Disturbance of Metacognition of Agency in Patients with Schizophrenia

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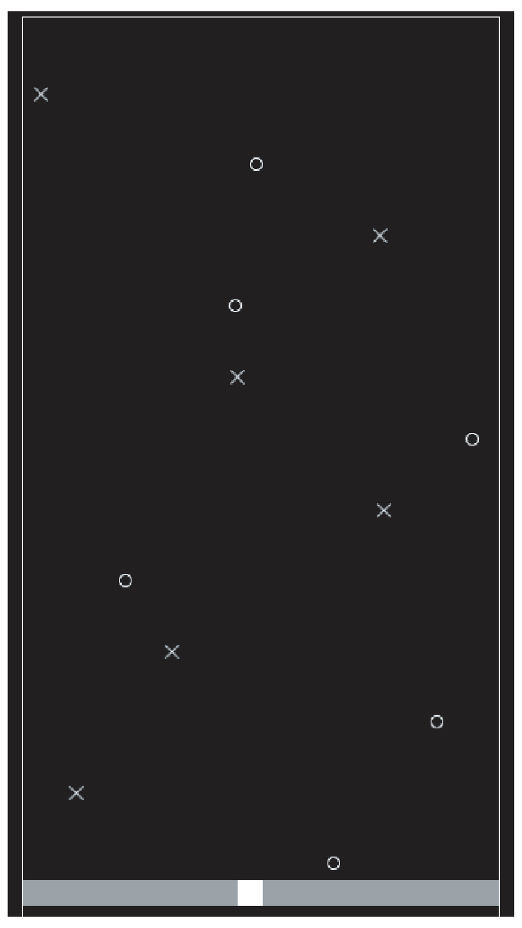
1. Objective

- The feeling that one's own actions and personal states are no longer under one's own control is one of the most disturbing symptoms experienced by people with schizophrenia. Misattributions of agency are associated with the Schneiderian first-rank symptoms (FRS), which clinically include hallucinations, thought insertion, and broadcasting. Metacognitions of agency--of knowing whether and when one is in control of a movement (or a thought)-- are, hence, central to the core deficit in schizophrenia.
- Our objective was to investigate metacognition of agency in patients with schizophrenia using a task that has been used to examine metacognition of agency in healthy participants (Metcalfe & Greene, 2007) as well as meth-amphetamine abusers (Kirkpatrick, Metcalfe, Greene, & Hart, 2008).

2. Metacognition of Agency Task



- Participants see a number of randomly placed X's andO's streaming down the computer screen (see figure, left).
- Participants use a computer mouse to move a white square horizontally across the screen. They are instructed to move the cursor to touch as many of the X's as possible, while avoiding the O's. Each time an X or O is touched, the target disappears from the screen and audio feedback is given. The task is presented to participants as a game.
- On some trials, a discrepancy was introduced between the movements made by the participant and the movement of the cursor.
- In the lag conditions, either a short (250 ms) or long (500 ms) delay was introduced to the mouse controls. Thus, the cursor moves where the person moved the mouse but only after a delay.
- In the turbulence conditions, psuedo-random noise was introduced to the mouse controls. The variance of the noise added in each turbulence condition was matched to the variance of one of the two delay conditions.
- After each 20 s trial, participants make a judgment of their own performance (Judgment of Performance; JoP) and a judgment of their control over the cursor (Judgment of Agency; JoA) during the trial. Both judgments are made on a visual analog scale with the computer mouse.

