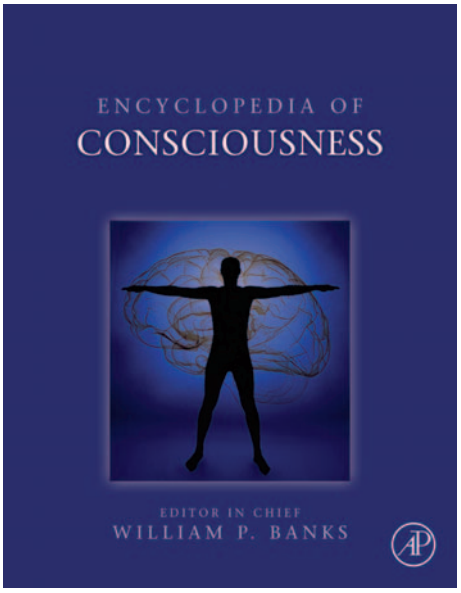

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Neglect and Balint's Syndrome

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Glossary

Anosognosia – A neurological disorder, usually caused by brain injury, characterized by the sufferers denying they have a specific impairment, such as hemiplegia.
Balint's syndrome – A neurological disorder characterized by simultanagnosia and optic ataxia, typically caused by bilateral damage to the posterior parietal cortex.
Extinction – A neurological disorder where the ability to attend to stimuli in a particular region of the visual field is impaired by the presence of stimuli outside that region.
Optic ataxia – The inability to guide the hand toward an object using visual information that cannot be explained by motor or sensory deficits.
Simultanagnosia – The inability to perceive more than one object at a time.
Somatoparaphrenia – The belief that part of one's body belongs to another person.

Introduction

Neglect, also known as unilateral neglect, hemispatial neglect, hemineglect, neglect syndrome, or spatial neglect, is a disabling brain disorder, usually caused by a brain lesion. Patients with neglect typically have difficulty paying attention to contralesional space. Thus, if the lesion causing the neglect occurs in the right cerebral cortex, the patient may find it difficult to attend to an object situated to the left of their current point of fixation. Neglect is most often caused by damage to the right cerebral cortex, but can be caused by damage to the left cerebral cortex, though the resultant neglect is usually less severe. Because its symptoms can vary from individual to individual and because it can be caused by a lesion in any of several different locations in the brain, it may not be a single disorder but rather a family of several related disorders. It is especially likely to be caused by lesions near the junction of the temporal lobe and the inferior parietal lobule, but can also be caused by lesions in the frontal cortex, in the white matter, or in subcortical areas such as the thalamus and basal ganglia.

Neglect is necessarily oriented relative to a specific frame of reference. For example, to say that a patient has left-sided neglect one must first specify what frame of reference is used to define the term 'left.' Neglect oriented relative to the patient is referred to as egocentric. Egocentric neglect is most often orientated relative to the patient's point of fixation. For example, a patient with left-sided egocentric neglect will typically ignore objects to the left of their point of fixation. However, egocentric neglect may also be orientated relative to a part of the patient's body. For example, a patient may ignore objects to the left of their left hand. Even when oriented primarily relative to the patient's point of fixation, the degree of egocentric neglect may be influenced by the orientation of parts of the patient's body, such as the head and trunk. For example, an object that is to the left relative to the point of fixation, but to the right relative to the head and to the right relative to the trunk, may be less neglected than an object that is to the left in all three coordinate systems. Although left-sided and right-sided neglect are the most common, other forms of egocentric neglect are possible. For example, a patient may have upper visual hemifield neglect, and so ignore objects that are situated above their point of fixation.

Neglect is not always oriented relative to the patient and may instead be oriented relative to the object that is being viewed, in which case it is referred to as allocentric. Unlike a patient with left-side egocentric neglect, a patient with left-sided allocentric neglect may be able to attend to

objects on their left, but will ignore the left half of each object, regardless of where the object is located. Curiously, if the object has a well-defined left side, a patient with left-sided allocentric neglect may continue to ignore the left side of the object even when the object is rotated by 180°, so that its left side is now situated on the right. For example, when viewing a face with a small blemish on the left side, a patient with left-sided allocentric neglect may continue to ignore the side of the face with the blemish even when the face is rotated by 180°. It seems that when presented with a face, the patient mentally rotates the face until it is orientated in the standard fashion (i.e., the eyes above the mouth) and then ignores the left side.

Although neglect can be so extreme that the patient fails to notice large objects on the neglected side, it need not be total. Instead, it may manifest itself only as a tendency not to respond to stimuli in the neglected region. If neglect is not total, the addition of stimuli to the nonneglected side may further decrease the ability to attend to stimuli on the neglected side, a phenomenon known as extinction. As extinction and neglect can occur independently of each other, they may be distinct disorders. For example, a patient may exhibit left-sided extinction without exhibiting left-sided neglect. Such a patient would have no difficulties attending to an isolated object presented on their left. However, introducing objects on their right, might make it hard (or even impossible) for the patient to continue to attend to the object on the left. Conversely, a patient might exhibit neglect without exhibiting any extinction, so the patient's ability to attend to an object on the neglected side would not be influenced by whether or not objects are presented on the nonneglected side.

Forms of Neglect

Neglect most commonly occurs in the visual domain, in which case it may result in some or all of the following symptoms: Patients may shave or apply makeup to only one side of their face. They may eat from only one side of a plate. When moving in a wheelchair, they may bump into objects on the neglected side. If asked to bisect a line that crosses the visual midline, they may be biased in the nonneglected direction. When copying a picture, they may have a tendency to copy only the nonneglected side. When presented with an image, they may look mainly (or exclusively) at the nonneglected side. Rapid eye movements (REM) to the nonneglected side may occur in REM sleep. If asked to circle all occurrences of a specific letter, they may concentrate on the occurrences that appear on the nonneglected side, circling them repeatedly to the near, or even total, exclusion of those that appear on the neglected side.

