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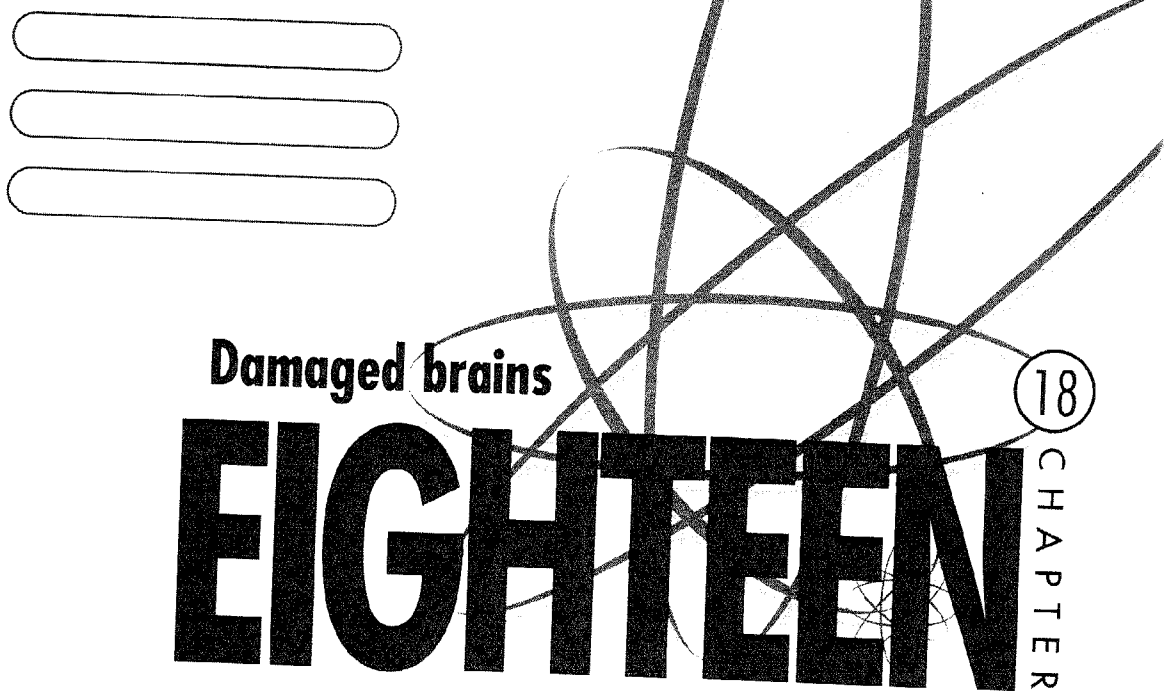

Damaged brains

EIGHTEEN

CHAPTER 18

What is it like not to notice that you don't notice half the world? What is it like to be blind but believe that you can see, or to be paralysed but convinced that you can move? What is it like to be suspended in the present moment with no memory? These, and many other questions, are prompted by the neuropsychological changes caused by brain damage. Here we will consider just three examples that have particular relevance to consciousness.

PRACTICE

IS THIS EXPERIENCE PERCEPTION OR MEMORY?

As many times as you can, every day, ask yourself **'Is this perception or memory?'**.

Starting with immediate sensory experience, you can investigate how much of what you are experiencing now would change if you had no memory, no words or labels to attach to things, and no learned associations. Is consciousness possible at all without memory? Look! Write down your answer – yes or no.

AMNESIA

'What year is this, Mr G.?' asked the neurologist Oliver Sacks (1985).

'Forty-five, man. What do you mean?' he went on, 'We've won the war . . . There are great times ahead.'

'And you, Jimmie, how old would you be?'

'Why, I guess I'm nineteen, Doc'.

Sacks then had an impulse for which he never forgave himself. He took a mirror and showed the 49-year-old grey-haired man his own face. Jimmie G. became frantic, gripping the sides of his chair and demanding to know what was going on. Sacks led him quietly to the window where he saw some kids playing baseball outside. He started to smile and Sacks stole away. When he returned a few minutes later, Jimmie G. greeted him as a complete stranger.

Jimmie G. had Korsakoff's syndrome, and nothing can be done to restore memory in such cases. Jimmie's amnesia was 'a pit into which everything, every experience, every event, would fathomlessly drop, a bottomless memory-hole that would engulf the whole world' (Sacks, 1985: 34).

Korsakoff's is the most common form of amnesic syndrome, and is caused by the toxic effects of alcohol, as well as thiamine deficiency caused by malnutrition in heavy drinkers. It typically involves specific destruction of the mamillary bodies and the dorso-medial nucleus of the thalamus, as well as other more diffuse damage to frontal lobes. As is typical in these cases, Jimmie G. suffered from two kinds of amnesia. First there is anterograde amnesia, which is the inability to form new long-term memories. Short-term memory remains intact, with patients gaining normal scores on tests. This means it is possible to talk, play games, do calculations (as long as they can be done relatively quickly), remember a phone number long enough to dial it, and even do certain kinds of work, but as soon as thoughts or perceptions leave working memory they are gone. The patient is isolated in a very brief present.

