



An ERP study of the interaction between verbal information and conditioning pathways to fear

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ABSTRACT

Two experiments are described that explore the effects of verbal information and direct conditioning in the acquisition and extinction of fear responses. Participants were given verbal threat information about novel animals before conditioning trials in which the animals were presented alongside an aversive outcome (Experiment 1), or positive information about the animals before extinction trials (Experiment 2). Fear was measured using self-reported fear beliefs, expectancy of the unconditioned stimulus (US) and event-related brain potential (ERP). The results showed a direct effect of verbal information on acquisition (Experiment 1) and extinction (Experiment 2). There was a P2 peak latency shift at acquisition (Experiment 1) and P1 mean amplitude response at extinction (Experiment 2) based on the interaction between verbal information and US-contingency. However, the P2 response showed little evidence for an enhanced conditioned response (CR) when verbal threat information and direct conditioning combined: earlier P2 responses were found for all animals that had been associated with either threat information or the aversive US. Additionally, increase in P1 mean amplitude response (Experiment 2) seemed to stem from the conflict between verbal information and contingency information, rather than the predicted decrease in response where positive information and extinction training were combined. Future studies are suggested that might explore whether attention/arousal modulate the P1 response as a result of such expectation violations.

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1. Introduction

Fears can be acquired through direct conditioning, observational (vicarious) and verbal threat information (Rachman, 1968, 1977). These pathways are now well-established as direct causal mechanisms through which fears develop. Direct conditioning has been demonstrated to cause fear in countless laboratory and case studies spanning nearly a century of research (see Craske et al., 2006, for a review). Also, in numerous studies, verbal threat information about novel animals has been shown to change children's fears as indexed by all of Lang's response systems (Lang, 1968b, 1978): fear beliefs measured through both self-report and reaction time tasks increase, and during behavioural tasks children avoid the animals and show increased physiological responses (Field, 2006a, 2006c; Field et al., 2001, 2008; Field and Lawson, 2003, 2008; Field and

Price-Evans, 2009; Field and Schorah, 2007; Muris et al., 2003; Muris and Field, 2010). In addition, similar studies have shown that mild vicarious learning experiences can promote changes in self-reported fears and behavioural avoidance in children (Askew and Field, 2007, 2008; Broeren et al., 2011; Gerull and Rapee, 2002).

The status of these pathways as causal mechanisms through which fears develop is well established; however, experiences in the real world are not so easily compartmentalised as in the laboratory. Consequently many theorists have discussed the interaction between these pathways. Davey (1997) and Mineka and Zinbarg (2006) have developed similar models of fear acquisition that have direct conditioning at their core (i.e., an association between a conditioned stimulus, CS, and an aversive unconditioned stimulus, US, that is generated by a direct traumatic experience), but incorporate other pathways to fear. In both models, the role of verbal information is to influence the CS–US association once it has been formed through conditioning (i.e., experiencing a CS in temporal contiguity with a traumatic US experience). Mineka and Zinbarg's model differs from Davey's in that they believe this conditioning experience can be direct or vicarious: Mineka has argued that vicarious learning is procedurally and mechanistically the same as direct

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conditioning in that the observed response acts as a US because it is traumatic in its own right to the observer (Mineka and Cook, 1993).

Field offers a slightly different take: unlike Davey and Mineka and Zinbarg he does not assume that a direct (or vicarious) traumatic conditioning experience is necessary for a CS–US association to be formed: he suggests that a mental link between a representation of a stimulus and a representation of ‘threat’ can be formed through any one of the three pathways without the need for a overtly traumatic US (Field, 2006b; Field and Purkis, 2011). This view is based on findings that vicarious learning can create fear even when the observed response is not intrinsically fear-evoking (Askew and Field, 2007), and that verbal instruction can lead to conditioned fear responses even in the absence of any US presentations (Mechias et al., 2010).

As such, all three theories agree that the underlying mechanism that drives a fear response to a stimulus is a mental link (associations or propositions) between a representation of the stimulus and a representation of ‘threat’. Field believes that this link can be formed and moderated by direct conditioning, verbal information and vicarious learning whereas the other models suggest that the link is formed only in the presence of an intrinsically-traumatic US, but that verbal information can mediate the strength of the link. In the context of our study, the biggest difference is that Field believes that verbal information alone is sufficient to form a CS–US association that can drive a fear response.

