

### ***Learning by Doing – Actions Reinforced by Fear Termination***

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Animals and people do not merely react to fear-eliciting stimuli, they are also motivated to take action in order to escape and avoid these stimuli. Animal studies have shown that passive or pavlovian fear reactions, such as freezing, are mediated via a pathway between the amygdala and the brainstem. It is hypothesized that active or instrumental responses, such as reactions that terminate fear-eliciting stimuli requires a pathway between the amygdala and motor circuits in the ventral striatum. Interestingly, such responses can be learned in the absence of a primary reinforcer (e.g. electric shock), suggesting that the termination of fear itself may serve as a reinforcer for action learning.

In the present study, we developed a novel procedure to study escape from fear (EFF) learning in humans. Subjects were presented with either fear-eliciting or neutral images. A few seconds after the image presentation, a colored frame appeared around the image. The subjects were instructed to press a button whenever they observed the colored frame. The frames appeared in one of two colors (e.g. blue or yellow). For each color, the button press had a different outcome – either the image presentation was terminated (escape outcome), or the image remained for an additional two seconds (non-escape outcome). Galvanic skin responses (GSRs) to the images served as an index of fear and button-press reaction time served as the dependent measure for EFF learning.

GSRs were greater to the fear-eliciting images than to the neutral images, confirming the negatively arousing effect of these images. Reaction time measurements of the button press to the colored frames showed no difference between the escapable and non-escapable neutral images. In contrast, reaction times to the escapable fear-eliciting stimuli were faster than responses to the non-escapable images, suggesting that EFF learning was successful. Interestingly, reaction times to the escapable fear-eliciting stimuli were similar to those associated with the neutral images.

Consistent with previous findings, our results suggest that negatively loaded affective stimuli lead to slower reactions and to a tendency to dwell longer before responding. They also show that this negative emotional bias was abolished when the response was reinforced by the elimination of the aversive stimuli. These results support the notion that humans can learn an instrumental EFF response with fear-termination as the reinforcer.

We are currently investigating brain areas involved in the shift from passive fear to active coping in the human brain using fMRI. In particular, we are interested in looking into the role of amygdala-striatal interactions in using fear termination as a reinforcer to guide actions, as well as to examine whether fear-termination and appetitive reinforcers recruit similar brain systems to guide behavior.

Support: Fulbright award to DS and NIMH grants to JEL and EAP