Distress in brain scan

A laboratory test that discloses a state of mind would take psychiatry to new levels

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Deficiency in nutrition can be associated with changes in mood and behaviour. Pathological tests can also indicate, or at least explain some mind-related symptoms. The principal use of lab tests, however, is to assess physiological conditions and the mental health clinician needs to be guided mainly by what a patient himself or herself says or communicates.

Mental illness, however, has serious social consequences when individuals become depressed, dysfunctional or violent. Suicide, usually the result of acute psychological distress, is reported as the second most frequent cause of death of young persons. The report by Marcel Adam Just, Lisa Pan, Vladimir L Cherkassky, Dana L. McMakin, Christine Cha, Matthew K Nock and David Brent from the Universities of Carnegie Melon, Pittsburgh, Florida, Columbia and Harvard, in the journal, *Nature Human Behaviour*, of a brain scan that can identify suicidal tendencies, is hence of significance.

"… suicidal patients may disguise their suicidal intent as part of their suicidal planning or to avoid more restrictive care. Nearly 80 per cent of patients who die by suicide deny suicidal ideation in their last contact with a mental healthcare professional. This status identifies a compelling need to develop markers of suicide risk that do not rely on self-report," the *Nature* paper says.

The study uses functional Magnetic Resonance Imaging as a brain scan to identify areas in the brain that were stimulated by exposure to different concepts, to see if there was a correlation in the responses, to words associated with depression or death, of a group of persons known to have suicidal tendencies, as opposed to a control group. Functional MRI is a non-invasive technology that detects differences in the blood flow in different areas of the brain. Words related to different concepts provoke activity, and hence blood flow, in specific areas of the brain. For instance, the paper explains, the word "spoon" leads to activity in the part of the brain associated with motor functions, as spoons are manipulated, and in the gustatory area, as spoons are used for eating. The word, "house", on the other hand, stimulates the regions related with shelter and location.

This "neural signature" of words and concepts is common and reproducible among normal people, the paper says. Testing with the neural response to concepts like "hate" and "hug" has been 97 per cent accurate in making out persons suffering from autism, it says.

The study hence examined whether the brain regions that responded to positive, negative and suicide-related concepts were different in the case of persons who harboured thoughts about suicide, as compared to persons who did not. And if so, whether there was a pattern in the differences, so that an assay of the brain areas, during the time that different concepts were presented to participants, could result in accurately classifying them as suicidal or not.

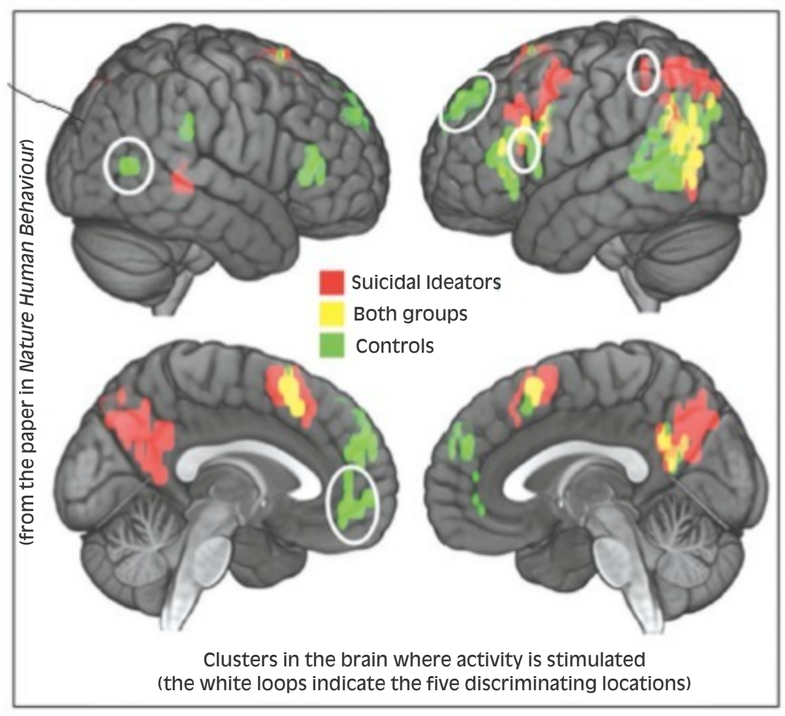
This line of investigation was suggested by the observation that suicidal persons show a change in concepts formed, as revealed by measurable behaviour, in response to different words. One such is the difference in reaction time to suicide-related words as compared to neutral words. Another is of reaction times in response to pairing suicide-related words and self-related words. It has been found that persons who have attempted suicide may process certain concepts or concept pairs in a different way.

