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Visual search for verbal material in patients with obsessive–compulsive disorder

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ABSTRACT

This study aimed at investigating attentional mechanisms in obsessive–compulsive disorder (OCD) by analysing *how* visual search processes are modulated by normal and obsession-related distracting information in OCD patients and *whether* these modulations differ from those observed in healthy people. OCD patients were asked to search for a target word within distractor words that could be orthographically similar to the target, semantically related to the target, semantically related to the most typical obsessions/compulsions observed in OCD patients, or unrelated to the target. Patients' performance and eye movements were compared with those of individually matched healthy controls. In controls, the distractors that were visually similar to the target mostly captured attention. Conversely, patients' attention was captured equally by all kinds of distractor words, whatever their similarity with the target, except obsession-related distractors that attracted patients' attention less than the other distractors. OCD had a major impact on the mostly subliminal mechanisms that guide attention within the search display, but had much less impact on the distractor rejection processes that take place when a distractor is fixated. Hence, visual search in OCD is characterized by abnormal subliminal, but not supraliminal, processing of obsession-related information and by an impaired ability to inhibit task-irrelevant inputs.

1. Introduction

Patients with Obsessive Compulsive Disorder (OCD) suffer from time consuming obsessive thinking, which provokes anxiety and distress, and interferes with everyday activities (Abramowitz et al., 2009). Usually, the obsessions result in associated compulsions, such as repetitive behaviours, rituals, or constant checking, by which patients reduce the anxiety generated by their obsessions (Menzies et al., 2008). There is broad agreement that OCD involves abnormalities of the fronto-striatal circuits (Pujol et al., 2004). Accordingly, OCD patients are impaired on the neurocognitive functions sub-served by these brain areas (Chamberlain et al., 2005), showing alterations in executive functions such as response inhibition and working memory (Jaafari et al., 2013; Snyder et al., 2015), in decision-making processes (Sachdev and Malhi, 2005) and in attentional control mechanisms (Morein-Zamir et al., 2013).

According to the literature review by Kuelz et al., (2004), there is little evidence for a specific impairment of basic attentional abilities in OCD patients. However, several studies suggest that OCD patients have trouble ignoring irrelevant stimuli and show impaired selective attention abilities. In recent reviews, Kashyap et al., (2013) and Snyder et al., (2015) argued that the attentional deficits observed in OCD patients were mainly a by-product of their impaired executive functions, pointing to reduced skills in the organization of incoming information and optimization of cognitive resources (Kashyap et al., 2013). According to Snyder et al., (2015), the depression and motor slowing which are often observed in OCD patients cannot explain the broad executive functions' impairment typically observed in these patients. In accordance with this idea, Chamberlain et al., (2005) suggested that failures in cognitive and behavioural inhibitory processes underlie

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many of the neurocognitive symptoms found in OCD patients. More precisely, they proposed that two main types of inhibitory processes are impaired in OCD patients, namely the cognitive inhibition processes that control internal thinking and prevent intrusive thoughts and mental rituals, and the behavioural inhibition processes that control motor actions such as checking behaviours.

Some theories suggest that abnormal processing of the information related to obsessions constitutes an essential element of OCD. More specifically, the hypothesis is that attentional processing would be biased towards obsession-related information, thus contributing to develop and sustain intrusive obsessive thinking (Rachman, 1997). For example, Lavy et al., (1994), using a Stroop color-naming task, observed that OCD patients were slower in naming the colour of OCD-related words with negative valence than that of neutral words. Using a similar task, Unoki et al., (1999) observed that OCD patients were more sensitive to compulsion-related words than healthy controls, but only when the words were presented subliminally and could not be consciously identified. However, other studies failed to find any attentional bias for OCD-related information presented either supraliminally (Moritz et al., 2008) or subliminally (Kampman et al., 2002).

An alternative way to study attentional bias in OCD is to study the patients' eye movements during the visual search paradigm, which requires people to find a target object presented among other visual stimuli that are called "distractors". When people are free to move their eyes, current eye movement models indicate that the location of the attentional focus usually coincides with the location of gaze fixations (Deubel and Schneider, 1996; Zelinsky, 2008). Hence, eye movement recordings are often used to study human attentional behaviour. More precisely, the assumption of a strong relationship between attention and gaze is supported by strong psychophysical evidence, which shows that the focus of attention moves towards the location of the next fixation just before the corresponding saccade occurs (Deubel and Schneider, 1996). In other words, the locations of successive saccades within the search display would reflect how the searcher's attention is guided within the display.

