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Identifying Other People's Perspective and their Facial Emotions – A Comparison between Patients on Long-term Second-generation Antipsychotic Treatment for Schizophrenia and Neurotypical Controls

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ABSTRACT

Previous studies report that the inhibition of one's own perspective in favour of acknowledging somebody else's perspective relates to the neurotypical development of Theory of Mind (ToM) processes. ToM processing seems to be negatively affected in patients diagnosed with schizophrenia (PwS). Different tasks, using different populations, have been used to examine ToM (e.g. Hinting, facial emotion recognition, on-line perspective-taking), making generalizations problematic. We investigated ToM processing, using different paradigms, in one patient group on long-term second-generation antipsychotic treatment for schizophrenia and in neurotypical controls.

Methods: Twenty-five patients on treatment with second-generation anti-psychotic medication for schizophrenia for more than ten years and neurotypical controls took part in a Hinting task, a facial emotion recognition task, and an on-line visual computational perspective-taking task. A battery of neuropsychological tests provided the input of a Principal Component Analysis (PCA).

Results: Patients performed significantly less effectively than controls on the Hinting Task, and even patients in remittance struggled more with the task. No significant differences in facial emotion recognition between groups were found. The on-line perspective-taking task results revealed that controls, but not patients, presented an intrusion of the other perspective when judging their own perspective (altercentric behaviour). Reaction time results revealed that patients were significantly slower than controls when evaluating the "Other" perspective. The results of the perspective-taking task were examined further by relating them to components from the PCA. Errors in perspective-taking appeared correlated mostly to difficulties in mentalizing and cognitive control (neurotypical participants) and to hinting comprehension skills (patients).

Conclusions: Results suggest that mentalizing and cognitive control are relevant functions for perspective-taking and that even after long-term treatment with second-generation antipsychotics, patients still have more difficulties in judging the Other perspective. The facial emotion recognition task suggested that facial emotion recognition is a separate interpretation skill not directly related to ToM.

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Introduction

Several studies focusing on mentalizing skills in patients diagnosed with schizophrenia have shown that people who received a diagnosis of schizophrenia have problems identifying other people's point of view [1]. In general, when neuro-cognitive functions related to acknowledging somebody else's point of view are underperforming or present a deficit, self-perspective might be more likely to gain a larger dimension, becoming more prominent, even perhaps leading to more individualised and peculiar interpretations of reality. This seems to be the case with PwS, who have difficulties in recognising the legitimacy of other people's disagreeing views of the facts they report (REF). These symptoms highlight that these patients regularly tend to take a rather self-centred position in relation to reality.

However, most studies have used off-line measures and, in the case of PwS, which are the focus of our research, most have used inpatients, which tend to present more severe symptomatology and possibly more severe ToM deficits . It is not clear whether PwS who have been on long-term second-generation anti-psychotic medication will show similar difficulties. We investigated Theory of Mind (ToM) in medicated PwS in 3 different tests that have been argued to measure perspective-taking skill: 2 off-line tests and 1 on-line test [2-4].

Shifting from your own perspective to another person's perspective involves the ability to inhibit one's own knowledge of the situation, suggesting that there can be an inhibitory or control process present in recognizing another person's point-of-view. If we consider that attention to external stimuli can only happen if there is an inhibition of internal stimuli, we must consider the precedence of inhibitory and control processes when ToM is involved. In addition, some evidence suggests that in certain tasks, working memory is implicated in successful perspective-taking in a neuro-typical population [5].

Inhibitory mechanisms mature with age and that is the reason why younger children are less able to inhibit or control the intrusion of the self- perspective [6]. In neuro-typical adults, the process of inhibiting one's perspective in favour of acknowledging somebody else's perspective has been associated with ToM , In schizophrenia, it could be the case that inhibitory or control mechanisms are dysfunctional, making it harder for patients to monitor egocentric responses and behavior [7]. Evidence for this comes from studies that have demonstrated that PwS tend to do worse in tasks involving executive functions, which are not necessarily related to IQ measures [8]. Thought rigidity (present in the development of delusions) has been linked to poor flexibility of thought. Hence, flexibility of thought, as well as inhibitory control, can be a valuable measurement of a patient's level of ability to shift to the other perspective.