Neglect can occur in other sensory domains such as the auditory, olfactory, or somatosensory domains. If it occurs in the somatosensory domain the patient will ignore a region of her body and may even deny ownership of neglected limbs, sometimes believing that they belong to someone else (somatoparaphrenia). Often the neglected area is also paralyzed. In such cases, the patient may be unaware of or deny the paralysis (anosognosia). Neglect can also affect motor responses. Although the patient may have no physical impairments, the patient might have difficulty initiating movement or their movement may be slow.

Although comparatively rare, a patient may exhibit representational neglect and ignore a portion of an imagined scene. For example, when patients with left-sided representational neglect were asked by Bisiach and Luzzatti to imagine viewing the Piazza del Duomo in Milan standing next to the cathedral in the piazza, the patients often failed to mention streets or places on the left side of the piazza. However, when asked to imagine looking directly at the cathedral, so that they imagined viewing the same scene as before, but from the opposite direction, the patients then recalled the objects and places they had previously failed to mention, since these objects were then situated on the right side of the piazza, relative to their new viewpoint.

Processing of Neglected Stimuli

Neglect is not caused by a disruption of the visual system *per se*, but by a disruption of the cortical system that deploys attention. The only reason

why a patient with neglect fails to consciously perceive stimuli located in their neglected region is because the patient cannot attend to them. If patients are prevented from seeing because of an abnormality in their visual system such as in their eyes, optic nerves, lateral geniculate nuclei, or visual cortex, they are said to exhibit blindness, not neglect. To diagnose a patient as having neglect, one must first rule out any other reason why the patient might not be able to see.

Some stimuli can be perceived even when they are not attended, so can be readily seen by a patient with neglect. For example, if a bright spot of light is presented in complete isolation on a uniform black background, most neglect patients will be able to detect it, regardless of where it is located, especially if it is flashed repeatedly.

There is evidence that quite sophisticated processing can occur in the neglected region. For example, if a word is presented on the neglected side, even when it is not consciously seen, it may cause the patient to respond more quickly to similar words presented on the nonneglected side. Similarly, if a patient is simultaneously presented pictures of two different houses and asked which would be better to live in, the patient might reliably choose the house that is not on fire, even though the flames appear only in the neglected hemifield, so are not consciously perceived. When asked to explain their choice, the patient will not be able to do so and will often confabulate. Other studies have asked patients to compare two simultaneously presented pictures and report whether they are the same or different. Patients could do this task even when one or both of the pictures were presented to the neglected hemifield.

Balint's Syndrome

Balint's syndrome is a brain disorder, closely related to neglect, first reported by Reszo Balint in 1909. Whereas neglect is caused by unilateral damage, Balint's syndrome is caused by bilateral damage, typically to the posterior parietal cortex. Unlike a patient with neglect, who is unable to attend to objects in a particular region of the visual field, a patient with Balint's syndrome will be able to attend to an isolated object, regardless of where it is located. However, the patient will find it difficult to point to the object (optic ataxia) or to perceive more than one object at a time (simultanagnosia). While such patients can often perceive the features in a scene, they have difficulty determining which features belong to which object, an issue known as the binding problem. As a result, they have a tendency to conjoin features that belong to different objects and so perceive illusory conjunctions. For example, if a scene contains only red vertical bars and blue horizontal bars, a patient with Balint's syndrome might perceive a blue vertical bar.

Conclusion

Studies on neglect indicate that there is interhemispherical competition between the cortical circuits that control the deployment of attention. For example, damage to the right cerebral cortex may allow the attentional circuits in the left cerebral cortex to dominate. As the left cerebral cortex is responsible for processing the right visual hemifield, attention is directed more often (or even exclusively) to the right visual hemifield, causing the patient to ignore objects that occur to the left of the point of fixation. Similarly, damage to the left cerebral cortex may cause the patient to ignore objects that occur to the right of the point of fixation. If both cerebral hemispheres are damaged, then neither can dominate, so a patient with Balint's syndrome can perceive an isolated object regardless of where it is located. However, due to the damage to their attentional circuits, the patient may be able to perceive only one object at a time.

Several studies have shown that an object located in the neglected region can be represented even when not consciously seen. How this occurs is controversial. A possible explanation is that the attention required for conscious awareness might be different from that required to form object representations, and in neglect, only the first type of attention is inhibited.

See also: Attention: Change Blindness and Inattentional Blindness; Psychopathology and Consciousness.

Suggested Readings

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Biographical Sketch

Piers Howe graduated as an exhibitioner from Oxford University in 1998, with a masters in physics. Winning a Presidential University graduate fellowship, he obtained his PhD from Boston University in 2003, under the guidance of Stephen Grossberg. His PhD thesis was titled 'Cortical mechanisms of depth and lightness perception: Neural models and psychophysical experiments.' He then worked as a Helen Hay Whitney postdoctoral fellow with Margaret Livingstone at Harvard Medical School, before moving on to Brigham and Women's Hospital to work as a research fellow with Todd Horowitz and Jeremy Wolfe. His research has involved a variety of techniques including computational modeling, macaque neurophysiology, human fMRI, and human behavioral experiments. He has published articles on lightness perception, motion perception, depth perception, and visibility. More recently his focus has shifted to visual attention and to devising computational techniques for determining brain connectivity from fMRI data. He is a member of the Harvard fMRI Center for Neurodegeneration and Repair. He has taught a psychology course at the University of Massachusetts (Boston) and at a cognitive modeling course at Boston University. He lives in Boston, Massachusetts.