Building on this finding, the study sought to discover patterns in the locations or sets of locations where activity was affected by specific concept stimuli and whether there was a significant difference between suicidal individuals and others. In addition to such neural signatures, the study tried to identify their "emotion component". This was with the help of an existing library of neural signatures and the associated emotions, in healthy, normal people. The library contains, for instance, neural signatures associated with emotions of "sadness", "shame", "anger", "pride" and it was taken that the nature of emotions stayed the same with suicidal and non-suicidal persons.

Trials were then conducted with two groups, balanced in respect or sex ratio, age and intelligence, of 17 persons who harboured suicide-related thoughts and 17 others who did not. Thirty stimuli concepts (shown in the table) were presented, for three seconds each, to the subjects. After several presentations of the stimuli, the locations in the brain where the stimuli repeatedly evoked activity were recorded, as shown in the picture.

STIMULUS CONCEPTS (from the paper in *Nature-Human Behaviour*)

SUICIDE	POSITIVE	NEGATIVE
Apathy	Bliss	Boredom
Death	Carefree	Criticism
Desperate	Comfort	Cruelty
Distressed	Excellent	Evil
Fatal	Good	Gloom
Funeral	Innocent	Guilty
Hopeless	Kindness	Inferior
Lifeless	Praise	Terrible
Overdose	Superior	Trouble
Suicide	Vitality	Worried



(from the paper in *Nature Human Behaviour*)

Clusters in the brain where activity is stimulated
(the white loops indicate the five discriminating locations)

Given 36 concepts and many locations of brain activity, correlating the data with "suicidal or non-suicidal" can be a daunting task. The job was hence assigned to a machine learning classifier procedure which can handle Big Data. These algorithms, known as "data mining", are routinely used to extract patterns that are concealed within huge numbers of figures. For instance, the data of credit cards used at a supermarket contains information of the categories of people who buy particular products — which could enable effective advertising and provisioning.

The result of the exercise was that the locations of brain activity could be classified with 0.85 per cent accuracy or 14 of the 17 suicidal and 15 of the 17 non-suicidal participants being correctly identified. Within the suicidal group, those who had attempted suicide could be separated. "Interpretable, clinically meaningful differences existed in the individuals in the suicidal ideator and control groups, and within the suicidal ideator group, there were differences between the attempters and the non-attempters," the report says. "The specific concepts that were altered in people with suicidal ideation — 'death', 'cruelty', 'trouble', 'carefree', 'good' and 'praise' — include items from all three stimulus categories, one that is suicide-related, two that are negative, and three positive concepts," the report says. "… And six of the concepts and five of the brain locations provided the most accurate discrimination between the two groups."

The findings have immediate value in quickly identifying possible suicides in a population through a simple brain scan. This could help reduce the number of suicides, which is said to be 800,000 each year, worldwide. While the technique could be used generally to deal with neuropsychiatric disorders, it could, conceivably, be used as a wider diagnostic tool, given the undeniable connection between the psycho and the soma.

A question that arises, however, is what does this ability imply, outside its medical applications? The manner in which the brain physically responds to emotions or words and concepts can now be discovered. A brain scan, carried out to treat a migraine patient, may hence also reveal something personal about how she thinks. This may enable the use of brain scans for non-therapeutic ends and may call for regulation.

