



BEATING HEARTS AND SWEATY PALMS: MEAN SKIN CONDUCTANCE RESPONSE DURING FEAR CONDITIONING IS LARGER FOR THOSE WITH LOWER RESTING RESPIRATORY SINUS ARRHYTHMIA



Introduction

- Thayer and Brosschot (2005) suggest that individuals with greater heart rate variability (HRV), an index of cardiac vagal control, should recover more quickly from emotional or physiologically demanding situations.
- The present study sought to examine the relationship between cardiac vagal control, as indexed by respiratory sinus arrhythmia (RSA), and subsequent sympathetic arousal during fear conditioning, as indexed by skin conductance response (SCR).

Method Overview

- The experiment has three phases:
 - Day 1 (learning phase), where participants underwent habituation and fear conditioning.
 - Day 3 (intervention phase), where participants were randomly split into groups for different fear inhibition training experiences (not discussed here).
 - Day 8 (test phase) that paralleled Day 1 involving CS presentation without the UCS, followed by CS presentation with the UCS re-paired with CS+.
- Stimuli were a picture of a snake and of a spider from the IAPS set. One picture was paired with the UCS (CS+), while the other was the CS- (counterbalanced across participants). The UCS was a 1000B white noise blast for 1 second duration and onset with the CS+ picture offset. Trial order was semi-random by CS type. The reinforcement schedule was 100% during CS+/UCS pairing (conditioning).
- Participants: 94 non-phobic female undergraduates from an introductory psychology class.
- Resting EKG was obtained for 4 minutes before habituation training, from which RSA was derived. Skin conductance (SC) was recorded during image presentation.
- The square root transformed raw scores of SCRs (baseline SC - peak SC) for each trial were compared by groups of participants with High ($n=46$, mean, range: 7.33, 6.53-8.63) versus Low ($n=47$, mean, range: 5.62, 1.50-6.50) resting baseline logRSA.

Day 1 Method

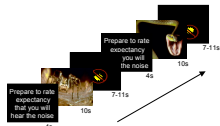


FIGURE 1a: An illustration of habituation trials. The yellow blast with the red cross indicates that the UCS was not presented.

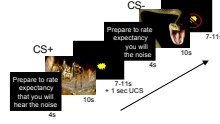


FIGURE 1b: An illustration of a CS+ and a CS- conditioning trial. The yellow blast mark represents the UCS noise blast that initiated at CS+ offset.

- Habituation:** 6 unreinforced (no UCS) presentation trials each of picture (see Figure 1a for a trial of each).
- Conditioning:** 8 presentations each of CS+ and CS- (see Figure 1b for example of a trial of each CS type), followed by one unreinforced presentation each of CS.

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Results

- Habituation:** As can be seen in Figure 2, in contrast to Thayer and Brosschot's (2005) theory's predictions, the Low RSA group had a trend toward a greater negative slope over the course of the trials, as compared to the High RSA group ($F(1,74)=3.68$, $p=.059$).
- However, Low RSA participants tended to be more aroused in general by the stimuli than the High RSA participants as shown by a trend toward greater SCRs to the stimuli for the Low RSA group as compared to the High RSA group ($F(1,74)=3.49$, $p=.066$).
- Conditioning:** The High RSA group had a flatter slope across trials than the low RSA group ($F(1,74)=5.08$, $p<.05$), which was qualified by a trend toward a CS type interaction ($F(1,74) = 3.37$, $p=.071$), where the Low RSA group, as compared to the High RSA group, had a comparatively greater slope difference for the CS- (right panel) than the CS+ (left panel).
- Note: Correlational analysis indicated that log RSA did not predict the mean magnitude of SCRs to the CS+ ($r(87)=-.058$, $p>.2$) or CS- ($r(89)=-.046$, $p>.2$) during the Conditioning trials. Accordingly, individual differences in RSA did not account for much variability in overall SCRs.

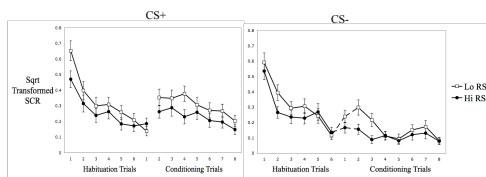


FIGURE 2: Mean square root transformed SCR for each habituation and conditioning Day1 trial by Low and High baseline resting RSA group. Left panel is for CS+ and the right panel for the CS- trials.

