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# Dissociation of explicit and implicit responses during a change blindness task in schizophrenia

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ABSTRACT

*Background:* Patients with schizophrenia are abnormally disturbed by information onsets, which may result in a disadvantage in filtering relevant information. The paradigm of change blindness offers the interesting possibility of studying sensitivity to the sudden irruption of visual information with ecological stimuli in schizophrenia. An increased attentional capture by the irruption of visual information would suggest better performance in patients than in healthy controls. This approach has the advantage of circumventing a non-specific general attentional deficit in schizophrenia.
*Methods:* Sixteen patients with schizophrenia and 16 healthy controls were asked to detect changes in 99 scenes with 0, 1 or 3 changes. We measured the participants' speed and accuracy in explicitly reporting the changes via motor responses and their capacity to implicitly detect changes via eye movements.
*Results:* Although the controls were faster and more efficient in explicitly reporting changes, the patients' eyes shifted more quickly toward the changes. Regardless of the group, increasing the magnitude of change improved the performance.
*Conclusions:* The better capacity of the patients to shift their eyes toward changes confirmed the capture by the sudden irruption of visual information in schizophrenia while avoiding the effects of general attentional deficits. However, the striking dissociation between this implicit response and the capacity to explicitly report changes could be interpreted as a deficit in access to conscious perception.


## 1. Introduction

Patients with schizophrenia exhibit clear disadvantages in filtering relevant information in a flow of sensorial input during everyday life activities, such as following conversations or watching television (Place and Gilmore, 1980). In the substantial literature regarding these attentional troubles, studies with various experimental paradigms have shown that the attention of patients may be captured by the sudden irruption of visual information, even if irrelevant, thus losing relevant information (Giersch et al., 2013a). To cite only a few examples, backward masking is frequently used to study the earliest stages of visual processing in schizophrenia, allowing control over timing at the millisecond level. Several studies have shown that the sudden irruption of a mask after the target impairs patients' identification of the target at intervals that do not affect the performance of normal controls. (for a review, see Green et al. (2011)). Similarly, Ducato et al. (2008) used an attentional capture paradigm to measure the capacity to locate a target either above or below a cross in the presence of distractors. Unlike the control group, response times of patients with schizophrenia were not reduced when the target always appeared on the same side of the cross, demonstrating the difficulty of patients to ignore irrelevant information (distractor). As a last example, Lalanne et al. (2012) showed, using an asynchrony detection task involving the asynchronous irruption of two targets, that controls anticipated the second target, whereas the attention of patients with schizophrenia was captured by the first target.

To control the experimental procedures, this literature is primarily based on experiments that involve simple geometric or abstract stimuli. However, an understanding of patients'

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performance in complex visual environments, such as everyday life, would mark a step forward, particularly to clarify how abnormalities of visual perception influence patients' behavior in complex environments.

From this perspective, the paradigm of change blindness offers an interesting possibility to study the selection of visual information with ecological stimuli such as natural scenes (Felsen and Dan, 2005). The paradigm of change blindness is defined by the failure to notice changes in scenes (e.g., addition or removal) when these changes occur following brief disruptions, such as eye movements, blank intervals or distractors (for a review, see Rensink (2000)). According to Rensink and colleagues, visual search in the paradigm of change blindness relies on the extraction of the essential information necessary to understand a scene (Rensink et al., 1997).

If the attention of patients with schizophrenia is captured by the irruption of visual information, they could rapidly detect the sudden onset of a change, even if dampened by a flicker, thus attenuating the effect of change blindness. This hypothesis is in line with the proposition of Frith and Shakow (Frith, 1992, Shakow, 1950), which assumes that patients' attention captures every detail of a scene without considering the entire picture. This hypothesis is even more attractive because distinguishing a specific cognitive deficit from the effects of non-specific general attentional deficits remains a perennial challenge in the schizophrenia literature. To overcome this shortcoming, several strategies have been devised to isolate precise cognitive function (for a review, see Silverstein (2008)), including the use of a method that leads to better results in patients compared with healthy controls (Knight, 1984). This approach was recently applied to the attentional effects of acute alcohol intoxication, with a surprising increase in change blindness performance in subjects under the influence of alcohol (Colflesh and Wiley, 2013).

