

Introduction

Defensive reactions are elicited by harmful or potentially harmful stimuli and are believed to be coordinated by a common neural system (defense system). It has been argued that defense responses are inhibited by concurrent appetitive motivation (positive emotion) and facilitated by concurrent defensive motivation (negative emotion) (Lang, 1995). Support for this primarily stems from research on the acoustic startle reflex (a defensive response elicited by abrupt noise). However, we have shown that the nociceptive flexion reflex (NFR, a nociception-specific defensive reflex) and pain are also modulated by emotion, similar to the acoustic startle reflex. Positive emotions inhibit NFR and pain, whereas negative emotions enhance NFR and pain. Given that defense is thought to be coordinated by a common system, then other reactions to noxious stimuli should be modulated by emotion.

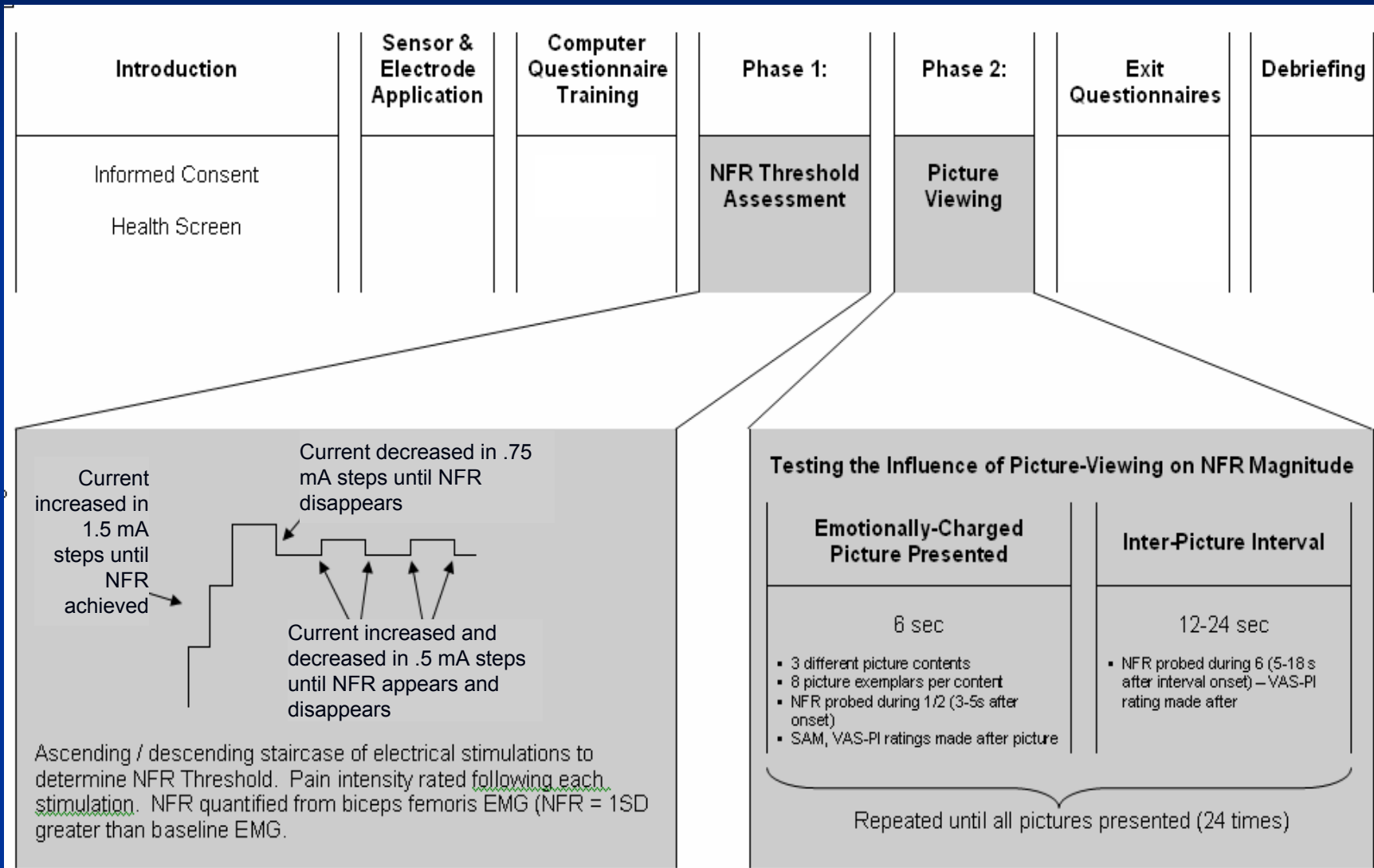
The Present Study

- Noxious electric stimulation of the sural nerve was used to elicit autonomic reactions (skin conductance response, heart rate acceleration) during emotionally-charged picture-viewing
- It was predicted that ANS reactions would be enhanced during unpleasant pictures (negative emotion) and inhibited during pleasant pictures (positive emotion)

Participants