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Why we love to be scared

Here's a look into the science of fright where context matters most

ARASH JAVANBAKHT & LINDA SAAB

Fear may be as old as life on Earth. It is a fundamental, deeply wired reaction, evolved over the history of biology, to protect organisms against perceived threats to their integrity or existence. Fear may be as simple as a cringe of an antenna in a snail that is touched, or as complex as existential anxiety in a human. Whether we love or hate to experience fear, it's hard to deny that we certainly revere it — devoting an entire holiday to the celebration of fear (read Halloween).

Thinking about the circuitry of the brain and human psychology, some of the main chemicals that contribute to the "fight or flight" response are also involved in other positive emotional states, such as happiness and excitement. So, it makes sense that the high arousal state we experience during a scare may also be experienced in a more positive light. But what makes the difference between getting a "rush" and feeling completely terrorised?

We are psychiatrists who treat fear and study its neurobiology. Our studies and clinical interactions, as well as those of others, suggest that a major factor in how we experience fear is the context. When our "thinking" brain gives feedback to our "emotional" brain and we perceive ourselves as being in a safe space, we can then quickly shift the way we experience that high arousal state, going from one of fear to one of enjoyment or excitement.

When you enter a haunted house during Halloween season, for example, anticipating a ghoul jumping out at you and knowing it isn't really a threat, you are able to quickly re-label the experience. In contrast, if you were walking in a dark alley at night and a stranger began chasing you, both your emotional and thinking areas of the brain would be in agreement that the situation is dangerous, and it's time to flee. But how does your brain do this?

Fear reaction starts in the brain and spreads through the body to make adjustments for the best defence, or flight reaction. The fear response starts in a region of the brain called the amygdala. This almond-shaped set of nuclei in the temporal lobe of the brain is dedicated to detecting the emotional salience of the stimuli — how much something stands out to us.

For example, the amygdala activates whenever we see a human face with an emotion. This reaction is more pronounced with anger and fear. A threat stimulus, such as the sight of a predator, triggers a fear response in the amygdala, which activates areas involved in preparation for motor functions involved in fight or flight. It also triggers the release of stress hormones and the sympathetic nervous system. This leads to bodily changes that prepare us to be more efficient in a danger — the brain becomes hyperalert, pupils dilate, the bronchi dilate and breathing accelerates. Heart rate and blood pressure rise. Blood flow and stream of glucose to the skeletal muscles increase. Organs not vital in survival, such as the gastrointestinal system, slow down.

A part of the brain called the hippocampus is closely connected with the amygdala. The hippocampus and prefrontal cortex help the brain interpret the perceived threat. They are involved in a higher-level processing of context, which helps a person know whether a perceived threat is real or not.

For instance, seeing a lion in the wild can trigger a strong fear reaction, but the response to a view of the same lion at a zoo is more of curiosity and thinking that the lion is cute. This is because the hippocampus and the frontal cortex process contextual information, and inhibitory pathways dampen the amygdala fear response and its downstream results. Basically, our "thinking" circuitry of brain reassures our "emotional" areas that we are, in fact, alright.

Fear creates distraction, which can be a positive experience. When something scary happens, in that moment, we are on high alert and not preoccupied with other things that might be on our mind (getting in trouble at work, worrying about a big test the next day), which brings us to the here and now.

Furthermore, when we experience these frightening things with the people in our lives, we often find that emotions can be contagious in a positive way. We are social creatures, able to learn from one another. So, when you look over to your friend at the haunted house and she's quickly gone from screaming to laughing, socially you're able to pick up on her emotional state, which can positively influence your own.

While each of these factors — context, distraction and social learning — have the potential to influence the way we experience fear, a common theme that connects all of them is our sense of control. When we are able to recognise what is and isn't a real threat, re-label an experience and enjoy the thrill of that moment, we are ultimately at a place where we feel in control. That perception of control is vital to how we experience and respond to fear.