According to Zelinsky's model (Zelinsky, 2008), visual search relies on the elaboration of a retinotopic target-map, which gives a point-by-point measure of the similarity between the items present in the visual field and the target, and which is updated after each eye movement. The search process consists in an alternation of fixations and saccades until the target is found. Each saccade is the result of an attentional guidance mechanism, which identifies the most likely target candidate on the current target map. According to current visual search models (Soto et al., 2005; van Zoest and Donk, 2010; Wolfe et al., 2011), the observer is generally unaware of the particular features that attract her or his attention towards this particular item. Once the saccade is made and the most likely target candidate is fixated, the observer must decide whether the candidate *is* really the target, or instead a distractor item that must be rejected. In the latter case, programing of the next saccade begins right away. In contrast with what happens during saccade programing, visual search models assume that the observer has some awareness of the decision he makes about the currently fixated item (Dampuré et al., 2014).

To our knowledge, the few studies that employed the visual search paradigm to investigate attentional mechanisms in OCD patients were only based on response times and accuracy (Kaplan et al., 2006; Morein-Zamir et al., 2013), but did not analyse patients' eye movements. The main goal of the present study was thus to investigate online attentional processes in OCD by recording OCD patients' eye movements during a visual search paradigm with verbal material.

Participants had to search for target words within lists of distractor words (Léger et al., 2012). The distractor words were manipulated to be orthographically similar to the target, semantically related to the target, obsession-related words (i.e., words that were semantically related to the patients' most frequent obsessions) or neutral, target- and obsession-unrelated words. According to Zelinsky (2008), the number of fixations made on each type of distractor words was taken as an index of the words' ability to attract attention, while fixation durations were taken as an index of the processing time needed to consciously reject the distractor words once they were fixated.

The experiment was designed to compare the impact of target-distractor similarities on attentional guidance and word processing times in OCD patients versus healthy controls. In particular, the lists containing obsession-related words were compared with the lists containing neutral distractors, which represented the baseline condition, to assess whether obsession-related information is processed differently from other kinds of verbal input by patients. Consistent with Unoki et al., (1999), obsession-related words were expected to influence the unconscious attentional guidance process, but not the conscious rejection of non-target words.

Many previous studies reported working memory impairment in OCD patients (Jaafari et al., 2013; Moritz et al., 2002; Nakao et al., 2009; van der Wee et al., 2003). According to the literature (see Jaafari et al., 2013), the patients' working memory deficit would result from abnormalities in memory control and/or executive functioning. Since visual search tasks require the active maintenance of a representation of the target (the "target template") in working memory (see for instance Soto et al., 2005), the verbal and visuo-spatial components of the participants' working memory were measured to establish possible relationships with participants' performance in the search task. The verbal and visuo-spatial components of working memory were evaluated using tests known to involve both the storage and manipulation of information, namely the reading span test (Desmette et al., 1995) and the backward location span test (Fournier-Vicente et al., 2008). Consistent with previous literature, OCD patients were expected to show lower working memory scores than control participants. Hence, given the prominent involvement of working memory in visual search processes, OCD patients were expected to need more time and more fixations than controls to find the target in the visual search task. More precisely, there should be a reliable inverse correlation between working memory scores and visual search efficiency among OCD patients. The patients with higher working memory were expected to show less reduction of efficiency in the search task than those with lower working memory scores.

Another reason to expect a reduction of the efficiency of visual search for words in OCD patients follows from the fact that, as stated above, OCD patients have trouble ignoring irrelevant stimuli and show impaired selective attention abilities, probably because of their impaired executive functions (Kashyap et al., 2013; Snyder et al., 2015). As a result, OCD patients should have more difficulties rejecting irrelevant distractor words while searching for the target word than control participants.

2. Material and methods

2.1. Participants

Thirty-six patients with a primary diagnosis of OCD, and 36 healthy control volunteers with no history of or current psychiatric or neurological illness participated in the experiment (Table 1). Patients were recruited at a specialized psychiatric hospital (Centre Hospitalier Henri-Laborit, Poitiers). The controls were recruited from local community and were individually matched with patients for sex, age (to within 5 years) and years of education. All participants gave their informed consent to participate in the study, and the experimental protocol was approved by the local ethics committee.[2]

Patients were examined by a psychiatrist using the Mini

[2] The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.