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Implicit integration in a case of integrative visual agnosia

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Abstract

We present a case (SE) with integrative visual agnosia following ischemic stroke affecting the right dorsal and the left ventral pathways of the visual system. Despite his inability to identify global hierarchical letters [Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology*, 9, 353–383], and his dense object agnosia, SE showed normal global-to-local interference when responding to local letters in Navon hierarchical stimuli and significant picture-word identity priming in a semantic decision task for words. Since priming was absent if these features were scrambled, it stands to reason that these effects were not due to priming by distinctive features. The contrast between priming effects induced by coherent and scrambled stimuli is consistent with implicit but not explicit integration of features into a unified whole. We went on to show that possible/impossible object decisions were facilitated by words in a word-picture priming task, suggesting that prompts could activate perceptually integrated images in a backward fashion. We conclude that the absence of SE's ability to identify visual objects except through tedious serial construction reflects a deficit in accessing an integrated visual representation through bottom-up visual processing alone. However, top-down generated images can help activate these visual representations through semantic links.

Keywords: Integrative agnosia; Visual agnosia; Local–global processing; TPJ; Grouping

1. Introduction

Visual agnosia is a modality-specific deficit in recognizing visually presented objects. Over a century ago, Lissauer (1890) suggested a distinction between apperceptive and associative agnosia, each representing a breakdown in different stages of the perceptual hierarchy. Lissauer viewed *apperception* as a deficit in the initial stages of sensory processing in which the perceptual representation is constructed, and *association* as a deficit in mapping the final structural representation onto stored knowledge. According to this differentiation, a patient with apperceptive agnosia would typically fail to copy or match basic visual stimuli, whereas an associative agnosic would experience "normal vision stripped of its meaning" (Lissauer, 1890).

Although this classification has provided a simple and useful framework for dealing with visual disorders, it has not gone uncontested. Some neuropsychologists have cast doubt on the very concept of associative agnosia, claiming that underlying perceptual deficits can always be found in such cases if sensitive enough measurements are used (Delvenne, Seron, Coyette, & Rossion, 2004; Farah, 1990). Others have argued that the classification is too coarse and insensitive to the complex stages characteristic of normal vision (Marr, 1982; Riddoch & Humphreys, 1987; Ullman, 1996). Indeed, variations in deficits reported across both apperceptive and associative visual agnosias have led to further divisions and refinements.

An important example for the purposes of the present paper is the case of a patient (HJA), clinically diagnosed with associative agnosia and found later to have apperceptive components. In their classic report, Riddoch and Humphreys (1987) experimentally tested this patient and found abnormal perceptual organization abilities. Specifically, HJA's difficulty resulted in

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deficient integration or binding of local features of a visual stimulus into a coherent perceptual whole. Consequently, the presence of local features actually hindered his recognition performance. Riddoch and Humphreys (1987) suggested the term *integrative* agnosia for such cases, and we adopt this terminology here (for reviews see Behrmann, 2003; Humphreys, 1999).

HJA's perceptual abilities suggested a basic problem in visual integration. He was either lacking the ability to form a global integrated gestalt, or he was unable to gain access to one. The distinction between forming versus accessing an integrated perceptual representation is important because each alternative leads to a different conceptualization of the functional impairment. If formation is the problem in this type of agnosia, then perceptual integration would be more closely tied to perceptual identification processes themselves. However, if a fully integrated representation is formed, but conscious access to it is denied, then the breakdown in integrative agnosia is not an integrative one per se, but, more likely, a problem in selecting the proper level of representation for object identification. If the latter account is valid, we should find evidence for visual integration even without awareness of the object's identity.

In the present study we describe patient SE who, like HJA and other integrative agnostics (see Behrmann, Peterson, Moscovitch, & Suzuki, 2006), has specific difficulties in integrating features into coherent global percepts. We demonstrate that SE's integrative agnosia may be better characterized as a lack of conscious access to an established integrated perceptual representation.

