

Changes in patterns of brain activity predict fear memory formation

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Psychologists at the University of Amsterdam (UvA) have discovered that changes in patterns of brain activity during fearful experiences predict whether a long-term fear memory is formed. The research results have recently been published in the prestigious scientific journal *Nature Neuroscience*.

Researchers Renee Visser MSc, Dr Steven Scholte, Tinka Beemsterboer MSc and Prof. Merel Kindt discovered that they can predict future fear memories by looking at patterns of [brain activity](#) during fearful experiences. Up until now, there was no way of predicting [fear memory](#). It was also, above all, unclear whether the selection of information to be stored in the long-term memory occurred at the time of fear learning or after the event.

Picture predicts pain stimulus

During magnetic resonance brain imaging (MRI), participants saw neutral pictures of faces and houses, some of which were followed by a small [electric shock](#). In this way, the participants formed fear memories. They showed fear responses when the pictures were shown that were paired with shocks. This [fear response](#) can be measured in the brain, but is also evident from increased pupil dilation when someone sees the picture. After a few weeks, the participants returned to the lab and were shown the same images. Brain activity and pupil diameter were once again measured. The extent to which the pupil dilated when seeing the images that were previously followed by a shock, was considered an

expression of the previously formed fear memory.

Pattern Analysis

In order to analyse the fMRI data, (spatial) patterns of brain activity (Multi-Voxel Pattern Analysis, or MVPA) were analysed. By correlating patterns of various stimulus presentations with each other, it is possible to measure the extent to which the representation of two stimuli is the same. It appears that images that have nothing in common, such as houses and faces, lead to increasing neural pattern similarity when they predict danger. This does not occur when they do not predict danger. This leads to the formation of stronger fear responses. The extent to which this occurs is an indication of fear memory formation: the stronger the response during learning, the stronger the fear response will be in the long term.

These findings may lead to greater insights into the formation of emotional memory. As a result, it is possible to conduct experimental research into the mechanisms that strengthen, weaken or even erase fear memory in a more direct fashion, without having to wait until the fear memory is expressed.

More information: Visser, R. M., Scholte, H. S., Beemsterboer, T. & Kindt, M.: Neural pattern similarity Predicts Long-term fear memory, *Nature Neuroscience* (2013).
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