Second there is retrograde amnesia, which is a loss of long-term memory that stretches back into the past. This also occurs after accidents, concussion or trauma, in which case there is usually a period of blank memory for the accident itself, and for a variable time before. This blank period sometimes shrinks with recovery. In Jimmie G.'s case his retrograde amnesia stretched back to the end of the war, even though he had remained in the Navy until 1965, and was only hospitalised with alcoholic delirium in 1970. In Korsakoff's syndrome, episodic memory (that is, memory for the events of one's life) remains perfectly good for the far past, before the blank period, but no new episodic memories are laid down.

Although this may sound like a complete loss of all memory, it is not. Classical conditioning remains unimpaired so that patients easily learn to blink to a sound if it is paired with a puff to the eye; to associate certain smells with lunchtime, or to respond to a given visitor with pleasure, even if they claim

never to have seen that person before. Procedural learning also remains intact. Not only do amnesics frequently retain such skills as driving a car or typing, but they can learn new ones as well. They might, for example, learn to control a computer mouse, improving at every session while denying they have ever encountered such a gadget before.

"I have just become conscious for the first time."

C.W., amnesic patient

This was true of H.M., the most famous case of amnesic syndrome. H.M. was a young engineer who suffered from intractable temporal lobe epilepsy. In 1956, when all other treatments had failed, he had parts of both temporal lobes including both hippocampi removed, leaving him with devastating and permanent memory loss. In the 1960s he was trained to follow a moving target with a pointer, and to do mirror writing, skills at which he rapidly improved while denying that he had ever done them before. He also showed evidence of priming; getting quicker at recognising fragmented pictures and completing words if they had been shown before, even though he could not consciously remember having seen them. For this reason, amnesic syndrome is sometimes described as a dissociation between performance and consciousness (Farthing, 1992; Young, 1996).

Are amnesics conscious? Surely the answer is yes. They are awake, responsive, able to converse, laugh and show emotion. But who is conscious? Without the capacity to lay down new memories, their self is a person trapped in the past, unrelated to the events and people of the present. They have lost the interaction between current and stored information that, according to Weiskrantz (1997), makes possible the 'commentary' that underlies conscious experience. Some amnesics repeatedly exclaim 'I have just woken up!' or 'I have just become conscious for the first time!'. C.W. was a professional musician struck with dense amnesia by herpes simplex encephalitis (Wilson and Wearing, 1995). Although he could still sight-read music, extemporise, and even conduct his choir, his episodic memory was almost completely destroyed. He kept a diary of what was happening to him and there he recorded, hundreds of times, over a period of nine years, that he was now fully conscious, as if he had just woken from a long illness. He was conscious all right, but trapped in an ephemeral present, unconnected with the past.

Asking amnesics about such matters is difficult. As Sacks puts it

> If a man has lost a leg or an eye, he knows he has lost a leg or an eye; but if he has lost a self – himself – he cannot know it, because he is no longer there to know it.
>
> (Sacks, 1985: 34)

Amnesics create no memory of a continuous self who lives their life, or, as some would say, no illusion of a continuous self who lives their life.

Amnesia will come to many of us, and to our parents and loved ones, in the form of Alzheimer's or senile dementia. In this form it is less specific and comes on gradually. For some time the person may have enough memory to realise their predicament, which makes it all the harder. Yet, as the Russian psychologist Luria pointed out to Sacks, 'a man does not consist of memory

PROFILE

Antonio Damasio (b. 1944)

Until confronted by patients with frontal lobe damage, Antonio Damasio accepted the traditional view that 'sound decisions come from a cool head' and that reason and emotion are separate. Since then much of his work has proved the opposite. According to his 'somatic marker' hypothesis, the ability to feel emotions is intrinsic to rationality and decision making, and is closely bound up with dynamic, on-line representations of what is happening in the body. In *Descartes' Error* (1994) he explains that the mistake was to tear body and mind apart. In *The Feeling of What Happens* (1999) he distinguishes between core consciousness and extended consciousness, and between the proto-self, core self and autobiographical self. He claims that the conscious mind and its private, subjective experiences are not illusions but real entities that must be investigated as such. Born in Portugal, Damasio is Van Allen Professor and Head of Neurology at the University of Iowa College of Medicine, and Adjunct Professor at the Salk Institute.

alone. He has feeling, will, sensibilities, moral being – matters of which neuropsychology cannot speak' (Sacks, 1985: 32).

NEGLECT

How would you react if you had a stroke that left you paralysed on one side of your body? Perhaps you would feel frustrated, frightened or depressed, or perhaps you would try to be brave and immediately start finding ways to cope. It is much harder to imagine that you might not think there was anything wrong, yet this is what happens in anosagnosia (Damasio, 1999; Weiskrantz, 1997).

A patient who is completely paralysed down his left side may say that he can move perfectly well if he wants to, while making excuses for not trying to get out of bed. Another may readily explain that she is paralysed on one side yet still ask for her knitting needles to give her something to do. Part of their mind seems to know the facts, while another part does not. Psychoanalytic theories interpret the denial as psychologically motivated, or as a coping strategy based on childhood experiences, but this does not fit the facts. For example, anosagnosia only occurs with damage to particular parts of the right parietal lobe and not with damage to the left. Damasio (1999) describes it as leaving 'core consciousness' intact while damaging the 'extended consciousness' that goes beyond the here and now, and at its height is uniquely human. The connections between autobiographical memory and the body representation based in the right parietal lobe, are destroyed and this affects the core self as well.

