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The neuronal basis of fear generalization in humans

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ABSTRACT:
Organisms tend to respond similarly to stimuli that are perceptually close to an event that predicts adversity, a phenomenon known as fear generalization. Greater dissimilarity yields weaker behavioral responses, forming a fear-tuning profile. The perceptual model of fear generalization assumes that behavioral fear tuning results from perceptual similarities, suggesting that brain responses should also exhibit the same fear-tuning profile. Using fMRI and a circular fear-generalization procedure, we tested this prediction. In contrast with the perceptual model, insula responses showed less generalization than behavioral responses and encoded the aversive quality of the conditioned stimulus, as shown by high pattern similarity between the conditioned stimulus and the shock. Also inconsistent with the perceptual model, object-sensitive visual areas responded to ambiguity-related outcome uncertainty. Together these results indicate that fear generalization is not passively driven by perception, but is an active process integrating threat identification and ambiguity-based uncertainty to orchestrate a flexible, adaptive fear response.

STATEMENT:
Our fMRI study casts light on the neuronal mechanisms of fear generalization in the healthy human brain. Generalization allows humans and many other animals to effortlessly select appropriate behaviors when they encounter new situations similar to their previous experiences. However, in many anxiety disorders this ability is impaired, resulting in an inappropriate generalization of previously acquired aversive experiences to novel but otherwise neutral events. Our results provide evidence that fear generalization observed at the behavioral level results from the integration of separate sources of information, associated with threat detection and threat uncertainty. We found that these two neuronal processes had antagonist effects on the strength of generalization observed at the behavioral level. This dissociation provides healthy humans an ability to flexibly control fear generalization in an adaptive way. Most importantly however these findings will possibly allow a better characterization of many anxiety disorders in the future.

BACKGROUND:
This work was realized by Selim Onat and Christian Büchel at the Department of Systems Neuroscience. Selim Onat is a senior postdoctoral researcher working together with Christian Büchel, who is the head of the department. Christian Büchel's interdisciplinary work focuses on the characterization of complex cognitive phenomena such as placebo, learning, fear and pain using fMRI. During his doctoral studies, Selim Onat focused on perceptual and sensory mechanisms under natural conditions with the aim of bringing ecological validity within the laboratory experiments. Their work was supported by SFB/TRR 58.