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Smokers 'salivate' to cigarettes: The physiological reactions to associated images

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It is commonly known that, much like Pavlov's dogs salivating in response to hearing the bell they associate with dinner time, smokers feel cravings and have physiological reactions to pictures they associate with smoking. New research published in BioMed Central's open access journal *BMC Neuroscience* has shown that a smoker's cravings can also be trained to non-smoking related stimuli.

Classical conditioning experiments link a neutral stimulus, such as a sound or a picture, to an event, like eating or smoking. Higher order, sometimes called second order conditioning, links this neutral stimulus to a second event. In the case of Pavlov's dogs, if they could have been trained to associate a light being switched on with the sound of the bell and consequently began to salivate to the light only this would be second order conditioning.

Marianne Littel and Prof Franken, from the Erasmus University Rotterdam, compared the reactions of smokers and non-smokers to a smoking related picture or to a neutral (non-smoking related) picture. These classical responses were then paired to a second round of neutral stimuli – the researchers chose a geometric shape (a cube or a pyramid). The responses of the subjects, such as their cravings and EEG measurements of brain activity, were recorded at each stage.

For both smokers and non-smokers the EEG results showed that P3 brain waves (thought to be involved in attention) are bigger for the shape paired with smoking related stimulus (CS2s) than to the shape paired

with non-smoking related cues (CS2n).

Marianne Littel explained, "All our participants had greater second order conditioning for smoking-related cues than the neutral cues, showing how smoking captures everyone's attention. However for the smokers only this training was related to feelings of craving and pleasure."

She continued, "Importantly, the smokers had larger P3 waves for CS2s than non-smokers, suggesting that smokers also have an enhanced ability for drug-related 'associative learning' compared to non-addicts. When the experiment was continued the differences between smokers/non-smokers were lost. This may indicate that second order conditioning is transient or simply that the participants lost interest and concentration."

More information: Electrophysiological correlates of associative learning in smokers: a higher-order conditioning experiment, Marianne Littel and Ingmar HA Franken, *BMC Neuroscience* (in press)

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