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Attention: Disorders

‘Attention’ can imply various skills, such as staying ‘on-task’ (as when driving down a monotonous highway), multi-tasking (as when talking to a passenger whilst driving), or focusing on one specific thing (as when reading a road-sign). Students of perception are usually concerned with the latter meaning of attention, as a process of selection. Insights into how selective attention works can be gained from studying people in whom selection has broken down due to brain damage (usually caused by stroke). Attention is normally considered as the gateway to conscious awareness, and disorders of attention thus entail losses of awareness for certain parts of the world. This entry discusses three major disorders of attention, and considers what sorts of perception may be possible for things outside of awareness.

Neglect

Neglect is a common and disabling consequence of brain damage. When it is severe, the eyes and head deviate towards the side of the damage, and the person may fail to dress or groom the opposite half of their body, to eat food from that half of their plate, or to acknowledge anything on that side. Neglect is strongly associated with damage to the right side of the brain, particularly the posterior parietal and superior temporal lobes, so it is usually the left side of space that is neglected. It is important to appreciate that the problem is not one of sensory transmission. The independence of neglect from sensory factors was illustrated elegantly by Eduardo Bisiach and Claudio Luzzatti, who asked two patients to describe a familiar Milanese square from memory. Both described buildings on the right, but not on the left, relative to their imagined viewpoints, showing that even mental images may be neglected.

Neglect is usually understood as a spatial bias of attention, such that items in relatively rightward positions are selected at the expense of those further to the left. Unawareness is not restricted to the visual world. Patients may neglect sounds, touches and even smells. They may also neglect internal sensations, contributing to a loss of awareness for one side of the body. However, the world is experienced as

complete since, by definition, the patient is unaware of the neglected parts. It may thus be difficult for a patient to achieve direct insight into their problem, and neglect can be very hard to treat. At a theoretical level, the condition offers a unique window on spatial attention. No two patients are exactly alike in their symptoms, and the differences between them can inform us about how attention is organised in the brain. For instance, a patient that neglects visual objects might nonetheless be alert to touches on that side, or vice-versa. Such patterns show that attention is not a single function shared across sensory modalities. The mechanisms by which we attend to our different senses must be at least partially separate, because they can be disrupted separately by brain damage.

Research into neglect has tended to focus on its visual effects, but even here the symptoms are remarkably varied, suggesting many sub-divisions of visual attention. For instance, visual space can be divided conceptually into that which can be accessed directly by reaching and grasping (near space) and that which cannot (far space). This distinction may be of significance for the control of behaviour, and neglect research has helped to confirm its biological reality. Peter Halligan and John Marshall reported a neglect patient who made large errors in estimating the midpoints of horizontal lines in near space, yet who could accurately bisect lines of equivalent visual extent in far space, by pointing a light-pen or throwing a dart. A further, distinct region of space is personal space, bounded by and immediately surrounding the body. Patients have been reported who can search both sides of external space effectively, yet fail to notice bright markers, such as balls of fluff, attached to one side of their clothing. Visual neglect for personal space may interact with neglect of bodily sensations to destroy awareness for one side of the body.

Visual neglect also highlights the fact that the apparently straightforward concepts of left and right are far from simple, since their definitions depend upon the spatial reference frame adopted. A primary distinction is drawn between egocentric and allocentric reference frames: the former specify positions relative to the viewer; the latter relative to things within the environment. If you look at a building, then tilt your head to one side, the building seems to stay upright despite your altered viewpoint. Your perception of up-and-down (and left-and-right) is not determined by your egocentric viewpoint alone, but also by environmental cues (in this case, the building

itself, other objects in the scene, and gravity). Similar manipulations have been applied to patients with neglect, for instance asking them to search for objects in a display whilst sitting upright or lying on one side. Under such conditions, some objects may be neglected on the left side with respect to the current viewpoint (i.e. the bottom of the display if the patient is lying on their left side), and some on the left of the display regardless of posture. These patterns suggest that egocentric and allocentric factors interact to determine the space that is neglected.

One special class of allocentric reference frame is object-centred. If a familiar object (like a building) has a recognisable top and bottom, we tend to think of it as having left-and-right sides that are independent of its positioning within the visual field. Consistent with this idea, neglect can affect the left side of individual objects, regardless of their position or orientation in space. For instance, a patient that usually neglects letters at the left end of words may continue to neglect the *initial* letters of words shown upside down, even though these are now seen on the right (e.g. reading PEAR as EAR). Patients may even show object-centred neglect at the same time as neglecting whole objects within the left part of space. These remarkable observations imply that selective attention uses spatial representations encoded with respect to multiple frames of reference. These representations are flexibly created, and re-created, as different frames of reference become relevant to the task at hand.

The diversity of symptoms across patients with neglect shows that it is not a single entity, but an umbrella term covering a constellation of related impairments. Moreover, in any given case, the clinical picture may depend not only on biased spatial attention, but also on co-occurring consequences of brain damage. These include reduced arousal and vigilance, which aggravate the lack of attention to the neglected side, and spatial memory problems, which impede structured searching of space. Neglect is thus a syndrome of many components, not all of which are necessary for neglect, but each of which can colour its expression. At its core, however, is the skewing of attention away from one side. This may sometimes appear as a simple lack of attention for one half of space, but what is more typically seen is a directional bias across the entire space, with things in relatively rightward positions exerting a stronger pull on attention than those that are relatively leftward.

