confidence interval for the LARS is [−22.68 to −7.56], which suggests that the apathy score differs significantly from 0.

Mean ratings and standard deviations for specificity and phenomenal characteristics associated with projecting oneself into future positive and negative events (IAPS) are presented in Table 2 as a function of group (control participants and schizophrenia patients) and future event valence (positive and negative). These ratings were analyzed using 2 (group) × 2 (event valence) ANOVAs. The ANOVAs revealed similar results for the four experiential indices (i.e., phenomenal characteristics): (1) a main effect of group, with controls reporting more sensory details than patients (F(1,45) = 22.80, d.f.= 1, p = 0.0002), and no interaction with event valence (F(1,45) = 2.09, d.f.= 1, p = 0.05); (2) a main effect of group, with controls reporting more contextual details than patients (F(1,45) = 10.48, d.f.= 1, p = 0.002), and no interaction with valence (F(1,45) = 3.23, d.f.= 1, p = 0.05); (3) a main effect of group (F(1,45) = 11.60, d.f.= 1, p = 0.001), with controls reporting more self-referential information independently of the valence of events (F(1,45) = 1.47, d.f.= 1, p > 0.05); and (4) a main effect of group (F(1,45) = 9.05, d.f.= 1, p = 0.004), with controls reporting more other-referential information, independently of the valence of events (F(1,45) = 0.12, d.f.= 1, p > 0.05). As for specificity, an ANOVA revealed a main effect of group, with controls reporting more specific events than patients (F(1,45) = 20.07, d.f.= 1, p = 0.0001). This effect interacted significantly with valence (F(1,45) = 4.53, d.f.= 1, p = 0.039): controls reported more specific events than patients, particularly for positive pictures (t(48) = −4.06, p = 0.0002) relative to negative pictures (t(48) = −2.58, p = 0.013). These results were replicated using analyses of covariance (ANCOVAs) with working memory as a covariate and yielded a similar pattern of results. Furthermore, regarding specificity, an ANCOVA with depression as a covariate showed the same pattern of results as well. Finally, we examined the level of pleasure experienced in response to the IAPS slides. A 2 (group) × 2 (event valence) ANOVA revealed a main effect of valence, with significantly more pleasure for positive than negative IAPS slides (F(1,45) = 132.8, d.f.= 1, p = 0.00001). This effect did not interact with group (F(1,45) = 0.005, d.f.= 1, p > 0.05), indicating that the schizophrenia patients rated levels of pleasure similarly to the healthy controls.

Thus, patients scored significantly lower on all four experiential indices and were less specific than controls, revealing that the ability to richly imagine new and specific experiences is impaired in schizophrenia. It might be suggested that the construction of imagined future events was too difficult for the schizophrenia patients. However, when we examined perceived task difficulty, the results showed no significant difference between patients and controls in the perceived difficulty of imagining events for positive (t(45) = −0.20, p = 0.85) and negative pictures (t(45) = 0.59, p = 0.56). In order to control for verbal output impairments that might explain specificity impairments in schizophrenia patients, we conducted correlation analyses between specificity and items P2 and N6 of the PANSS. No significant correlation was found between the specificity of both positive and negative imagined future episodes and verbal output measured with items P2 (r = −0.26, p = 0.23; r = −0.12, p = 0.57, respectively) and N6 (r = −0.17, p = 0.43; r = −0.03, p = 0.90, respectively). Furthermore, in order to verify that patients had followed the instructions to create something new, we considered the similarity between imagined experiences and actual memories. No significant difference between groups for positive (t(45) = 0.48, p = 0.64) or negative (t(45) = 0.62, p = 0.54) pictures was observed.

Finally, we computed ANOVAs to look for possible effects of medication or gender on apathy and the future projection task. An ANOVA with type of medication (atypical and typical antipsychotics) as between-subject factor and valence (positive and negative) as within-subject factor revealed no significant main effect or interaction for the experiential indices and specificity (all ps > 0.05). As for apathy, as assessed with the LARS and item N4 of the PANSS, no significant differences were observed regarding the type of medication (t(23) = −1.12, p = 0.28; t(21) = −0.19, p = 0.85, respectively). Similarly, for gender, a 2 (gender) × 2 (valence) ANOVA revealed no main effect or interaction for the experiential indices and specificity (all ps > 0.05) in the control group or in the schizophrenia group. Regarding apathy assessed with the LARS and item N4 of the PANSS in the schizophrenia group, no significant difference was observed for gender (t(23) = −0.28, p = 0.78; t(21) = 0.14, p = 0.89, respectively).