- 53 healthy students
 - 23% male and 77% female
- Participants were excluded for:
 - < 18 years of age
 - Current acute illness
 - Cardiovascular, neurological, and/or circulatory problems
 - Recent use of analgesic, antidepressant, anxiolytic, or antihypertensive medication
 - Recent psychological trauma
 - Specific phobia of snakes or spiders
 - Problems healing
 - Raynaud's disease
 - Medical problems exacerbated by stress

Procedure



Noxious Electric Stimulation

- Stimulating electrodes attached over left sural nerve
- Stimulations were trains of 5 pulses of 1 ms duration at 250 Hz delivered randomly during pictures (balanced across picture valence)
- Stimulus intensity was based on the nociceptive flexion reflex threshold (1.2x NFR threshold)



Emotion-Induction: Picture-Viewing

- The International Affective Picture System (IAPS)¹
- 24 pictures, 8 per category (threat, neutral, erotic)
- Presented in random order
- Noxious stimuli (intensity = 1.2x NFR threshold) delivered during 50% of pictures (balanced across picture type)
 - ANS responses scored, standardized by individual (z score), & averaged by picture type



Unpleasant
(Threat)



Neutral

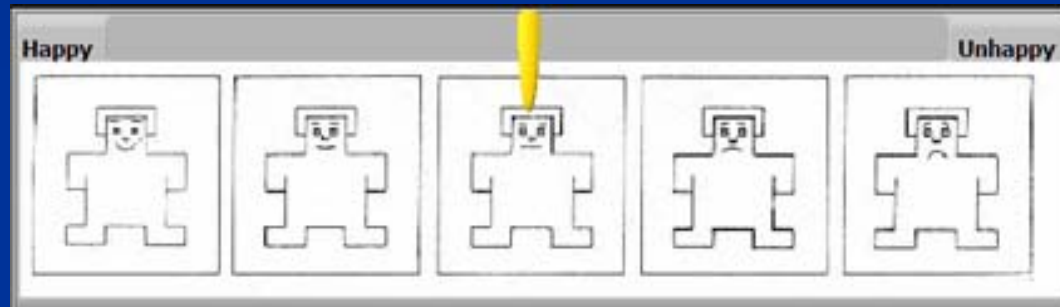


Pleasant
(Erotic)

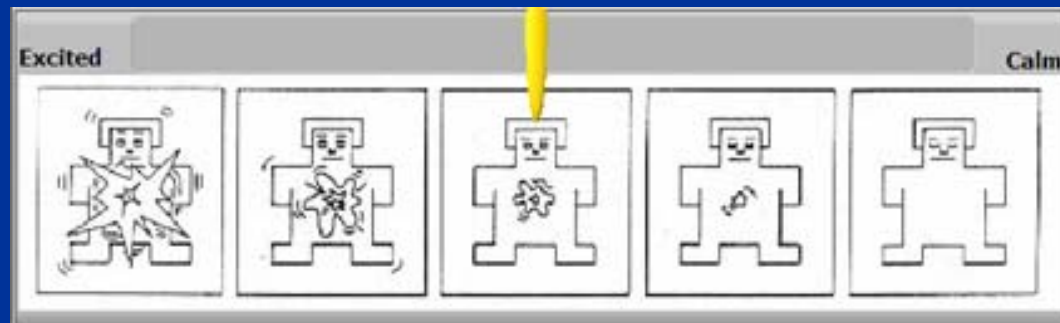
¹Center for the Study of Emotion and Attention, 1999

