J. Behav. Ther. & Exp. Psychiat. 44 (2013) 201–206

Contents lists available at SciVerse ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Rating data are underrated: Validity of US expectancy in human fear conditioning

Yannick Boddez [a], Frank Baeyens [a], Laura Luyten [a], Debora Vansteenwegen [a], Dirk Hermans [a], Tom Beckers [a,b,*]

[a] Department of Psychology, KU Leuven, Belgium
[b] Department of Clinical Psychology, University of Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Received 21 December 2011
Received in revised form
1 August 2012
Accepted 20 August 2012

Keywords:
Human fear conditioning
US-expectancy
Shock-expectancy
Emotion
Anxiety
Fear

ABSTRACT

Background and objectives: Human fear conditioning is widely regarded as one of the prime paradigms for the study of fear and anxiety disorders. We provide an evaluation of a commonly used subjective measure in the human fear conditioning paradigm, namely the US-expectancy measurement.
Methods: We assess the validity of US-expectancy with respect to conditions of pathological fear and anxiety using four established criteria for scrutiny of a laboratory test or model (i.e., face validity, diagnostic validity, predictive validity, construct validity).
Results: Arguably, there is sufficient evidence for the face validity, diagnostic validity, predictive validity and construct validity of the US-expectancy measure.
Limitations: Presumed limitations of the US-expectancy measure, including its susceptibility to experimental demand and memory bias, are discussed.
Conclusions: The US-expectancy measure is a valuable measurement method that can be effectively used in research that aims to enhance our understanding of fear and anxiety disorders.

1. Introduction

The human fear conditioning paradigm is a powerful model for studying fear and anxiety disorders (e.g., Craske, Hermans, & Vansteenwegen, 2006). Our understanding of both (1) the psychological processes and (2) the neurophysiological and genetic underpinnings underlying these disorders and their treatment has benefited tremendously from the use of the fear conditioning procedure (e.g., Craske et al., 2006; Fanselow & Poulos, 2005; Lang, Davis, & Öhman, 2000; Lonsdorf et al., 2009).

In essence, the human fear conditioning procedure entails the pairing of an initially neutral conditioned stimulus (CS) with an intrinsically aversive unconditioned stimulus (US), often an electrocutaneous stimulus or a loud auditory stimulus (e.g., Lipp, 2006). When an electrocutaneous stimulus is used as US, the intensity is typically set individually at a level perceived as *uncomfortable, but not painful*. This procedure allows for the control of subjective US aversiveness. A burst of white noise, a loud tone or a more complex human scream can also serve as US. An intensity of about 100–105 dB presumably guarantees the aversiveness of such auditory stimulus (e.g., Lipp, 2006). The pairing of a CS with such US typically results in the CS coming to elicit a variety of responses indicative of fear. Lang (1971) identified three response systems: (1) subjective apprehension or verbal responses, (2) physiological arousal, and (3) avoidance behavior.

When in fear conditioning research multiple indices of fear are included -typically a verbal measure and one or more physiological measures- this is usually done for reasons of cross-validation. Although verbal, physiological, and behavioral indices of fear most often covary (Craske et al., 2006), the fact that response systems can diverge has long been recognized (e.g., Hodgson & Rachman, 1974; Mineka, 1979). The occasional lack of correlation is often attributed to measurement error or differences in sensitivity, but research has also demonstrated more systematic dissociations between parameters of fear learning. Bechara et al. (1995) reported a double dissociation between skin conductance responses, a physiological measure of the skin's ability to conduct electricity, and US-expectancy, a verbal measure of the extent to which participants expect the US upon presentation of the CS. Sevenster, Beckers and Kindt (2012) added to this finding by demonstrating a double dissociation between the startle response, a physiological measure of sensorimotor gating, and US-expectancy. Single dissociations, although methodologically more difficult to interpret, have been reported as well. For example, Soeter and Kindt (2010) (also see Soeter & Kindt, 2011 and Weike, Schupp, & Hamm, 2007) obtained a dissociation between, on the

* Corresponding author. Department of Psychology, KU Leuven, Tiensestraat 102, box 3712, 3000 Leuven, Belgium.
E-mail address: tom.beckers@ppw.kuleuven.be (T. Beckers).

0005-7916/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jbtep.2012.08.003

one side, the startle response and, on the other side, both skin conductance and US-expectancy. Soeter and Kindt (in press) later added feelings of anxious apprehension to the picture: They demonstrated a dissociation between, on one side, self-reported fear and the startle response and, on the other side, skin conductance and US-expectancy ratings; but it should be added that Pappens et al. (in press) reported a dissociation between self-reported fear and the startle response themselves. These exciting, but as of now inconsistent, findings of response system divergence illustrate the need to thoroughly evaluate the various indices of fear learning. A full comprehension of the respective responses is a prerequisite for a meaningful interpretation of (dissociations between) the responses.

A number of recent reviews on all three response systems identified by Lang (1971; e.g., Lipp, 2006) and on a number of specific fear responses (e.g., physiological startle potentiation; e.g., Grillon & Baas, 2003) are currently available. What is, however, missing is an evaluation of the most commonly used subjective measure in the human fear conditioning paradigm, namely the US-expectancy measurement. The present paper aims to fill this lacuna. As said, US-expectancy is a verbal measure of the extent to which participants expect US-occurrence. Often, these expectancies are collected either in a pre- and postexperimental test session or trial-by-trial during actual training. Participants typically indicate their expectancy of the US using visual analog scales, Likert scales or specialized devices such as dial and pointer setups or choice-button boxes. The (implicit) assumption among researchers interested in human fear conditioning appears to be that the subjective nature of US-expectancy makes it an inferior index of fear and anxiety compared to supposedly more objective physiological and behavioral indices. The implicit nature of this assumption emphasizes the necessity to systematically evaluate the merits and limitations of the US-expectancy measure.