Perhaps the most extreme example of such denial is Anton's syndrome, first described in 1899. Patients with Anton's syndrome are blind and yet insist that they can see. When they bump into things, as they frequently must, they confabulate, inventing an ingenious range of excuses rather than concluding that they are blind. Sacks describes one completely blind man who acknowledged that his eyes were not all that good but said that he enjoyed watching television. Watching television, for him, meant listening attentively and inventing scenes to go along with the soundtrack. 'He seemed to think, indeed, that this was what "seeing" meant, that this was what was meant by "watching TV", and that this is what all of us did' (Sacks, 1992: 188).

You might be wondering what such people are experiencing. Surely, you might think, they must either be seeing a blank darkness in front of them

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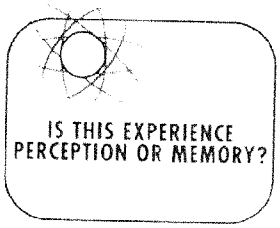
(like a seeing person does with their eyes closed), or they must be hallucinating and seeing things that are not there. If you think this way you may be imagining that there must always be *something* on the screen in the Cartesian theatre. If so, it is worth remembering James's unnoticed 'gaps', and the troublesome case of filling in the blind spot (see Chapter 6). As we saw, there may be no need for the blind spot to be filled in. As Dennett put it, there is a lack of 'epistemic hunger' in that part of the visual field. There are no neurons corresponding to that spot saying 'tell me what's there'. Perhaps Anton's syndrome is more like this than like ordinary blindness. When I shut my eyes the expected information is missing so I see a blank darkness, but if I had no neurons to expect the information then there would be no sign that anything was missing (there would be an absence of information rather than information about an absence). Perhaps this is what Sacks meant when he said of his blind patient 'Thus he had apparently lost the very idea of seeing.'



"without direct experience we will never know what is it like to be a patient affected by unilateral neglect"

Bisiach, 1988: 117

Some people do not lose their sight, but instead lose half their world. In the phenomenon of hemifield neglect, or unilateral neglect, patients seem not to realise that the left-hand side of the world even exists (Bisiach, 1992). Like anosagnosia, hemifield neglect occurs only with right-brain damage. After a stroke to the right hemisphere one woman applies make-up only to the right side of her face, and eats only from the right side of her plate. A man shaves only the right side of his beard, and sees only the right side of a photograph.

Many tests reveal the peculiarities of this condition. When asked to copy a drawing of a flower, some patients accurately copy the right half, while others squash all the petals onto the right side. When asked to draw a clock face, some just leave out the left half, while others squash all the numbers onto the right, either way they do not draw a complete face. When asked to draw maps, they may distort them so as to squeeze important cities or landmarks into just one side. And when asked to bisect a horizontal line they typically mark it far to the right of the mid point, suggesting that they do not see the left-hand part of the line. However, it is not as though they have lost half their vision, which would be simple enough, but that they have lost something much more fundamental.

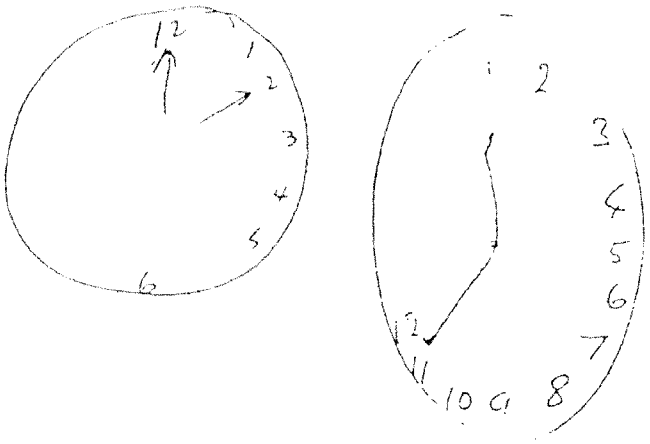


FIGURE 18.1 • An example of a drawing by a patient in the acute phase after a stroke.

In Milan, Italian neurologist Edoardo Bisiach asked his neglect patients to imagine that they

were standing in the beautiful cathedral square. First he asked them to imagine standing at one side, facing the fantastic Duomo with its pinnacles and magnificent façade, and to describe what they saw. They knew the piazza well and described the buildings that would lie to their right if they were standing in that position, leaving out all those on the left. But they had not forgotten the very existence of those on the left. When asked to imagine standing on the other side, facing the other way, they described all the buildings they had previously left out (Bisiach and Luzzatti, 1978).

Hemifield neglect can partly be explained as a deficit of attention, in that patients simply do not attend to, or have their attention drawn to, the left-hand side of their world, and to some extent they can be helped by training them to keep turning from side to side, like a lighthouse. Yet clearly the unattended side is not completely blanked out. Emotional stimuli shown in the neglected field can influence attention, and stimuli that are not consciously seen can prime later responses. In one experiment patients were shown two pictures of a house, identical except that one had flames pouring from a window on the left-hand side. While insisting that the houses were identical, patients still said they would prefer to live in the one that was not on fire (Marshall and Halligan, 1988). Although subsequent studies have shown rather different results for the house test, the conclusion remains that stimuli that are not consciously seen can still affect behaviour.

