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Impaired facial and vocal emotion decoding in schizophrenia is underpinned by basic perceptivo-motor deficits*

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ABSTRACT

Introduction: Emotional decoding impairments have been largely demonstrated in schizophrenia for facial and prosodic stimuli, when presented separately. Nevertheless, the exploration of crossmodal integration has been far less considered, despite its omnipresence in daily social interactions. Moreover, the role played by basic visuo-motor impairments in unimodal and crossmodal decoding remains unexplored.

Methods: Thirty-two patients were compared with 32 matched controls in an emotional decoding task including unimodal (visual and auditory) and crossmodal (congruent and incongruent) conditions. A control perceptive task was also conducted to take potential low-level perceptual deficits into account.

Results: Schizoprenic patients presented lower performance and higher reaction times for both unimodal tasks (visual and auditory) and crossmodal conditions. Moreover, reaction times for the visuo-perceptive task were also significantly longer for patients compared to controls.

Conclusions: The consistency of the results across unimodal and crossmodal tasks suggests a globalised emotional impairment in schizophrenia, independent of the sensorial modality and crossmodal nature of the stimuli. Centrally, given the results in the visuo-perceptive task, the impairments observed for emotional recognition appears at least partly explained by primary cognitive deficits, namely reduced processing speed.

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Schizophrenia; emotions; crossmodality; visuo-motor deficits; cognition

Introduction

It has been widely demonstrated that people with schizophrenia experience significant impairments in decoding facial (Chan, Li, Cheung, & Gong, 2010; Kohler, Walker, Martin, Healey, & Moberg, 2009) and vocal (Kohler et al., 2003; Mandal, Pandey, & Prasad, 1998) emotional stimuli. However, it is not yet clear whether impaired emotional recognition constitutes a specific deficit in schizophrenia (Kring & Elis, 2013), as a generalised deficit for facial processing (encompassing non-emotional features) has been

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suggested (Chan et al., 2010), as well as impaired decoding of neutral sounds (Leitman et al., 2005). The emotional specificity of the deficit has thus still to be directly tested.

Moreover, emotional stimuli are most often multimodal in real life (Driver & Spence, 2000), simultaneously involving several sensorial modalities (e.g. a face and a voice displaying the same emotion). Congruent multimodal information leads to faster and more accurate processing compared to unimodal cues (i.e. crossmodal facilitation, Collignon et al., 2008), incongruent audio-visual stimuli conversely inducing crossmodal interference (McGurk & McDonald, 1976). Most past emotion research on schizophrenia was limited to unimodal designs, but this condition appears related to reduced crossmodal facilitation (Giannitelli et al., 2015; Williams, Light, Braff, & Ramachandran, 2010). Incongruent crossmodal processing has also been investigated, leading to contradictory results as studies reported reduced (De Jong, Hodiamont, Van den Stock, & De Gelder, 2009), increased (De Gelder et al., 2005) or intact (De Jong, Hodiamont, & De Gelder, 2010; Müller, Kellermann, Seligman, Turetsky, & Eickhoff, 2012) incongruency interference in schizophrenia.

These previous studies centrally presented two limits which might explain their contradictory findings. First, they did not propose an exhaustive design simultaneously testing all unimodal–crossmodal and congruent–incongruent combinations. Second, most focused on complex emotional stimuli and did not consider potential underlying low-level perceptual deficits. Indeed, below their emotional deficits, schizophrenia patients present strong perceptual and motor impairments (Butler, Silverstein, & Dakin, 2008; Tek et al., 2002) potentially influencing emotional decoding. The present study thus aims at offering the first integrated exploration of unimodal and congruent/incongruent crossmodal decoding in schizophrenia, whereas controlling for lower level perceptual impairments.

Materials and methods

Participants

Thirty-two patients (15 women) diagnosed with schizophrenia based on the DSM-IV and 32 controls paired on age, gender and education participated in this study. Positive and negative symptoms were explored among patients with the Positive and Negative Syndrome Scale (PANNS, Kay, Fiszbein, & Opler, 1987). All patients were recruited in three Belgian psychiatric hospitals, had presented schizophrenia for at least five years and had been in a stabilised state for at least six months. Three patients were receiving first-generation antipsychotic drugs, 15 were taking second-generation drugs, 11 were taking a combination of first and second-generation drugs and three were not taking antipsychotic drugs. No significant correlation was found between medication and experimental measures ($p > .05$). Controls were free of psychotropic medication. The study was approved by the Ethics Committee of the St Luc University Hospital (Belgium). All participants gave informed written consent.

Materials

Psychological measures

Participants completed anxiety (State and Trait Anxiety Inventory A-B, Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) and depression (Beck Depression Inventory, short version, Beck & Steer, 1987) questionnaires.

Simple reaction time

The Simple Reaction Time is a control task used to identify potential perceptivo-motor deficits. Participants had to press a response-key as fast as possible when a white cross appeared on the computer screen. Crosses appeared at random intervals (inter-stimulus interval: 1000–3500 ms) and disappeared when an answer was given. Fifty stimuli were presented and the mean reaction time was computed.

