



## The influence of state anxiety on the acquisition and extinction of fear

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### ABSTRACT

**Objective:** Fear conditionability has been found to be elevated in samples with high trait anxiety or anxiety disorders. Since these studies provide circumstantial evidence for a causal link between anxiety and conditionability we examined fear conditionability after experimental induction of anxiety in two experiments.

**Method:** In **Experiment 1**, 60 participants were randomized to one of two film conditions inducing an anxious or happy emotional state. They subsequently underwent a differential conditioning acquisition procedure. Two pictures of faces served as conditioned stimuli (CS+ and CS–), and an electric stimulus served as aversive unconditioned stimulus (US). In **Experiment 2**, after similar acquisition procedure as used in **Experiment 1**, 90 participants watched one of three films (anxious, neutral, happy) prior to an extinction procedure. In both studies, skin conductance response (SCR) served as measure of fearful responding.

**Results:** Conditioning was successful in both studies. In **Experiment 1**, the anxious group exhibited decreased SCRs to both CS+ and CS– during acquisition. In **Experiment 2**, during extinction SCRs to both CSs were highest in the anxious group, intermediate in the neutral, and lowest in the happy group.

**Discussion:** State anxiety did not enhance conditionability during acquisition or reduce the extinction procedure. However, individuals in an anxious state show less responding during fear learning, but more responding during unlearning. Thus, our results suggest that state anxiety changes the sensitivity with which individuals react to stimuli presented in different contexts.

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### 1. Introduction

Fear conditionability refers to the individual ability to learn the association of a neutral (conditioned) stimulus (CS) with an aversive (unconditioned) stimulus (US) and/or the ability to extinguish this association. Individuals with enhanced fear conditionability typically show stronger conditioned responses (CR) to the conditioned stimuli (CSs) during the acquisition and/or extinction (Orr et al., 2000).

Enhanced fear conditionability has been put forward as a potential etiological factor for the development of anxiety disorders, because it could explain why upon exposure to fearsome incidents only some individuals develop pathological fears, whereas others show an adaptive fear response (Orr et al., 2000). To establish enhanced conditionability in patients with anxiety disorders experimentally, patients and healthy controls typically undergo a classical conditioning paradigm, in which one CS is

paired with an US during the acquisition phase (the CS+) and another CS is not (the CS–). During a subsequent extinction phase, both CSs are presented without the US (e.g., Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Michael, Blechert, Vriends, Margraf, & Wilhelm, 2007). Such studies have revealed encouraging evidence for enhanced conditionability – and slowed extinction in particular – in patients with different anxiety disorders relative to healthy control samples. Such cross-sectional patient studies do, however, not establish the causality between anxiety (disorders) and enhanced conditionability since it remains unclear if enhanced fear conditionability is an etiological precursor of the disorder or an epiphenomenon of the active disease process. Further, such studies do not clarify which mechanism increases conditionability in patients with anxiety disorders.

Differences in conditionability between anxiety patients and healthy controls may be the result of stable temperament factors that are partially heritable. Several studies have shown that individuals high in trait anxiety show more rapid and stronger aversive conditioning (e.g., see Levey & Martin, 1991, for an early review; Zinbarg & Mohlman, 1998). Recently Barrett and Armony (2008) compared healthy subjects with high versus low trait anxiety and found higher anxiety responses only during extinction in high trait

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anxious participants. Also Otto et al. (2007) found an association between conditionability and subsyndromal characteristics of anxiety disorders such as worry and anxiety sensitivity (Otto et al., 2007). Thus, both high trait anxiety as well as being diagnosed with an (subsyndromal) anxiety disorder may operate as facilitators of conditioning.

Studies relating clinical anxiety and/or trait anxiety to conditionability only provide circumstantial evidence that anxiety per se is a mechanistic (or causal) factor for increased conditionability. A third variable, such as neurotransmitter system differences between groups or personality variables may be responsible for the observed differences. Only experimental variation of a factor in a randomized design can establish a causal link between this factor and the outcome (Kraemer et al., 1997). Thus, to convincingly test if anxiety itself is a facilitator of conditioning, anxiety/fear needs to be experimentally manipulated before conditioning effects are measured. To our knowledge, only one study related to this question has been conducted. Jackson, Payne, Nadel, and Jacobs (2006) induced stress with a social anxiety stressor 1 h before a conditioning paradigm. Only in men, stress exposure increased conditioned responding (measured by skin conductance response, SCR) during acquisition and extinction (Jackson et al., 2006). Interpretability of study results is limited, however, since the 1 h interval between the stressor and the conditioning had resulted in reported anxiety having decreased to normal at the start of the conditioning task. Clearly, to test the influence of anxiety on conditionability anxiety needs to be induced immediately before conditioning starts.