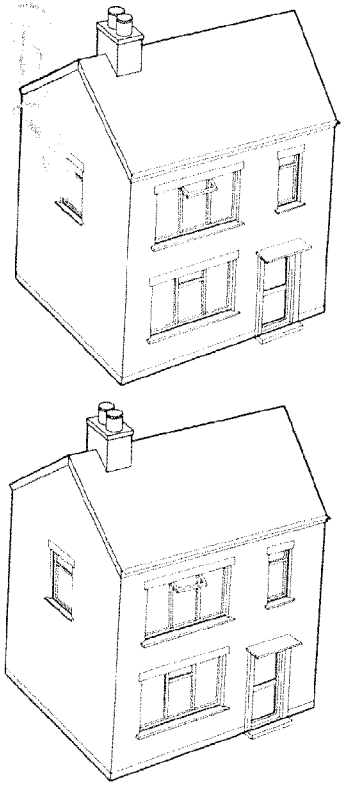


FIGURE 18.2 • Figure used to investigate covert processing in a patient with hemi-neglect of the left half of the visual space. The two figures looked identical to the subject because only their right halves were reported as seen. Nevertheless, when required to indicate which house she would prefer to live in, she chose the bottom one, although she said she was guessing. In the original, the fire in the top figure was coloured red (after Marshall and Halligan, 1988).

Weiskrantz describes it this way: 'The subject may not "know" it, but some part of the brain does' (Weiskrantz, 1997: 26), but perhaps this implies a unitary, superordinate 'subject' who watches the workings of the lower mechanisms. According to Bisiach (1988) there is no such entity, for the task of monitoring inner activity is distributed throughout the brain. When lower-level processors are damaged, higher ones may notice, but when the higher ones are gone there is nothing to notice the lack.

Bisiach (1988) claims that we can never know what it is like to suffer neglect, but perhaps we already do. Remembering the snakes, and the fish in the garden pond (see Chapter 12), it is easy to accept that we neither see in the

infra-red nor notice its absence. In this sense we all live our lives in a profound state of neglect.

BLINDSIGHT

Imagine the following experiment. The subject is D.B., a patient who has had a small non-malignant brain tumour removed. The tumour had encroached into area V1 and, since input from the right visual field goes to the left visual brain and vice versa, removal of V1 on one side left him blind on the other (a condition called hemianopia). If he looks straight ahead and an object is placed on his blind side he cannot see it.

In the experiment D.B. is shown a circle filled with black and white stripes in his normal field. Naturally enough he says he can easily tell whether the stripes are vertical or horizontal. Now he is shown the same thing in his blind field. He says he can see neither the circle nor the stripes; for he is blind there. Even so, the experimenters encourage him to guess which way the stripes go. He protests that this is pointless, because he cannot see anything, but nevertheless he guesses. He is right 90 or 95 per cent of the time.

'Blindsight' is the oxymoronic term invented for this strange phenomenon by Oxford neuropsychologist Lawrence Weiskranz. Together with neuropsychologist Elizabeth Warrington, he tested D.B. from the early 1970s for ten years or more (Weiskrantz, 1986; 1997). Since then many other blindsight patients have been tested, the most famous of whom is G.Y., who suffered traumatic head injury in a car accident when he was eight years old. Most 'blindseers' (as we may call them) have extensive damage to visual striate cortex on one side, which causes degeneration of cells

FIGURE 18.3 • Which way do the stripes go? When such a display was shown to the blind field of a subject with hemianopia (blind on one side), he said he could see nothing at all. Yet when pressed to guess he was able to discriminate vertical from horizontal stripes with over 90% accuracy. This is how the term 'blindsight' originated (after Weiskrantz, 1997).

ACTIVITY

Blind for an hour

This is a simple exercise designed to give a hint of what it is like to be blind. You need to work in pairs and can take it in turns to be blindfolded or to be the guide. You need a good blindfold that does not allow you to peep. It is possible just to wear dark glasses and to keep your eyes closed, but the temptation to open them is too great for most people, so a blindfold is easier.

Take an hour for the exercise and plan what you will do. For example, you might go shopping, or take a walk, or go to a party or visit friends. Try to do as much as you can without help, but be careful to avoid dangerous activities such as cooking. Your guide must take responsibility for crossing roads and other obvious dangers, and should stay close to you all the time.

Afterwards, think about what surprised you. Which things were easier or more difficult than you had expected? What happened in social situations?

If you are blind this exercise is no use to you, but you can be of great help to others. You might teach them to use a long cane, or discuss the ways in which you cope without vision.

For a devastating and insightful description of what it is like to go blind see Hull (1990).

down through the lateral geniculate and even to the retina, while other, non-cortical visual pathways are left intact. Other similar phenomena such as 'deaf hearing', 'blindsmell' and 'numbsense' have added to the cases in which people deny having conscious sensory experiences and yet behave as though they can see, hear, smell or feel (Weiskrantz, 1997).

