Nature vs nurture: Twin study sheds light on heritable brain activity

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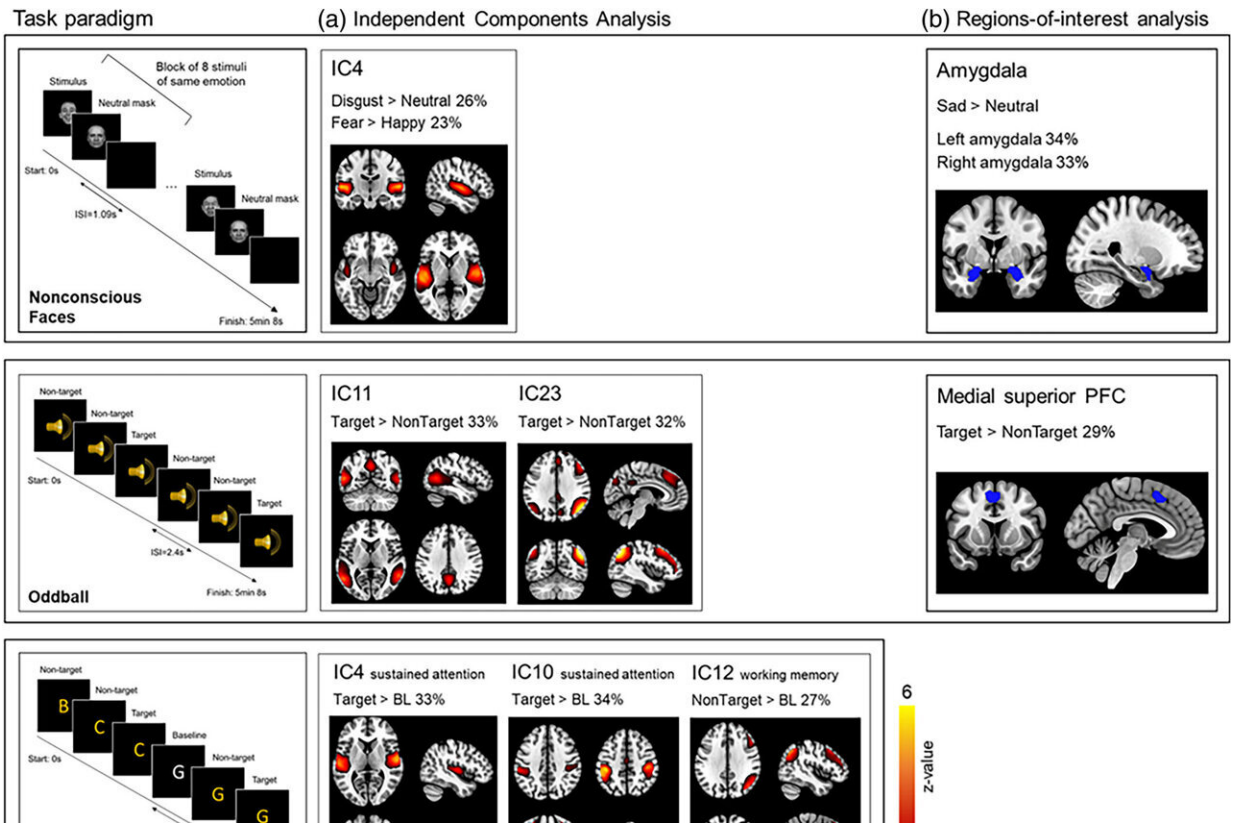

Credit: *Human Brain Mapping* (2024). DOI: 10.1002/hbm.26557

The way our brain processes different emotional and cognitive tasks may be underpinned by common factors, find scientists from UNSW and Neuroscience Research Australia (NeuRA).

In this latest study, published in the journal Human Brain Mapping, Dr. Haeme Park and Associate Professor Justine Gatt, who hold joint positions at UNSW Psychology and NeuRA, looked at how both emotion and cognition are influenced by the environment and genetics, using functional MRI (fMRI) scans on twins.

"There has been quite a lot of research looking at genetic versus environmental influences on brain structure," says Dr. Park, lead author of the study. "But it's a lot harder to understand the function of our brains."

The results revealed that the picture is extremely complex. Some emotional and cognitive tasks were partly associated with genetics, and others exclusively with environment.

But they also found that some of the same genetic and environmental factors can play a role in the brain reacting to two different tasks. For example, the analysis showed that some of the same genetic factors are influencing how we process fear and happiness and also how we sustain our attention.

"This study is interesting because we have further insight into how much of our life experiences modulate certain brain processes, which to a certain degree we have more control over, versus your biology, which you can't change," says A/Prof. Gatt, Director of the Center for Wellbeing, Resilience and Recovery.