1.1. SE: clinical history

SE is a 52 year old, left-handed male, who was admitted for rehabilitation following bilateral ischemic stroke in January 2004. Prior to hospitalization, SE had been fully independent and gainfully employed. He had no history of previous neurological or psychiatric disorders. An intake examination at admission in the rehabilitation ward (13 days after stroke) showed reported expressive and receptive speech to be normal. Similarly, gross and fine motor functions were unaffected by the stroke. His visual sensory performance, as assessed by computerized perimetry, revealed restrictions in the upper quadrants of the right and left hemifields. This condition improved substantially over the course of time. After one month, only a slight attenuation in dynamic visual stimulus detection was present in both fields, with no basic visual field defect. Visual acuity on a Snellen-equivalent computerized test was 20/20, there were no crowding effects and SE could easily fixate and report a small central target embedded in other patterns.

Clinically, it was evident that SE could not recognize common objects and faces on sight, although tactile and auditory recognition was intact. He displayed an acquired disturbance of color perception, as suggested by his inability to identify any of the numbers in the Ishihara plates, as well as a difficulty to discriminate between different color shades. However, he was not color agnosic: He was able to name basic colors presented in isolation and to associate such colors with typical items (e.g., red with tomatoes, etc.). Informal observation suggested that SE also suffered from topographical agnosia. His orientation while on the hospital ward, as well as his ability to describe his home neighborhood, were far lower than expected given his visual functioning in everyday activities. There was no evidence of unilateral neglect or extinction as tested by the Behavioral Inattention Test (a standard, comprehensive clinical test of neglect), although his overall score was low 111/146). Specifically, SE's performance was flawless on the line bisection subtest, and on the free drawing subtest. In contrast, the cancellation subtests revealed that SE omitted targets from both sides, with no evidence for a consistent unilateral neglect profile (line cancellation score: 13 right, 16 left; letter cancellation score: 18 right, 13 left; star cancellation score: 18 right, 19 left).

Reading was reduced to a somewhat slow yet accurate process that initially took place in a letter-by-letter fashion, but rapidly improved in efficiency and speed. However, when words contained more than 5–6 letters, SE occasionally replaced the last letter with a semantically meaningful and visually related substitute (note that Hebrew is written from right to left). Interestingly, such left-sided substitutions were never observed in pseudowords. An auditory memory testing (Rey-AVLT Rey, 1964) demonstrated an initial word span in the low average range (5/15 on list I) with a low learning curve (9/15 on list V). Performance dropped substantially following a distracting list (4/15) and remained low after a 20-min delay (3/15).

CT scanning conducted within 24 h of the initial hospitalization indicated bilateral infarcts in non-homologous regions affecting the left ventral and right dorsal visual streams. More specifically, lesions were present in the ventral regions of the left hemisphere, particularly the hippocampal region and lingual gyrus. Lesions were also present in the dorso-lateral posterior regions of the right hemisphere, including the dorso-lateral occipital gyri, inferior parietal lobule, junction of supramarginal and superior temporal gyri, and junction of angular and middle temporal gyri. This pattern did not change 2 months later as revealed by a second CT scan session (Fig. 1).

1.2. Initial neuropsychological investigations of basic visual function

We first tested SE while he was still on the rehabilitation ward, about 2 months after stroke. Before experimental testing began, consent was obtained from SE in accordance with the declaration of Helsinki (World Medical Association, 1997). SE had no difficulty visually matching geometric shapes to exemplars (100% accurate—20/20). He could also easily copy and name simple figures (Fig. 2).

We next tested him on the Efron shape test (Efron, 1968), which presents pairs of two-dimensional shapes, controlled for overall brightness and total surface area, and is considered a sensitive test of apperceptive agnosia. The patient's task is to report whether items in each pair are the same or different shape. SE was 100% accurate (30/30).

SE's performance on a test of orthographic shape recognition was also perfect (25/25 trials; Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)) (Kay, Lesser, & Coltheart, 1992), and his spontaneous naming