Blindsight seems to be tailor-made for resolving philosophical arguments about consciousness. Yet it has not done so. Blindsight has been used to support qualia and to reject them, to bolster zombies and to undermine them, and to support controversial distinctions between different kinds of consciousness (Dennett, 1991; Holt, 1999; Block, 1995). The arguments have been so long and fierce that it is worth considering blindsight in some detail.

What is going on? Superficially, the most obvious interpretation goes something like this. The blindseer has vision without consciousness. He is an automaton or a partial zombie who can 'see' functionally but has none of the visual qualia that go with normal seeing. This proves that consciousness is something separate from the ordinary processes of vision. It proves that qualia exist and functionalism is wrong.

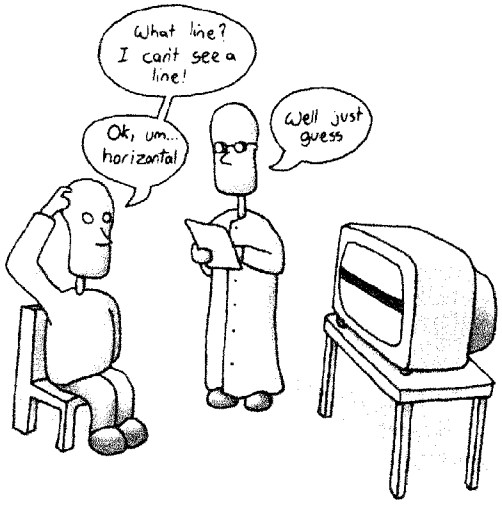
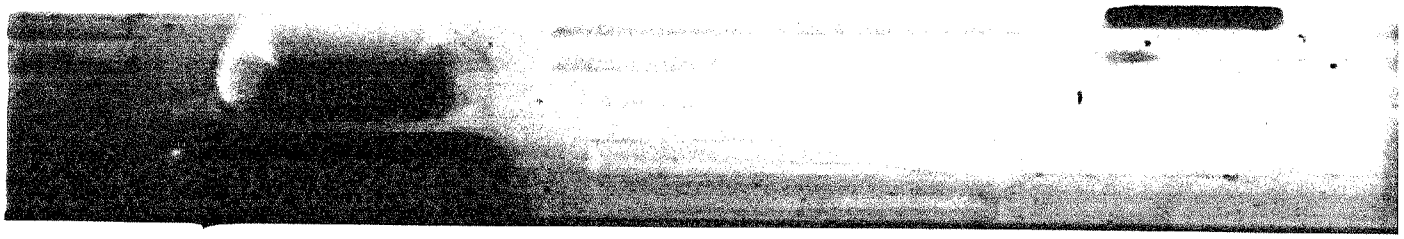


FIGURE 18.4 • The blindsight subject has to be pressed to guess the orientation of a line he cannot see. Yet his guesses can be very accurate. Is he a partial zombie who has vision without conscious vision?

If it were valid, this line of reasoning would have many other implications. For example, it would hold out the hope of finding the place in the brain where 'consciousness happens', the place where visual qualia are produced, or where representations 'enter consciousness'. We would know, for example, that qualia happen in V1 while all the rest of vision goes on elsewhere. This would encourage speculations about the evolution of consciousness; for if we have qualia *as well as* vision then there must be some extra function for consciousness.

But this apparently natural way of thinking about blindsight walks straight into all the usual troubles we have met before: the Cartesian theatre where consciousness happens, the Cartesian materialist idea of a 'finishing line' marking entry into consciousness, the hard problem of how subjective qualia can be produced by objective brain processes, and a magic, unexplained, difference between those areas that are conscious and those that are not. This explains why blindsight has become such a *cause célèbre*. Either it really has all these dramatic and mysterious consequences and they need explaining, or there is something wrong with the 'obvious' interpretation.

What could be wrong? The first possibility is that blindsight does not really exist. This possibility has been pushed to the limit. Sceptics have raised three main objections (Kentridge and Heywood, 1999; Weiskrantz, 1986). First they suggested that light might have strayed from the blind field into the seeing field. This was dealt with by flooding the seeing field with bright light



so that if there were any stray light from the other side it would not be detectable, and this made no difference to the phenomenon. In other experiments, the stray light function was measured and found not to account for the effects. Finally, the blind spot was used as a control, on the grounds that stray light should have the same effects there if it were responsible for blindsight. In this experiment, the subject guessed whether or not there was a light, while it was shone either on his blind spot or on some other part of his blind field. In all cases he said he saw nothing, but when the light was on his blind spot he guessed at chance, while on neighbouring areas of his blind field he guessed significantly above chance. Stray light cannot account for blindsight.

The second objection was that blindsight is nothing more than degraded normal vision – in other words, blindseers have severely restricted visual function and severely degraded qualia to match. One way of testing this is to ask subjects to give confidence ratings for their guesses. In normal subjects, confidence correlates closely with the accuracy of detection, but in blindsight this is not so. Another way is to use the 'commentary-key paradigm', developed by Weiskrantz, in which subjects not only press keys to say where, when or whether a stimulus is there, but also have two commentary keys to press. One indicates that 'yes' they had some experience of the stimulus (a feeling, knowing, tingle or whatever) and the other 'no', they had no experience at all. Using this paradigm, blindseers have been shown to respond very accurately while claiming no awareness at all (Weiskrantz, 1997).