This raises yet another question — while many can enjoy a good fright, why might others downright hate it? Why do some people not enjoy being scared? Any imbalance between excitement caused by fear in the animal brain and the sense of control in the contextual human brain may cause too much, or not enough, excitement. If the individual perceives the experience as "too real", an extreme fear response can overcome the sense of control over the situation.

This may happen even in those who do love scary experiences — they may enjoy Freddy Krueger movies but be too terrified by *The Exorcist* as it feels too real, and fear response is not modulated by the cortical brain.

On the other hand, if the experience is not triggering enough to the emotional brain, or if is too unreal to the thinking cognitive brain, the experience can end up feeling boring.

A biologist who cannot tune down her cognitive brain from analysing all the bodily things that are realistically impossible in a zombie movie may not be able to enjoy the show, *The Walking Dead* as much as another person.

So if the emotional brain is too terrified and the cognitive brain helpless, or if the emotional brain is bored and the cognitive brain is too suppressing, scary movies and experiences may not be as fun.

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The Independent

PLUS POINTS

Preventing Alzheimer's

A novel approach to enhancing brain activity is being explored by researchers at the University of Strathclyde, in a bid to prevent Alzheimer's disease taking hold.

The study is investigating new ways in which build-up of a protein toxic to brain cells, known as beta amyloid, could be halted, with the use of light stimulation, in areas of the brain, which are particularly vulnerable to Alzheimer's. It may ultimately lead to a novel prevention strategy for Alzheimer's in people at high risk of the disease.

Dr Shuzo Sakata, a senior lecturer in Strathclyde Institute of Pharmacy and Biomedical Sciences, is leading the study. He said, "The lack of a cure for Alzheimer's disease means there is an urgent need to develop new, innovative approaches to combating it.

"We have known for a long time that the beta amyloid protein is toxic to brain cells; it has recently been found that manipulating the activity of neurons can reduce the protein in some regions of the brain. But what is not well understood is how it can be used to do this across many brain regions at the same time."

The pre-clinical research will be focused on a brain area, which communicates with many other areas and is among those most affected by Alzheimer's. It will discover whether activating neurons in this brain area, using light, can enhance fast brainwaves which are impaired in people with Alzheimer's.

Longer beaks

A British enthusiasm for feeding birds may have caused UK great tits to have evolved longer beaks than their European counterparts, according to new research.

The findings, published in *Science*, identify for the first time the genetic differences between UK and Dutch great tits, which researchers were then able to link to longer beaks in UK birds.

Using genetic and historical data, the team also found that the differences in beak length had occurred within a relatively short time frame. This led them to speculate that there may be a link with the relatively recent practice of putting out food for garden birds.

The study is an international collaboration involving researchers from the Netherlands Institute of Ecology and the Universities of Wageningen, Oxford, Exeter, East Anglia, Sheffield.

The findings are part of a long term study being carried out on populations of great tits in Wytham Woods, and in Oosterhout and Veluwe, in the Netherlands.

The team screened DNA from more than 3,000 birds to search for genetic differences between the British and the Dutch populations. These differences indicate where natural selection might be at work.

The specific gene sequences, which had evolved in the British birds, were found to closely match human genes known to determine face shape. There were also strong similarities with genes identified with beak shape in Darwin's study of finches — one of the best-known examples of how physical traits have adapted to different environments in the wild.

Researchers at Oxford University have been studying the Wytham Woods great tit population in Oxfordshire for 70 years and so the team had access to a wealth of historical data, which clearly showed that the British great tits' beaks were getting longer over time. They were also able to access data from electronic tags fitted to some of the Wytham Woods birds, which enabled them to track how much time was spent at automated bird feeders.

The team also found that birds with genetic variants for longer beaks were more frequent visitors to the feeders than those birds, which did not have that genetic variation.