3.3. Correlations with clinical ratings

Pearson’s correlations analyses revealed that no study variable significantly correlated with any demographic variable (age and number of years of education). The confounding role of antipsychotic medications was explored in the schizophrenia group. Medication dosages (CPZeq) did not significantly correlate with any study variable. Finally, a significant correlation between the LARS and item N4 of the PANSS (r = 0.56, p = 0.006) was observed.

3.4. Partial correlations between apathy and phenomenal characteristics in the future projection task in schizophrenia

Considering the strong association between sensory details and contextual information, for both positive (r = 0.82, p < 0.0001) and negative pictures (r = 0.78, p < 0.0001) in schizophrenia patients, we grouped these two phenomenal characteristics together.

Partial correlations were computed between apathy measures (LARS and item N4 of the PANSS) and phenomenal characteristics of positive and negative pictures in the future projection task (MCQ), after controlling for working memory. A level of p < 0.05 was defined and adjusted for multiple comparisons using the Benjamini–Hochberg–Yekutieli procedure; the adjusted p-level = 0.008 (see Table 3).

In healthy controls, there were no significant correlations between apathy and the four experiential indices of either positive or negative pictures. In the schizophrenia patients, partial correlation analyses revealed that apathy (assessed with the LARS) correlated negatively and significantly with self-referential information for positive pictures, even after controlling for working memory. The correlation between apathy as assessed with item N4 of the PANSS and self-referential information, after controlling for working memory, just failed to reach statistical significance (p = 0.01).

Lastly, correlations between the five factors of the PANSS and the phenomenal characteristics of positive and negative pictures in the future projection task were computed. The results did not

Table 3

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<tr>
<th></th>
<th>LARS (total score)</th>
<th>Item N4 (PANSS)</th>
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</thead>
<tbody>
<tr>
<td>Sensory details and contextual information (P)</td>
<td>−0.24</td>
<td>−0.47</td>
</tr>
<tr>
<td>Self-referential information (P)</td>
<td>−0.56*</td>
<td>−0.54</td>
</tr>
<tr>
<td>Other-referential information (P)</td>
<td>−0.20</td>
<td>−0.24</td>
</tr>
<tr>
<td>Sensory details and contextual information (N)</td>
<td>−0.02</td>
<td>−0.12</td>
</tr>
<tr>
<td>Self-referential information (N)</td>
<td>−0.33</td>
<td>−0.40</td>
</tr>
<tr>
<td>Other-referential information (N)</td>
<td>−0.35</td>
<td>−0.04</td>
</tr>
</tbody>
</table>

* p < 0.008 (Benjamini–Hochberg–Yekutieli correction).
show a significant association between any PANSS factors and the experiential indices (all ps > 0.05).

3.5. Correlations between BDI-II factors and phenomenal characteristics in the future projection task in schizophrenia

Using the Benjamini–Hochberg–Yekutieli procedure, with an adjusted p-level = 0.003, correlation analyses revealed a trend toward significance for the correlation between the apathy factor and self-referential information for positive pictures (p = 0.04). The other phenomenal characteristics did not correlate significantly with any BDI-II factors (see Table 4).

4. Discussion

There is evidence that schizophrenia is associated with an impaired ability to imagine possible future happenings (e.g., D'Argembeau et al., 2008). Despite the fact that most everyday future-event simulations are emotionally charged (D'Argembeau et al., 2011), no study had yet examined schizophrenia patients' ability to imagine future emotional events by asking them to project themselves into future pleasant and unpleasant events. The first objective of this study was to explore future projection for emotional events in schizophrenia patients compared to healthy participants. In addition, we also examined the relationships between mental time travel into future episodes of pleasure and apathy in schizophrenia.