Emotion Manipulation Checks

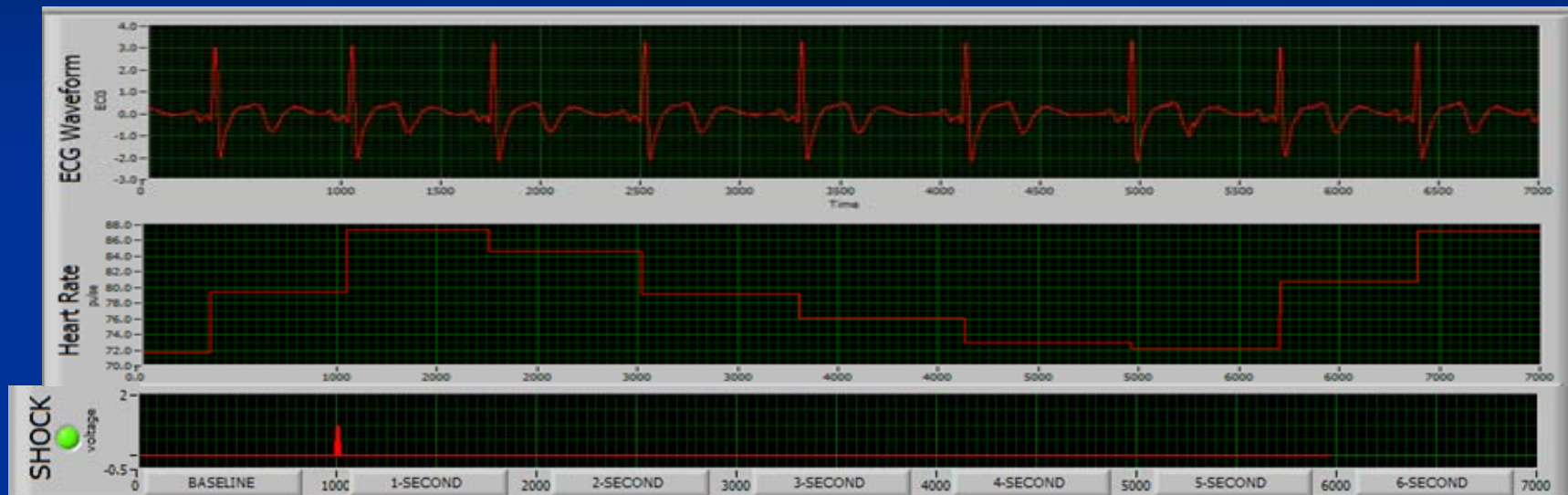
- Pleasure (valence) ratings
 - 1 (unhappy) to 9 (happy)



- Arousal ratings
 - 1 (calm) to 9 (excited)