A related argument is that blindseers are just overly cautious about saying they can see something. In the terminology of signal detection theory (see Chapter 19), it is not their sensitivity that is affected but their response criterion that is raised. This, and other objections, have been countered by German physiologist Petra Stoerig (Stoerig and Cowey, 1995). For example, the response criterion can be altered by varying the proportion of stimuli to blank trials but this does not affect blindsight.

Another possibility was that blindsight might depend on residual islands of cortical tissue. Although some patients do have such residual visual cortex, there are many who do not. PET and fMRI scans of G.Y. show no activity at all in V1, suggesting that his blindsight depends on other structures. There are something like 10 separate, parallel pathways from the eye to different parts of the brain. About 85 per cent of cells take the major route through the lateral geniculate to primary visual cortex but the rest go via the superior colliculus to various other cortical and subcortical areas. These are not affected by destruction of V1. The evidence suggests that true blindsight occurs when V1 is destroyed and these other pathways remain intact.

Blindsight can be detected in many ways. For example, while denying consciously seeing anything, subjects can makes saccades to stimuli, point to the location of objects, mimic the movement of lights or objects in the blind field, and show pupillary and other emotional responses to stimuli they cannot see. G.Y., for example, can discriminate different facial expressions presented in

CONCEPT

SENSORY SUBSTITUTION

Can the blind learn to see? Retinal implants, or completely artificial eyes, may one day be possible but for the moment the task of wiring them into the brain is too difficult. Fortunately there is another way of solving the problem: by substituting one sense for another.

The first attempts at sensory substitution were made by Paul Bach-y-Rita in the late 1960s (Bach-y-Rita, 1995). Signals from low-resolution cameras on special glasses went to an array of just 16 by 16 vibrators fixed to a subject's back. Even with this crude device people could walk about, read signs and even identify faces. Much higher-resolution devices followed (called Tactile Vision Substitution Systems – TVSS), with tactile arrays on the back, abdomen, thigh and fingertips. After sufficient training with TVSS, blind people experienced the images as being out in space rather than as vibrations on their skin, and they learned to make judgements using parallax, depth, looming and other visual cues.

The tongue is far more sensitive than the back, and is highly conductive, so more recent brain–machine interfaces have used 144 gold-plated electrodes on the tongue. By moving the video camera around, either by hand or on the head, the subject can explore the environment in the way that sighted people do by moving their eyes. The effects are dramatic. Within a few hours, one congenitally blind woman was able to move about, grasp objects, and even catch and toss a ball rolled towards her. She specially asked to see a flickering candle – something she had never been able to experience through any other sense (Bach-y-Rita and González, 2002).

A similar array on the tongue was used to replace vestibular feedback in a woman who had lost her vestibular system and therefore could not walk, or even stand upright, on her own. She could stand almost immediately using the new system, and without any training.

his blind field. This ability was shown to depend on information in the minor pathway running through the superior colliculus and amygdala (Morris *et al.*, 2001). Stimuli in the blind field can prime or bias detection of stimuli in the seeing field, and there are other odd effects. For example, if a half circle is shown in the seeing field a half circle is reported, and if shown in the blind field, nothing is reported. But if both halves are shown together, a complete circle is seen (Weiskrantz, 1997).

Several blindseers can correctly guess the colour of stimuli they cannot see. As Weiskrantz points out, 'The subjects seemed to be able to respond to the stimuli that would normally generate the philosophers' favourite species of "qualia", namely colours, but in the absence of the very qualia themselves!' (Weiskrantz, 1997: 23).

The phenomenon of blindsight is therefore real enough, but what does it tell us about consciousness? 'Does it provide a disproof (or at any rate a serious embarrassment) to functionalist theories of the mind by exhibiting a case where all the *functions* of vision are still present, but all the good juice of *consciousness* has drained out?' asks Dennett. Not surprisingly he replies 'It provides no such thing' (Dennett, 1991: 325).

To explain why not, Dennett notes that in most experiments blindseers have to be prompted to guess, and are given no immediate feedback on their success. Dennett now imagines training a blindsight patient by giving him feedback on his guesses, until he comes to realise that he has a useful ability. Next he is trained, again by giving feedback, to guess on his own, without being prompted. After this training he should spontaneously be able to talk about, act upon, and use the information from his blind field just as well as from his seeing field. Others have dubbed this 'super blindsight' (Block, 1995; Holt, 1999) and it has been much disputed.

The argument really hinges on this question – if the superblindseer could really use the information about a stimulus in his blind field in this way, would that mean he was necessarily conscious of

it? It is worth trying to imagine this in some detail to decide on your own answer. Functionalists would say yes (because being conscious *is* performing these functions), while those who believe in the existence of qualia, conscious inessentialism, and the possibility of zombies would say no (because the functions and the qualia are separate things and the superblindseer has one but not the other).