3. Demographic Data

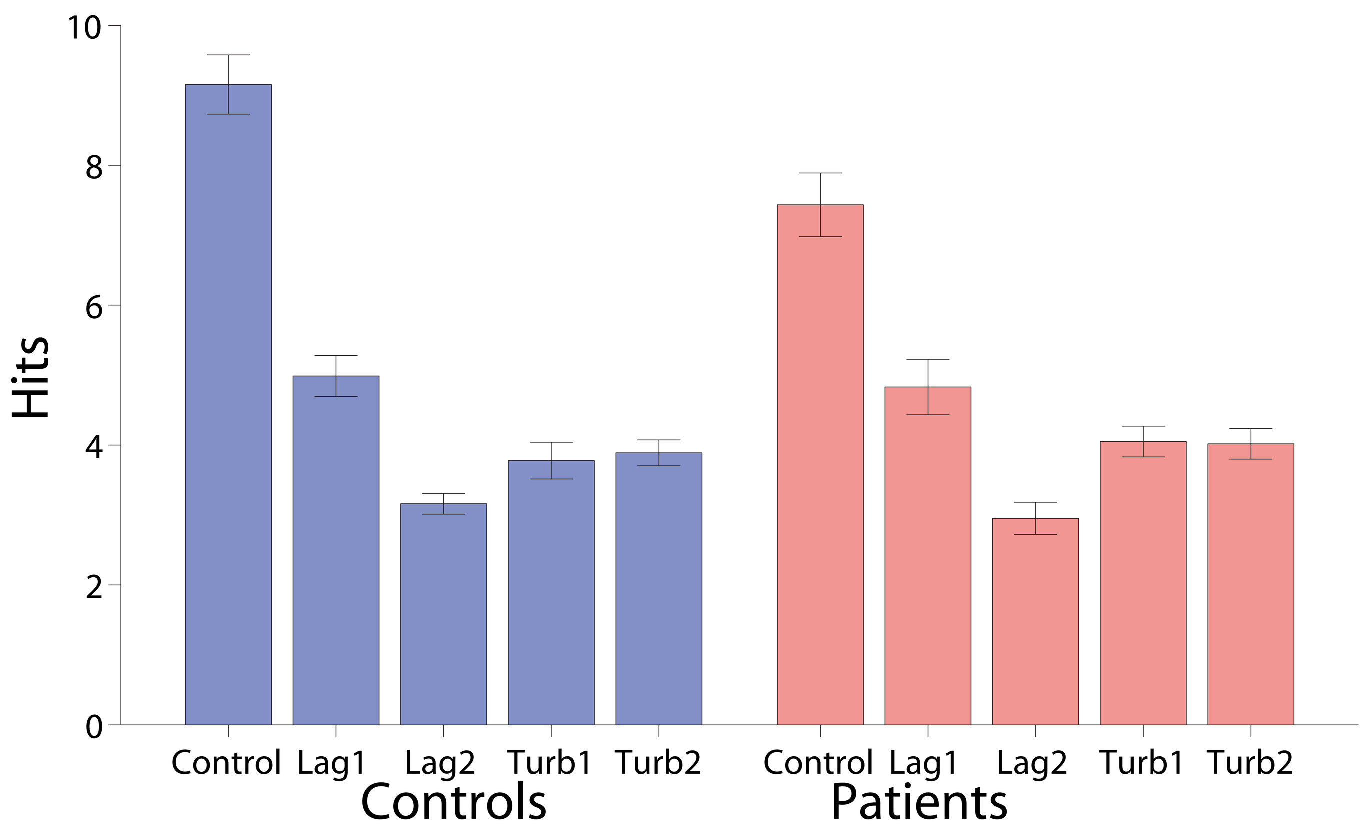
- Patient participants were all medicated inpatients at the Zucker Hillside Hospital.

Participant Demographics

	n	% Female	Mean Age	BPRS (Total)	SANS
Controls	20	45.0%	35.1	-	-
Patients	22	40.9%	42.3	27.2 (5.8)	29.3 (12.2)

BPRS = Brief Psychiatric Rating Scale; fMRI = functional Magnetic Resonance Imaging; SANS = Scale for the Assessment of Negative Symptoms

4. Task performance



- Patients performed significantly worse than controls in the control condition ($p = 0.009$), but did not differ in any other condition (all $p > 0.40$).

Kirkpatrick, M. G., Metcalfe, J., Greene, M. J., & Hart, C. L. (2008). *Effects of intranasal amphetamine on metacognition of agency.* Psychopharmacology, 197, 137 - 144.

Malapani, C., Van Volkinburg, H., Towey, J., Bruder, G., & Fortin, C. (2009). *Temporal processing dysfunction in medicated and unmedicated patients with schizophrenia.* Talk presented at the 9th World Congress of Biological Psychiatry.