Emotional task

This computer task required binary emotional identification (happiness-anger) of facial and vocal stimuli. Visual stimuli, from the Radboud Face Battery (Langner et al., 2010), were morphed at 40–60% (i.e. 40% happiness—60% anger or conversely) to obtain similar visual-auditory performance. Auditory stimuli, from a standardised battery (Maurage, Joassin, Philippot, & Campanella, 2007), displayed the word "paper" with emotional prosody. Twenty-four stimuli were used in each modality (6 identities X 2 genders X 2 emotions). Five experimental conditions were proposed: (1) visual unimodal task presenting facial expressions; (2) auditory unimodal task presenting auditory stimuli; (3) congruent crossmodal task, where visual and auditory stimuli were displayed simultaneously, depicting the same emotion, and in which participants had to simultaneously focus on both modalities; (4) visual incongruent crossmodal task where participants had to focus on visual processing, whereas incongruent auditory information was presented simultaneously; and (5) auditory incongruent crossmodal task where participants had to focus on auditory processing, whereas incongruent visual information was presented simultaneously. Each condition included 96 trials consisting of a fixation cross (500 ms), the target (700 ms) and a black screen (1300 ms). Participants had 2000 ms to answer. Accuracy (%) and Reaction times (RT, ms) were measured.

Procedure and statistical analyses

Procedure

The one-hour experiment was individually conducted, starting with the Simple Reaction Time followed by the emotional task (where the conditions were performed in a random order, counterbalanced across participants).

Statistical analyses

Groups were compared using one-way ANOVAs for psychological measures and simple reaction time task. 2 (groups) × 5 (conditions) ANOVAs were conducted separately for accuracy and RT for the emotional task. Psychological variables for which group differences were identified were included as covariates in the ANOVAs. *Post-hoc* paired-sample *t*-tests were performed to explore significant effects. An additional analysis was also performed to control for the influence of visuo-motor impairment on emotional decoding, using a subtractive method: mean Simple Reaction Time RT were subtracted from emotional task RT for each participant, and group comparisons were then reconducted using these subtractive scores. This method was used as it provides, by subtracting raw RT's in both tasks from each other, enhanced precision regarding reaction time comparisons. As such, this method ensures a better understanding of the involvement of perceptive-motor delay in emotional decoding.

Results

Psychological measures

As shown in Table 1, groups did not differ for age, $F(1, 62) = 0.124$, *NS*, gender, χ^2 $(1, N = 64) = 0.250$, *NS*, education, $F(1, 62) = 2.183$, *NS*, and state anxiety, $F(1, 62) = 2.372$, *NS*. Groups significantly differed for depression, $F(1, 62) = 10.388$, $p < .01$, and trait anxiety, $F(1, 62) = 8.144$, $p < .01$. PANSS results indicated the mean intensity of positive ($M = 20.84$; $SD = 8.57$), negative ($M = 24.03$; $SD = 9.43$) and psychopathological ($M = 50.31$; $SD = 17.85$) symptoms.

Experimental measures

Simple reaction time

RT were significantly longer for patients ($M = 551.19$; $SD = 329.9$) than controls ($M = 368.19$, $SD = 177.61$), indicating a visuo-motor deficit among patients, $F(1, 62) = 7.53$, $p < .01$.

Emotional task

Accuracy. For accuracy (Table 2), a main group effect was found (patients being less accurate than controls), $F(1, 60) = 28.969$, MSE = 797.13, $p < .001$, but there was no condition effect, $F(4, 240) = 2.285$, MSE = 110.69, *NS*, or interaction, $F(4, 240) = 1.148$, MSE = 110.69, *NS*.

Reaction times. For RT, a main group effect was found (patients being slower than controls), $F(1, 60) = 17.628$, MSE = 119841.07, $p < .001$, as well as a main condition effect, $F(4, 240) = 3.339$, MSE = 11943.91, $p < .05$, but no interaction, $F(4, 240) = 0.798$, MSE = 11943.91, *NS*.

Auditory Unimodality led to longer RT than Visual Unimodality, $t(63) = 7.284$, $p < .001$, Visual Crossmodality, $t(63) = 5.063$, $p < .001$, and Congruent Crossmodality, $t(63) = 3.874$, $p < .001$. Auditory Crossmodality led to longer RT than Visual Crossmodality, $t(63) = 4.247$, $p < .001$, Congruent Crossmodality, $t(63) = 2.67$, $p < .05$, and Visual

Table 1. Psychological measures for patients with schizophrenia and control participants: Mean (SD).

	Age	Education	BDI	STAI-A	STAI-B
Patients	47.31 (10.01)	11.16 (2.897)	10.94 (10.46)	42.44 (10.11)	47.50 (9.88)
Controls	46.41 (10.55)	12.16 (2.50)	4.47 (4.41)	37.56 (14.78)	40.00 (11.11)

Table 2. Percentage of correct answers (Accuracy) and mean reaction times (Latencies) in each experimental condition for patients with schizophrenia and control participants: Mean (SD).