Indirect support for Field’s idea that any of the three pathways can create a mental link between a stimulus and a representation of threat comes from Olsson and Phelps (2004), who manipulated a fear learning procedure to compare the effects of conditioning, vicarious learning and verbal instruction in adults. Comparable differences in skin conductance (SCR) were observed between supraliminal CS+ and CS– in all three learning conditions, thus providing evidence for a physiological conditioned response (CR) generated via all three pathways in isolation. Although SCR serves as one physiological index of conditioning, it represents a relatively late biological response when compared with the neural activity that presumably underlies SCR production as well as the early stage of stimulus processing. While it is possible to use fMRI to examine BOLD signal responses both prior to and after SCR responses (Critchley et al., 2000), the recording of event-related potentials (ERPs) can provide millisecond resolution of the perceptual and decision making processes that follow stimulus onset. Both SCR and ERP are equipped with the temporal resolution necessary to provide insights into how stimulus processing unfolds in real time during and prior to overt behavioural responding; however, ERP allows for a representation of early neural activity that precedes any kind of galvanic skin response. For example, when comparing scalp-recorded electrical activity and SCR response, the onset one particular electrophysiological response (N200) that had particular relevance to skin conductance, occurred at least 900 ms before the onset of the SCR response (Lim et al., 1999). As such, SCR analysis does not provide a sufficient temporal resolution for comparing how the influence of threatening verbal information and the influence of conditioning modulate early visual processing. *The first aim of the current study is to unpack these early processes, by using ERP as a measure of the CR.*

Olsson and Phelps (2004) also observed effects of direct conditioning, vicarious learning and verbal instruction in isolation; however, all of the aforementioned models of fear acquisition assume that the three pathways to fear interact. The three pathways should have an additive as well as an individual effect. In his expectancy model, Davey (1997) argues that verbal threat information creates expectancies that translate into a heightened fear response after a direct traumatic conditioning experience. As such, expectancies created by verbal threat information lead to

a stronger CS–US association after a direct experience. Field and Storksen-Coulson (2007) tested this idea and showed that children developed comparative fear beliefs and avoidance response of a novel animal as a result of verbal threat information and a direct mildly negative experience, but in combination the effect was significantly stronger. In fact, the self-reported change in fear cognitions (expectancies) created by the verbal information mediated the effect that the direct experience had on children’s avoidance of the animal. However, as yet there are no data to show that this interactive effect operates on the physiological response system and affects neurological indices of learning (such as ERPs). *The second aim of the current study is to test whether verbal threat information facilitates the acquisition of fear CRs through direct conditioning.*

It is worth noting that although the evidence so far has tended to focus on the role of verbal threat information in strengthening fear associations, positive verbal information potentially has an influence too. Positive information is a plausible way in which a fear response can be weakened (by devaluing the US). This idea is central to prevention and intervention (Davis and Ollendick, 2005): children’s fear beliefs about and behavioural avoidance of a novel animal (the CS) that had been heightened by threat information, can be reduced by either verbal information or modelling interventions about the CS (Kelly et al., 2010).

Models of associative learning suggest that fear is reduced by learning a new inhibitory association between the CS and the aversive outcome (US). In extinction training, for example, the association is weakened by reducing the contingency between the CS and the US. A new association is formed between the CS and no aversive outcome, which weakens the previous association with the US. According to Field’s (2006b) view, this new association could be formed not only through direct contingency experience, but also verbal information and vicarious learning (because he perceives them all as capable of creating an inhibitory association directly). Additionally, if combined threat information and direct experience magnify a fear response in comparison to either pathway alone (as in Field and Storksen-Coulson, 2007), this combination of pathways should have a superior effect in reducing the fear response too. *The third aim of the current study is to test whether positive verbal information facilitates the extinction of fear CRs through direct conditioning.*

To address our three aims we present two experiments that explore the interaction between verbal information and direct conditioning in the acquisition and extinction of fear responses. Measures of fear beliefs, expectancy learning and an online measure of ERP response were used to determine the effects of verbal information and CS–US contingency. Additionally, by tracking change in ERP response across and extinction phases, these experiments explore rates of CR acquisition and extinction.

If verbal information can act as a US (as proposed by Field, 2006b), a CS–US association should be formed through the verbal threat information prior to directly experiencing a CS–US contingency (Experiment 1). We hypothesise that this association would lead to higher fear beliefs pre-acquisition, faster US–expectancy learning during and a faster rate of change in ERP response towards the CS+ (in comparison to a no-information condition) during. Equally a CS-verbal positive information pairing, pre-extinction, in Experiment 2 should lead to a new association being formed that weakens the CS–US association previously acquired through direct exposure to CS–US contingencies. We hypothesise that this association will lead to a reduction in fear beliefs pre-extinction training, and a faster rate of change in ERP response towards the CS+ (in comparison to a no information condition) during extinction. Finally, if verbal threat information heightens aversive outcome expectancies we might expect resistance to extinction in Experiment 1, towards the CS+ in a threat information condition, on the

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