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Research report

Face and object imagery in congenital prosopagnosia: A case series

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ABSTRACT

It has been reported that congenital prosopagnosics may have a general imagery deficit or an imagery deficit specific to faces. However, much of this evidence is based on self-report questionnaires, rather than experimentally based testing (Grüter et al., 2007, 2009). This study tested face and non-face based imagery in a case series of congenital prosopagnosics, utilising both questionnaire based and forced choice accuracy measures. Our findings indicate that all the prosopagnosics showed impaired face based imagery, which contrasted with normal performance on imagery of objects and colours – a pattern that is consistent with reports of acquired prosopagnosia (Barton, 2008; Michelon and Biederman, 2003). Given all our experimentally based testing indicated face imagery impairments, despite no such problems being seen on self-report questionnaires, we would argue that testing based only on the latter must be interpreted with some caution. Overall, we would advocate that our findings demonstrate a *category specific* visual imagery impairment in congenital prosopagnosia, such that general imagery skill can be intact in such cases.

Visual mental imagery is commonly thought to be analogous to seeing an object in the 'mind's eye' (Kosslyn, 1996). Whether visual imagery is really visual has been debated since the early 1970s, but the widely accepted view is that imagery and perception rely on similar neural mechanisms (Farah, 1984; Kosslyn, 1996). In particular, patients showing an association of deficits in visual perception and visual imagery have provided evidence for imagery and perception sharing common neural substrates. Farah (1988) documented a group of patients where colour perception impairments correlated with colour imagery and other aspects of vision were similarly impaired in imagery. These patients appear to demonstrate not only a link between imagery and perception, but moreover that impairments of imagery can be *category specific*, such that perceptual impairment within a particular category, such as colour, can impair mental imagery of that same category.

The current research explores the theme of category specific impairment and mental imagery by focussing on face processing. Individuals with a condition known as prosopagnosia, appear to present with a specific impairment in recognising and identifying faces along with normal lower-level visual input processing – a pattern that is consistent with disruption to the mechanisms underpinning face recognition (Bodamer, 1947). This condition has traditionally been associated with adults who have suffered brain injury that consequentially disrupts previously normal face

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recognition mechanisms (termed *acquired prosopagnosia*); however a growing number of case studies have described individuals who report a life long problem with face recognition (since childhood) with no obvious evidence of neurological injury. Research presented by Grüter et al. (2007) suggests a distinction should be made between individuals who have had face processing impairments since childhood linked to obvious early acquired brain damage or neurological disturbance (which they term *developmental prosopagnosia*) and those without obvious acquired injury to the brain or neurodevelopmental disorders (termed *congenital prosopagnosia*). However, this distinction is not without its critics, particularly given the term 'congenital' suggests that individuals have had face processing impairments from birth – a fact that is very difficult to verify, with many such congenital cases likely developing face recognition problems due to developmental failures after birth. Moreover, eliminating the possibility of some form of brain damage early in life is by no means easy either. For this reason, we acknowledge that considerable debate remains about the usage of these labels – for our purposes, we will focus on the distinction between cases who manifest face processing problems in adulthood as a consequence of brain injury, who otherwise had normal face recognition abilities (acquired prosopagnosia) and cases who have had life-long problems with face recognition since childhood accompanied by no history of neurological injury, that we will label congenital prosopagnosia (in line with Grüter and colleagues, whose work we are seeking to re-examine).

Although the early literature suggested that congenital prosopagnosic cases were likely rare, Grüter et al. (2007) have since suggested that the rate of congenital prosopagnosics may be much higher than had been previously expected (perhaps as high as 1 in 50), although this suggestion remains controversial and remains to be confirmed. Nonetheless, the identification of cases of congenital prosopagnosia in the general population has led to a substantial increase in research activity in the past two decades (e.g., De Haan and Campbell, 1991; Ariel and Sadeh, 1996; Nunn et al., 2001; Duchaine et al., 2003; Kress and Daum, 2003; Steede et al., 2007; Bate et al., 2008) – but so far the focus of the bulk of this work has been on understanding the visual/perceptual components of face processing impairments in the context of congenital prosopagnosia. The present work, explores the issue of mental imagery of face and non-face items in congenital prosopagnosia, in an effort to shed light on what if any imagery impairments might be present in this condition.