Change blindness paradigms also offer the possibility of recording both an explicit motor response and an implicit response caught by eye movements. Because of the confusion generated by generalized attentional deficits in schizophrenia, several studies have used the distinction between implicit and explicit responses to measure subtle differences in information processing in schizophrenia (for an example, see Lalanne et al. (2012)). The presence of an implicit measurement enables the avoidance of decisional bias, as demonstrated in schizophrenia (Giersch et al., 2009; Giersch et al. 2013b).

In the present study, we investigated the selection of visual information in schizophrenia using natural stimuli as a paradigm for change blindness. The performance of patients and healthy controls was measured using motor responses and eye movements. Because of the sensitivity to sudden onsets observed in schizophrenia, our main hypothesis postulated that the attention of patients would be attracted by the elements of the scene that were ignored by the controls. Thus, we expected that the patients would be more efficient in the detection of changes than the controls.

## 2. Methods and materials

### 2.1. Participants

#### 2.1.1 Patients

Sixteen patients with schizophrenia were recruited from the Public Mental Health Institute of Lille Metropole, the Public Mental Health Institute of Val de Lys, the Association AREV and the Department of General Psychiatry at Lille University Hospital. The inclusion criteria required an age of 18–50 yr, a diagnosis of schizophrenia based on the standard DSM-IV criteria (APA, 1994) and normal or corrected vision. The exclusion criteria included a history of neurological illness or trauma that occurred in the previous six months. All patients had received antipsychotic medication and were clinically stable at the testing time. The symptoms of schizophrenia were assessed with the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987).

The Ethics Committee of Lille University Hospital approved this study. Written consent was obtained from all participants. The participants were not paid for their participation in the study.

#### 2.1.2 Controls

Sixteen age- and gender-matched healthy controls were recruited. The controls were free from DSM-IV axis-I diagnoses according the MINI test, and no medications were reported.

### 2.2. The change blindness task

We based our change blindness task on thirty-three original environments that represented complex 3D indoor and outdoor scenes. We created these environments using L'Architecte 3D Expert software (Mindscape, France). Of the 33 environments, there were 6 gardens or outdoor scenes, 6 bedrooms, 5 rooms, 5 bathrooms, 5 kitchens and 6 garages. For each environment, we selected 3 images with different points of view, which resulted in 99 scenes.

To create the change blindness task, we modified 0, 1 or 3 objects in each scene so that the initial set of 99 scenes provided 297 stimuli (Figs. 1a and 1b). The changed objects were semantically consistent with the contexts of the scenes. Their sizes were between 2° and 4° of visual angle. The changes were substitutions, rotations or color changes.

On this basis, we created 3 different controlled sets of 99 different stimuli (33 environments × 3 points of view); each set contained 33 stimuli with one change, 33 stimuli with 3 changes and 33 stimuli with no change presented in a random order. Each participant saw one stimulus set among the 3 different sets. The choice of the set was controlled and counterbalanced in patients and controls.

We subsequently created a flicker paradigm to create a change blindness effect. Each stimulus was presented for 240 ms and interspersed with a visual mask for 80 ms during a loop of 10,240 ms.

The mask was a grayscale textured scene, which was created using the algorithm of Portilla and Simoncelli (2000) (Fig. 2).

### 2.3. Equipment

The equipment consisted of a PC connected to a laptop and an eye tracker. The stimuli were presented on an LG 17-inch screen placed 60 cm from the participants and were controlled by the screen of the laptop. The PC monitored gaze calibration and eye movement.

The presentation of the stimuli was programmed using Presentation® software, which enabled the measurement of response time.

We monitored binocular eye position using an iViewX HED (SensoMotoric Instruments) eye tracker with a scene camera. The eye tracker enabled us to record the number and duration of fixations in the area of interest (substitution area). These data were analyzed using Begaze® software.

### 2.4. Measurement procedures

To calibrate the eye tracker, the participants were asked to successively fixate on 9 markers in the display area. The pupil-center