SCIAM OBSERVATIONS

Opinions, arguments and analyses from the editors of *Scientific American*

September 4, 2007

10:20:34 am, Categories: Life Sciences, Medicine, Mind Matters, 1515 words

Blindsight: When the brain sees what you do not

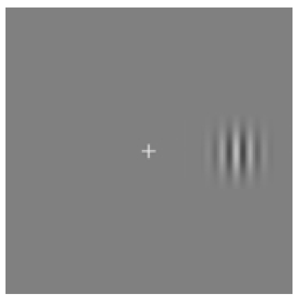
Welcome to

Mind Matters

where top researchers in neuroscience, psychology, and psychiatry explain and discuss the findings and theories dr iving their fields. Readers can join them. We hope you will.

This week:

Blindsight: When the Brain Sees What You Do Not



A Gabor patch (at right). Such patches are commonly used to test for blind spots or visual awareness. At least one blind person, however, can see these better than sighted people can.

——

Introduction

by David Dobbs

Editor, Mind Matters

When can you see what you can't see? When you have blindsight, a "condition," says the Oxford Concise Dictionary, "in which the sufferer responds to visual stimuli without consciously perceiving them." Here vision researcher Susana Martinez-Conde desc ribes how a man named DB perceives flickering Gabor patches (see illustration above) much more accurately and consistently in his "blind " eye than in his sighted eye -- even though he denies ever seeing anything with the blind eye. Sacksian stuff here; read it and wonder.

——

Blindsight: The Blind Leading the Sighted

Susana Martinez-Conde
Barrow Neurological Institute
Phoenix, Arizona

DB is a 67-year-old man who has been blind to the left half of his visual field since age 26, following a neurosur gical operation. The operation, which was necessary to remove a vascular malformation in his occipital lobe, unfortunately destroyed the part of D B's right hemisphere corresponding to the primary visual cortex. The primary visual cortex, also called area V1, is the brain's largest area and one of over two dozen regions dedicated to vision. V1 serves many important functions. Among them, it relays visual information fr om the eyes to higher cortical visual areas.

Since DB lost the right half of area V1, it did not surprise his doctors that he became blind in the left half of his visual field. (The right part of the brain processes visual information from the left half of the visual field, and vice versa.) But they were asto unded that, although DB denied seeing any visual targets presented to the left visual field, he was nevertheless able to accurately "guess" many properties of targets presented there, such as shape, specific location and other aspects one could only know of by seeing them.

DB's ability to provide accurate information about unseen targets is called " blindsight." Blindsight is thought to be due to information flow through secondary neural pathways that bypass area V1 but which nevertheless convey a small amount of visual infor mation to higher visual cortices. For some unknown reason, these secondary routes are not sufficient to maintain the feeling of sight. Thu s the blindsight patient has the subjective feeling that he or she is blind, and reports visual information only when forced to take a guess.

Oxford University psychologist Larry Weiskrantz and colleagues tested began testing DB's abilities extensively during in the 1970s and 1980s and have continued to this day. In the meantime, other blindsight patients have been identified and examined. DB's detection abilities are considerably superior to other blindsight cases, however. In the paper reviewed here, " Can Blindsight be Superior to "Sighted-Sight'?," Ceri Trevethan, Arash Sahraie and Weiskrantz set out to directly compare DB's blind field sensitivity with his sighted field sensitivity and also with normal vision in a group of healthy volunteers.

In the Country of the Sighted, the Blind-Sighted Man is King

Trevethan, Sahraie and Weiskrantz conducted three experiments. In Experiment 1, they informed DB that a visual sti mulus called a Gabor patch (see figure below) would appear on a gray screen in one of two time spans. They would then ask DB to indicat e, with a button press, which time interval the target had appeared in; he was asked to pick one of the two intervals even if he wasn't co mpletely sure he saw anything -- in other words, to guess. In this first experiment the stimulus presentations to the blind and the sig hted fields were "blocked" â€“ that is, a block of 30 sequential stimulus presentations (each with two time intervals, only one of which containe d a stimulus) were made to DB's blind field (his left eye), followed by 30 stimuli presentations to the sighted field. Astonishingly, DB perf ormed better in his blind field than in his sighted field, and by a wide margin. He correctly identified the time span containing the stimulus 87 perce nt of the time in his blind field as opposed to only 50 percent of the time in his sighted field -- a rate consistent to that he would achieve if he were guessing.