We will describe 3 experiments involving ToM skill in a sample of long-term medicated PwS and neuro-typical controls matched for basic cognitive functions using the WAIS- IV.

Experiment 1: Hinting Task
The Hinting Task requires participants to interpret the intention of a character in a story that is presented to them [2]. Hence, participants need to understand hints in a conversation, which involves ToM. Previous research found that PwS significantly underperformed in this task, except for patients in remission and patients with non-persecutory delusions, who performed more similarly to controls [2,9].

Participants
Twenty-five patients with a diagnosis of schizophrenia participated in the study (average age 40; range 20-55; 17 males and 8 females; average duration of illness of 15 years; age of onset range 20-25 years). They had an average of 14 years of formal education (range: 9-22) and had been on second-generation anti-psychotic medication for an average of 15 years (range: 11-19). Both patient and control group participants were matched for IQ using the WAIS-IV. Patients were recruited through advertisements in local newspapers in London and controls were recruited through Gumtree. Diagnosis was confirmed with the Structured Clinical Interview for DSM- IV/SCID and symptoms assessed with the PANSS (Positive and Negative Syndrome Scale) questionnaire [10,11]. Sixteen individuals met criteria for current paranoid schizophrenia and eleven for a single episode of paranoid schizophrenia in partial remission.

Twenty-five controls (average age 30; range 20-55) with current or lifetime diagnosis of mental disorder (confirmed with the SCID) and who had an average of 13 years of formal education (range: 11-19) were also recruited (HOW?). None of the controls had ever been on any psychiatric medication, nor had any of their first-degree relatives. No neurological/developmental disorders assumed. All of them were native speakers of English.

All participants were tested for verbal comprehension IQ and working memory with the WAIS-IV and reading comprehension with the GSRT. The groups did not significantly differ on each sub-test of the WAIS-IV used for this stage and the GSRT did not significantly differ either (all ps > .50).

Table 1: Cognitive Skills Assessment

Test	Patients – Mean Percentages (SDs)	Controls – Mean percentages (SDs)
WAIS-IV		
Similarities	57.8% (4.47)	59.7% (5.27)
Vocabulary	56.4% (8.81)	52.9% (9.77)
Information	57.4% (4.15)	49.7% (5.22)
Comprehension	53.7% (4.34)	55.2% (4.35)
Digit Spam forwards	78.7% (2.27)	78.2% (2.21)
Digit Spam backwards	57.2% (2.55)	59.2% (2.92)
Digit Spam sequencing	47.7% (1.49)	49.8% (1.72)
Arithmetic	63.8% (3.85)	68.5% (3.96)
Letter-number sequencing	58.7% (4.41)	62.6% (2.9)
GSRT	60.4% (5.3)	63.0% (5.41)

Stimuli and procedure
Ten stories of one paragraph each taken from were read aloud by the experimenter [2]. Participants answered the question posed after the hint and scored 2 points if correct. If participants needed a second hint, they scored 1 point if correct. Otherwise, participants received 0 points for that story. In addition to the accuracy measure, we introduced two new measures: time and degree of difficulty. Time is an important measurement in the Hinting Task because it can tell a lot about how participants react to the task, as well as about how straightforward the hints sounded to participants. The Degree of Difficulty estimate is useful because it can show how easy or difficult participants perceived the task. Time was measured as the overall time to complete the study, degree of difficulty was measured on a 10-point scale.

Results & discussion
The Hinting Task results can be found in Table 1. Independent samples t-tests showed significant differences in all three measurements, Hinting Task Score: $t(48) = 2.13$, $p < .05$; Time: $t(48) = 3.68$, $p = .001$; and Degree of Difficulty: $t(48) = 3.56$, $p = .001$. Hence, PwS perform at a lower level than controls. In addition, they take longer to carry out the task and recognize that the task is relatively challenging for them.

Table 2: Hinting Task results

	Patients	Control
Hinting Task Score (Maximum score = 20)	14.5 (2.8)	16.0 (2.6)
Hinting Task Time (seconds)	450.4 (105.6)	354.0 (78.0)
Degree of Difficulty in the Hinting Task (1-10)	3.7 (1.9)	2.2 (1.0)

Note: Standard deviation in brackets.