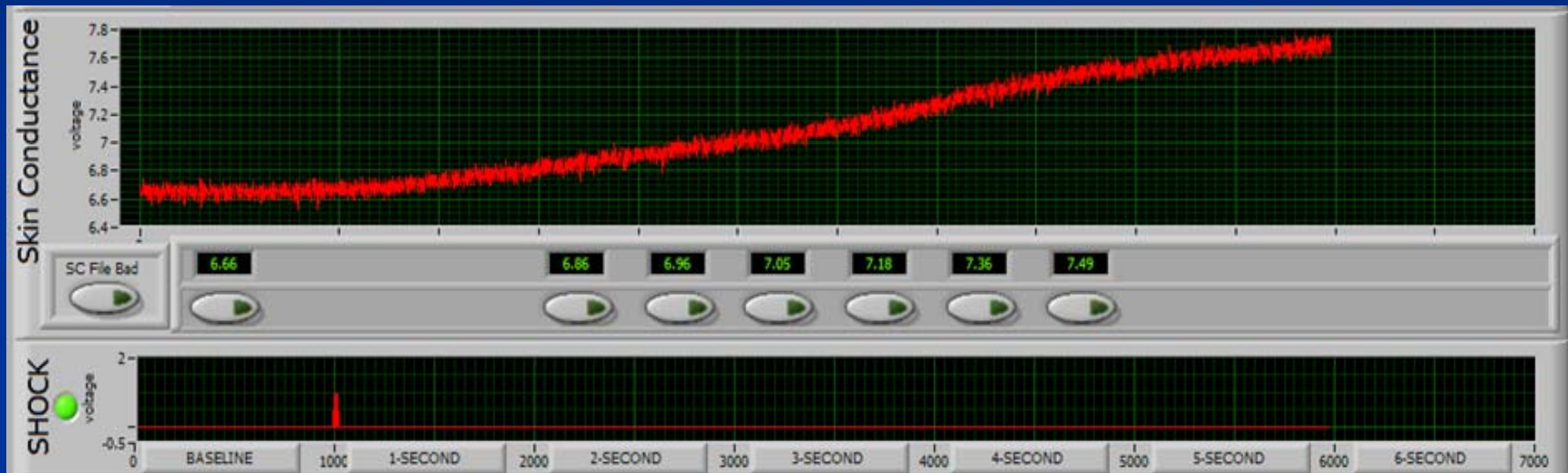


Autonomic Defense Responses: Heart Rate Acceleration



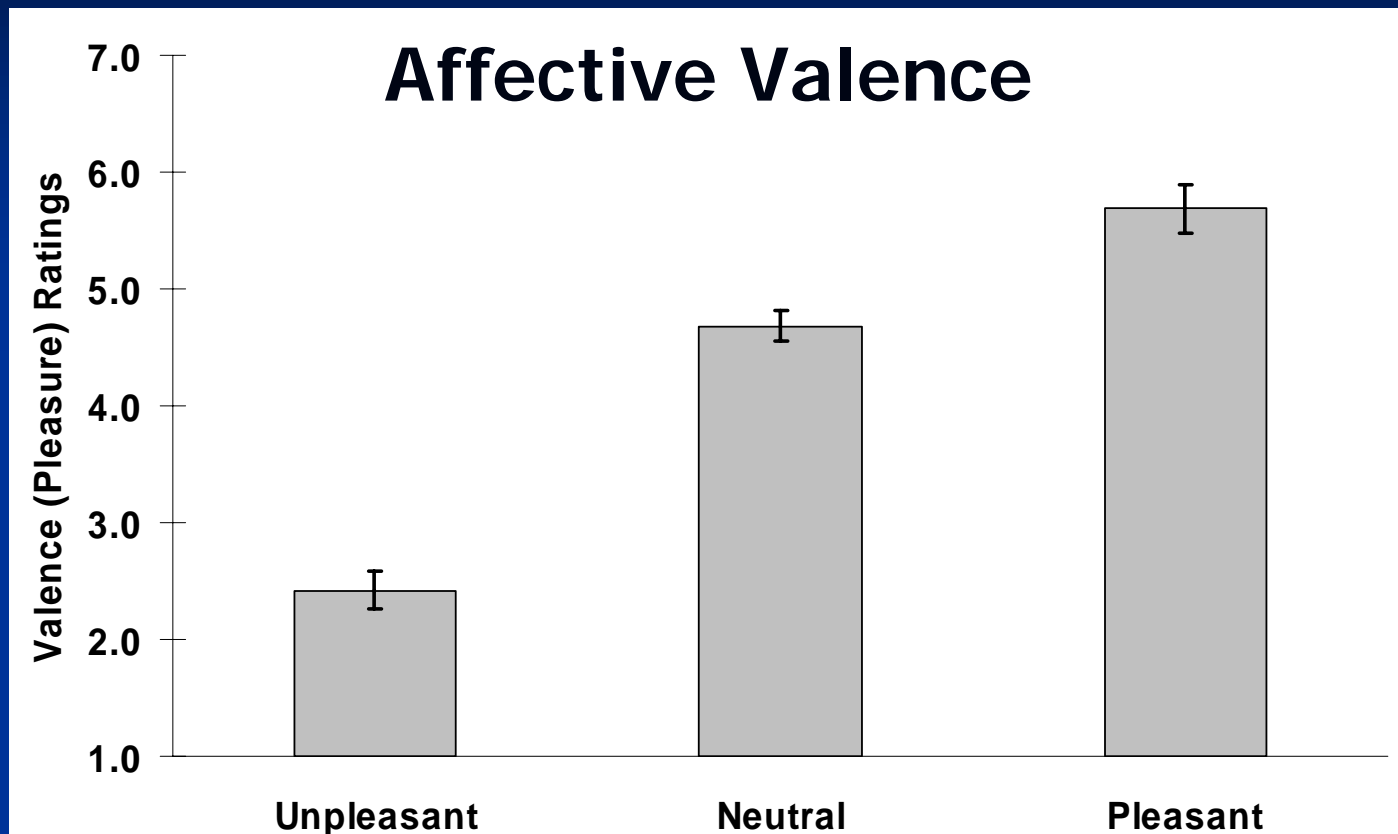
- Electrocardiogram (ECG) – recorded from left and right forearms.
- ECG was converted offline to heart rate in beats per minute from interbeat interval.
- Heart rate acceleration was defined as the maximum acceleration post-stimulation.

