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Diminished visual motion priming in schizophrenia

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To perceive the visual world coherently, the brain must take prior information into account while processing current information. In schizophrenia, disorganization of thought and behavior suggest that patients may have difficulty with this type of processing. For example, studies on visual backward masking have repeatedly shown altered performance in patients, but forward masking appears intact (Green, Nuechterlein et al. 1994; Schechter, Butler et al. 2003). This pattern of results suggests that people with schizophrenia are not simply unable to use prior information, but instead are selectively impaired in certain conditions and perceptual domains.

Visual motion perception is one domain where processing of dynamic stimuli is strongly modulated by the presence of previous stimuli (Barlow and Hill 1963; Raymond and Isaak 1998). While impaired motion perception in general has been found in schizophrenia (Chen, Nakayama et al. 1999; Kim, Wylie et al. 2006), how patients are able to use prior motion information during current motion perception remains unexplored.

The present study examined how perceptual discrimination of the direction of motion is primed by previous motion of the same or opposite direction in schizophrenia patients (SZ, n=24) and normal controls (NC, n=21). Patients were diagnosed using the SCID-IV. The mean chlorpromazine equivalent for patients was 554.2 (SD=409.2), and mean PANSS scores were 15.2 (SD=7.3), 13.6, (SD=5.9) and 29.1 (SD=10.1) for the positive, negative and general scales respectively. The groups did not differ in sex, age or verbal IQ, but the controls had a higher education level ($t(43)=2.79$, $p=0.008$).

The stimulus was a random dot pattern comprising a portion of dots moving coherently to the left or right (0, 5, 10, 20, 40 or 100%), and a remaining portion moving in random directions (Chen, Nakayama et al. 2003). The task was to judge whether the coherent dots moved leftward or rightward. There were two task conditions *Congruent*: Directions of motion in the prime (previous trial) and probe (current trial) were the same, and *Incongruent*: The directions of motion in the prime and probe were opposite (Figure 1a). The motion priming effect (MPE) was defined as the difference in accuracy in the congruent and incongruent conditions, when the prime was 100% coherence. In the 0% coherence condition, direction of motion was assigned randomly.

Two-way ANOVAs with group (patients and controls) and coherence (0 or 100%) as independent variables revealed that MPE was significantly greater in NC than in SZ

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($F(1,5)=6.07$, $p=0.016$), even with IQ and education as covariates (Figure 1b). The interaction between coherence and group was also significant ($F(1,5)=2.58$, $p=0.031$), indicating that the effect was present primarily when the probe had low motion coherence levels. MPE was not correlated with IQ, education level or age in either group, or with medication levels or PANSS scores in the patients.

The reduced motion priming in schizophrenia found here was direction-specific, and thus points to altered direction-selectivity in the visual motion processing system. This and other studies have shown that perceptual sensitivity to the current motion is improved after exposure to a prior motion in the opposite direction (Raymond and Isaak 1998; Kanai and Verstraten 2005). The direction-specific perceptual enhancement for the current motion is due to the inhibition induced by the prior motion (Raymond 1993), which is presumably GABA-mediated. The weakened priming effect in patients is therefore consistent with dysfunctional GABAergic inhibition in schizophrenia (Benes 2000).

In this study, when current motion provided weak signals, prior motion played a more significant role in perception. The weak motion signals (i.e. low coherence levels) were where MPE was significantly reduced in patients (Figure 1c). Considering that this is the range where the modulation of prior motion is significant for perceptual processing, the reduced MPE in patients suggests that their ability to benefit from the exposure to prior motion is compromised, and highlights deficient adaptive process as one mechanism that undermines motion perception in schizophrenia.

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Figure 1.

a. Study paradigm. Coherent dots are shown here in black, while random dots are shown in gray. The RDP occupied 7° of visual angle. Each stimulus was presented for 390 msec. The inter-stimulus interval (ISI) was 260 ms plus reaction time for the preceding stimulus, and was not greater than 2600 ms. **b.** Perception of coherent motion. The abscissa denotes the coherence level of the probe. The Ordinate denotes SZ and NC performance accuracies under the congruent and incongruent conditions. **c.** Motion priming effect. The abscissa denotes the coherence level of the probe. The ordinate denotes the difference between the performance accuracies in the congruent condition and in the incongruent condition. Error bars represent ± 1 standard error. Asterisks denote significant group difference at $p < 0.05$.