However, because the trials were blocked, it was theoretically possible that DB might have somehow varied his perf ormance based on whether he expected to see the stimulus; after all, he expected to see it in his right eye but not in his left. So in a second variant of Experiment 1, a total of 100 stimuli presentations were randomly interleaved to the two sides. In this trial DB could not kno w whether a given stimulus would appear in the blind or the sighted field, so he had to approach the task in exactly the same manner in eithe r situation. He again did much better detecting the stimulus in the blind field (84 percent correct) than in the sighted field, where he aga in correctly detected just 50 percent. Ironically, DB found the field tests on the sighted side hard work, whereas the blind field tests seemed effortless ("No problem, I'm just guessing").

In Experiment 2, Trevethan and colleagues quantified the sensitivity difference between blind and sighted fields b y presenting a range of stimulus contrasts, with some figures at higher contrast, and thus easier to detect, than others. In his blind fie ld, DB was able to detect stimuli with contrast as low as 6 percent. In his sighted field he required a 12 percent contrast stimulus for successful detection.

Although these results so far seemed astounding, one potentially mundane explanation remained. Perhaps DB's sighte d field simply suffered from poor vision. If so, his superior performance in his blind field might simply reflect the abnormally poor visi on in hs sighted field. To rule out this possibility Trevethan and colleagues carried out a final experiment. In Experiment 3, they tested a group of six naive (that is, new to such testing) aged-matched participants with normal vision, using the same detection task as in Experiment 1. The resul ts showed DB's vision in his sighted field to be equivalent to that of normal, healthy subjects. In conclusion, DB's blind field sensitivity is not merely superior to his own sighted field, but also to normal vision.

Awareness without perception

An interesting aside concerns DB's reports of subjective awareness during the experiments. In Experiment 1, DB was asked to report any feelings of subjective awareness of the stimuli, or lack thereof, after each stimulus presentation. He reported no awareness of stimuli presented to the sighted field (confirming that he was essentially guessing), but he had subjective awareness of 8 0 percent of stimuli presented to the blind field. However, this subjective awareness was nothing like a visual experience; he denied h aving any experience of vision in his blind field, but described his subjective awareness of stimuli as "feeling as if a finger is pointin g through the screen." Interestingly, DB's subjective awareness of stimuli presented to the blind field disappeared during the interleaved trials, in wh ich stimuli presentations to the blind and sighted fields were intermixed. This finding suggests that DB's subjective awareness during blind field presentations is related to his expectation that he will not be able to actually see the stimulus during those trials.

The most fascinating aspects of this study are two-fold. First, the study intriguingly dissociates the feeling of awareness from the feeling of visual experience. That is, DB is sometimes subjectively aware of stimuli that he is blind to. Thus (the lack of) function in area V1 may not be critical to subjective awareness per se, but to the feeling of visual experience. If a missing V1 is your vision s ystem's only flaw, you may actually be aware of much that you cannot see.

Second, this work revolutionizes the definition of blindsight from a residual set of vision skills to a type of su perior sight. But let's not be too quick to conclude that blindsight individuals have vision superpowers -- Daredevil, the blind Marvel Comics superhero with radar-like perception, comes to mind. Someone playing (Dare)devil's advocate might suggest that DB, who has participated in m any vision experiments over the years, shows impressive detecting abilities because he has spent years practicing a specific type of skil l in a familiar experimental condition. It may also be that other patients with similar lesions may not share DB's extraordinary blindsight. An d despite his prowess in the lab, DB might not want to don a spandex costume and start fighting crime just yet.

Nonetheless, this paper raises some questions that vision and consciousness researchers are sure to focus on, and it demonstrates that -- at least in certain conditions -- blindsight can be superior to normal sight. As Daredevil once said: "Yeah, tell the m you got beat by a blind man, too."

Susana Martinez-Conde is the director of the Barrow Neurological Institute's Laboratory of Visual Neuroscience, where she studies, the neural code and dynamics of visual perception.

Posted by David Dobbs · 2 comments

COMMENTS ✔ – Editor's Pick 1 - 2 of 2