Fear reduction without fear through reinforcement of neural activity that bypasses conscious exposure

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Abstracts:
Fear conditioning is a fundamentally important and preserved process across species. In humans it is linked to fear-related disorders such as phobias and post-traumatic stress disorder. One extensively studied procedure to overcome fear is to repeatedly pair encounterance of a fear conditioned stimulus (CS+) with a rewarding outcome (i.e., counter-conditioning). However, such counter-conditioning involves explicit presentations of CS+, which is itself aversive until fear extinguishes. Using real-time fMRI neurofeedback with multivariate decoding, we extinguished fear by directly counter-conditioning the activation patterns in visual cortex that resembled the decoded features of visual CS+. We first constructed a decoder to distinguish two visual stimuli from their multivoxel activation patterns in the primary and secondary visual areas (V1/V2). Participants then went through Pavlovian conditioning, and acquired fear for the two visual stimuli (CS+) as they were paired with electric shocks. Afterwards, participants went through three days of Neural reinforcement sessions during which they were rewarded on a trial-by-trial basis when the activation patterns in V1/V2 resembled the previously decoded patterns for one of the CS+ (Target) but not for the other (Control). Participants were not informed of the purpose of this procedure, and post-session tests confirmed that they were not consciously aware of the neural representation of Target CS+ during the Neural reinforcement sessions. Nevertheless, participants showed reduced fear response for the Target CS+ relative to the Control CS+ when these stimuli were explicitly presented on a following day. Such reduction of fear was observed both in terms of skin conductance response as well as of amygdala hemodynamic activity. These results show that fear can be reduced without explicit reactivation of the fear memory, and this procedure may support new treatments for fear-related disorders such as phobia and post-traumatic stress disorder (PTSD), via unconscious processing.