New research shows how our bodies interact with our minds in response to fear and other emotions

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New research has shown that the way our minds react to and process emotions such as fear can vary according to what is happening in other parts of our bodies.

In two different presentations today (Monday) at the British Neuroscience Association Festival of Neuroscience (BNA2013) in London, researchers have shown for the first time that the heart's cycle affects the way we process fear, and that a part of the brain that responds to stimuli, such as touch, felt by other parts of the body also plays a role.

Dr Sarah Garfinkel, a postdoctoral fellow at the Brighton and Sussex Medical School (Brighton, UK), told a news briefing: "Cognitive neuroscience strives to understand how biological processes interact to create and influence the conscious mind. While neural activity in the brain is typically the focus of research, there is a growing appreciation that other bodily organs interact with brain function to shape and influence our perceptions, cognitions and emotions.

"We demonstrate for the first time that the way in which we process fear is different dependent on when we see fearful images in relation to our heart."

Dr Garfinkel and her colleagues hooked up 20 healthy volunteers to heart monitors, which were linked to computers. Images of fearful faces

were shown on the computers and the electrocardiography (ECG) monitors were able to communicate with the computers in order to time the presentation of the faces with specific points in the heart's cycle.

"Our results show that if we see a fearful face during systole (when the heart is pumping) then we judge this fearful face as more intense than if we see the very same fearful face during diastole (when the heart is relaxed). To look at neural activity underlying this effect, we performed this experiment in an MRI [magnetic resonance imaging] scanner and demonstrated that a part of the brain called the amygdala influences how our heart changes our perception of fear.

"From previous research, we know that if we present images very fast then we have trouble detecting them, but if an image is particularly emotional then it can 'pop' out and be seen. In a second experiment, we exploited our cardiac effect on emotion to show that our conscious experience is affected by our heart. We demonstrated that fearful faces are better detected at systole (when they are perceived as more fearful), relative to diastole. Thus our hearts can also affect what we see and what we don't see – and can guide whether we see fear.

"Lastly, we have demonstrated that the degree to which our hearts can change the way we see and process fear is influenced by how anxious we are. The anxiety level of our individual subjects altered the extent their hearts could change the way they perceived emotional faces and also altered neural circuitry underlying heart modulation of emotion."

Dr Garfinkel says that her findings might have the potential to help people who suffer from anxiety or other conditions such as post traumatic stress disorder (PTSD).

"We have identified an important mechanism by which the heart and brain 'speak' to each other to change our emotions and reduce fear. We

hope to explore the therapeutic implications in people with high anxiety. Anxiety disorders can be debilitating and are very prevalent in the UK and elsewhere. We hope that by increasing our understanding about how fear is processed and ways that it could be reduced, we may be able to develop more successful treatments for these people, and also for those, such as war veterans, who may be suffering from PTSD.

"In addition, there is a growing appreciation about how different forms of meditation can have therapeutic consequences. Work that integrates body, brain and mind to understand changes in emotion can help us understand how meditation and mindfulness practices can have calming effects."

In a second presentation, Dr Alejandra Sel, a postdoctoral researcher in the Department of Psychology at City University (London, UK), investigated a part of the brain called the somatosensory cortex – the area that perceives bodily sensations, such as touch, pain, body temperature and the perception of the body's place in space, and which is activated when we observe emotional expressions in the faces of other people.

"In order to understand other's people emotions we need to experience the same observed emotions in our body. Specifically, observing an emotional face, as opposed to a neutral face, is associated with an increased activity in the somatosensory cortex as if we were expressing and experiencing our own emotions. It is also known that people with damage to the somatosensory cortex find it difficult to recognise emotion in other people's faces," Dr Sel told the news briefing.

However, until now, it has not been clear whether activity in the somatosensory cortex was simply a by-product of the way we process visual information, or whether it reacts independently to emotions expressed in other people's faces, actively contributing to how we

perceive emotions in others.

In order to discover whether the somatosensory cortex contributes to the processing of emotion independently of any visual processes, Dr Sel and her colleagues tested two situations on volunteers. Using electroencephalography (EEG) to measure the brain response to images, they showed participants either a face showing fear (emotional) or a neutral face. Secondly, they combined the showing of the face with a small tap to an index finger or the left cheek immediately afterwards.

Dr Sel said: "By tapping someone's cheek or finger you can modify the 'resting state' of the somatosensory cortex inducing changes in brain electrical activity in this area. These changes are measureable and observable with EEG and this enables us to pinpoint the brain activity that is specifically related to the somatosensory cortex and its reaction to external stimuli.

"If the 'resting state' of the somatosensory cortex when a fearful face is shown has greater electrical activity than when a neutral face is shown, the changes in the activity of the somatosensory cortex induced by the taps and measured by EEG also will be greater when observing fearful as opposed to neutral faces.

"We subtracted results of the first situation (face only) from the second situation (face and tap), and compared changes in the activity related with the tap in the somatosensory cortex when seeing emotional faces versus neutral faces. This way, we could observe responses of the somatosensory cortex to emotional faces independently of visual processes," she explained.

The researchers found that there was enhanced activity in the somatosensory cortex in response to fearful faces in comparison to neutral faces, independent of any visual processes. Importantly, this

activity was focused in the primary and secondary somatosensory areas; the primary area receives sensory information directly from the body, while the secondary area combines sensory information from the body with information related to body movement and other information, such as memories of previous, sensitive experiences.

"Our experimental approach allows us to isolate and show for the first time (as far as we are aware) changes in somatosensory activity when seeing emotional faces after taking away all visual information in the brain. We have shown the crucial role of the somatosensory cortex in the way our minds and bodies perceive human emotions. These findings can serve as starting point for developing interventions tailored for people with problems in recognising other's emotions, such as autistic children," said Dr Sel.

The researchers now plan to investigate whether they get similar results when people are shown faces with other expressions such as happy or angry, and whether the timing of the physical stimulus, the tap to the finger or cheek, makes any difference. In this experiment, the tap occurred 105 milliseconds after a face was shown, and Dr Sel wonders about the effect of a longer time interval.

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