Neuroscientists gain insights into blindsight

Nadja Geipert

EUROSCIENTISTS using transcranial magnetic stimulation to induce temporary blindness report that healthy volunteers are still able to sense colour and orientation of visual stimuli through a secondary unconscious visual pathway.

The study answers the thirty-year old question whether this phenomena, called blindsight - first observed several decades ago in legally blind patients due to primary visual cortex damage - exists in healthy humans.

The researchers used transcranial magnetic stimulation (TMS) to induce very short-term blindness in four healthy women and two men. The first step was to use TMS to localise the primary visual cortex and determine the stimulation intensity needed for disruption. Then the scientists presented the study participants with either green or red dots while "blinding" them briefly with TMS. They did a similar experiment with six different volunteers, this time using vertical or horizontal lines.

The stimulation with TMS, which lasts only 60-100 milliseconds over visual cortex, has to occur after presenting the visual stimulus to effectively interrupt the information being projected from the retina to visual cortex, he explained.

Blinded subjects discriminate colour and orientation of visual stimuli

When asked what they had seen, the volunteers responded that they couldn't see anything. But when forced to choose between a vertical and horizontal line or a green and red dot, the participants guessed correctly 75% of the time when it came to the stimulus' orientation and 81% of the time when guessing the stimulus' colour. One person even guessed the colour of the visual stimulus correctly every time. Statistical analysis confirmed that the "blinded" volunteers' performance was well above chance.

"We showed that people can discriminate colour and orientation of visual stimuli at highly accurate levels without any conscious awareness and while their primary visual cortex was disrupted," said Tony Ro PhD, associate professor of psychology at Rice University in Houston, Texas and the study's lead investigator. As a last step, the investigators asked the study participants to rate how confident they felt about their guesses on a scale from 1 to 10. When they rated themselves more confident about their guesses, they also were more accurate. But still, even the participants who rated their confidence low guessed accurately much more often than they estimated, which suggests the subjects had processed more information than they were aware of.

"There is a dissociation between what people know about their performance and their actual performance," said Dr. Ro.

In the cases of higher confidence ratings, the subjects might have been unaware of their knowledge, but the unconscious processing probably still affected their sense of their own performance, according to Dr. Ro.

Most importantly however, the findings indicate that the brain has an alternate visual pathway that bypasses the primary visual cortex and allows for the "correct" processing of visual information without consciousness.

Secondary pathway of visual processing

Vision researchers have known for some time that the pathway for conscious processing of visual information runs from the retina to a sub-cortical structure, the thalamus, and then to the visual cortex. They have also long believed that there is a secondary pathway that springs to action when patients with visual cortex damage demonstrate some ability to respond to visual stimuli even though they can no longer "see". Until now it was unclear whether this secondary pathway also functions in healthy subjects with an intact visual cortex, and many researchers hypothesised that the secondary pathway, which most likely runs from the retina to the superior colliculus directly to the extrastriate cortex, only strengthens when people suffer from primary visual cortex damage.

“We will learn more about how the visual brain is organised through this kind of work,” Sabine Kastner PhD

“If you would have asked me if the secondary pathway functions in healthy people, I would have said no way. We will learn more about how the visual brain is organised through this kind of work,” said Sabine Kastner MD PhD, associate professor of psychology at Princeton University, New Jersey.

This research provides first evidence that the secondary pathway for visual processing is functional, she emphasised.

"The secondary pathways are used almost for sure. If they were recruited later, then you would not be able to show it on this kind of short-term basis with TMS. The experiment delivers strong evidence that they are being used and that they have some function.”

Expanding applications for TMS

Transcranial magnetic stimulation involves using a large coil placed on a subject's skull that produces a magnetic field that can penetrate a few centimetres deep and induce electrical signals in the brain. As a result, the brain's regular biochemical activities are disrupted.

Aside from its ability to induce temporary blindness, TMS has many other applications. It can also deactivate other parts of the brain for investigation. The technology has been around for more than 20 years but has only recently become advanced enough for the stimulation of very specific brain regions. It is currently used in some countries for the treatment of depression. Some optimists even see potential for future use in the treatment of schizophrenia, Parkinson's disease and epilepsy.

A second experiment also published in the Proceedings of the National Academy of Sciences just a few weeks before Dr. Ro's research used TMS successfully to induce affective blindness - the ability to detect the emotional expression of a face without seeing it.

"It shows that we process emotional information outside of visual awareness," said Dr. Sabine Kastner.

In the experiment, ten neurologically normal volunteers were presented with schematic faces or emoticons that expressed a neutral, a happy or a sad face. The face appeared either to the left or the right of a fixation dot, and the study participants had to report on both the location and the emotional expression of the face. When activity in the striate cortex was disrupted, they couldn't localise the faces but they still guessed the faces' emotion well above chance level.

"I think our studies firmly establish TMS as an important tool in the study of blindsight and visual awareness, and convincingly show that blindsight can be induced in normal observers," Jacob Jolij PhD, a postdoctoral fellow at the Swiss Federal Institute of Technology in Lausanne, told EuroTimes.

jacob.jolij@epfl.ch

By placing a transcranial magnetic stimulation coil over the visual cortex of the brain, a brief period of blindness was induced in sighted individuals. Nonetheless, it was shown that both colour and orientation can be processed unconsciously without primary visual cortex, a phenomenon being referred to as blindsight.