"Knowing what areas of our brain function are linked strongly to our environment can help us develop personalized intervention approaches to promote higher mental well-being."

The importance of twin studies

The so-called 'nature vs. nurture' debate isn't new.

In fact, twin studies have become a unique research tool used by geneticists and psychologists to evaluate the influence of genetics and the effect of a person's shared environment (family) and unique environment (the individual events that shape a life) on a particular trait.

"With twin studies, it's important to recruit both identical and non-identical twins," says A/Prof. Gatt. "Identical twins share 100 percent of their genetics and if they're grown up together, they share the same environment. Whereas with the non-identical twins, they only have 50 percent shared genetics, but they also have that common environment."

"In this study, we wanted to bridge lots of gaps in the literature and provide a more robust and thorough picture of how our genetics and environmental factors impact the expression of brain activity during emotional and cognitive tasks, by analyzing twins," says Dr. Park.

Cognitive and emotional tasks

The most recent paper is one of many from the TWIN-E study, which recruited 1,600 identical and non-identical twins from across the country in 2009 and is led by A/Prof. Gatt.

A subset of the original cohort participated in this particular study, with a total of 270 adult twins taking part.

"We get participants set up on the fMRI scanner bed which is fitted with goggles that enable them to see the tasks in front of them. The functional tasks involve them viewing different images, different stimuli, through the goggles," says A/Prof. Gatt.

While the participants were completing the tasks, the fMRI machine was scanning their brain to measure its activity.

The twins completed a total of five tasks. Two were linked to emotional responses, such as reactions to various expressions of different faces, and the other three were associated with cognition, such as the ability to sustain attention and short-term memory.

Processing the fMRI scans shows you which part of the brain lights up for different processes, and how strongly the brain is activated can be measured on a scale.

"So individuals who show a lot of activation in that region have a higher number, whereas those with lower activation have a smaller number. We then use these figures to carry out what we call 'twin modeling' processes," says Dr. Park. "This is where we use statistics to break down how much of a role genetics and environment contribute to that number."

Twin modeling results

Twin modeling methods revealed two key findings in their analysis of the results.

Firstly, the researchers looked at the genetic versus environmental influence on each individual task. "We know that we use different brain networks for different processes—for example, processing either a crying face or a happy face is going to use different regions in the brain compared to trying to remember someone's phone number," says A/Prof. Gatt.

"But we found that for some of these networks, genetics plays a small to moderate, but significant role. And for other processes, it's only the

environment that determines brain function."

The second part of the analysis found that there were similarities in the genetic and environmental factors that underpinned different tasks.

"For example, we discovered that how the brain processes fear and happiness (which was measured in the emotional tasks) and our ability to sustain attention (which was measured in the cognitive tasks), have some shared genetic factors," says Dr. Park. "This suggests that some common genetic features may underpin these very different processes."

In contrast, the team also found that our ability to sustain our attention and our working memory have some of the same environmental contributions, suggesting that life experiences—which come from your environment—play a significant role in how brain activity is expressed for these two processes.

Mental well-being and resilience

While it's clear that both our genetics and life experiences are important in determining how our brain functions, the puzzle is far from solved.

"There's still so much more to find out," says Dr. Park. The current participants have already been followed up more recently and have performed the same tasks again after 10 years. A/Prof. Gatt, Dr. Park and their team will be reassessing the results to see how the influences of genetics and environment on these brain processes change over time.

"All these results paint a complex picture of the relationship between genes and environment that give rise to the brain activity underlying our cognition and emotion," says A/Prof. Gatt. But knowing more precise details may help to develop personalized intervention approaches in order to promote, for instance, higher mental well-being, or reduced

psychological distress.

In fact, the ongoing TWIN-E study focuses more broadly on mental well-being and resilience. "So, what we're using this data for, beyond looking at genes and environment, is actually predicting mental well-being and resilience trajectories over time, and seeing how differences in markers like brain function and structure might profile people who are a bit more resilient or at more risk to a mental health problem," says A/Prof. Gatt.

Understanding how much of our life experiences influence certain processes versus the influence of genetics is important when knowing what factors we can change and control, which is particularly significant for people with mood and anxiety disorders, explains A/Prof. Gatt.

"If someone has a tendency to attend to negative stimuli more than positive, and we know that there's an element of environment contributing to that, with intervention or training, it's potentially something we can target and improve for the better."

More information: Haeme R. P. Park et al, Heritability of cognitive and emotion processing during functional MRI in a twin sample, *Human Brain Mapping* (2024). DOI: 10.1002/hbm.26557

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