Autonomic Defense Responses: Skin Conductance



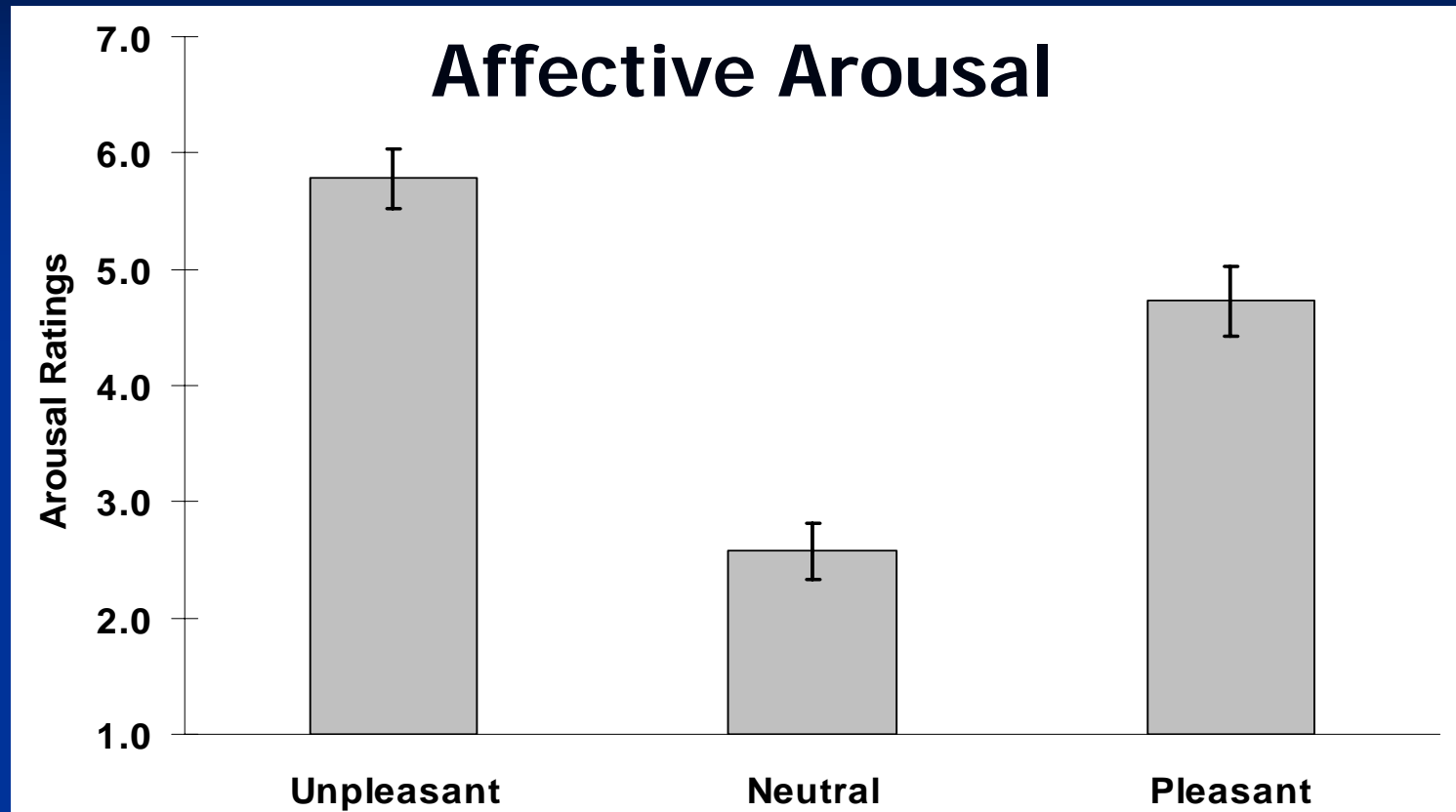
- Sensors attached to palmar surface of index and middle fingers
- Measures sympathetic arousal
- Response determined by maximum increase 1-4 s post-stimulation