Note: For the left (CS-) panel, the line is dashed because of the semi-random presentation of stimuli. Some participants would have the UCS paired with the CS+ before their first CS- conditioning trial (9th presentation) and others before their second CS- conditioning trial (10th presentation).

- Given the trend toward lower overall SCRs for the High RSA group as compared to the Low RSA group, another way to test Thayer and Brosschot's (2005) theory is by comparing the differential increase in SCRs from habituation to conditioning.
- As can be seen in Figure 3 (next panel), the High RSA group showed less of an increase in SCR from habituation to conditioning for the CS+ ($F(1, 87) = 3.79$, $p = .055$) and also less of an increase for the CS- ($F(1, 89) = 8.33$, $p = .005$) as compared to the Low RSA group.

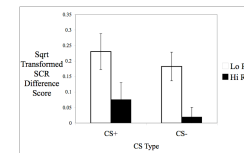


FIGURE 3: Day 1 mean square root transformed SCR difference for first conditioning trial - last habituation trial for Low and High baseline resting RSA groups.

Day 8 Method

- Parallel to Learning phase.
- Unpaired Presentation:** Method parallels Day 1 habituation, with 6 unreinforced (no UCS) presentation trials each of CS+ and CS- (as per Figure 1a).
- Re-Conditioning:** Method parallels Day 1 conditioning, with 8 presentations each of CS+ and CS- (as per Figure 1b), followed by one unreinforced presentation each of CS+ and CS-.

Results

- To test the predictive value of the High and Low RSA Day 1 groupings, they were used to compare SCRs to the stimuli 8 days later.
- Unpaired Presentation:** As shown in Figure 4 (right panel), for the CS-, the High RSA group showed a greater initial drop in SCR across trials as compared to the Low RSA group ($F(1,68)=7.15$, $p<.01$).
- Re-Conditioning:** The Low RSA group showed greater reactivity to the CS+/UCS pairing ($F(1,64)=4.55$, $p<.05$), as shown by increases in SCR that took more trials to reduce as compared to High RSA participants.

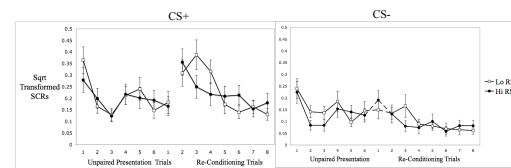


FIGURE 4: Mean square root transformed SCRs for each unpaired and Re-conditioning Day 8 trial by Low and High baseline resting RSA. Left panel is for CS+ and the right panel for the CS- trials.

- Unlike Day 1 (Figure 3), there was no differential increase in SCR responses from Unpaired Presentation to Re-conditioning ($F<.1$).

Discussion

- Supporting Thayer and Brosschot's (2005) theory, Ruiz-Padial and colleagues (2003) found that while viewing pleasant, neutral, and unpleasant pictures, higher resting HRV was associated with lower within-trial emotion-modulated startle magnitude. Participants with the highest HRV showed the most differentiated emotion-modulated startle effects, whereas those with the lowest HRV showed significantly increased startle response to not only negative, but also neutral, images.
- Results from the present study are consistent with these findings in a fear-conditioning paradigm using skin conductance response (SCR) as the dependent measure.
- Relative to Low RSA participants, High RSA participants demonstrated a trend towards reduced within-trial arousal, as measured by SCR, and less SCR reactivity to the CS+ after the start of conditioning during Day 1.
- There was also the consistent finding on Day 1 of greater reactivity to the CS- for the Low RSA group, as compared to High RSA group, suggesting less differentiated arousal.
- The present study extended prior work by demonstrating results generally consistent with these findings on Day 8.
- However, correlational analyses suggested that individual differences in logRSA did not account for much variability in overall skin conductance responses ($R^2=.003$ for CS+ and $R^2=-.002$ for CS-) during the Conditioning trials on Day 1.
- In sum, results trend toward supporting Thayer and Brosschot's (2005) theory that individuals with higher cardiac vagal control recover more quickly, and have generally reduced physiological reactivity, from emotional or physiologically demanding situations.

References

Ruiz-Padial, E., Sollers III, J.J., Vila, J. & Thayer, J.F. (2003). The rhythm of the heart in the blink of an eye: emotion-modulated startle magnitude covaries with heart rate variability. *Psychophysiology*, 40, 306-313.

Thayer, J. F. & Brosschot, J. F. (2005). Psychosomatics and psychopathology: Looking up and down from the brain. *Psychoneuroendocrinology*, 30, 1050-1058.

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