In the context of acquired prosopagnosia following fusiform damage, deficits of face recognition have been shown to parallel impairments of imagery for faces, linked to lesions of the right fusiform face area (FFA). The FFA is a neural region highly (but not exclusively) activated by a range of face perception tasks (Kanwisher et al., 1997). Barton and Cherkasova (2003) and Barton (2008) have examined visual imagery abilities in acquired prosopagnosia following fusiform damage cases using an imagery test involving a list of thirty-seven questions – the participants had to imagine two celebrity faces and were asked which had a specific property. Eighteen questions focused on a facial feature (e.g. *who has a wider moustache, Joseph Stalin or Adolf Hitler?*) and nineteen focused on global facial shape (e.g. *who had the more pear-shaped face, John F. Kennedy or Richard Nixon?*). This manipulation in focus allowed the authors to determine whether acquired prosopagnosic cases differed on feature or global based face visual imagery. It has been proposed that visual face/object recognition involves the extraction of either local featural information (i.e., the parts of the face, eyes, nose, mouth etc.) or configural/holistic information (i.e., the relation between parts of a face). Given all faces tend to look the same in a gross anatomical way, it is argued that face recognition is likely heavily dependent on the configural/holistic system, whereas object recognition is heavily dependent on featural processing (Diamond and Carey, 1986). Interestingly, Barton and colleagues report that patients with a right sided lesion implicating the occipital lobe and fusiform gyrus (i.e., the FFA) were impaired at global face imagery but not feature imagery, whilst a case who had sustained a left sided occipital lobe and fusiform gyrus lesion (i.e., the contra-lateral region to that typically implicated in prosopagnosia) showed the reverse (Barton, 2008). Cases with lesions implicating the occipital lobe and fusiform gyrus bilaterally were impaired at both types of questions.

Michelon and Biederman (2003) described a prosopagnosic with more impairment in face perception than face imagery. Although an adult, MJH acquired prosopagnosia at the age of 5 after a fall, resulting in lesions to the left visual cortex and right fusiform gyrus. MJH (34 at the time of testing) was poor at identifying familiar faces, having to rely on salient features alone (e.g., hairstyle). On a test of face imagery, MJH was given the names of three famous people and asked to match two on physical similarity. On this test, MJH performed moderately poorly, but within normal range. To test non-facial imagery performance, MJH was tested on colours, relative lengths and mental size comparisons and again scored within the normal range (Michelon and Biederman, 2003). In a subsequent study, Brunsdon et al. (2006) reported another prosopagnosic case (with a less clear cut diagnosis of early onset acquired prosopagnosia) still in childhood. AL presented with a deficit in perceiving facial features, particularly eye and nose features, and was similarly impaired in perceiving basic visual properties of objects. Interestingly, despite AL's obvious face processing difficulties, there was no evidence of impairment when testing visual imagery of configural face similarities (deciding which two out of three people are most similar to each other) and AL performed well with internal representation of facial features. But this testing only focused on family members, and other categories of imagery, such as objects, were not tested. Overall, it would therefore appear that the face imagery abilities of early and late acquired prosopagnosic cases can vary from impaired to within normal range.

In the context of congenital prosopagnosia, the same may well be true. Nunn et al. (2001) describe case EP, who is described as having a life long difficulty with recognising famous and familiar faces – like so many cases, EP used feature-matching strategies to identify faces, rather than a more configural method. Testing with EP demonstrated both normal object recognition and normal visual imagery for objects. Imagery of faces was tested by drawing a generic face, which he performed well, but when asked to picture in his mind different famous faces, he could only remember salient