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Influence of positive subliminal and supraliminal affective cues on goal pursuit in schizophrenia

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ABSTRACT

Goal pursuit is known to be impaired in schizophrenia, but nothing much is known in these patients about unconscious affective processes underlying goal pursuit. Evidence suggests that in healthy individuals positive subliminal cues are taken as a signal that goal pursuit is easy and therefore reduce the effort that is mobilized for goal attainment. Patients with schizophrenia and healthy controls were instructed that a long run of successive correct responses in a visual attention task would entitle them to a reward (the goal to attain). Affective pictures were displayed supraliminally or subliminally during each run and electrophysiological activity was recorded. Patients self-assessed the emotional content of the pictures correctly. However, differences between patients and controls emerged during the goal pursuit task. Healthy controls mobilized less effort for the positive than the neutral subliminal pictures, as suggested by increased error rates and the weaker contingent negative variation (CNV). For the patients, no influence of positive subliminal pictures was found on performance and on the CNV. Similarly the influence of positive pictures was absent or abnormal on components which are usually impaired in patients (fronto-central P2 and N2). In contrast, positive pictures influenced normally the parieto-occipital N2, related to a component of visual attention which has been proposed to be preserved in schizophrenia. The present study indicates the difficulties of patients to modulate effort mobilization during goal pursuit in the presence of positive subliminal cues. The results question the role of cognitive deficits on affective influences.

1. Introduction

In schizophrenia motivation deficits are related to impeding symptoms such as avolition, a reduction in the ability to initiate and persist in goal-directed behaviour (Barch and Dowd, 2010). It is likely that this impairment affects a range of cognitive functions requiring a representation of goal information to guide behaviour (Lesh et al., 2010; Barch and Ceaser, 2012). Research into schizophrenia has mainly explored goal pursuit in relation to conscious mental faculties. However, research in healthy individuals has now established that subtle affective signals can modulate goal pursuit even though they do not reach awareness (Custers and Aarts, 2010). Given the clinical importance of goal-directed behaviour impairments in schizophrenia, we aimed at checking how patients are influenced by subliminal affective cues.

It has been shown that people's goal pursuit is influenced by subtle cues in the environment outside their awareness (Custers and Aarts, 2005, 2010; Capa et al., 2011a; 2011b). Positive subliminal cues are thought to decrease the perceived difficulty of a task and consequently reduce effort mobilization (Niedenthal, 2008; Gendolla and Silvestrini, 2011; Silvestrini and Gendolla, 2011; Gendolla, 2012), which may result in decreased performance (Zemack-Rugar et al., 2007). Positive subliminal cues represent a sign that goal pursuit is easy and induce coasting. When people consciously perceive the pictures (supraliminal presentation), they attribute affect information to the picture displayed and not to their progress with goal pursuit in the task. One implication is that the effects of unconscious positive primes on goal pursuit are more pronounced than those of conscious affective primes (Clore and Huntsinger, 2007).

Recent research indicates that patients with schizophrenia self-report similar emotions to those of control participants (Burbridge and Barch, 2007; Gard et al., 2007; Heerey and Gold, 2007; Herbener et al., 2008; Kring and Moran, 2008; Cohen and Minor, 2010; Oorschot et al., 2013) and have intact initial event-related potential (ERP) components and partially preserved brain activity during an affective picture viewing task (Dichter et al., 2010; Dowd and Barch, 2010; Horan et al., 2010, 2012; Anticevic et al., 2011, 2012; Ursu et al., 2011; van Buuren et al., 2011; Taylor et al., 2012). Although it is clear from a clinical point of view that not all aspects of emotional experience are intact (Bleuler, 1950), it would nonetheless appear that patients have

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emotional perception which is roughly comparable to controls (Kring and Moran, 2008). However, consistent with clinical observations that patients with schizophrenia have problems translating emotional experience into behaviour (Bleuler, 1950) several studies have suggested that there is a disconnection between affective experiences and their influence on motivated behaviours (Heerey and Gold, 2007; Trémeau et al., 2010). Our point is that all these studies have mainly explored conscious emotional experience and little is known about the influence of subliminal affective cues in schizophrenia. As research suggests that subliminal processing of information is intact in patients (Dehaene et al., 2003; Del Cul et al., 2006; Huddy et al., 2009; Jahshan et al., 2012) any difference in the effects of positive subliminal cues compared to healthy individuals would indicate a deficiency in translating emotional information in motivated behaviour.

In the present study, patients with schizophrenia and controls were invited to perform long runs of successive correct responses in a visual attention task—a task in which difficulties of the patients are minimized (Luck et al., 2006; Gold et al., 2009). During each run, neutral, negative, or positive pictures were displayed either subliminally (24 ms, unconscious condition) or supraliminally (500 ms, conscious condition). Negative emotions related to anger and aggression share an important motivational property with positive emotion (Carver and Harmon-Jones, 2009). We thus explored whether negative pictures can also induce disengagement in goal pursuit (Freydefont et al., 2012). Influence of the subliminal and supraliminal affective pictures on goal pursuit and perseverance were examined by measuring how they modulated the number of successive correct responses and event related potentials (ERPs). Previous studies in healthy volunteers have shown the involvement of different ERPs during visual attention tasks: fronto-central positive and negative waves (P2/N2 complex) and parieto-occipital negative wave (N2). The fronto-central P2 and N2 components are related to the evaluation of the relevance of task stimuli and to conflict resolution and response selection, respectively (Di Russo et al., 2006; Gajewski et al., 2008). The parieto-occipital N2 reflects the allocation of visual attention (Luck and Hillyard, 2000). We also focus on the fronto-central contingent negative variation (CNV) which increases during trials in which healthy volunteers invest preparatory effort (Capa et al., 2013).

