An Empirical Comparison of Commonly Used Methods of Quantifying Startle Potentiation

Mark J. Starr[1], Daniel E. Bradford[1], Alexander J. Shackman[2], John J. Curtin[1]
Department of Psychology[1] & Department of Psychiatry[2], University of Wisconsin - Madison

Abstract

Two common methods to calculate startle potentiation during threat use either difference scores (threat – neutral) or percent change ((threat – neutral) / neutral). These methods can produce divergent conclusions when study groups or conditions differ in startle response in the neutral condition. The current study systematically compared conclusions from these two startle potentiation calculation methods about affective response during threat of shock in four scenarios where neutral startle response differs: 1) alcohol intoxicated vs. non-intoxicated participants, 2) 95dB vs. 100dB vs. 105dB startle probes, 3) first vs. second half of experiment and 4) across participants with low vs. high baseline startle response. Analyses of startle potentiation yielded different conclusions across calculation methods. Conclusions from startle potentiation were most similar to pattern of raw responses when difference scores rather than percent change were used. Difference scores were also more stable than percent change across varied startle probe intensities. These results suggest potentiated startle is best represented as a difference score rather than percent change score.

Aims

Compare conclusions from startle potentiation calculated as a **difference score** or **percent change** in four scenarios where *neutral* condition response differs:

1) Variable startle probe intensity (95 dB, 100 dB, and 105 dB)
2) Alcohol intoxication
3) Across the range of individual differences in baseline startle response magnitude
4) First versus second half of an experiment

A valid measure of startle potentiation will show stability across probe intensities, sensitivity to the anxiolytic effect of alcohol, either a null or positive association with baseline startle, and insensitivity to the habituation of response expression

Methods

Participants

96 undergraduate students (48 F) were randomly assigned to either a No Alcohol (N=48) or Alcohol (N=48) beverage group

Procedure

Baseline Startle Measurement

- While participants sequentially viewed two neutral colored squares, eyeblink startle magnitude was elicited by 100dB startle probes
- Startle probes were administered during half of each square's six presentations

Drug Administration

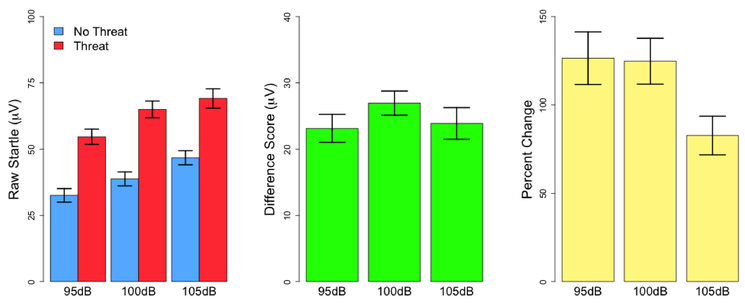
- Participants in the Alcohol group were administered a dose of alcohol sufficient to bring their blood alcohol level to the target, 0.08% (mean achieved level, 0.079%; SD, 0.013%)

Main Session

- Participants were instructed which one of the previously viewed neutral squares would now coterminate with electric shock (50% reinforcement)
- Eyeblink startle magnitude was recorded during the square predicting shock (24x; 4.75 post-cue onset), the square predicting no shock (24x; 4.75 post-square onset), and the 10-14s inter-trial interval (24x; 4 or 8s post-square offset)
- Eyeblink startle was elicited by equiprobable 95dB, 100dB, or 105dB probes
- Each square was presented 42 times across 84 trials