Results: Manipulation Checks



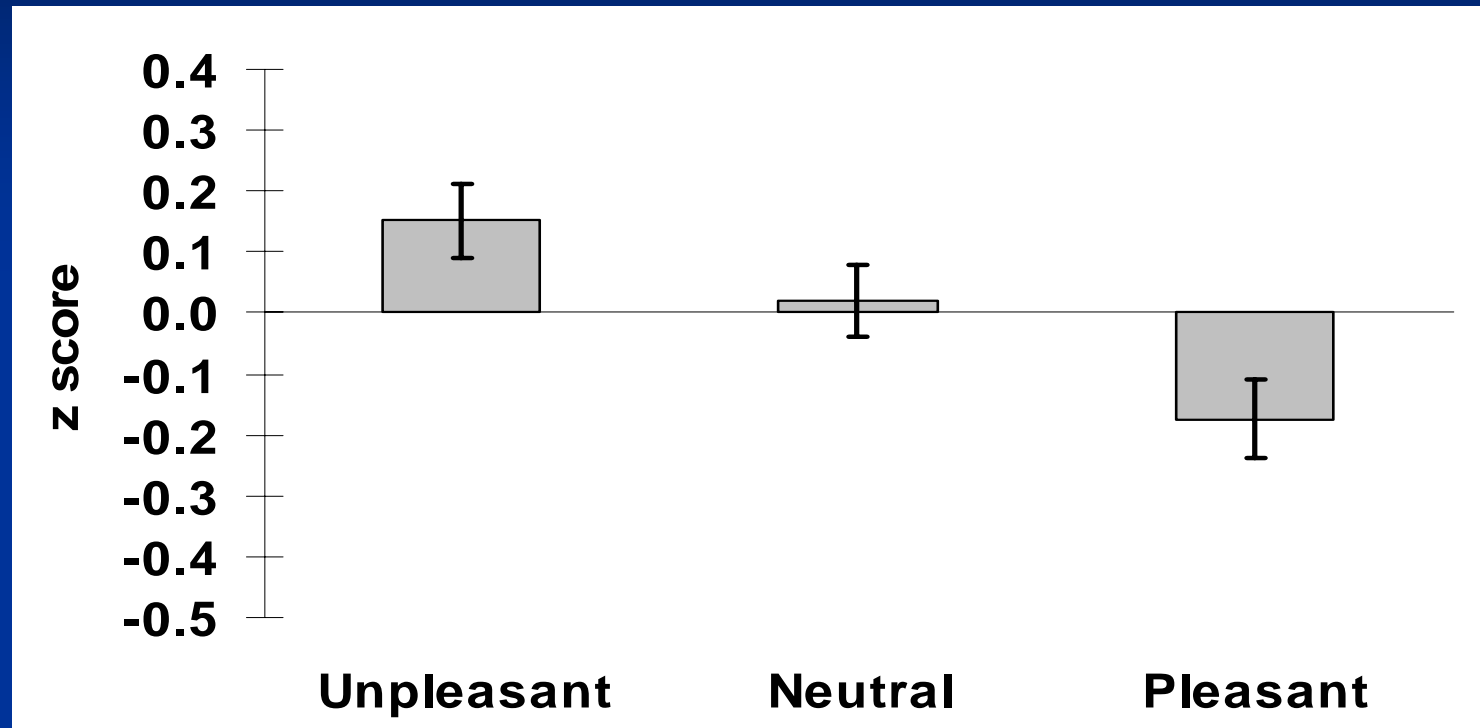
- Effect of picture type was significant: $F=89.15$, $p<.001$, $\eta^2=.78$.
- Relative to neutral pictures, valence ratings were lower for unpleasant pictures ($p<.001$) and higher for pleasant pictures ($p<.001$).
- Thus, pictures manipulated emotional valence.

