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Less impairment in face imagery than face perception in early prosopagnosia

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Abstract

There have been a number of reports of preserved face imagery in prosopagnosia. We put this issue to experimental test by comparing the performance of MJH, a 34-year-old prosopagnosic since the age of 5, to controls on tasks where the participants had to judge faces of current celebrities, either in terms of overall similarity (Of Bette Midler, Hillary Clinton, and Diane Sawyer, whose face looks least like the other two?) or on individual features (Is Ronald Reagan's nose pointy?). For each task, a performance measure reflecting the degree of agreement of each participant with the average of the others (not including MJH) was calculated. On the imagery versions of these tasks, MJH was within the lower range of the controls for the agreement measure (though significantly below the mean of the controls). When the same tasks were performed from pictures, agreement among the controls markedly increased whereas MJH's performance was virtually unaffected, placing him well below the range of the controls. This pattern was also apparent with a test of facial features of emotion (Are the eyes wrinkled when someone is surprised?). On three non-face imagery tasks assessing color (What color is a football?), relative lengths of animal's tails (Is a bear's tail long in proportion to its body?), and mental size comparisons (What is bigger, a camel or a zebra?), MJH was within or close to the lower end of the normal range. As most of the celebrities became famous after the onset of MJH's prosopagnosia, our confirmation of the reports of less impaired face imagery in some prosopagnosics cannot be attributed to pre-lesion storage. We speculate that face recognition, in contrast to object recognition, relies more heavily on a representation that descibes the initial spatial filter values so the metrics of the facial surface can be specified. If prosopagnosia is regarded as a form of simultanagnosia in which some of these filter values cannot be registered on any one encounter with a face, then multiple opportunities for repeated storage may partially compensate for the degraded representation on that single encounter. Imagery may allow access to this more complete representation.

Keywords: Apperceptive prosopagnosia; Visual mental imagery; Visual perception

1. Introduction

Evidence from different domains of investigation suggests that visual imagery and visual perception share representations and processes (see [26] for a review). In the neuropsychological domain, cases of patients showing parallel impairments in imagery and perception have been considered as evidence that these activities share neural structures. However, dissociated impairments have also been reported, with individuals manifesting impaired perception with intact imagery [4,5] or vice versa [29,38]. Such observations have led some authors [5,18,26,27] to propose that although imagery and perception activate the same store of representations, they can differ in terms of processes. Parallel deficits in imagery and perception would result from impaired shared processes, such as those involved in accessing previously stored material. In contrast, isolated imagery deficits would result from impairment of processes specific to the imagery activity (such as the image generation processes) and isolated perceptual deficits would result from impairment of processes specific to the perceptual activity (such as edge detection and feature grouping). Imagery in individuals with a perceptual deficit could still be manifested by using visual representations processed and stored before the lesion occurred. In the face recognition domain, a few cases of preserved face imagery in prosopagnosia have been reported [3,15]. As expected from the standard account, these individuals could only imagine faces of persons learned before the lesion.

Two broad types of prosopagnosia are usually distinguished: apperceptive (or perceptual) and associative (or mnesic) prosopagnosia [16]. Apperceptive prosopagnosia is

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defined by a perceptual deficit affecting the visual processing of faces. In associative prosopagnosia the deficit is at the memory level: faces can be correctly processed but associated information (personality, name, etc.) can no longer be retrieved. As Young et al. [43] suggest, only patients with apperceptive agnosia may show preserved face imagery. Patients with associative prosopagnosia could not access visual representations of faces from names.

In this study, we report the case of an apperceptive prosopagnosic patient, MJH, whose pattern of performance—less impaired imagery, relative to his perceptual recognition, of faces acquired after the onset of his prosopagnosia—is not readily, prima facia, reconciled with the standard accounts of the relation between perception and imagery. We do, however, offer a speculation as to how these results might be accommodated by a general model of face representation.

2. Case description

At the age of 5, MJH fell off an 8 ft high platform and sustained lesions in his left visual cortex (Area 18) and right fusiform gyrus, as confirmed by an MRI scan. At the time of testing, MJH was 34. MJH underwent several neuropsychological evaluations (in 1979 at local hospitals, in 1986 at Harvard Medical School, and in 1996 at the University of Southern California (Biederman and coworkers, unpublished data). Results of these evaluations are presented in Table 1. They suggest that MJH is now alert, attentive, socially functional, and has no general intellectual deficit. He has a degree from a college oriented to individuals with various kinds of disabilities. He is quite outgoing and has a good sense of humor. Previously, he was employed as a writer for television sitcoms and he currently performs as a motivational speaker for various corporations. However, MJH suffers from several problems such as tunnel vision beyond approximately 10° in the right visual field (stemming from his lesion in Area 18), particularly in the lower portion of that field. He has difficulty comprehending abstract drawings, a mild learning disability involving arithmetic, spelling, and handwriting, slowed reading speed, poor sense of direction, impaired motor speed and coordination and a history of tics.

MJH is above average at naming object pictures, missing only three in the Boston Naming Test. He manifests no problem in recognizing people from the sound of their voice but he is extremely poor at recognizing familiar faces and matching or distinguishing unfamiliar faces. Given a forced choice test in which one had to select a celebrity from a pair of pictures, the other being a noncelebrity, MJH was correct on only 22 out of 40, or 55%. The celebrities were limited to those that were highly familiar according to MJH, according to his self report [30]. Normal controls averaged 39 out of 40, or 97.5%. Whereas normal subjects were almost always able to respond immediately, MJH often required approximately 10 s to make his choice. In attempting to identify individuals from pictures of their faces, MJH relies on local cues. In Mangini and Biederman's test, he was able to name five of the celebrities based on such cues, e.g. Woody Allen: hair, hairline, and big glasses; Goldie Hawn: mole on lip and long blonde hair; Pope John Paul: no one wears a "cap" like that. (If we eliminate these five instances, then he was 17 out of 35, or 48.6%.) In another test, MJH required several minutes to identify a picture of Albert Einstein from a set of 10 distractor pictures [2]. Normal individuals were able to perform the task at RSVP rates (one picture every 200 ms). He succeeded in this task solely on the basis of Einstein's long hair.

In a forced choice match-to-sample task in which one of two pictures is identical to the sample and the distractor is on a morphed dimension of being a different individual of the same sex and same expression, MJH requires far more stimulus "energy" (i.e. image differences) than normal subjects to reach an accuracy level by staircase threshold method of 75% [30]. Insofar as the three pictures were presented simultaneously with no pressure to respond quickly, neither memory nor familiarity nor retrieval of a person identity node [10] are required to perform this task. Indeed, one does not even have to employ any aspect of face processing to perform this task insofar as the task only requires matching two

Table 1
MJH's performance on 12 classical neuropsychological tests

Test	MJH's score
WAIS	Average range, except difficulty with complex constructions
WISC	Average range
Boston Naming Test	Average range
Benton Judgment of Line Orientation Test	Average range
WRAT	11.8 (reading), 9.5 (spelling), 7.8 (arithmetic)
Rey Auditory Verbal Learning Test	11/15 words encoded after five presentations, nine words produced on immediate recall and seven words after a delay
Gray Oral Reading test	46th percentile; 73rd when given more time to read the text in the comprehension test
Rey–Osterrieth Complex Figure	Disorganized and distorted copy, delayed and immediate recalls about the same
Hooper Visual Organization test	Nine failed out of first 21. MJH identified the isolates of images, but could not integrate them
Groove Peg Board	25 pegs placed in 79 s with his right hand but only seven with his left hand (same time span)
Random Letter Cancellation Test	One target omitted in the lower right and two targets in the lower left (which he later self corrected)