Taking these considerations into account, we investigated the influence of state anxiety on conditionability in healthy subjects in a differential fear conditioning paradigm. We tested the assumption that anxiety enhances fear conditioning during acquisition and particular reduces extinction. Due to the temporary nature of experimentally induced emotional states (Gilet, 2008) it appeared necessary to study their effects separately for acquisition and extinction. In Experiment 1, subjects were randomized to one of two film conditions inducing an anxious or happy emotional state. They subsequently underwent a conditioning acquisition procedure. In Experiment 2, subjects watched one of three films (anxious, neutral, happy) following a similar acquisition phase, and immediately preceding an extinction phase. In both studies two pictures of faces served as conditioned stimuli (CS+ and CS–), and an aversive electric stimulus served as unconditioned stimulus (US). SCR served as the dependent variable since it is the best-established outcome measure of fear in human fear conditioning studies.

## 2. Experiment 1: acquisition of conditioned fear

Experiment 1 investigated fear conditionability in subjects with either an anxious or a happy induced emotional state during the acquisition phase of a differential fear conditioning paradigm. According to previous results indicating enhanced conditionability in (subsyndromal) anxiety we expected higher conditionability in the anxious compared to the happy emotional state.

### 2.1. Method

#### 2.1.1. Participants

Female participants were recruited at the faculty of psychology of the University of Basel. We included only women, as the meta-analysis of Westermann, Spies, Stahl, and Hesse (1996) has shown that emotional state induction can be achieved more reliably in women compared to men. Participants were psychology undergraduates recruited using advertisements on websites and pin

boards of the University of Basel. The advertisement described that the study was about human decision making and judging. Seventy-nine women (age range 18–40 years,  $M = 23.0$ ,  $SD = 4.6$ ) provided written consent for participation in the study. Data from the first 10 participants were discarded since the intertrial intervals proved too short for sufficient recovery of the skin conductance levels, requiring adjustment of the procedure. Data from another 5 participants were lost due to equipment malfunctioning. Finally, 7 participants were electrodermal nonresponders and therefore excluded from the analyses. Of the 55 women who were included in the analyses 28 were randomly assigned to the anxiety state group and 27 to the happiness state group. Participants underwent the 1-h protocol in exchange for course credits. Table 1 displays data on demographics, psychometric data and characteristics of the conditioning task of the two groups. No significant differences were found between groups in age ( $t = 0.43$ ), psychopathology (trait anxiety,  $t = 0.60$ ; social anxiety,  $t = 1.25$ ; and depression,  $t = 0.24$ ), or the objective strength and subjective intensity as well as startling properties of the electric stimulus (US;  $\chi^2 = 7.21$ ;  $t = -0.144$ ; and  $t = 0.93$ , respectively), nor for contingency awareness ( $\chi^2 = 1.06$ ).

#### 2.1.2. Procedure

**2.1.2.1. Selection of the CS+, CS– and control stimulus.** Participants were assessed individually. After informed consent was obtained, the electrodes for psychophysiological measurement were attached (see Apparatus and physiological recordings section below). Then participants were invited to watch a set of 60 color pictures of neutral human faces (30 male) on a computer screen one by one by clicking the mouse. All photographs (256 colors,  $640 \times 480$  pixel resolution,  $13 \times 19$  cm size, viewing distance 1 m) were presented against a black background on a 19 inch Monitor (100 Hz refresh rate). Then they watched the pictures again and evaluated them on a valence and arousal Likert-type, 21-point scale ( $-100 =$  'very unpleasant',  $0 =$  'neutral',  $+100 =$  'very pleasant'; and  $-100 =$  'very calming',  $0 =$  'neutral',  $+100 =$  'very arousing'). The experimenter used these ratings to select appropriate CS+, CS–, and control stimuli (see below for the selection procedure).

**2.1.2.2. Adjustment of the electric stimulation (US).** After picture ratings electrodes for the electric stimulation were attached to participants' right forearm. Together with the experimenter, participants increased the intensity of the electric stimulation to a level that they described as being "unpleasant and demanding some effort to tolerate". Between 3 and 6 electric stimuli were applied to arrive at the final intensity. After a 5-min adaptation period, a rating dial was introduced. The rating dial was a linear slider on which a visual analogue scale was affixed; the lower

**Table 1**  
Descriptive data of participants and conditioning parameters in Experiment 1.

	Mood	
	Anxious <i>N</i> = 28	Happy <i>N</i> = 27
Age in years, <i>M</i> ( <i>SD</i> )	22.3 (3.6)	22.8 (5.5)
STAI-trait anxiety, <i>M</i> ( <i>SD</i> )	36.6 (7.8)	38.0 (6.9)
Social interaction anxiety scale, <i>M</i> ( <i>SD</i> )	19.2 (9.9)	23.0 (8.9)
Beck depression inventory, <i>M</i> ( <i>SD</i> )	7.2 (6.8)	7.7 (5.7)
Electrical stimulus intensity (%)		
1 mA	7	0
2 mA	25	11
5 mA	61	59
10 mA	7	30
Subjective US-intensity, <i>M</i> ( <i>SD</i> )	3.18 (0.39)	3.04 (0.34)
Subjective US-startle, <i>M</i> ( <i>SD</i> )	3.40 (0.79)	3.59 (0.80)
Contingency awareness %	100	96

Note: STAI = Spielberger state-trait anxiety scale.

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