Results: Manipulation Checks



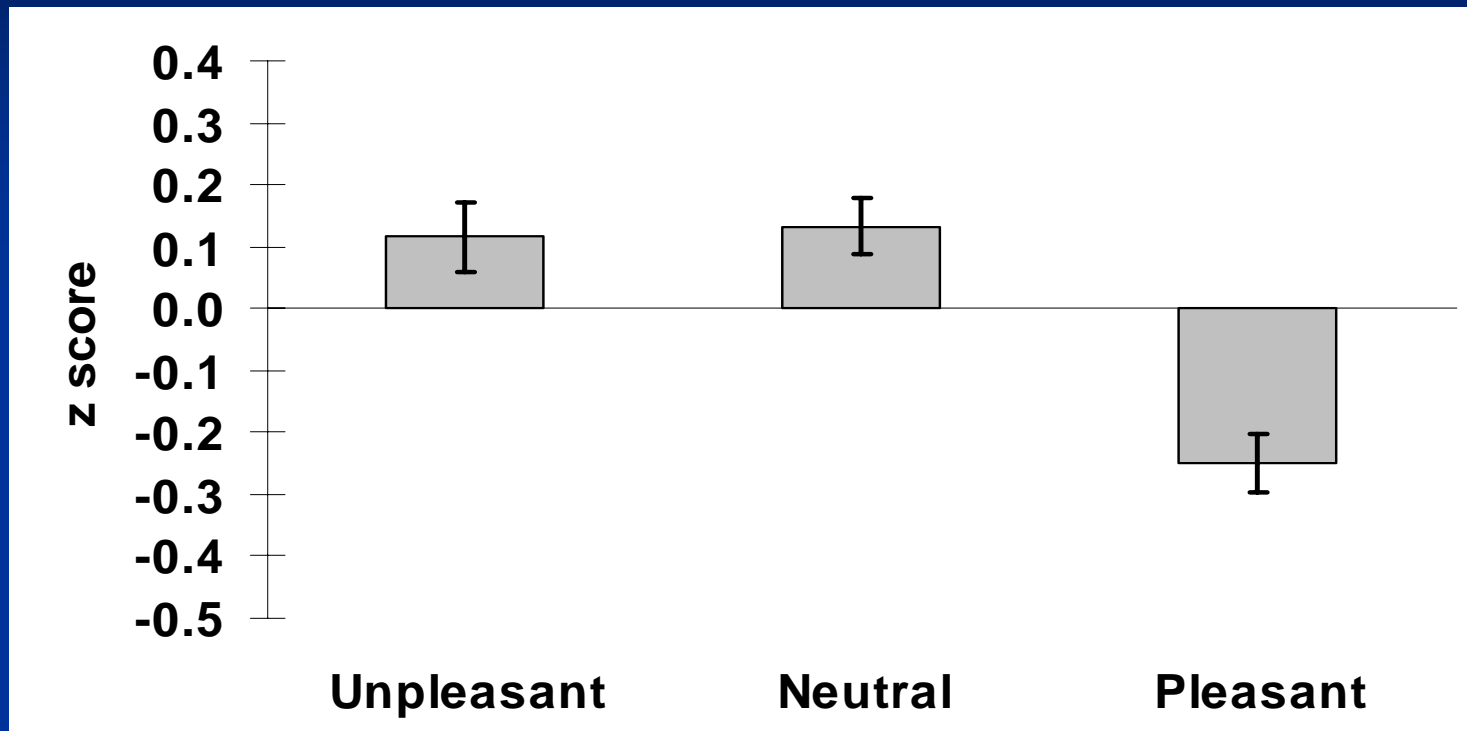
- Effect of picture type was significant: $F=77.60, p<.001, \eta^2=.75$.
- Relative to neutral pictures, arousal ratings were higher for unpleasant pictures and pleasant pictures ($ps<.001$).
- Thus, pictures manipulated emotional arousal.