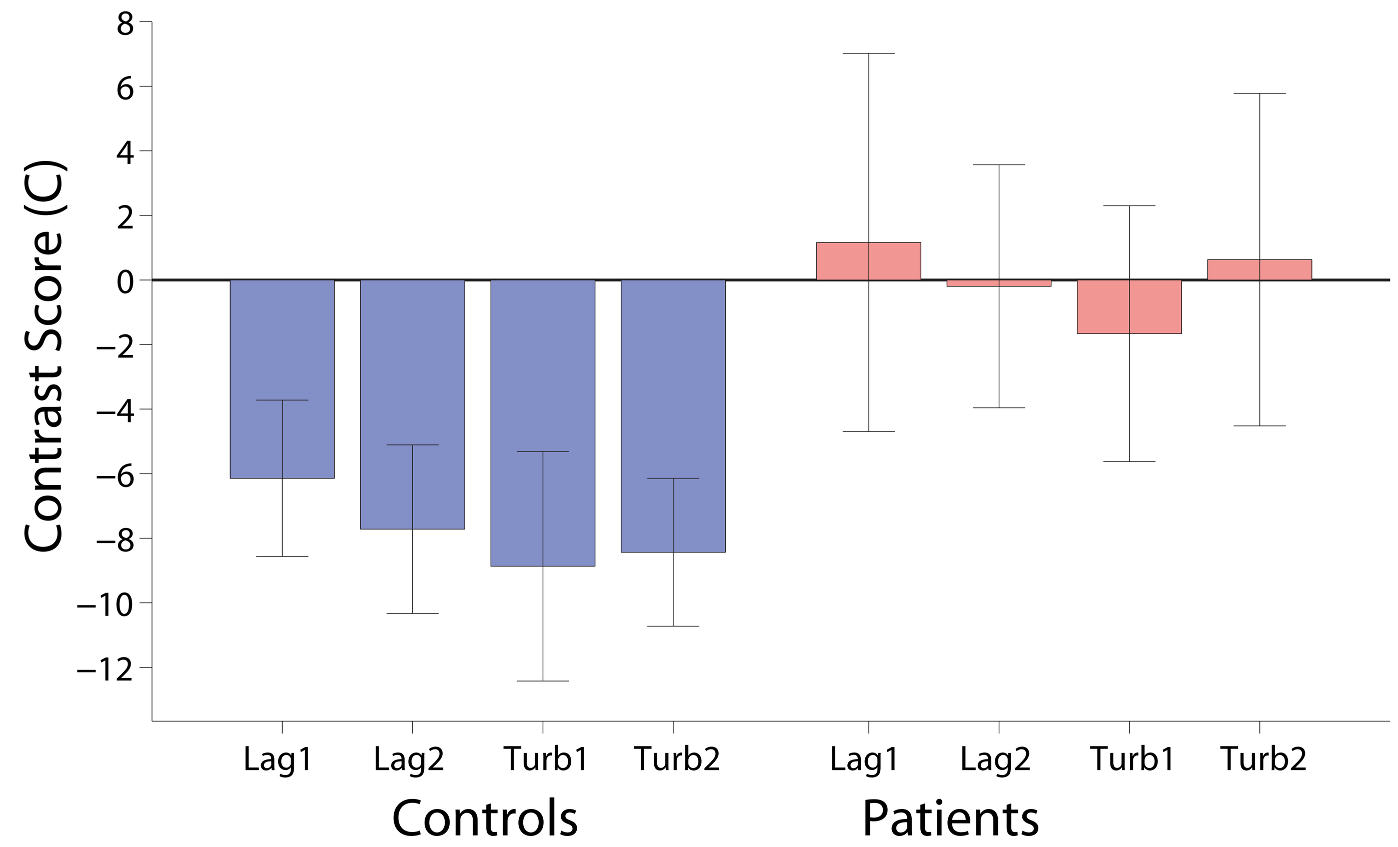
Metcalfe, J., & Greene, M. J. (2007). *Metacognition of agency.* Journal of Experimental Psychology: General. 186, 184 - 199.