We organize our evaluation of the use of reported US-expectancy in human fear conditioning around four established criteria for scrutiny of the validity of a laboratory test or model (e.g., Luyten, Vansteenwegen, van Kucyk, Gabriëls, & Nuttin, 2011; Sarter & Bruno, 2002; Vervliet & Raes, in press). The criteria are (1) the overlap in symptomatology between laboratory model and the condition being modeled (i.e., face validity), (2) the potential of the laboratory test to distinguish healthy individuals from patients or at risk individuals (i.e., diagnostic validity), (3) sensitivity of the laboratory test to clinically effective treatments for the condition that is being modeled (i.e., predictive validity) and (4) reliance on the same underlying process of the laboratory test and the condition being modeled (i.e., construct validity). All four criteria together determine the external validity of a laboratory test or model and can be used to answer the issue at stake here: Does the use of US-expectancy as a measure of human fear conditioning have external validity with respect to conditions of pathological fear and anxiety? Below, the validity of using US-expectancy as a measure of fear conditioning will be discussed according to these criteria and, in addition, threats to the validity of the US-expectancy measurement will be discussed.

2. Validity assessment

2.1. Face validity

The face validity of a test or model refers to the surface similarity between the test and the condition that the test aims to model. Face validity is merely based on the appearance of the test and therefore not the most stringent criterion. Face validity does, however, represent the most straightforward validation barometer and therefore provides a common starting point for validity assessment.

The US-expectancy measure gives an indication about the extent to which participants expect the aversive outcome. As such, US-expectancy mimics danger expectancies, which are a clear-cut symptom of pathological fear and anxiety. Let us illustrate with some examples. Individuals with a simple phobia, say dog phobia, typically expect a harmful outcome, like being bitten, upon confrontation with their phobic object (e.g., Di Nardo, Guzy, & Bak, 1988; Thorpe & Salkovskis, 1995). Among the same lines, panic patients tend to anticipate panic attacks when confronted with exteroceptive or interoceptive cues that previously co-occurred with panic (e.g., Bouton, Mineka, & Barlow, 2001). Generalized anxiety disorder is associated with a more free-floating and chronic expectancy of danger, which can also be grasped successfully with a US-expectancy measure in a human contextual fear conditioning paradigm (e.g., Vansteenwegen, Iberico, Vervliet, Marescau, & Hermans, 2008).

In summary, at face value the expectation of an unpleasant electric shock or loud noise in the human fear conditioning paradigm seems to be similar to the anticipation of harm characteristic of pathological fear and anxiety. Although US-expectancy thus seems to grasp an important characteristic of fear and anxiety, the US-expectancy measure does not cover all symptomatology associated with fear and anxiety emotions. Fear and anxiety are often accompanied by a state of emotional arousal (e.g., Lang et al., 2000). In addition, overt behavioral impulses are vital to fear emotions as well (Lang, 1971): There is evidence that fear learning results in conditioned avoidance behavior (e.g., Grillon, Baas, Cornwell, & Johnson, 2006; Lommen, Engelhardt, & van den Hout, 2010) and pathological fear in real-life is also known to interfere with performance on normal daily tasks (e.g., Rosen & Schulkin, 1998). The US-expectancy measure does not grasp the arousal and behavioral outcomes of fear and anxiety, thereby limiting its face validity. Indeed, a limitation of every outcome measure is that it illuminates certain aspects of the phenomenon under study, but leaves other aspects in the dark.

2.2. Diagnostic validity

Vervliet and Raes (in press) emphasized the importance of diagnostic validity. A laboratory model or test has diagnostic validity if it can distinguish healthy individuals from patients or at-risk individuals. So, if the US-expectancy measure in human fear conditioning research has diagnostic validity with respect to pathological fear and anxiety, one would expect differences in US-expectancy between, on the one hand, anxiety patients or at-risk individuals and, on the other hand, healthy controls. Empirical studies provide some support for this idea.

In an early study, Streiner and Dean (1968) found that high trait anxious participants had higher mean US-expectancies during acquisition training in a fear conditioning procedure, relative to low anxious individuals. In a more recent study, Chan and Lovibond (1996) demonstrated that individuals with heightened trait anxiety display an expectancy bias in a conditioned inhibition procedure. In this procedure, trials on which a single stimulus is followed by the US are intermixed with trials on which the stimulus is presented together with a second stimulus and the US is left out. Individuals high in trait anxiety showed heightened US-expectancy to the (safe) compound of both stimuli. A recent study in our lab moreover provides evidence that trait anxiety is also positively correlated with US-expectancy to a blocked stimulus (Boddez et al., 2012). In a blocking procedure, a single CS, termed the blocking stimulus, is paired with a US in the first stage. During the subsequent stage, this blocking CS is presented together with a second CS, termed the blocked stimulus, and this compound is followed by the same US. Results revealed that the level of US-expectancy to the