■Special Lecture

PROSOPAGNOSIA

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Faces provide us with information on gender, age, personality, emotional, atentional, and intentional states, health and social situation. Faces serve a vital and highlybefficient role in social dayly life. It is quite understandable that (1) face identification is of paramount importance in social and affective life and is acquired very early in life, (2) we store in our memory a huge amount of individual faces (approximately one thousand), (3) the similarity that faces bear to each other is much greater than that found among the exemplars of any other category.

Prosopagnosia, the inability to recognize familiar face has been singled out in the field of neuropsychology. The term "Prosopagnosia" was introduced in 1947, by Bodamer, but the phenomenon was recognized earlier in nineteenth century by Quaglino, Italian ophtalomologist. Prosopagnosia represents a form of visual agnosia, in which familiar face recognition is selectively impaired despite intact intellectual functioning and even apparently intact visual recognition of most other stimuli.

1. prosopagnosia in the light of a multi-stage cognitive model

The comprehension of face recognition disorders has been greatly improved by the development of cognitive models of face processing. According to Bruce and Young's modular model (schema), face identification is achieved by processing visual information at four different levels, perceptual analysis, face recognition units, person identify nodes and name generation.

1) perceptual analysis : The final product of perceptual analysis is an abstract face description, based on its invariant features, extracted from variations in pose and changes in expression. This first step of face recognition can be accessed by Benton face matching test and face age discrimination test.

2) Recognition units : Internal representations of known faces that, when activated by the appropriate output of perceptual analysis, trigger a feeling of familiarity (not yet of recognition). This process can be tested by familiarity check test.

3) Identity nodes : They are a subsection of the semantic system, which, when activated by the output of recognition units, provides information about the person's biography (except his / her name), and can be examined by name-face matching, naming, categorization, retrieval of biographic information.

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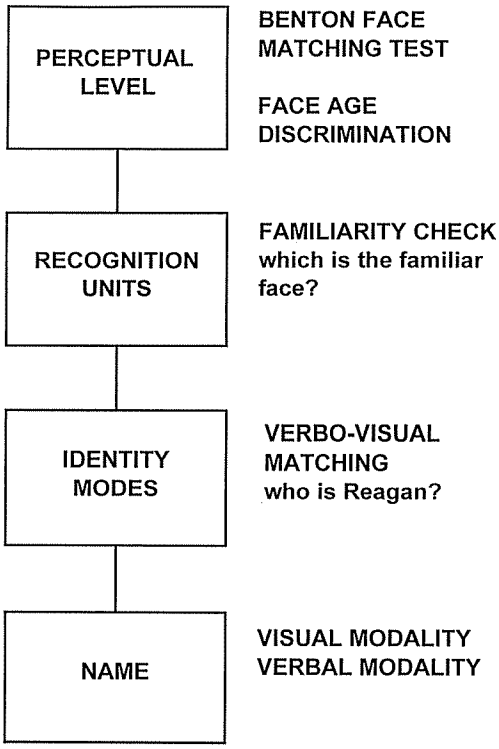

4) Names : Names are stored separately, as shown by the tip-of-the-tongue phenomenon and by patients, who are unable to provide the name of a face they recognize. Naming process can be examined by comparison naming with autobiographic knowledge and contrast visual naming (visual modality) with naming to verbal definition (verbal modality).

We have considered the flow of information in Bruce and Young's model in a bottom-up direction. However, information can also flow in a top-down direction, priming the activation of recognition units. This is shown by the following patient who presented a pattern of results on the foregoing face tests that would appear contradictory, if considered from a bottom-up perspective alone.

Patient Anna, 45 year-old, right-handed.

Following a car accident, which produced bilateral posterior damage, the patient complained of difficulty in recognizing familiar faces. The only other cognitive disorder was impaired reading.

Object recognition	
Boston naming test	83/85
Snodgrass drawings (250 msec.)	94/97
Ghent overlapping figures	44/44
Street completion test	9/14
Numbers of errors on face tests	
Benton test	6/27
Age discrimination	10/96
Familiarity checking	21/36**
Verbo-visual matching	2/32
Visual naming	16/36**
verbal naming	0/55
Imagery comparison	5/24

2. apperceptive, associative or mnestic prosopagnosia

Object agnosia is traditionally categorized in two forms, apperceptive agnosia and associative agnosia. In a similar vein, we can differentiate prosopagnosic patients with a disruption at the level of perceptual analysis (*apperceptive prosopagnosia*) from those with a disorder affecting the memory stages of recognition (associative or mnestic prosopagnosia).

apperceptive prosopagnosia : Damage to the structual encoding stage results in apperceptive prosopagnosia, which reflects the impairment of perceptual analysis and, therefore extends to other categories of objects, especially those whose members are similar in form.

associative prosopagnosia : Associative prosopagnosia ensues the lesion of face recognition units or of person identify nodes and may be remarkably pure.

mnestic prosopagnosia : The isolated disrup-

tion of the name generation stage causes proper name anomia, which is a verbal and not a recognition deficit.