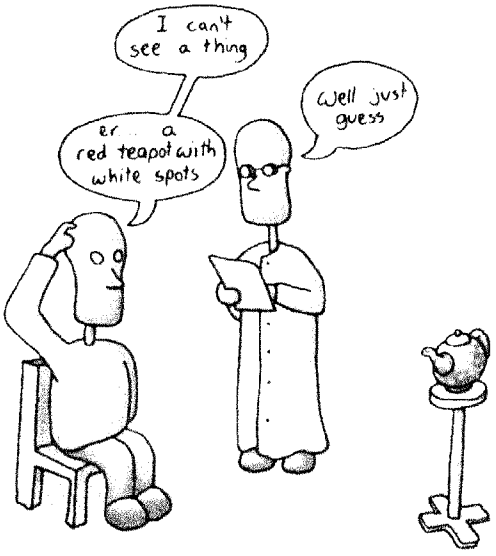


FIGURE 18.5 • Super-blindsight. Imagine that a patient with blindsight is trained to make spontaneous guesses about things he cannot see.

There is some evidence that bears on this. First, it is important to realise just how impoverished blindsight is. In spite of their remarkable ability to detect stimuli and simple features without awareness, blindseers generally cannot recognise forms or identify familiar objects. They cannot (or at least do not) use their blindsight in ordinary life (in this sense they really are blind). When thirsty, they would not pick up and drink from a glass of water that lay in their blind field (Marcel, 1986). They have to be prompted, and even pushed, to make their accurate guesses in the laboratory. Indeed some have, understandably, refused to cooperate, and only a few are willing to spend days, weeks or even years, guessing at things they

FIGURE 18.7 • Pat Fletcher is seeing with 'Soundscapes'. She wears headphones and has tiny video cameras are concealed in her glasses. A notebook computer in her backpack carries out the video-to-audio transformations that enable her to see well enough to walk about, pick up objects and even recognise people. But is it seeing? She says it is.

CONCEPT CONTINUED

In a completely different approach, sound is used to replace vision. In Peter Meijer's (2002) method a video image is converted into 'soundscapes'; swooping noises that might be thought of as sound-saccades, in which pitch and time are used to code for left–right and up–down in the image. He put the necessary software on the web, and among those who tried it was Pat Fletcher (2002), who was blinded in an industrial accident in 1999. The system took her many months to master, unlike the tactile systems, but eventually she began to see depth and detail in the world.

But is it really vision? Fletcher says it is, and that she does not confuse the soundscapes with other sounds. She can have a conversation with people while using the soundscapes to look at them, and she even dreams in soundscapes.

All this has profound implications for the nature of sensory awareness. The ease with which one sense can stand in for another suggests that there is nothing intrinsically visual about information that goes in through the eyes, or intrinsically auditory about information that comes in through the ears. Rather, the nature of the information, and the way it changes with a person's actions, are what determine how it is experienced. This fits well with sensorimotor theory, which treats vision and hearing as different ways

CONCEPT CONTINUED

of interacting with the world. The same conclusion is reached from experiments in which the sensory systems of ferrets are rewired soon after birth. If visual information is routed to auditory cortex, that cortex develops orientation-selective responses, maps of visual space and control of visual behaviour as visual cortex normally would (Sur and Leamey, 2001). In other words, it seems as though the nature of the input determines the way sensory cortex is organised.

This kind of research might help solve a classic mystery: how the firing of some neurons leads to visual experiences while identical kinds of firing in different neurons leads to auditory experiences. Perhaps more important for the blind, it suggests that seeing does not necessarily need eyes.

SELF-ASSESSMENT QUESTIONS

- What is amnesic syndrome? Which kinds of memory are lost and which are retained?
- Describe two or more amnesic patients. What do their cases tell us about consciousness?
- What is Anton's syndrome and how might it be explained?
- Describe some experiments that reveal the nature of the deficits in hemifield neglect.
- What is blindsight? How is it caused, and how can it be detected?
- Compare the arguments that have used blindsight to support the possibility of zombies with those that use blindsight to undermine it.
- What is sensory substitution and why might it be relevant to consciousness?

cannot see. So the hypothetical superblindseer has abilities way beyond those of actual blindsight.

Second, blindseers are sometimes aware of certain kinds of stimuli in their blind field, especially fast-moving, high-contrast ones. This is known as the 'Riddoch phenomenon' since its discovery in 1917 by the Scottish neurologist George Riddoch (1888–1947), who worked with injured soldiers in the First World War. This residual ability makes sense in terms of the anatomy because the minor visual pathway has projections to V5, which is motion-sensitive. Indeed activity in V5 has been shown in G.Y. by PET scan (Barbur *et al.*, 1993).

Using the commentary-key paradigm, Weiskrantz showed that G.Y. could accurately detect both slow- and fast-moving stimuli, but was only aware of the fast ones. Morland (1999) explored this awareness further by getting G.Y. to match the speed of moving stimuli shown in his blind field to those in his seeing field. The results showed that the two were perceived as equivalent. In other words, as far as motion is concerned G.Y.'s perception in the blind field is the same as that in his seeing field. Yet G.Y. does not identify the experience as really 'seeing'; he explained that 'the difficulty is the same that one would have in trying to tell a blind man what it is like to see' (Weiskrantz, 1997: 66). This makes sense because it is very difficult to imagine what it is like to see movement without seeing the thing that is moving, yet that is the ability that G.Y. has. Morland concludes that primary visual cortex is not needed for consciousness, but it is needed for binding the features of objects. So the experience of movement in blindsight is just that – seeing movement that is not bound to a moving object.

