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Research report

The self survives extinction: Self-association biases attention in patients with visual extinction

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ABSTRACT

People show biases to self-related information on a range of tasks. Key but controversial questions are whether self-related information is processed without attention, and whether self-related information determines what is attended. We examined this using patients showing visual extinction. We had patients associated shapes with themselves or their best friend prior to carrying out a shape identification task. We demonstrate that extinction was modulated by whether patients associated stimuli with themselves or their best friend. Notably, patients were biased to identify their own shape relative to the shape associated with their friend, when the two shapes were placed in competition. This occurred even when the self-associated shape fell in the contralesional field. The data indicate that self-relatedness can be computed pre-attentively and can cue attention to regions of space that would otherwise be ignored by neuropsychological patients.

1. Introduction

Human cognition is biased towards self-related information in comparison with information relating to other people (Conway & Pleydell-Pearce, 2000; Sui, He, & Humphreys, 2012), but it is controversial whether such biases operate without attention (Humphreys & Sui, 2015a; Keyes & Dlugokencka, 2014). For example in a classic study, Moray (1959) showed that participants tended to notice their own name more than other names when the stimuli were presented to an unattended ear, suggesting that self-reference is computed without attention. On the other hand, momentary shifts of attention to the unattended side could support the better identification of self-related items (Lachter, Forster, & Ruthruff, 2004). Stronger evidence would accrue if self-reference affected performance for stimuli that participants were otherwise unaware of. We assessed this by examining whether self-related information modulates extinction in neuropsychological patients.

Extinction patients can respond to a single stimulus on their affected side but fail to report the same item if another stimulus appears at the same time on the unimpaired side (Driver & Vuilleumier, 2001; Karnath, 1988). This can be attributed to the brain lesion biasing attention so that contralesional stimuli lose the competition for selection (Duncan, Humphreys, & Ward, 1997; Vuilleumier & Rafal, 2000). Although patients are typically unable to report the extinguished stimulus, there is evidence of stimulus processing –

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for example extinction reduces when contra- and ipsilesional stimuli group (Humphreys, 1998), when the stimuli are pictured to interact with one another (Riddoch, Humphreys, Edwards, Baker, & Willson, 2003), when they have a common exemplar identity (Berti et al., 1992) and extinguished stimuli can still receive some residual on-line processing in order to enhance implicit memory (Vuilleumier, Schwartz, Clarke, Husain, & Driver, 2002). Indeed when a salient object is on the contralesional side, extinction can even reverse so that patients report the contralesional not the ipsilesional stimulus (Riddoch et al., 2003). Extinction in patients can then be used to examine whether contralesional stimuli are processed pre-attentively, indexed by the degree of extinction to these stimuli.

We evaluated self-reference effects by having patients associate themselves or a best friend with a shape and then asking patients to identify the shape(s) when they were presented as single items or pairs (Sui, Yankouskaya, & Humphreys, 2015). Previous studies have shown that this self-association procedure induces strong biases for self-related items, even when factors such as the frequency, length and concreteness of the words has been controlled for, even when the self is pitted against a highly familiar other person (best friend, mother), and even when participants are just presented with the (formerly) neutral shapes (Sui et al., 2012). The effect is correlated with the psychological distance individuals feel to the people used for the other associations (Sui & Humphreys, 2015a) and it shows stable trait-like properties in participants (Humphreys & Sui, 2015a and 2015b). We assessed whether self-association to a shape modulates whether it is extinguished or consciously reported in a task requiring participants to judge whether a shape is associated to themselves, to their best friend or new. We tested performance in six patients, three of them showing right-side extinction after left-hemisphere damage and three of them showing left-side extinction after right-hemisphere damage. Although left-side extinction after right hemisphere damage can be more severe than right-side extinction after left hemisphere lesion (Chechlacz, Rotshtein, Demeyere, Bickerton, & Humphreys, 2014), cases of right-side extinction are still prevalent. Furthermore there is evidence that self-biases may be associated with right hemisphere processing, at least with face stimuli (Keenan, Nelson, O'Connor, & Pascual-Leone, 2001). By testing patients with either right or left hemisphere lesion here we sought to demonstrate a general effect of self-relatedness on extinction, to provide a proof-of-principle test for self-bias modulating pre-attentive processing. To optimise the effects, the patients who were selected also demonstrated self-bias effects on basic perceptual matching, a defining case to produce self-bias in subsequent shape identification (cf. Sui et al., 2012). To foreshadow the results we found that both self and friend-associated shapes were better reported than new shapes but, when the self-shape was paired with the shape for the friend, patients showed extinction of the friend shape and reported the self shape. This result occurred even when the self shape fell in the contralesional field, reversing the standard pattern of spatial extinction. The data indicate that self-related stimuli can be processed pre-attentively and modulate the subsequent allocation of attention.

2. Materials and methods

We first measured self-bias using a perceptual matching procedure introduced by Sui et al. (2012), to ensure that the patients were sensitive to self-related information. We subsequently evaluated whether shapes associated with the self or a best friend were subject to extinction, when the patients were presented with shape pairs rather than single shapes.

2.1. Patients

The six patients (RR, PH, MH, SW, JB, and DT) were selected from the panel of neuropsychological volunteers at the Cognitive Neuropsychology Centre (CNC), University of Oxford. Patients were selected from (i) a continuous series in neuropsychological patients coming into the CNC (ii) whether they had extinction in the right or left visual field based on their unilateral lesion and (iii) whether they showed self-biases in perceptual matching. RR and PH had acquired left-hemisphere brain lesions following a stroke, and MH had suffered carbon monoxide poisoning. SW, JB and DT had acquired right-hemisphere brain lesions following a stroke. All patients were at a chronic stage (>12 months post-injury) and provided written informed consent in agreement with ethics protocols at the CNC. RR had lesions including left parietal, temporal cortex extending into inferior frontal and insula. PH's lesion extended across the left inferior frontal, parietal (angular gyrus) and superior temporal cortices, extending into the left caudate and adjacent subcortical regions. The main overlap between RR and PH's lesion was the left inferior parietal cortex extending to subcortical regions. MH had a grey matter lesion including the left parietal cortex, with an overlap with RR and PH in white matter underlying the parietal cortex. SW had lesions including the right parietal, supramarginal, temporal, and occipital cortex extending to hippocampus. JB had lesion including the right insular, putamen inferior frontal cortex extending to the parietal operculum and temporal cortex and subcortical regions. DT had lesions across the right parietal, occipital, and temporal cortex extending to the middle frontal gyrus and subcortical regions and a lesion in the left inferior frontal gyrus and insula. The main overlay between SW, JB and DT's brain lesion was the right parietal cortex which to some degree was mirrored to the overlay with RR and PH (Fig. 1a).

All patients had undertaken the Oxford Cognitive Screening (OCS) test (Demeyere, Riddoch, Slavkova, Bickerton, & Humphreys, 2015; online available, http://isis-innovation.com/outcome-measures/the-oxford-cognitive-screen-ocs/) and the Birmingham Cognitive Screen (BCoS) (Bickerton et al., 2014; Humphreys, Bickerton, Samson, & Riddoch, 2012) (online available, http://www.bcos.bham.ac.uk/) to provide a background neuropsychological profile (for details see Table 1).

2.2. Healthy controls for self-bias measure

Forty healthy controls (20 males and 20 females, mean of age ± SD = 39.95 ± 18.83 years, range 19–70) with no history of stroke, brain damage or neurological disorders were recruited