Ad hoc tests permit to assess the patient's performance at these different levels. This distinction can be grounded on quantitative, objective data, by comparing the performance on perceptual and mnestic tasks (Benton test+Age discrimination test vs Familiarity cheek+Face recognition test) and making reference to the discrepancy between the two sets of tests found in normals.

3. Is prosopagnosia a specific disorder, confined to a class of visual percepts that are subserved by an independent neural system?

Prosopagnosia can occur as a remarkably pure disorder, the question arises of whether faces represent a unique class of percepts that are subserved by a specific brain mechanism. Some authors have taken a negative stance, arguing that the apparent specificity of faces is due to the fact that, differently from other objects, they must be identified in their individuality and not simply as belonging to a class.

Damasio has pointed out that, while object recognition is usually assessed by requiring the identification of the class to which an item belongs, faces must be identified in their individuality. The basic deficit underlying prosopagnosia would concern the identification of an exemplar within a class whose members share great perceptual similarity. On this view, a defective performance is expected, whenever a single item must be recognized within a perceptual category, whose exemplars are very similar. If confirmed, this finding would undermine the concept that in prosopagnosia the deficit is specific for faces. There have been such cases reported, De Renzi's patient (perfect identification of his own belongings), Sergent and Signoret's patient (172/210 car makes identified), McNeil and Warrington's patient (learning face-arbitrary name associations turned out to be better for sheep than humans), and Farah's patient (face identification was poorer than eyeglass frame identification).

Now, the next question is what the basis for face recognition specificity is, a discrete neuronal apparatus or a distinct mode of processing visual data?

Farah endorses the latter view, arguing that faces are processed as a whole, in contrast to words that must be decomposed in their constituent parts (letters), while objects would undergo both a holistic and an analytical processing. Thus the perceptual capacity underlying visual recognition would determine which type of recognition disorder results. This theory predicts that: (1) There must be no case of object agnosia, which in not associated either to alexia or to prosopagnosia. (2) No case can exist, which shows prosopagnosia and alexia, but not object agnosia. Farah found that Rumiani's case, and De Renzi and di Pellegrino's case in a review of the literature provided support for her conceptualization.

Prosopagnosics would, however, be expected to also fail with objects when they are requested to recognize a stimulus that has a specific value from among stimuli of the same category. At variance with this prediction, they were found to be perfectly able to identify their constituent parts (analytic approach). On this account, face and word recognition are viewed as instances

of opposite modes of perceptual processing ——global vs. analytic——, while object recognition would participate of both modes. This theory predicts that no case should exist, which presents prosopagnosia and alexia, but not object agnosia. We have data that disconfirm this hypothesis. In conclusion, we think that the concept that faces represent a unique set of stimuli, subserved by a discrete representation in the brain, is plausible.

4. The anatomical basis of prosopagnosia, ——bilateral damage or right hemisphere damage——

Anatomical findings provide indirect support for this notion. A privileged role of the right hemisphere in subserving face processing has long been advocated, based on normal and clinical studies of unknown face recognition. They provide evidence of a left visual field advantage, when normal subjects process laterally projected faces and of a greater impairment of right posterior brain-damaged patients on tasks of face matching. It was, however, questioned whether unfamiliar and familiar faces tap the same kind of cognitive skills and whether the right hemisphere ascendancy in unknown face processing justifies the conclusion that damage to this side of the brain is crucial for causing prosopagnosia.

A strong argument against the latter assumption was provided by the finding that almost all cases of prosopagnosia with autopsy documentation showed a bilateral lesion of the medial occipito-temporal area. Necropsy data, however, are rare, not always temporally related to testing and may be intrinsically biased, in that they tend to be available in the most severe cases only.

Imaging techniques can, therefore, represent an alternative source of evidence for assessing the anatomical correlates of prosopagnosia. A perusal of the literature shows a substantial number of cases, in which prosopagnosia was associated with a lesion confined to the right brain. CT, MRI and PET studies provide evidence that in more than 30 patients the damage was confined to the right hemisphere.

This pattern is the opposite of that found in object agnosia, which is frequently linked to left brain damage. It would be hazardous to draw from these findings the inference that in all right handers familiar face representations are exclusively stored in the right hemisphere, since prosopagnosia is far from being a consistent accompaniment of right posterior brain damage. Taken the fact in consideration that normal people vary in the degree of their hemisphere specialization, a more balanced conclusion is that in the majority of right handers, familiar face processing also involves the subordinate participation of the left hemisphere, which secures a potential for compensating right hemisphere injury, whereas in a minority of them facial skills are so lateralized to the right brain as to be severely impaired following its damage.