Some patients show appropriate eye movements to track displays they cannot see, or can mimic the path of an invisible stimulus with their hands. Some can make reasonably accurate movements to grasp invisible objects, and even to post invisible cards through slots with the correct orientation. This may seem very odd, but it makes sense in terms of the distinction between the dorsal and ventral streams. Milner and Goodale (1995) suggest that 'blindsight is a set of visual capacities

mediated by the dorsal stream and associated subcortical structures' (Milner and Goodale, 1995: 85). This fits with the finding that the accuracy of some responses in blindsight (such as limb movements) is higher than others (such as eye movements), as well as with Weiskrantz's observation that 'the intact field seems to be biased towards object identification, and the blindsight field towards stimulus detection' (Weiskrantz, 1997: 40). If this is correct, it means that the detection of stimuli in blindsight is based on visuomotor responses.

Milner and Goodale also note that G.Y. reports a different non-visual experience when asked to use different visuomotor responses. They do not conclude that consciousness is obliterated along with the ventral stream, but rather that there may be 'a distinct non-visual experiential state associated with each different visuomotor system activated' (Milner and Goodale, 1995: 79). On their view blindsight should not be seen as perception without consciousness, but as action without perception.

"the difficulty is the same that one would have in trying to tell a blind man what it is like to see"

G.Y., patient with blindsight

A third kind of evidence comes from studies of sensory substitution, in which people are given information in one sense to replace another – for example, touch or sound to replace vision. They, too, have trouble describing what the experience is like, but with practice it comes to seem more and more like seeing. If this is correct, it suggests that consciousness comes along with increasing function, rather than being something separate from it.

What can we now conclude about the status of blindsight? Is it really a mysterious phenomenon that proves the existence of qualia and the possibility of zombies?

Among those who think so, Marzi (1999) argues that the residual functions in blindsight are 'banned from consciousness' because the neural activity does not reach the 'consciousness centres'. Holt (1999) argues that blindsight and superblindsight are both evidence for the reality of qualia, although he leaves open the question of whether qualia are epiphenomenal or identical to neural states or processes. Stoerig and Cowey (1995) refer to blindsight as visual processing in the absence of phenomenal vision. They suggest that conscious access to processed information requires higher cortical structures, and its function is to enable conscious retrieval, thinking and planning.

In his paper 'On a confusion about a function of consciousness', Block (1995) rejects this kind of argument. On his view, it reveals a confusion between two kinds of consciousness (see Chapter 2). Access consciousness is the availability of information for use in reasoning, speech and action. Phenomenal consciousness is experience, or 'what it is like' to be in a given state. He argues that stimuli in blindsight are both access-unconscious (because the patient cannot use the information) and phenomenally unconscious (because the patient denies experiencing them), but that people confuse the two, wrongly giving a function to P-consciousness that really belongs to A-consciousness. Note, however, that according to the way we are using the term 'consciousness' in this book, only P-consciousness counts as 'consciousness', which is why I have not used Block's distinction here. For Block, the superblindsight case is indeed a partial zombie who has A-consciousness (because he can talk

"blindsight does not support the concept of a zombie; it undermines it"

Dennett, 1991: 323

about stimuli in his blind field) but no P-consciousness (because he still has no visual qualia). On this view the mystery of P-consciousness remains.

For others the mystery is disappearing as we learn more about the phenomena. As far as Dennett is concerned all the kinds of evidence discussed here weigh against both zombies and qualia. The superblindseer would not go on denying having qualia, but would acquire experiences to match the quality of the abilities he came to have. If he could be trained to act on, and talk about – in other words, to have access to – stimuli in his blind field then he would also become conscious of them.

Weiskrantz suggests that blindseers lack what he calls the 'commentary stage' in which information becomes available for comment, either verbally or in other ways. So, again, the superblindseer who could comment on his own abilities would thereby become conscious of them. This is similar to HOT theory in which information is conscious only if there is a higher-order thought to the effect that the person is experiencing it.

Finally, Milner and Goodale suggest that 'Blindsight is paradoxical only if one regards vision as a unitary process' (Milner and Goodale, 1995: 86). On their view of the visual system, there is no single visual representation that is used for all purposes, but lots of semi-independent subsystems; those in the ventral stream leading to perception and those in the dorsal stream to fast visuomotor control. Any or all of these can give rise to different kinds of experience. Once again, the mystery looks quite different to those who are prepared to abandon the idea of unified consciousness, or a show in the Cartesian theatre.

READING

Block, N. (1995) On a confusion about a function of consciousness. *Behavioral and Brain Sciences 18, 227–87.*

Kentridge, R.W. and Heywood, C.A. The status of blindsight. *Journal of Consciousness Studies 6, 3–11.*

Sacks, O. Read any chapter from *The Man who Mistook his Wife for a Hat* (1985) or *An Anthropologist on Mars* (1995).