Our predictions are the following. For healthy controls, we expect to reproduce the disengagement from goal pursuit induced by positive affective pictures, with fewer successive correct responses and less efficient ERPs' amplitude (such as a decrease of the CNV amplitude), especially in the subliminal condition. Patients are expected to correctly self-assess affective pictures. We neither expect much effect in case of supraliminal pictures. However, if there is a decoupling of positive affect and effort mobilization even in case of unconscious primes, we expect a lack of disengagement from goal pursuit following nonconscious positive affective cues.

2. Methods

Details concerning participants, exclusion criteria, training task, selection and assessment of IAPS pictures, perceived difficulty scale, perceptual discrimination task and electrophysiological recording and analysis can be found in Supplementary data.

2.1. Participants

The participants' demographic and clinical data are presented in Table 1. All of the patients had been diagnosed by two senior psychiatrists based on the Mini International Neuropsychiatric Interview, according to the criteria laid down in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994) (paranoid, n = 9; residual, n = 7; undifferentiated, n = 3). Chlorpromazine equivalents were computed using the method of Woods (2003). Symptoms were assessed with the help of the Positive And Negative Syndrome Scale (PANSS; Kay et al., 1987) and the Scales for the Assessment of Positive Symptoms (SAPS; Andreasen, 1983) and Negative Symptoms (SANS; Andreasen, 1981).

Table 1
Demographic and clinical data.

	Patients	Controls
Gender (M/F)	13/6	13/6
Age (mean ± SD)	35.9 ± 8.3	34.5 ± 9.2
Years of education (mean ± SD)	12.9 ± 2.1	13 ± 2.2
Duration of illness (mean years ± SD)	13.5 ± 5.5	–
Onset of illness (mean years ± SD)	24.0 ± 5.6	–
Number of hospitalisation	5.8 ± 5.1	–
Medication (typical/atypical/no medication)	3/14/2	–
Dose of chlorpromazine equivalents (mg/day)	242	–
PANSS positive symptoms (mean ± SD)	14 ± 4.1	–
PANSS negative symptoms (mean ± SD)	16.9 ± 8.3	–
PANSS general symptoms (mean ± SD)	29.1 ± 7.7	–
PANSS total (mean ± SD)	59.9 ± 16.5	–
SAPS (mean ± SD)	19.6 ± 10.7	–
SANS (mean ± SD)	35 ± 24.9	–

The exclusion criteria for both patients and controls were: a history of alcohol or drug dependency, a neurological or medical pathology, a disabling sensory disorder, and general anaesthesia in the 3 months prior to testing. An additional exclusion criterion for controls was psychotropic medication in the 3 weeks prior to testing. Healthy controls were free of psychiatric diagnoses, were not taking psychiatric medications, and had no family history of psychosis. All participants had normal or corrected-to-normal visual acuity.

The project had the approval of the local ethics committee. All of the participants gave their informed written consent prior to testing. The experiment was conducted in accordance with the Declaration of Helsinki. Patients were stabilized, with relatively mild symptoms.

2.2. Procedure

Each participant first completed a training session, followed by the goal pursuit task. The training session minimized the possibility that learning interfered with the effects of affective primes on goal pursuit. Then, participants filled out a perceived difficulty scale (Eccles and Wigfield, 1995). Lastly participants were asked to perform a perceptual discrimination task and next to rate the valence and arousal of the IAPS pictures to ensure that supraliminal affective pictures were consciously perceived and subliminal affective pictures were not, and that participants self-assessed the emotional content correctly, respectively.

2.3. Goal pursuit task

The task was programmed with E-Prime and presented on an 85-Hz CRT screen. There were 54 runs (9 runs each for each of the 6 conditions). Each condition (2 picture presentation durations multiplied by the 3 affect pictures) was administered in random order across runs. However, the condition was identical within each run. At the start of each run, participants were told that if they gave a long series of successive correct responses they would receive a monetary reward (Fig. 1A). No information and feedback was given about the number of successive correct responses required to earn the reward. This method was adopted because feedback could have confused the results, since patients have abnormal brain responses to feedback (Waltz et al., 2010). This could have altered the effects of affective pictures on goal pursuit.

Next (Fig. 1B), a fixation cross appeared and was followed immediately by a neutral, negative, or positive picture taken from the International Affective Picture System (IAPS; Lang et al., 2005), a mask, and a fixation cross. The picture (10° × 8°) was displayed either supraliminally (500 ms) or subliminally (24 ms). The masks were textures of oriented lines covering the whole of the pictures, and were presented 150 ms after the pictures, for 150 ms. Patients are known to display impairments