Our results indicate first that individuals with schizophrenia reported fewer phenomenal characteristics (sensory, contextual, self- and other-referential details) and had difficulties imagining specific future positive and negative events (i.e., unique episode that occurs at a specific time and place) in response to both positive and negative cues, compared with healthy controls. Taken together, these results provide additional evidence of mental time travel impairments in schizophrenia that generalize to emotional events. Interestingly, the lower specificity was particularly marked for positive events, even after controlling for depression. It has been observed that healthy individuals imagine positive events as more specific and with a greater feeling of pre-experiencing them than negative events (D'Argembeau and Van der Linden, 2004). This positive bias has been interpreted as a way to create and maintain a positive self-concept. Indeed, most people tend to preferentially process information that conveys a positive view of themselves, and such self-enhancement goals may favor the elaboration of future positive events. In this regard, our results could suggest that schizophrenia patients have negative self-beliefs (Green et al., 2012), leading to reduced optimism about the future (Prentice et al., 2005), and thus to reduced specificity for future pleasant events. This hypothesis fits well with the conception of Strauss and Gold (2012), who consider that low levels of positive emotion for future experiences in schizophrenia (i.e., anticipatory anhedonia) reflect abnormal beliefs related to pleasure. More specifically, unlike healthy individuals, who tend to overestimate their level of pleasure both prospectively and retrospectively, schizophrenia patients have a reduced positive bias for noncurrent feelings (although this seems not to be the case for current positive feelings), which could contribute to the low specificity of their imagined future pleasant events.

Secondly, our findings revealed that apathy, as assessed with the LARS in the schizophrenia group, was closely related to difficulties envisioning pleasant events that might happen in the future; this relation remained significant even after working memory was controlled for (the same association was observed with the apathetic/social withdrawal item of the PANSS but just failed to reach statistical significance). More specifically, difficulties imagining future pleasant events, and particularly poor self-referential information for future pleasant events (i.e., the feelings of pre-experiencing positive events, the feeling of an emotion when imagining a pleasant event and the representation of one's own behavior), were associated with motivation deficits in pursuing personal goals in schizophrenia patients. The relationships between poor representation of one's own behavior in the future and apathy can be interpreted according to a well-known cognitive theory of motor cognition that suggests that cognition is embodied in action and that the ability to vividly simulate acting in the future could actually lead to increased action (Lotze and Cohen, 2006). In other words, the ability to imagine oneself performing (i.e., pre-experiencing) a possible future action could facilitate the later reproduction of this action, by increasing one's motivation and effort to attain imagined future goals and by prompting the effective motor sequences/behaviors needed to achieve these goals (D'Argembeau and Van der Linden, 2012).

Interestingly, a recent study showed that the sense of pre-experiencing the future is modulated by the personal importance attributed to the event, suggesting that this sense not only increases motivation, but is also partly shaped by the relevance of imagined events with respect to one's personal goals (D'Argembeau and Van der Linden, 2012). As for the association between the feeling of emotions when imagining future pleasant events and apathy, this result is consistent with the idea that anticipating an episode of pleasure (e.g., the receipt of a reward) after having imagined its consumption or attainment with high emotional intensity might constitute an intrinsic source of motivation that positively influences GDB (Benoit et al., 2011). In sum, these data confirm and provide additional evidence that the capacity for episodic prospection may favor effective plans to achieve goals (Boyer, 2008). In addition, it is important to note that the links between impaired ability to imagine future pleasant events and apathy in this study were specific. Indeed, impaired ability to self-project into future pleasant events was not associated with depression, emotional distress or positive or disorganized symptoms. Interestingly, the apathy dimension of the BDI-II and self-referential information for future positive events were closely related (although non-significantly), which constitutes additional evidence of a link between the ability to pre-experience future positive events and apathy in schizophrenia. The specific association between apathy and poor representations of future pleasant episodes should be further discussed. Heerey and Gold (2007) showed that, because of their poor working memory, schizophrenia patients had difficulties coupling their behaviors with the motivational properties of a stimulus, particularly when behaviors required the maintenance of an internal stimulus representation. Thus, it could be argued that our main finding is explained by working memory deficits. However, contrary to Heerey and Gold's findings, the association between self-referential details for imagined future pleasant events and apathy remained significant even after we controlled for working memory.