Our results of PwS performing less accurately than controls confirm previous research [2]. Moreover, our two additional measures, time and degree of difficulty, indicated that PwS needed more time to carry out the task and found it more difficult. While Corcoran et al. tested mainly inpatients, our results show that patients on long-term second-generation antipsychotic medication still displayed an impairment in ToM processing [2].

Corcoran et al. also compared patients in partial remission (N=8) to controls, and observed similar performance between these two groups [2]. We therefore compared our PwS in partial remission (N=11) to the control group. These patients did not significantly differ from controls in their hinting score (14.8 vs. 16.0; $t(34) = 1.42$, $p > .16$), but they significantly differed in relation to the time (420s vs. 354s; $t(34) = 2.42$, $p < .05$) and degree of difficulty (4.0 vs. 2.2; $t(34) = 3.46$, $p = .001$) measures. The finding that patients in partial remission still found the task more difficult than controls and took longer to complete it has not been reported before.

Experiment 2: Facial Emotion Recognition Task
Research has found that in schizophrenia, facial emotion recognition is impaired [12]. In this experiment, we used the Karolinska Directed Emotional Faces Test, where participants were required to choose from seven facial emotion options the one that best matched the photograph on the screen [3]. Recognizing facial emotions can be related to empathy, which could be considered a ToM skill. Evidence for this comes from Sucksmith et al. who found that people with autism performed more poorly both on a measure of empathy (the Empathy Quotient) and on the KDEF [13]. Research on inpatient PwS also showed poorer performance on the KDEF [14]. It is unclear whether patients on long-term second-generation anti-psychotic medication would still present the same impairment.

Participants
For this specific study, we had a slightly larger pool of participants: 27 PwS (18 males and 9 females) and 29 controls. They did not differ in terms of age and years of education. One participant from the patient group received a high score in the Levenson Self-Report Psychopathy Scale (score for primary psychopathy higher than 93.27% and score for secondary psychopathy higher than 83.97%), a screening test for this study, and his mistakes in the KDEF were the ones of a clear outlier (43), being then excluded from the analysis.

Stimuli and Procedure
A shortened version of the KDEF was used in this study, with 70 trials that consisted of 70 different photographs of people displaying one of seven different emotional expressions: fear, disgust, happiness, anger, neutrality, sadness and surprise. These seven basic emotional expressions appeared in five different face angles each (full left, full right, half left, half right and straight). Male and female photographs appeared equally often across the trials.
Participants saw a photograph on the computer screen of a person displaying one type of emotional expression. The options to choose from (angry, afraid, disgusted, happy, neutral, sad and surprised) appeared on the right-hand side of the computer screen. Participants judged the emotional expression of each picture and reported their choice to the experimenter. Participants were given as much time as they needed to analyse the options and respond.

Results & discussion
The KDEF results can be found in Table 2. We ran a 7 (Emotion Type) x 2 (Group) repeated measures ANOVA with the KDEF scores collected for both groups. There was a significant effect of Emotion Type: $F(6) = 34.10$, $p < .001$. There were no overall differences between the two groups ($F(1) < 1$), nor did we observe a significant interaction ($F(1) < 1$).

Table 3: KDEF results by group – Number of mistakes in percentages

	Surprised	Sad	Angry	Afraid	Happy	Disgusted	Neutral
Patient (27)	41 (1.8)	21 (2.2)	23 (2.1)	7 (0.6)	4 (0.7)	8 (1.0)	41 (2.5)
Control (29)	38 (2.1)	23 (2.0)	27 (1.8)	13 (1.6)	2 (0.4)	12 (1.5)	36 (2.9)

Note: Standard deviation between brackets

Results above indicate that, unlike Laroi et al., we did not find significant differences in facial emotion recognition between PwS and controls, with PwS making 20.7% mistakes overall, and controls 21.6% [14]. This suggests that being on medication long-term has a positive impact on facial emotion recognition and fits with the observation that facial emotion recognition impairments are usually more severe in the acute phase of the illness [15]. In addition, Laroi et al. used inpatients, not outpatients, and inpatients often present a more acute form of the disorder when compared to outpatients [14].