J Jacob Jolij

EuroTimes March 2006
Thirty years ago, Lawrence Weiskrantz and colleagues at Oxford University first observed blindsight in a patient with cortical blindness due to primary visual cortex lesions. Weiskrantz discovered that even though the subject performed like a blind person on visual performance tasks, when he forced the subject to make a decision about a visual stimulus, the patient performed at a 70% performance level - well above chance. Since that initial observation, this forced-choice paradigm, which was also used in the above experiment, was tested on many other subjects with similar lesions and usually led to the same findings.

The discovery of blindsight contributed to the popular neurological idea that visual processing occurs in two functionally and physiologically separate pathways. The first, conscious pathway runs from the retina through the lateral geniculate nucleus in the thalamus terminating in the primary visual cortex. A second, unconscious, pathway runs from the retina through the superior colliculus in the midbrain to the motor areas of the brain stem. The current study used colours and orientation, which cannot be processed very effectively in those brain regions of the midbrain and indicates that there is a pathway that bypasses the normal primary processing hierarchy, with direct thalamic projections to the extrastriate cortex.

Secondary pathways might make sense from an evolutionary standpoint, noted Dr. Ro.

“We think these alternative routes are there for coarse coding of visual information; these pathways allow us to react quickly without extensive processing.”

The discovery of blindsight contributed to the popular neurological idea that visual processing occurs in two functionally and physiologically separate pathways.

While blindsight is a rare phenomenon, Dr. Ro still thinks his research might have future clinical applications for patients with primary visual cortex damage or Riddoch syndrome in which patients can only perceive visual stimuli in motion. Maybe such patients could be trained through visual test trials combined with feedback on their

Europe’s ophthalmologists more united than divided on key issues

Dermot McGrath
in Lisbon

THEY might speak different languages but when it comes to problems of rising costs, tighter margins and coping with ever-higher volumes of cataract patients, Europe’s ophthalmologists all seem to be singing the same song.

The key issues facing the continent’s eye doctors were brought into sharp focus in a series of presentations on practice styles and trends in various European countries during the XXIII Congress of the ESCRS.

The 12th annual survey of Danish cataract surgery, Tom Eggert Hansen MD, O dense University Hospital, said that this year’s responses highlighted some interesting trends.

“There are just a little over 100 cataract surgeons in Denmark and 100 of them exactly responded this year, which is a high response rate. Of those who responded, 32% work in private practices and 68% at public hospitals. And on average we performed about 375 operations per year,” he said.

Dr. Hansen said that 13% of the cataract surgeries were paid for by patients themselves, while 87% were paid for by public funds. He noted that a government initiative to reduce cataract waiting lists on the national health service had the effect of reducing the number of patients willing to pay for the operation themselves.

“The statistics show that in the years 1998 to 2001, the waiting list for cataract removal was rising but in 2002 the government gave a two-month waiting list guarantee, which meant that patients were less inclined to spend their own money to have the surgery performed.”

“We do a lot of cataract and it is increasing all the time. About 27% of surgeons perform between 16 to 25 cataract operations per month, 48% between 26 and 50 and 12% over 50 per month,” said Dr. Henry, Academic Hospital Vrije University, Amsterdam, The Netherlands.

Dr. Henry noted that the approach to anesthesia is still quite conservative in Holland. Retrobulbar is still number one, although declining at 51%. Topical anesthesia is becoming more popular and is now used by about one fifth of respondents.

The same conservative approach also holds true for surgical technique, said Dr. Henry, with monomodal phaco used by over 80% of surgeons, compared to bimanual at 15%.

Dutch surgeons are almost unanimous in their preference for superior incisions (91%), with hardly any temporal or steepest k incisions.

The viscoelastic of choice is Healon (AMO) at 48% followed by ProVisc (Alcon) with 21%. The preferred technique for phacoemulsification is four-quadrant divide-and-conquer for 80% of surgeons.

In terms of lens choice, acrylic is the most popular IOL material, accounting for 75%, with a majority preferring hydrophobic lenses. Dr. Henry also noted that despite the growing range of multifocal IOLs coming on stream, more than 98% of respondents said they implanted five or less multifocal IOLs per year.

The Dutch survey revealed rates of dropped nucleus of 0.70 per 1000 cases. Endophthalmitis occurred at a rate of 0.45 per 1000 cases.

Concerning cataract outcome data collection, 54% of cataract surgeons are using a computer program to collect the data, compared to only 37% a year ago.

Refractive surgery growing in Germany

The evolving refractive practice trends of German ophthalmologists were analysed by Gerd Auffarth MD, University of Heidelberg, Germany. A survey, highlighting key issues in refractive surgery such as the type of technology used, prices charged and procedure volumes performed, was sent to 267 German refractive surgeons. A total of 132 (49%) surgeons replied.

The more notable findings included the fact that more than 90% of respondents performed LASIK surgery, 50% PKR, 43% LASEK, and 13% Epi-LASIK. Phakic IO Ls and refractive lens exchange are also increasingly popular procedures, noted Dr. Auffarth, with 42% of respondents performing both on a regular basis.

Some 77% of respondents said that they used their excimer laser in private practice or a laser clinic. For laser centre surgeons, 46% used the Bausch and Lomb 217 or 217z laser, followed by 24% for the Schwind Esiris, and 12% for the Waelkens Allegetor. Private practice users also preferred the Bausch and Lomb 217 (34%), followed by the Allegetor (33%) and C2 Meditec Mel 80 (17%). In university eye clinics, the Schwind Esiris is the most popular, used by 37% of respondents. The most widely used microkeratome is the B&L Hansatome (59%) followed by the AMO Amadeus (15%), he reported.

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