Object and Face Recognition

What is visual agnosia?

The impairment of visual object recognition in people who possess sufficiently preserved visual fields, acuity and other elementary forms of visual ability to enable object recognition, and in whom the object recognition impairment cannot be attributed to... loss of knowledge about objects... [The] impairment is one of visual recognition rather than naming, and is therefore manifest on naming and non-verbal tasks alike.

Two types of visual agnosia

Apperceptive agnosia
Object recognition is impaired because of deficits in perceptual processing.

Associative agnosia
Perceptual processes remain intact but object recognition is impaired because of difficulties in accessing relevant knowledge about objects from memory.

Martha Farah
Perception and Action

We typically consider object recognition as involving perceptual and memory processes - you see an object and then identify it. This is the "sitting in the chair" approach.

But object recognition often goes beyond visual recognition alone - we often interact with objects.

Physical interactions with objects often facilitates object recognition.

The What and Where Pathways

Ungerleider and Mishkin (1982) performed lesions in either the temporal and parietal lobes of monkeys.

The monkeys were asked to perform an object discrimination or a landmark discrimination task.

Monkeys with parietal lesion could not perform the landmark discrimination task.

Monkeys with temporal lesion could not perform the object discrimination task.

A Double Dissociation

Object Discrimination (What)
Pick the correct shape (triangle or rectangle) for a reward.

Landmark Discrimination (Where)
Pick the shape closer to the cylinder for a reward.
Explaining Visual Agnosia

Hierarchical model of object recognition

Riddoch and Humphreys proposed a model to account for the various deficits in object recognition shown by brain damaged patients.

- Edge grouping by collinearity
- Feature binding into shapes
- View normalization
- Structural description
- Semantic system

Edge Grouping by Collinearity

An early stage of processing where edges of objects are derived.

Collinearity means having a common line.
Evidence for Edge Grouping

Patient DF had severely impaired object recognition ability. She recognized only a few real objects and could not recognize any objects in line drawings (D. Milner, 1991).

She also had trouble with recognizing line orientation, which is important for detecting edges.

Principle of Good Continuation
Separate points/sections are perceived as if they form a straight line or smooth curve when they are connected.

Principle of Similarity
Similar things appear to be grouped together.

Feature Binding

Object features that have been extracted during the edge grouping stage and the feature detection stage are combined to form shapes.

This stage is akin to recognizing geons and/or geon assemblies in the RBC theory.

Evidence for Feature Binding

Integrative agnosia: Patients with this condition have trouble combining or integrating features of an object.

Patient HJA cannot find an inverted T among upright Ts, presumably because he found it hard to group the distractors together.

"I have come to cope with recognizing many common objects, if they are standing alone. When objects are placed together, though, I have more difficulties. To recognize one sausage on its own is far from picking one out from a dish of cold foods in a salad."
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More Evidence for Feature Binding

HJA did OK with configurations like this.

But not with these.

View normalization

View normalization allows a viewpoint-invariant representation to be derived. This is a controversial idea, because evidence generally suggests that successful object recognition does not require viewpoint-invariant representations.

Evidence for normalization

Warrington and Taylor asked patients to recognize objects presented at either a normal or an unusual view.

These patients performed particularly poorly when objects were shown at an unusual angle.

The same occurred when Warrington and Taylor showed two pictures simultaneously, with each depicting an object at a different angle, and had patients judge whether they were the same object.
Structural Description

During this stage, individuals gain access to stored knowledge about the structure (i.e., visual appearance) of objects.

Evidence for Structural Description

Object-decision task -- Ss see pictures or drawings of real and pseudo-objects, and they must decide which are real.

Some patients perform poorly on this task even though they perform at normal levels on tasks designed to assess earlier stages of object recognition (e.g., matching objects from different viewing angles).

Some patients perform extremely poorly when they have to name objects presented visually, but can perform normally when naming objects presented verbally.

Semantic System

At this stage, people gain access to stored knowledge of semantic (nonvisual) information relevant to the object.

Evidence for Semantic System

Patients with an impaired semantic system can show category-specific deficits in object recognition.

Category-Specific Deficit

Impaired for living things but intact for non-living things.

Impaired for man-made things (though much less common).
Category Specific Deficits

Why do more patients have trouble with living things?

Living things are more visually similar to each other than non-living things.

Although some evidence supports the living vs. non-living contrast, another possibility is visual/perceptual properties vs. functional properties.

Living things are defined by visual features.

Non-living things are defined by functions.

Neuroimaging experiments failed to provide clear support for the living vs. nonliving view.

More fine-grained deficits have also been found. Some patients have shown major deficits in naming animals but not plants and vice versa.

Face Recognition
Are Faces Special?

Yes!

One evidence comes from individuals with prosopagnosia.

Patients with prosopagnosia lose their ability to recognize faces, though they can recognize other objects.

fMRI evidence suggests that the fusiform face area specializes in face recognition.

Patient HJA

“...when shopping he (John) would wait for me outside the shop. I suggested he might recognise me by my height, spectacles, shape of coat, shoes, and handbag but he never spots me and I always have to call him. Once he tried to be very clever and began helping to unload a trolley at the check out, much to the surprise of the lady who must have been mystified by his apology.”

“I’m sorry. I thought you were my wife.”

Humphreys & Riddoch (1987)

To see but not to see: A case study of visual agnosia.

Featural vs. Configural Processing

Farah proposed two pattern-recognition systems.

Featural Processing: Recognition of simple parts and the assembly of those parts into larger wholes.

Configural Processing: Recognition of larger configurations. Responsible for analyzing the spatial relations among features in a face.

Farah claims that the second system is damaged in people with prosopagnosia.
Another distinguishing principle of face recognition is its strong dependence on orientation.

In one experiment, Yin (1969) showed subjects pictures of houses or faces during a study phase. During the test phase, subjects were shown upright or inverted houses and faces and must make recognition judgments on them.

The Face Inversion Effect

More Evidence for the importance of orientation in recognizing faces...

The Thatcher Illusion (Thompson, 1980)
What does this tell us?

Our perception of faces are specifically built to detect featural details (and to decode spatial relation among the features) from an upright position. When a face is inverted, that ability is lost. Our perception of faces upside down and right side up is very different!

Contrast Reversal

Contrast reversed faces are also much more difficult to recognized than contrast reversed objects.

Are Faces Special?

No!

A prosopagnosic farmer could not recognize his individual cows.

A prosopagnosic bird watcher lost his ability to discriminate warblers.

Another one lost his ability to tell cars apart. She had to read the license plate of each car in a parking lot to find her own car.

Dog show judges show the inversion effect for dogs as they do for humans.

Experience-Dependent Plasticity

Faces are typically recognized at the individual level but other objects are not (within- vs between-class discrimination).

We have more expertise with faces.

If we develop expertise at identifying objects in a particular category, recognition of these objects can invoke the same brain structure that is allegedly used only for face recognition — the fusiform face area.