The participant who was removed from the analysis due to a high score on the Levenson psychopathy scale made a disproportionate number of mistakes (43). It is unclear whether previous studies screened for psychopathy.

Experiment 3: On-line Perspective-taking Task
Understanding someone else's perspective is an essential part of successful ToM reasoning. When this perspective is different from our own perspective, it might be necessary to inhibit or suppress the latter. However, research has shown that children as well as adults are not always proficient at doing this quickly and/or effortlessly [16]. Samson et al. using a novel design to measure on-line perspective-taking, showed that neuro-typical adults had more difficulties when perspectives did not match, and showed evidence of both egocentricity (taking into account their own perspective when not appropriate) and altercentricity (taking into account the other perspective when not relevant) [17].

Participants
The same 25 patients and controls as used in the Hinting task experiment participated in the on-line perspective-taking task.

Stimuli and Procedure
The stimuli were taken from Samson et al. and showed a picture of a room with a human avatar in it [17]. When looking at the picture, participants could see three walls (back, left and right). These three walls had red discs presented on either one or on two of them. The human avatar was in the center of the room. The avatar, which could be male (for male participants) or female (for female participants), looked at the left or the right wall. On half of the trials, participants and human avatar would share the same perspective, meaning that the participant and the human avatar would see the same discs (consistent perspective condition). On the other half of the trials, the human avatar and the participants would not see the same discs, as the avatar would not be able to see the discs on a wall behind them, though these were still visible to participants (inconsistent perspective condition). Although the position of the discs changed across consistent and inconsistent trials, the position of the human avatar remained permanent.

Following Samson et al.'s design, participants first saw a fixation cross for 750ms, followed by the word "YOU" or "HE/SHE" (depending on whether the participant and avatar were male or female) 500ms later. This word remained on the screen for 750ms and it instructed participants to take either their own perspective ("Self" condition) or the avatar's ("Other" condition). Then a digit between 0 to 3 was presented for 750ms and it instructed participants on how many discs they should be certifying on the stimulus presentation. For example, in a scene with 2 discs on the wall in front of the avatar and 1 disc on the wall behind, the instructions "You – 3" and "He – 2" would be correct (i.e. consistent) while the instructions "You – 2" and "He – 3" would be incorrect (i.e. inconsistent). Participants had 5,000ms to respond to the stimuli by either clicking "YES" (left button) or "NO" (right button) on the mouse.

If participants did not respond to a trial within 5,000ms, the following trial appeared on the screen. On consistent trials, the number of discs matched the number instruction for a given perspective (either "Self" or "Other"), and the correct answer was YES. On inconsistent trials, the number instruction for a given participant's perspective did not match the number of discs that could actually be seen from that perspective, but could match the number of discs seen from the other perspective, and the correct answer was NO. Participants had to certify their own perspective (48 trials with 24 consistent, matching perspective and 24 inconsistent, mismatching perspective in relation to the avatar's), as well as the avatar's perspective (48 trials with 24 consistent, matching perspective and 24 inconsistent mismatching perspective). The 16 filler trials did not have any discs on the walls. There was a maximum of 3 successive trials of a given type.

The experiment consisted of an initial block of 26 practice trials, followed by 4 blocks of 48 test trials and 4 filler trials, totalling 196 test trials and 16 filler trials. A participant saw the same number of Self and Other perspective trials, and the same number of consistent and inconsistent trials. Presentation of the trials was randomized for each participant and presentation of the blocks was counterbalanced.

Results

Reaction times (correct trials) and accuracy percentages can be found in Table 4. We used a 2x2x2 Analysis of Variance (ANOVA) with Consistency (consistent vs. inconsistent) and Perspective (Self vs. Other) as within-items factors and Group (patients vs. controls) as a between-subjects factor.