Extinction

In the most basic assessment of visual extinction, the examiner faces the patient and holds up a finger on either side, whilst the patient looks straight ahead. The examiner then flexes one or both fingers rapidly, and the patient must report which fingers were moved. Extinction is diagnosed if the patient reports single flexions on either side, but only one when both occur together: one event ‘extinguishes’ awareness of the other. Analogous methods are used to diagnose extinction in other modalities (e.g. touch, hearing, smell). Like neglect, extinction reflects the outcome of a spatially biased competition for attention. However, it is elicited only when the stimulation is brief. Extinction may follow damage to either side of the brain, affecting the side of space opposite to the damage. Unlike neglect, extinction shows no preferential association with the right hemisphere. This has led some authors to suggest that it is separate from neglect, though others believe it to be a milder form of the same condition.

Morris Bender, who conducted the pioneering work on extinction, viewed it as a sensory disorder in which subtly impaired sensation on one side is exposed by stimulus competition. His observations of tactile extinction in patients with spinal injuries showed that the symptom can indeed arise from a sensory imbalance. Nonetheless, numerous phenomena have been found that defy sensory accounts and imply an attentional disorder. For instance, tactile extinction can be determined by position in external space rather than by the sensory surface: if a touch to the right hand extinguishes awareness of a touch to the left, then this reverses when the hands are crossed over the midline. Similarly, visual extinction can occur when the competing stimuli are within the same half of visual space, showing that it depends on relative, not absolute location. Visual extinction is also affected by various perceptual properties of the stimuli. For example, if two brackets are presented, extinction may be less likely when they face one another () than when they oppose one another)(. The former pair constitute a better group according to Gestalt laws of perceptual organisation, and are selected together rather than competing for attention.

Simultanagnosia

Simultanagnosia, one of the key features of Bálint’s Syndrome, typically requires damage to the posterior parietal lobes on both sides of the brain. The condition is reminiscent of extinction, in that the patient perceives only one object when multiple

objects are present. However, whereas extinction requires brief stimulation and is determined by spatial location, simultanagnosia persists with prolonged viewing and is insensitive to the layout of a scene, being determined instead by the objects within it. A patient with simultanagnosia will report being aware of only one object at a time. The focus may change intermittently, so that several objects are eventually perceived, but there is no experience of their simultaneous presence. In describing a scene, such a patient may give a halting commentary, naming one object and then another, without grasping their inter-relationships. A man posting a letter could be, “a man.... a letter.... a postbox”.

The existence of simultanagnosia provides reason to believe that visual attention can select specific objects, rather than just regions of space. Simultanagnosia cannot simply reflect spatially-restricted attention, because the object selected can be of any size, from a single snowflake to Mount Everest. Moreover, if two line drawings are overlapped so that they occupy the same region of space, only one of them will be perceived. Being object-based, simultanagnosia can allow researchers to probe what constitutes an object in vision. The governing principles are again predicted well by the Gestalt laws of perceptual organisation. Alexander Luria famously showed that a patient with simultanagnosia saw only one of two overlapping triangles of different colours, but a Star of David (✡) when the triangles shared the same colour, thereby cohering as one object. Similarly, only one of two side-by-side circles was seen, but a pair of spectacles was reported when a horizontal line connected the circles.

The fate of unattended things

Neglect, extinction and simultanagnosia are disorders of attention, not of sensory transmission, so the unattended stimuli are potentially available in the brain for processing. Researchers may thus ask what aspects of perception can proceed without attention, and whether things that escape awareness can shape behaviour. As noted, the likelihood of a stimulus being unattended is influenced by Gestalt grouping factors, suggesting that the perceptual organisation of a scene into its constituent parts is accomplished before attentional selection. Many other studies have reported that more complex aspects of unattended stimuli, even identity and meaning, can affect behaviour. In the most famous such experiment, a neglect patient was presented with two drawings, one of which had flames emerging from its left side. The patient

maintained that the houses were identical, but when forced to choose which house she would prefer to live in, reliably tended to choose the one that was not on fire. She avoided the flames unconsciously, despite expressing no awareness of them. Under some circumstances, unattended things may even have as strong an influence as attended things. For instance, a patient with visual extinction was found to avoid an obstacle during reaching, to exactly the same extent, regardless of whether he could report the obstacle's existence. Disorders of attention are thus powerful 'natural experiments' that allow us to query the purpose of conscious awareness, by studying what can be achieved without it. Sometimes, this is a surprisingly large amount.

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Cross-references

Attention; attention and consciousness; attention: object-based; attention: selective; attention: spatial; Bálint's syndrome; body perception: disorders of; consciousness: disorders of; perception: disorders of; neuropsychology of perception; Perceptual organization: Vision; perceptual segregation; sensation vs. perception; subliminal perception; unconscious processes; visual disorders: neuropsychological; zombies.

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