Heartbeats and memory suppression – the new tools for controlling fear

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Credit: George Hodan/public domain

Most of us feel afraid when faced with a threat or danger, but people with phobias and anxiety feel overwhelming levels of fear in situations that are relatively harmless. Scientists want to moderate this response by using drugs to wipe out scary memories or by harnessing the power of heartbeats to improve therapy.

Usually, people feel less scared after learning that a perceived threat – such as a non-poisonous spider—isn't actually dangerous. But it's not the case for people with anxiety disorders. "For some individuals, that doesn't happen so easily," said Tom Beckers, a professor of psychology at KU Leuven in Belgium.

Abnormal fear reactions can be treated with cognitive behavioural therapy (CBT) which involves repeated exposure to what they're afraid of. According to Prof. Beckers, it works reasonably well but it's not always effective in the long term, particularly for situations such as post-traumatic stress disorder. "The initial memory for the adverse event is still there and it can always gain the upper hand and cause people to become anxious again," he said.

Prof. Beckers and his colleagues think that directly manipulating fear memories – and perhaps even deleting them – could result in more effective treatments.

Proteins

When a long-term memory is formed, certain new proteins must be synthesised up to six hours after the experience to ensure that it is solidly stored. Similarly, research on animals in the last few decades indicates that when certain memories are recalled, new proteins need to be made again for them to be retained. Preliminary experiments have shown that administering drugs that interfere with synthesis of these new proteins seemed to be able to erase some memories – which could be useful for suppressing fear memories.

Through a project called WipeOutFear, Prof. Beckers' team is trying to understand the circumstances under which memories could be manipulated through drugs. They know that not all memories have the potential to become unstable – remembering information is vital for

survival so that would be maladaptive. "It seems to be bound to very specific retrieval circumstances and only then will memories become sensitive to interference," said Prof. Beckers.

Furthermore, it's not clear if messing with protein production actually abolishes memories. One theory is that the memory is erased when protein synthesis is blocked pharmacologically. But a second hypothesis is that the memory is still there, it just becomes harder to access. The researchers would therefore also like to pin down the underlying mechanism of forgetting.

So far, the team has found that most memories are permanent: they are only changeable in rare circumstances. And by conducting experiments in rats and humans, they managed to determine what some of these circumstances are. If a memory is retrieved and the brain perceives that it may not be completely accurate, for example, it can become unstable—presumably to allow it to be updated.

Generalised

Another challenge for the researchers is that a fear memory typically isn't linked to a single situation but is generalised to many similar scenarios. For example, if somebody has been mugged in an alley they are likely to feel afraid every time they encounter a narrow street or passage and not just in the actual alley where the attack took place.

Prof. Beckers and his colleagues found that although drugs could suppress a memory in one circumstance, it would reappear in a similar scenario. "The next challenge now is to find ways to induce some sort of generalised amnesia," said Prof. Beckers. "So not only for the situation that we use for retrieval but for all situations that would elicit the memory."

If they are successful, suppressing memories could have applications beyond controlling fear. Prof. Beckers thinks it could also help treat conditions such as addiction or depression. "There's probably potential for these types of interventions in any clinical condition where some sort of emotional memory is involved," he said.

Perhaps fear could also be curbed by another approach – tapping into the relationship between the brain and the heart. If a stimulus, such as pain, is processed by the brain at the same time as a heartbeat, it typically dampens the effect. "You're also more likely to forget a word if (it's presented) exactly when your heart is beating relative to in-between heartbeats," said Professor Sarah Garfinkel from the University of Sussex in Brighton, UK.

However, in previous research Prof. Garfinkel and her colleagues found that fear is an exception – it can be heightened if processed at the same time as a heartbeat. Their results overturned previous work that suggested that heartbeats are always inhibitory. "It's an exciting finding," said Prof. Garfinkel.

Shooting

The team followed up on their discovery to better understand how the relationship between the heart and the brain can drive fear as part of the CCFIB project. In one experiment, they looked at whether this mechanism played a role in shooting decisions when racial stereotypes make some people seem more threatening. "There are a lot of wrongful shootings, especially of black African Americans in America," said Prof. Garfinkel. "So we looked at that phenomenon, but as a function of when the heart was beating."

Participants in the study, who were all white, were presented with images of black or white individuals, either holding a gun or a mobile phone,

and had to make a snap decision about whether to shoot them or not. Results showed that they were more likely to shoot a black person with a phone if the image was shown at the same time as a heartbeat.

"It has implications for policemen who are in a state of high arousal and are scared themselves," said Prof. Garfinkel. "If their heart is beating really fast, then they're having more of these heart signals and are more likely to make a shot and a wrong choice in a split-second decision."

The team also investigated whether they could harness this mechanism to treat abnormal fear responses in people with spider phobia. They wanted to see if incorporating heartbeat timing could improve exposure therapy. Since this type of therapy works better if you 'feel the fear," the heightened response experienced when the heart beats could help. "This could lead to a more effective extinction of the fear," said Prof. Garfinkel.

Her team found that when exposure to a spider image coincided with a heartbeat, phobia sufferers showed improvements after just four half-hour sessions of therapy. Existing exposure therapy typically requires a longer period of exposure.

Prof. Garfinkel is interested in exploring how the relationship between the heart and the brain changes in other conditions such as post-traumatic stress disorder and schizophrenia. "Looking at this dynamic relationship between the brain and the heart opens up a whole new window of altered mechanisms," she said. "If you can see how they change, then you can find something to target that specific mechanism with the potential for new treatments."

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