Table 4: Results of the On-line Perspective-taking Task

	Consistent Other	Consistent Self	Inconsistent Other	Inconsistent Self
Accuracy (%)				
Patients	96.2	97.2	86.8	91.2
Controls	98.5	91.7	93.2	84.9
RT (ms)				
Patients	1066 (208)	1112 (205)	1276 (282)	1283 (297)
Controls	901 (254)	973 (373)	1051 (329)	1104 (460)

Notes: Accuracy is in percentages, reaction time is in milliseconds. Standard deviations can be found between brackets

As expected, both groups performed more accurately on consistent than on inconsistent trials ($F(1, 48) = 20.16$, $p < .001$). We also observed a significant interaction between Group and Perspective: $F(1, 48) = 6.38$, $p < .05$. Means comparisons showed that controls made more mistakes when judging the Self perspective compared to the Other perspective (88% vs. 96%; $t(24) = 2.18$, $p < .05$), which was not observed for the PwS (94% vs. 92%; $t(24) = -1.28$, $p > .21$).

The response time analyses indicated that consistent targets were reacted to faster than inconsistent targets ($F(1, 48) = 74.28$, $p < .001$), that Other-perspective trials were faster than Self-perspective trials ($F(1, 48) = 4.07$, $p < .05$), and that PwS were slower than controls overall ($F(1, 48) = 4.39$, $p < .05$). Although the interactions were not significant, the RTs suggested that there might be some subtle differences between the groups. Independent samples t-tests indeed showed that PwS were significantly slower than controls at judging the Other perspective (consistent trials: $t(48) = -2.29$, $p < .05$; inconsistent trials: $t(48) = -2.55$, $p < .05$). PwS reacted as fast as controls when judging the Self conditions (ps > .13). It should be noted that these comparisons are exploratory at this point and need further confirmation.

Executive Function Assessment

Because a deficit in executive functions could bear an impact on performance on ToM tasks, we tested participants for executive functions (working memory, flexibility of thought and cognitive control) using subtests from the Test of Everyday Attention (TEA; Robertson et al., 1994) that emphasised the capacity to switch a train of thought (Visual Elevator subtests), management of auditory-verbal information (Elevator Counting subtests) in working memory and a novel Cognitive Control (CC) task designed by the first author. To verify how this novel task integrated with the other tests used in the executive function assessment, we ran correlation analyses between the CC task and the other tests used in the executive function assessment. For controls, the CC task correlated positively with the TEA Elevator Counting with Reversal and TEA Visual Elevator 1, while for the PwS, the CC task correlated

In this task, participants were given 120 seconds to link 14 abbreviations to sentences containing words starting with the same letters (e.g. I.S.W.S.O. – "I'm sorry we're sold out"). Half of the abbreviations made up words (e.g. L.O.V.E. – "Linda Orwell visited Emma"). The task tests participants' ability to inhibit activation of non-relevant thoughts (e.g. suppressing the idea that "L.O.V.E refers to the word "love"). In addition to accuracy, participants were also asked to rate how difficult they thought the task was on a scale of 10.

Positively with TEA Elevator Counting with Distraction, TEA Visual Elevator 1, and negatively with the PANSS Positive, and the Cognitive Dimension of the PANSS. Overall, this suggests that better performance on the CC task is related to better flexibility and working memory skills, indicating that the novel task taps into relevant executive functions.

Table 5: Executive Function Assessment: Means and standard deviations

Test	Patients	Controls	t-test
TEA Visual Elevator 1	8.8 (3.7)	9.7 (3.6)	< 1
TEA Visual Elevator 2	4.4 (2.3)	6.0 (3.3)	$t(44) = 2.30$, $p < .05$
Elevator Counting with Reversal	9.3 (3.3)	8.6 (4.3)	< 1
Elevator Counting with Distraction	8.6 (3.1)	9.5 (2.6)	t(44) = 1.0, p > .30
Cognitive Control Task	46.3 (21.3)	64.3 (24.7)	t(44) = 2.65, p < .05
Degree of Difficulty in the Cognitive Control Task	5.0 (2.2)	3.3 (2.5)	t(44) = 2.43, p < .05

Note: TEA scores are in scaled scores, Cognitive Control task accuracy is in percentage, Degree of Difficulty in the Cognitive Control task is out of 10.

Principal Component Analysis

We conducted a principal component analysis (PCA) in R using results obtained from the battery of cognitive tests focusing on executive functions (see Table 5) and the results from Experiment 1 (Hinting task) and Experiment 2 (KDEF) [18].