Table 4

Correlations between BDI-II factors and phenomenal characteristics for positive pictures in the future projection task.

<table>
<thead>
<tr>
<th>Phenomenal characteristics</th>
<th>BDI-II factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dysphoric mood</td>
</tr>
<tr>
<td>Sensory details</td>
<td>−0.26</td>
</tr>
<tr>
<td>Contextual information</td>
<td>−0.15</td>
</tr>
<tr>
<td>Self-referential information</td>
<td>−0.15</td>
</tr>
<tr>
<td>Other-referential information</td>
<td>−0.06</td>
</tr>
</tbody>
</table>

*p < 0.003 (Benjamini–Hochberg–Yekutieli correction).
Finally, the fact that the subjective task difficulty was equiva-

lent for patients and controls is important, given that the sensation of difficulty perceived while performing a task is closely related to task engagement (Gendolla, 1999). This indicates that patients’ deficits in our future projection task were not due to low effort or task disengagement.

There are some limitations on our study. First, all patients were taking antipsychotic medications. Although no study variable was associated with CPZeq, the role of medications in cognitive processing cannot be fully examined unless non-medicated parti-

cipants are also enrolled. Second, lower levels of specificity for both positive and negative imagined events in schizophrenia patients could be due to an inability to voluntarily generate non-

overlearned responses (i.e., verbal fluency deficit). Indeed, although there was no significant correlation between the specific-

ity of imagined future events and verbal output as explored by items P2 and N6 of the PANSS, this is not enough to rule out verbal fluency deficits; thus, a more direct measure of verbal fluency should be used. Additionally, it could be argued that deficits in future projection observed in schizophrenia patients were due to the difficulty of grasping in detail the content of the IAPS slides. Although all the patients included in our study were able to construct a future event in reference to the content of each slide, it would have been useful to obtain a detailed description of each image (with no future element) to ensure that the deficits were specific to the future aspect of the task. Third, causal inferences cannot be drawn because of the cross-sectional nature of the data. In fact, the link between apathy and difficulties envisioning pleasant events that might happen in the future is probably bidirectional: difficulties projecting oneself into future pleasant events may play a role in the development of apathy, and the presence of apathy may account for difficulties envisioning plea-

sant future events. Indeed, as mentioned previously, difficulties projecting oneself into future events of pleasure could reduce the motivation to attain imagined future goals and thus initiate GDB.

Conversely, the executive problems or reduced motivation to mobilize effort associated with apathy may contribute to difficul-

ties in future projection by hindering the capacity to initiate strategies or reducing motivation to make an effort to self-

retrieve information from episodic memory and construct future events (Thoma et al., 2006).

A final limitation of our study concerns the tools we used to assess apathy. We considered the overall LARS score and not the different subscale scores, because the factor structure of this scale has not been explored in schizophrenia; the small size of our sample prevented us from conducting such an analysis in this study. In addition, the apathetic/social withdrawal item of the PANSS provides a hetero-evaluation of apathy, but does not allow one to capture the specific features of apathy. Future studies should use an apathy scale that has been validated with schizo-

phrenia patients, allowing the assessment of different dimensions of apathy.

To conclude, this study confirms that schizophrenia patients find it more difficult than healthy individuals to project them-

selves into the future: schizophrenia patients reported fewer phenomenological characteristics and were less specific about future positive and negative events. In addition, our findings revealed that apathy in schizophrenia was closely related to problems imagining future pleasant events, and particularly to poor self-

referential information for future pleasant events. These results should be replicated in future studies using a methodology that is less restrictive on the construction of future events (i.e., without being constrained by images). Specifically, participants could be asked to imagine emotional events with and without cues (images or words); this would allow researchers to better understand the nature of their problems. Finally, as mentioned earlier, apathetic manifestations are not determined only by the inability to self-

project into future pleasant events, but very likely involve other psychological mechanisms known to be affected in schizophrenia, namely planning, prospective memory, self-efficacy beliefs, estimation of the response cost and emotion maintenance.

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