Results

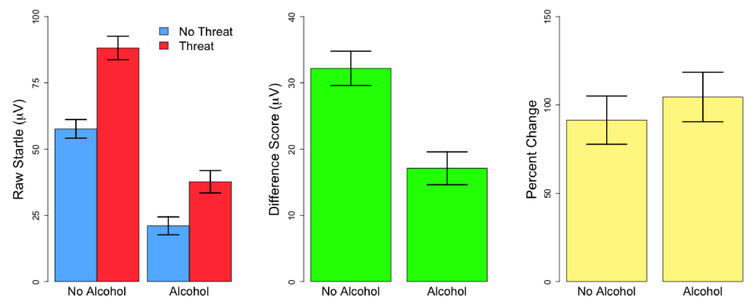
Probe Intensity



Difference scores were **stable** across probe intensities, $p > 0.12$

Percent change scores were **not stable** across probe intensities, $p < 0.05$

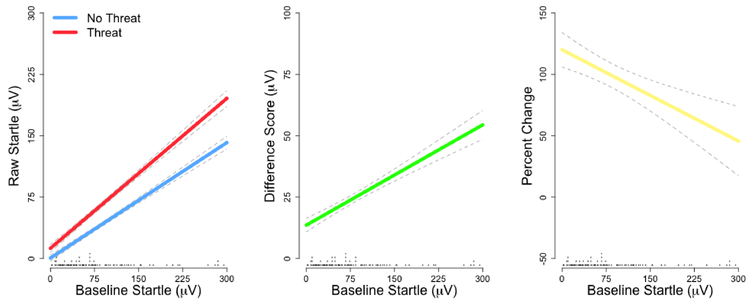
Beverage Group



Difference scores were **sensitive** to the anxiolytic effects of alcohol $p < 0.05$

Percent change scores were **not sensitive** to the anxiolytic effects of alcohol, $p > 0.28$

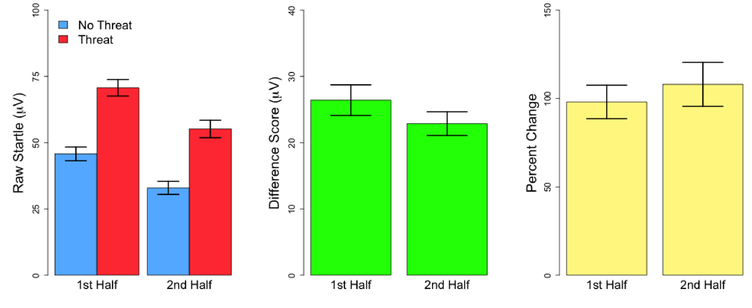
Baseline Startle



Difference scores were **positively associated** with baseline startle, $p < 0.05$

Percent change scores were **negatively associated** with baseline startle, $p = 0.068$

Time



Difference scores were **insensitive** to the effect of habituation, $p > 0.08$

Percent change scores were **insensitive** to the effect of habituation, $p > 0.38$

Conclusions

Three of the four scenarios tested indicate quantifying startle potentiation as a difference score is a more valid measure of affect than percent change:

1. Manipulating expression of the startle response by varying probe intensity should not alter the conclusions of a stable measure of affect. The significant main effect of probe intensity for percent change and null effect of probe intensity on difference scores, indicate difference scores are a more stable measure of affect than percent change
2. A wealth of multi-method animal and human research indicates alcohol intoxication reduces anxiety. Indeed, preliminary analyses of a criterion measure of affect, Corrugator EMG, suggest alcohol intoxication reduced negative affect during the main session of this task. A valid measure of affect should offer the same conclusion. The direction of the significant effect of alcohol for difference scores indicates they are a sensitive measure of alcohol-induced changes in negative affect. In contrast, the percent change method leads to the untenable conclusion that alcohol either nominally increases or has no effect on negative affect
3. The precise nature of the relationship between baseline startle and fear-potentiated startle remains controversial (see poster 63 on Friday for our lab's perspective). Depending on the interpretation of what baseline startle is measuring, a valid index of affect should show either a null or positive relationship between baseline startle and startle potentiation. Further, because percent change scores produce predictable distortions when neutral condition responses are high (eg, probe intensity effect) and low (eg, beverage group effect), the negative association between baseline startle and percent change scored startle potentiation should be interpreted with caution.

Broadly, these data highlight the need for thoughtful consideration and empirical testing of the validity of transformations of psychophysiological data prior to their implementation

Contact: starr2@wisc.edu