A Bartlett's test was run to establish whether there was an identity matrix in the correlation matrix and a KMO test was used to determine the degree of common variance in the data and suitability for a PCA analysis; a varimax rotation was applied. The principal component analysis extracted nine components from the data set. Four components accounting for 77% of the variance were retained based on Kaiser's Rule. Standardised loadings (pattern matrix) were based upon the correlation matrix within the data set, as their loadings were greater than 1, except for Component 4, which presented a loading of 0.97. Components received their names based on the strongest positive elements present in each component.

The four components listed in Table 6 appear in order of variance accounted for. Residuals statistics revealed a root means squared residual of 0.08, which was equal to the 0.08 threshold. The proportion of absolute residuals was 0.05, equal to the threshold.

Table 6: Principal Component Analysis - Four Factors with Loading Values

Component 1: Flexibility and Working Memory		Component 2: Difficulties in Mentalizing and in Cognitive Control		Component 3: Facial Emotion Recognition		Component 4: Hinting Comprehension	
Elevator Counting with Reversal	0.89	Degree of Difficulty in the Hinting Task	0.87	KDEF	0.93	Hinting Task Score	0.95
TEA Elevator 1	0.87	Degree of Difficulty in the Cognitive Control Task	0.84	Elevator Counting with Distraction	0.51		
TEA Elevator 2	0.70	Control and Flexibility	-0.67	Cognitive Control Task	0.35		
		Elevator Counting with Distraction	-0.44				
% of variance	0.25	% of variance	0.24	% of variance	0.15	% of variance	0.13
Cumulative variance	0.25	Cumulative variance	0.49	Cumulative variance	0.64	Cumulative variance	0.77

To find out how the cognitive, mentalizing (Hinting Task) and facial emotion recognition skills extracted related to perspective-taking, we ran, in an exploratory way, separate correlation analyses with the accuracy and the RT data for each group. Results for the accuracy correlations are presented in Table 7 and results for the reaction times correlations are presented in Table 8.

Table 7: Correlations between errors in perspective-taking and the PCA components

		Flexibility and Working Memory	Difficulties in Mentalizing and Cognitive Control	Facial Emotion Recognition	Hinting Comprehension
Patients	Consistent Other	r = -.365	r = -.119	r = .111	r = -.412*
	Consistent Self	r = -.356	r = -.207	r = .004	r = -.480*
	Inconsistent Other	r = -.350	r = -.184	r = -.170	r = -.454*
	Inconsistent Self	r = -.360	r = -.125	r = -.189	r = -.480*
Controls	Consistent Other	r = -.327	r = -.180	r = -.374	r = -.294
	Consistent Self	r = .360	r = .565**	r = .014	r = .354
	Inconsistent Other	r = .009	r = 102	r = -.595**	r = -.294
	Inconsistent Self	r = .129	r = -.178	r = .091	r = -.013

Note: Significance level is indicated by stars: *p <.05; **p < .01; ***p < .001.

Table 8: Correlations between reaction time in perspective-taking and the PCA components

Correlation results presented in the Tables 6 and 7 are uncorrected for multiple comparisons due to the relatively small number of participants. Results shown the tables are exploratory as we didn't want to miss trends that could be present in the data by being overly strict. After Bonferroni corrections, results for the control group remained significant for the error analyses; though the reaction time results became non- significant.

		Flexibility and Working Memory	Difficulties in Mentalizing and Cognitive Control	Facial Emotion Recognition	Hinting Comprehension
Patients	Consistent Other	r = -.116	r = .295	r = -.064	r = -.358
	Consistent Self	r = -.058	r = .318	r = .084	r = -.363
	Inconsistent Other	r = -.061	r = .445*	r = -.087	r = -.411*
	Inconsistent Self	r = -.104	r = .402*	r = .040	r = -.343
Controls	Consistent Other	r = -.286	r = .248	r = -.151	r = .265
	Consistent Self	r = -.378	r = .405	r = -.047	r = .246
	Inconsistent Other	r = -.188	r = .215	r = -.020	r = .137
	Inconsistent Self	r = -.363	r = .261	r = -.015	r = .181

Note: Significance level is indicated by stars: *p <.05; **p < .01; ***p < .001.

