



# Attentional and Affective Consequences of Safety Signals in the Presence and Absence of Threat

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## ABSTRACT

Improved understanding of fear inhibition processes can inform the etiology and treatment of anxiety disorders. Safety signals can reduce fear to threat, but the mechanism for this reduction remains unclear; they may acquire attentional salience and affective properties (e.g., relief) independent of the threat. Alternatively, safety signals may remain motivationally neutral except when presented during simultaneous threat.

This study examined the fear-reducing effects of safety signals. Participants viewed a series of red and green words from two semantic categories: animals and body parts. Shocks were administered following red words (CUE+). No shocks followed green words (CUE-). Words from one category were defined as Safety Signals; no shocks were administered on CUE+ trials for these words. Words from the other, control category did not alter shock administration. Threat (CUE+ vs. CUE-) and SS (Safety vs. Control) were fully crossed. Startle response and ERPs were recorded.

Startle response was increased during CUE+ vs. CUE-. Safety signals reduced startle response during CUE+, but safety signals had no effect on startle response during CUE-. ERP analyses (P2, P3) suggested that participants parsed threat and safety signals information in parallel. These analyses did not indicate motivated attention associated with safety signals in the absence of threat. Overall, these results confirm that fear can be reduced by safety signals. Additionally, safety signals do not appear to hold any inherent hedonic salience independent of their effect during threat. Instead, safety signals appear to cue participants to engage in relatively effective top-down emotion regulatory processes.

## BACKGROUND & AIMS

Emotion regulatory processes are important for both clinical and non-clinical populations. In particular, down-regulation of fear responses has direct relevance for clinical populations (e.g. PTSD, phobias, GAD).

A body of basic research on conditioned inhibition in animals indicates that safety signals established via conditioning can effectively reduce fear. However, the question of how safety signals operate in humans remains understudied.

The present study aimed to develop and validate a novel paradigm that could be used to evaluate the effects of safety signals established by instruction on attention and affective response in humans and to determine if these safety signals can be used to effectively inhibit fear. Such a paradigm could be used as a tool to investigate individual differences in the utility of safety signals (e.g. in clinical populations).

There are many potential applications of safety signals to clinical settings. Safety signals established via instruction offer potential utility as a clinical tool in anxious and/or phobic populations to enable down-regulation of maladaptive emotional responding in the real world. If safety signals can be established through instruction and effectively employed to down-regulate affective response through top-down processing, day-to-day patient functioning may be improved. On the flip side, patient use of safety signals could prove detrimental to exposure therapy or other treatments requiring a robust fear response to in order to be effective (i.e., for extinction to occur).

## METHOD

**Participants:** 32 participants (16 female) recruited from the undergraduate community

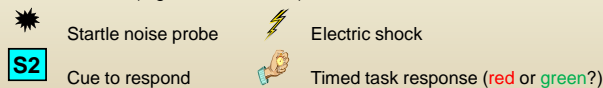
### Cued Threat Task with Safety Signals

- Participants viewed animal and body part words displayed in either red or green ink
- Threat status was established via **word color**: **RED** words (CUE+) indicated shock threat; **GREEN** words (CUE-) indicated no shock threat.
- Safety Signals were indicated via semantic category; e.g., Animal words indicated participant was safe regardless of cue type (SS+), whereas body part words provided no signal of safety (SS-).
- Task: Determine ink color and respond via button press.



## KEY

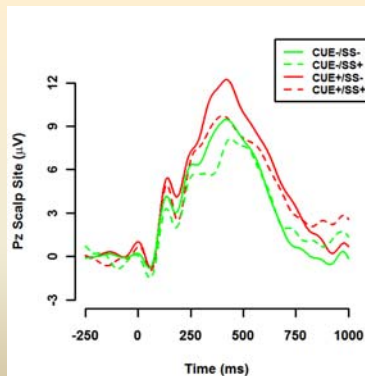
- S1:** CUE-/SS- (e.g., **FOOT, KNEE**)  
 CUE-/SS+ (e.g., **CROW, LAMB**)  
 CUE+/SS- (e.g., **FOOT, KNEE**)  
 CUE+/SS+ (e.g., **CROW, LAMB**)



## Measures:

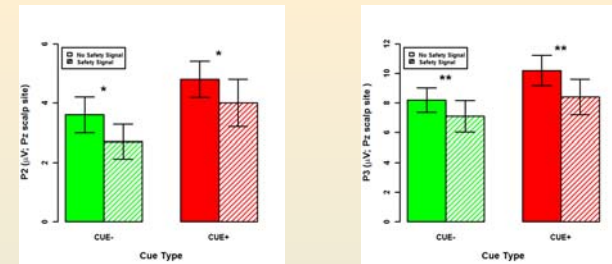
- Startle Response Potentiation
- Parietal P2 and P3
- Task Response Time

## RESULTS - ERP Waveform



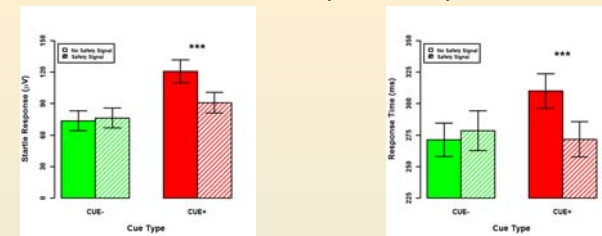
- Participants appear to process CUE and SS information independently (rather than configurally) during the first 500 ms.
- CUE+ trials engage greater attention as early as P2.
- Safety Signals allow participants to disengage attention, regardless of CUE type.

## RESULTS – ERP P2 and P3



- Significant main effects of CUE type were observed with increased P2 and P3 on CUE+ trials.
- Significant main effects of Safety Signal were observed with decreased P2 and P3 on SS+ trials.
- The CUE type X Safety Signal interaction was not significant.
- Clear threats (CUE+) attract attention regardless of Safety Signal presence. However, Safety Signals allow participants to disengage attention early in the processing stream.

## RESULTS – Startle Response and Response Time



- CUE Type X Safety Signal interaction was significant.
- The simple effect of Safety Signal was significant during CUE+ but not CUE- trials.
- Safety signals inhibit fear during CUE+ trials but do not indicate hedonic value on CUE- trials.
- CUE Type X Safety Signal interaction was significant.
- The simple effect of Safety Signal was significant during CUE+ but not CUE- trials.
- Safety signals reduce performance deficit during CUE+ trials but do not affect response time on CUE- trials.

## CONCLUSIONS, CLINICAL IMPLICATIONS & FUTURE DIRECTIONS

- Participants can effectively use safety signals that are established by instruction to down-regulate their fear responses to threatening stimuli.
- Early in the processing stream, participants also use safety signals to adaptively disengage their attention in an otherwise ambiguously threatening environment.
- Safety signals do not appear to alter participants' affective response independent of their modulatory effects during threat.
- These findings highlight the potential utility of treatments involving safety signals as a clinical tool for patients with otherwise poor emotion regulatory ability (e.g., anxiety disorders).
- Future research in this area should examine the effects of safety signals paired with aversive stimuli established via true conditioning (e.g., learning), the time course of affective response (via assessing startle response at earlier time points), and clinically-relevant individual differences.