5. Results

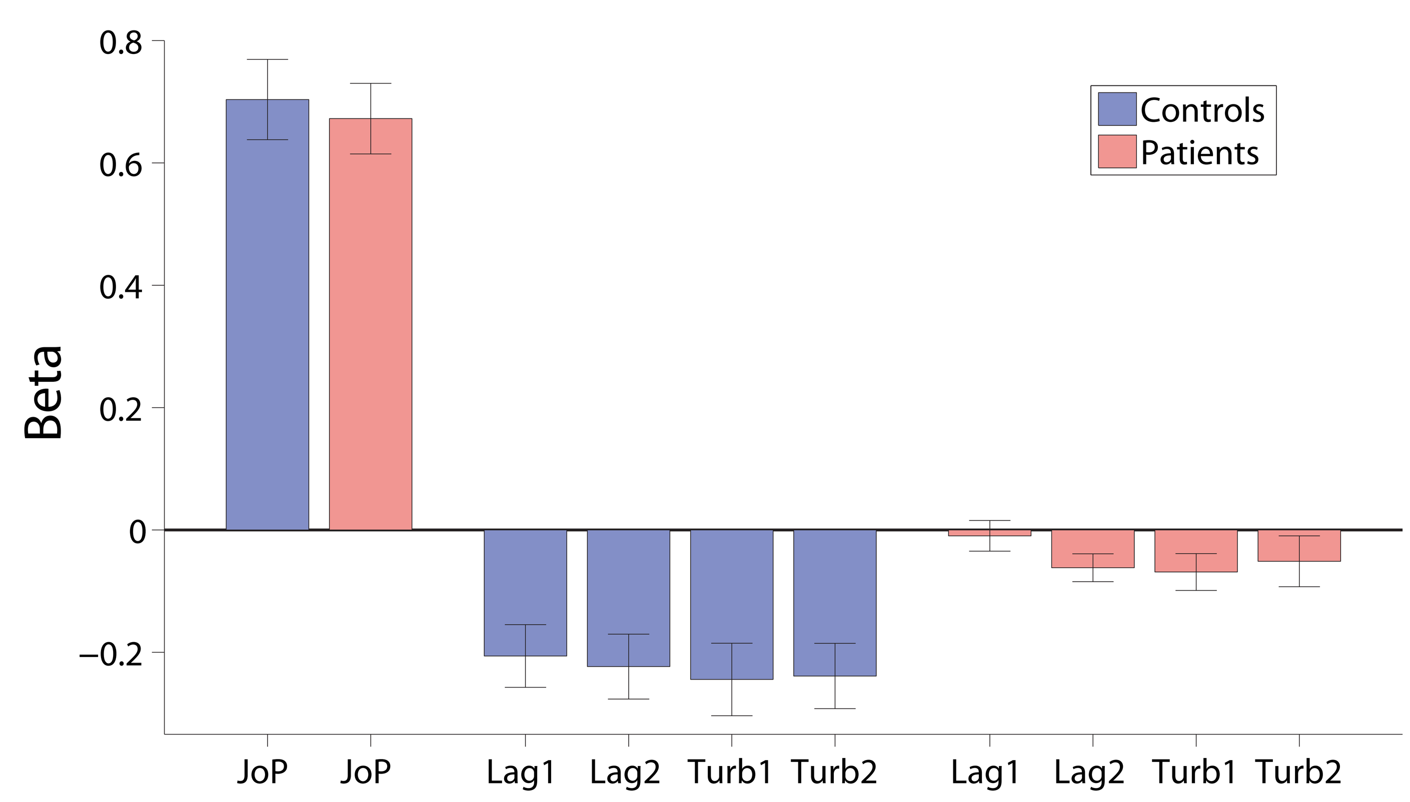
- Two seperate analysis approaches were taken.
- First, a contrast score was calculated seperately for each condition:

$$C = (JOP_{CTRL} - JOP_{COND}) - (JOA_{CTRL} - JOA_{COND})$$

- Negative values of the contrast score indicate that the participant reduced their JoA, relative to the control condition, to a larger extent than they reduced their JoP (also relative to the control condition). This indicates that the participant recognizes a loss of control that is above and beyond any decrement in their performance.



- Repeated measures ANOVA revealed that control participants' contrast scores appropriately reflected a feeling of loss agency during both the Turbulance and Lag conditions ($F(1,19) = 14.63$, $p = .001$), while patient participants' contrast scores did not ($F(1,21) = .10$, $p = .92$). In addition, a mixed between- and within- subjects ANOVA revealed a main effect of diagnosis ($F(1,40) = 4.56$; $p = .04$).
- Second, a two-level regression analysis was carried out.
- First-level regression models were calculated for each subject, with individual trials as the unit of analysis. JoA was the criterion variable, with predictors included for JoP and each of the four experimental conditions.
- At the second level, parameters from the first-level regression were analyzed with t-tests. A significant result in this analysis indicates the corresponding condition (or judgment, in the case of JoPs) has in impact on participants' JoAs, above and beyond the effect of all of the other parameters.



- Both groups JoAs were substantially predicted by their JoPs (both $p < 0.001$), suggesting that the extent to which participants feel in control in this task depends to some extent on how well they perform on a trial-by-trial basis. Patients and controls did not differ in the extent to which their JoPs predicted JoAs ($t(40) = 0.36$; $p = 0.720$).
- Control participants' JoAs were significantly reduced by each of the task manipulations (all $p < 0.001$; $df = 19$). In contrast, patient participants' JoAs were not affected by either the Turbulance or Lag manipulations (all $p > 0.05$). Finally, controls JoAs were reduced by each manipulation to a greater extent than patients JoAs (all $p < 0.01$; $df = 40$).

6. Discussion

- While misattributions of agency have usually been explained in terms of a faulty monitoring system, an alternative explanation is that the input to the monitoring system is distorted by the high variance seen in patients' timing, as is illustrated by Malapani et al. (see FC-33 002 on Thursday, July 2, 8:15am).
- Precision accuracy in timing is needed to allow accurate dynamic comparisons between the person's planned actions and their actual actions, as is needed to make accurate judgments of agency. If an individual has an impairment in timing, this will almost certainly will result in distortions in these agency judgments, because timing distortions will cause the match between the person's afferent and efferent pathways, which relay their planned and actual movements, to go awry.