Results revealed that patients who had more effective hinting comprehension skills made fewer errors when judging both the "Self" and "Other" perspectives. For controls, more difficulties in mentalizing and in cognitive control related to more perspective- taking errors in the Consistent Self condition. These results suggest that more effective mentalizing skills can have a positive impact on perspective-taking. Additionally, for controls, more effective facial emotion recognition skills related to fewer errors in judging the "Other" perspective in inconsistent trials.

Longer reaction times for patients related to difficulties in mentalizing and in cognitive control. For patients, more effective hinting comprehension skills related to shorter reaction times in judging inconsistent other trials, which corroborates the findings from the accuracy analysis. Considering all the results displayed in Tables 6 and 7, in general, more effective mentalizing skills helped participants from both groups perform better in the perspective-taking task, although these results can only be considered exploratory, due to the small number of participants in the analysis.

General Discussion

Results for the Hinting Task (Experiment 1) suggested that PwS who were on long- term second-generation antipsychotic medication, still present a deficit in mentalizing. While the subgroup of PwS in remittance performed similarly to controls, replicating Corcoran et al. when asked about how challenging they found the task, these patients reported a higher score than controls. In addition, they also took significantly longer to complete the task [2]. Hence, it seems that, although an impairment is no longer there for patients in remittance, mentalizing is not as straightforward for patients as it is for controls, and still more taxing than what might be assumed on the basis of previous research.

Unlike Laroi et al. who used inpatients, Experiment 2 found no significant differences in facial emotion recognition between our PwS and controls [12]. To our knowledge, this is the first study we know of that tested facial emotion recognition in patients in remission of schizophrenia and patients who have been on second-generation anti-psychotic medication for a long time. The fact that most of the patients used in this study were people who had been on medication for more than 10 years could have had a positive impact on the KDEF results, as facial emotion recognition impairments are usually more severe in the acute phase of the illness [13]. The idea that an impairment in facial emotion recognition could be a trait of schizophrenia (Kohler et al., 2009) is not supported by this study.

However, when testing facial emotion recognition, studies in the future must take into consideration the necessity of eliminating participants who have a high score in psychopathy scales. For the present study, the one participant we eliminated for this reason from the analyses made an inordinate number of mistakes (43/70). The patient group mean was much lower than that (16/70).

Results from the perspective-taking task supported Samson et al. in the sense that controls made more mistakes when judging the "Self" perspective when compared to the "Other" perspective [15]. Reaction time analyses corroborated the results for accuracy in the Perspective-taking task, as patients were significantly slower than controls when evaluating the "Other" perspective. These findings highlight a "self- reference effect" for patients, indicating that adjustments to the "Other" point-of-view can be challenging for patients.

In general, mentalizing and cognitive control were relevant cognitive functions for ToM. Additionally, more effective facial emotion recognition skills among controls contributed to a more effective judgment of the "Other" perspective. For patients, the component containing Hinting skills was clearly related to how accurately they performed the perspective-taking task, with patients scoring higher on the component also performing better on the on-line task.

Results from the PCA suggest that facial emotion recognition skill, as tested by the KDEF, does not belong in the same component containing Hinting skill, suggesting that these skills do not underlie the same type of ToM processing. However, facial emotion recognition apparently helps enhance performance of controls in recognizing the "Other" perspective in inconsistent trials in the Perspective-taking task. At present, it's unclear why facial emotion recognition skill would relate to processing in only this particular condition, though it might be linked to the KDEF being a visual task (as is the perspective-taking task) whereby the participant needs to assess the emotion of another person rather than their own emotion. On the other hand, recognizing facial emotions does not necessarily imply acknowledgement of the "Other" point-of-view. The fact that patients and controls did display similar results in the KDEF, unlike results from the perspective-taking task, suggests that recognition of facial emotions and recognition of the "Other" and "Self" perspectives can involve relatively autonomous operations. It is therefore possible that the recognition of "Self" and "Other" perspectives could require the presence of more complex neural operations.

As a whole, two main conclusions can be drawn from the study: 1) mentalizing and cognitive control are relevant functions for perspective-taking, which seem not to be as straightforward for patients as it is for neurotypical controls, even after a long- term course of second-generation anti-psychotics, and 2) facial emotion recognition seems not to involve the same neural processes that ToM does.

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