		Patients		Controls	
Task	Condition	Accuracy	Latencies	Accuracy	Latencies
Unimodality	Visual	62.31 (13.05)	796 (239)	79.69 (9.5)	633 (136)
Unimodality	Auditive	72.19 (21.40)	925 (208)	92.34 (6.62)	782 (143)
Crossmodality	Congruency	77 (18.92)	873 (243)	90.62 (7.93)	683 (161)
Crossmodality	Visual	62.19 (20.03)	825 (204)	79.75 (15.66)	666 (111)
Crossmodality	Auditive	69.31 (22.7)	912 (211)	85.31 (11.16)	727 (110)

Unimodality, $t(63) = 4.78$, $p < .001$. Visual Unimodality led to shorter RT compared to Congruent Crossmodality, $t(63) = 3.93$, $p < .001$. Auditory Unimodality and Auditory Crossmodality did not differ, $t(63) = 1.48$, *NS*, which was also found for Visual Unimodality/Visual Crossmodality, $t(63) = 1.709$, *NS*, and Visual Crossmodality/Congruent Crossmodality, $t(63) = 1.674$, *NS* comparisons.

Additional analyses

Subtractive method. When the subtractive method was applied, the main condition effect remained, $F(4, 240) = 3.339$, MSE = 11943.91, $p < .05$, but no group effect, $F(1, 60) = 0.156$, MSE = 365527.5, *NS*, or interaction, $F(4, 240) = 0.798$, MSE = 11943.91, *NS*, was revealed.

Influence of symptomatology. As negative symptoms have been found to impact emotional processing in schizophrenia (Castagna et al., 2013), Pearson's correlations were conducted between PANSS subscales and total score and the experimental measures. No significant correlations were found ($r < 0.294$, *NS*).

Influence of medication. As only three schizophrenic participants were taking first generation antipsychotics only, we compared patients taking second generation antipsychotic drugs ($n = 15$) with patients taking a combination of first/second generation drugs ($n = 11$). No significant differences were found between groups on the perceptivo-motor task, $F(1, 24) = 1.374$, *NS*, nor on the emotional task, $F(1, 24) = 1.298$, *NS*.

Discussion

Previous studies have mostly explored emotional decoding in schizophrenia by means of unimodal visual (Chan et al., 2010; Kohler et al., 2009) and vocal (Hoekert, Kahn, Pijnenborg, & Aleman, 2007) approaches. Recently, preliminary results have been found for crossmodal processing (De Gelder et al., 2005; De Jong et al., 2009; Müller et al., 2012), but these studies did not simultaneously explore all possible unimodal–crossmodal combinations and did not take into account the visuo-motor deficit presented by patients. The present study overcomes these limits by simultaneously exploring all possible crossmodal combinations, by controlling low-level processes, and by taking into account frequent psychopathological comorbidities and pharmacological status.

In line with earlier results, schizophrenia patients were significantly slower and less accurate than controls on all emotional conditions (unimodal and crossmodal), suggesting a general emotional decoding deficit, whatever the stimulus type. Both groups also showed: (1) slower auditory processing compared to visual and congruent crossmodal identification; (2) a congruency facilitation effect, with higher accuracy for congruent compared to incongruent crossmodal stimuli, which confirms earlier studies (De Jong et al., 2009) showing preserved facilitation effect in schizophrenia. Finally, patients presented similar deficits for both incongruent conditions, which contradicts previous results showing lower crossmodal bias in schizophrenia for visual incongruent identification (De Gelder et al., 2005). Nevertheless, those results could be explained by the visual morphing used here, as when visual cues are more difficult to interpret, auditory stimuli become the leading identification cue.

Centrally, when visuo-motor deficits were controlled for using the subtractive method, the delay in processing emotional information found in schizophrenia totally disappeared, as no significant group effect remained. This leads to the proposal that the slowdown and, consequently, potential generalised impairment found in schizophrenia for emotional processing might not be exclusively an emotional deficit per se, but might also be part of a more general low-level deficit, encompassing (but not limited to) emotional processing. However, as accuracy differences were also observed in the present study, future works should explore the specific influence of perceptual deficits in emotional abilities among schizophrenic patients.

The present results suggest that low-level functioning should be controlled for when exploring affective or social cognition in schizophrenia, and that perceptive-motor deficits should constitute a priority target for cognitive remediation in this population. It has to be underlined that clinical and psychopharmacology factors may contribute to the emotional deficit found in schizophrenia: whereas additional analyses did not index a specific influence of current symptomatology on emotional processing, previous studies had suggested a link between negative symptoms and emotional identification (Castagna et al., 2013). Additionally, antipsychotic drugs might be involved in the emotional deficit. Indeed, whereas no difference was found on emotional decoding between patients taking second or first/second generation antipsychotic drugs, no comparison was made between participants under first generation only and second generation only, due to sample size. Past research has shown differences between these patients in the dopamine release following fear conditioned cues, with second generation antipsychotic drugs being more effective in the reduction of dopamine release (Kawano et al., 2016). The role of dopamine within the emotion context is already well-established and drugs acting upon it might potentially moderate the abilities of schizophrenic patients regarding emotional processing. Future research will need to address these factors and their potential implication in emotional impairments in schizophrenia.

Disclosure statement

No potential conflict of interest was reported by the authors.

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