Results: Skin Conductance Response



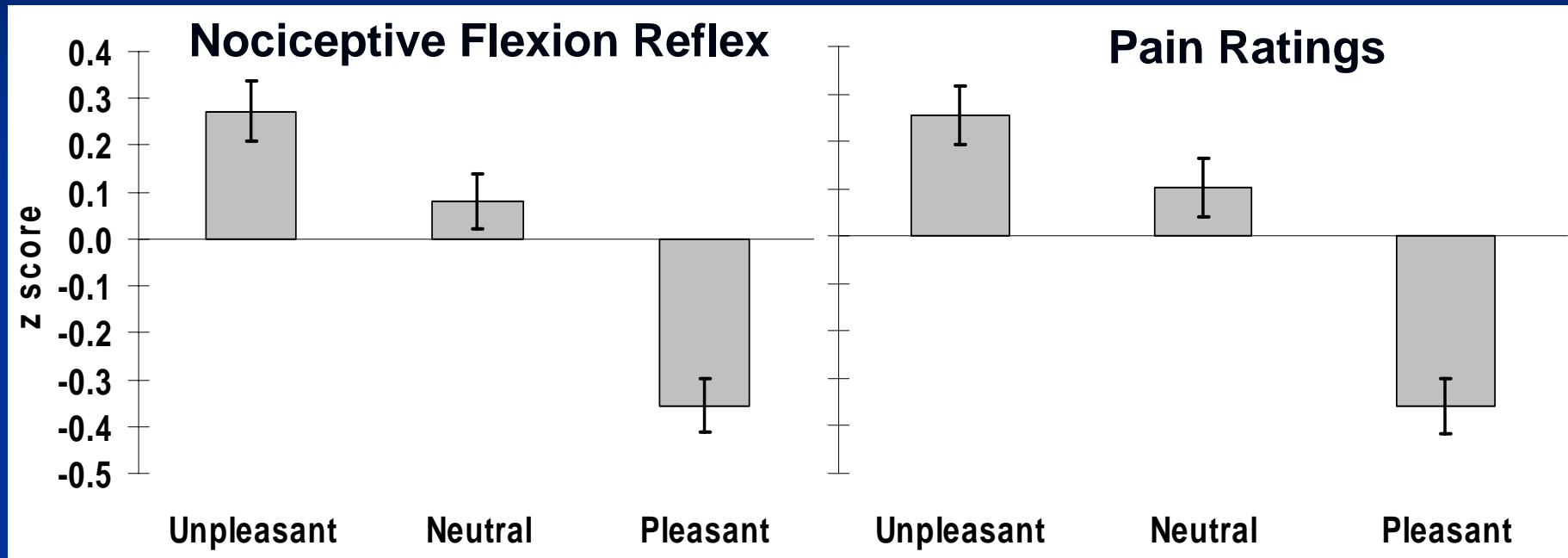
- Effect of picture type was significant: $F=4.31$, $p=.02$, $\eta^2 =.15$.
- Skin conductance responses were larger during unpleasant pictures than pleasant pictures ($p<.001$), but responses during unpleasant and pleasant pictures were not different from neutral ($ps>.05$).
- SCR was modulated by emotion.

Results: Heart Rate Acceleration



- Effect of picture type was significant: $F=15.06$, $p<.001$, $\eta^2 =.37$.
- Heart rate acceleration was reduced during pleasant pictures compared to neutral or unpleasant pictures ($ps<.01$), but the unpleasant versus neutral contrast was non-significant ($p=1.00$).
- HR was inhibited by pleasant emotion.

Results: Comparison to Nociception-Specific Measures



- Effect of picture type was significant for NFR magnitude ($F=19.77$, $p<.001$, $\eta^2 =.44$) and pain ratings ($F=19.69$, $p<.001$, $\eta^2 =.44$).
- Reactions were inhibited by pleasant pictures compared to neutral and unpleasant pictures ($ps<.001$), but the comparisons between unpleasant and neutral were non-significant ($ps>.05$).
- When SCR, HR, NFR, and pain were analyzed simultaneously using MANOVA, 52% of the variance was explained in all 4 measures by picture-viewing.

Conclusions

- Modulation of autonomic responses parallels other defense reactions
 - Responses were larger during negative emotion and smaller during positive emotion
- Emotion explained a large proportion (52%) of combined variance in autonomic and nociceptive-specific responses
 - This suggests a common modulatory mechanism (e.g, amygdala, PAG)
- Emotion explained less variance in ANS responses than nociceptive-specific responses
 - Additional central or peripheral influences may add variability to autonomic outcomes