

Physiology During Anxiety Provoking VR Simulations

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Background and Significance

In Vivo Exposure Therapy (IVET)

- Heart rate (HR) increase alone during exposure predicts treatment success (Foa & McNally, 1996).
- When phobics compared to controls, effect size for HR reactivity = 1.4, but effect size for skin conductance level (SCL) only 0.8 (Wilhelm & Roth, 1998; Alpers et al., 2005).

Virtual Reality Exposure Therapy (VRET)

- Heart rate (HR) changes are minimal and skin conductance level (SCL) discriminates phobics from non-phobics (Wiederhold et al., 2002).
- This basic physiological difference from IVET has theoretical implications for success of VR in long term training and treatment.

Comparative Study of VR and In Vivo Exposure (Wilhelm et al., 2005)

- Fear of heights VR simulation
- Groups of high and low anxiety undergraduates
- For VR study low anxiety group showed little SCL or HR responses.
- For VR study high anxiety group showed strong SCL response but little HR response.
- For in vivo study high anxiety group showed large SCL *and* HR responses.

Method

- Analyzed data from previous anxiety provocation study to determine if similar pattern present in data using other fear inducing simulations with normal subjects.
- 24 subjects, 12 males/12 females, age 18-57 (mean 25.6)

Designed four anxiety provoking simulations with endings based on static images from International Affective Picture System (IAPS).



Four different anxiety provoking simulations randomly presented

1. Rattlesnake in garage of house.
2. Mugger with gun at empty subway station.
3. Attacking dog in abandoned house.
4. Hit and run of pedestrian crossing street.

Hit and Run Simulation - ends with dead person on street



From VR simulation.



From IAPS (#3015).

Dog Simulation – ends with dog attacking in face after falling on floor



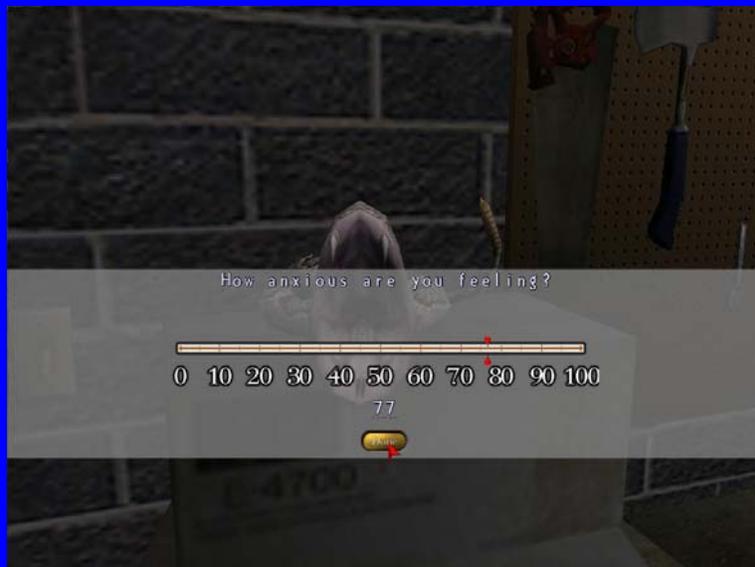
Mugger in Subway Simulation – ends with pulling gun and demanding money



Rattlesnake Simulation – ends with striking at face



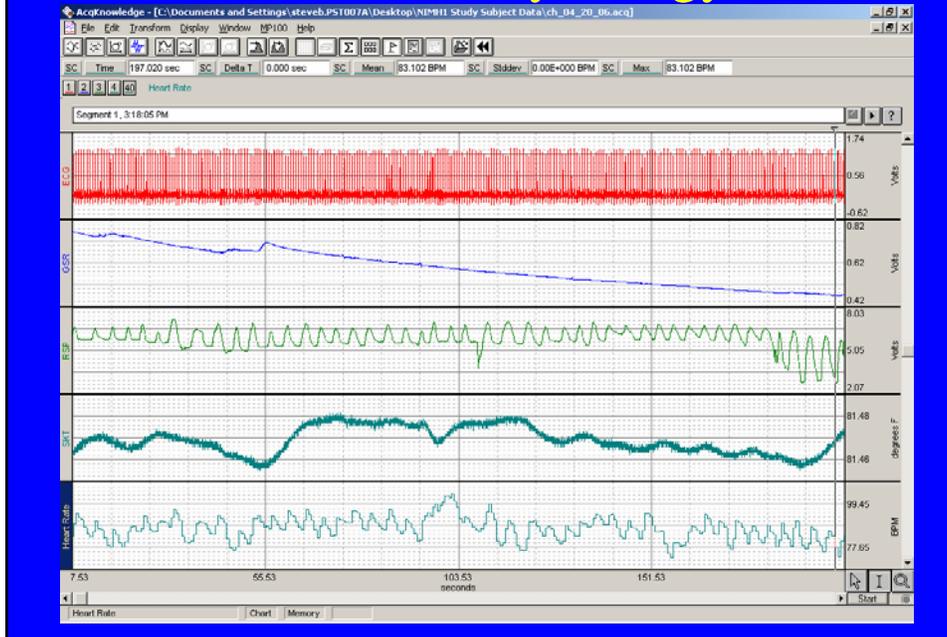
Rating Scale Overlaid



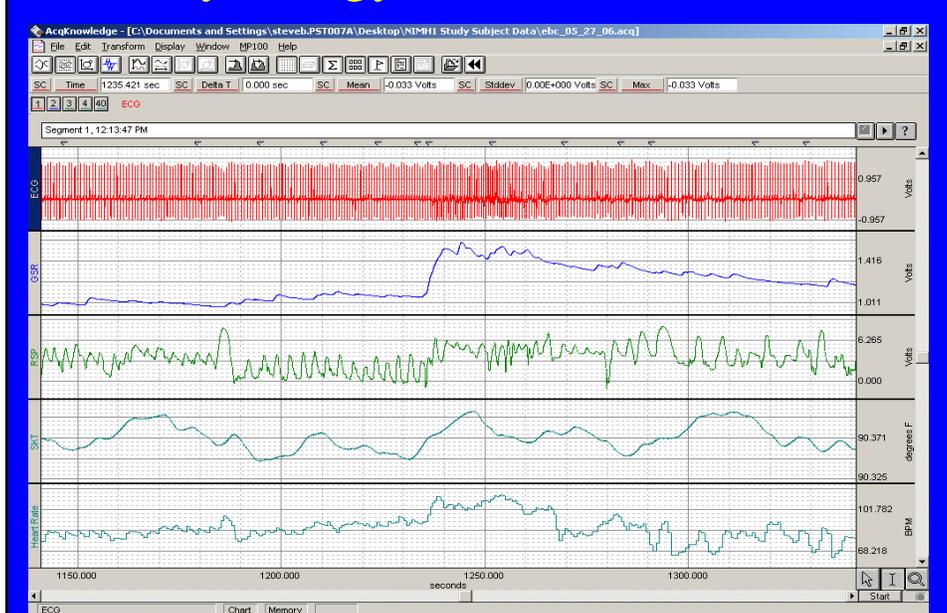
- Subjects navigated through virtual world (VR Worlds 1) for ~ 45 min.
- Recorded ECG, SCL, respiration, skin temp.
- Subjects occasionally encountered anxiety-provoking scenario, at which point they were locked in place and forced to view for ~10 seconds.

Results

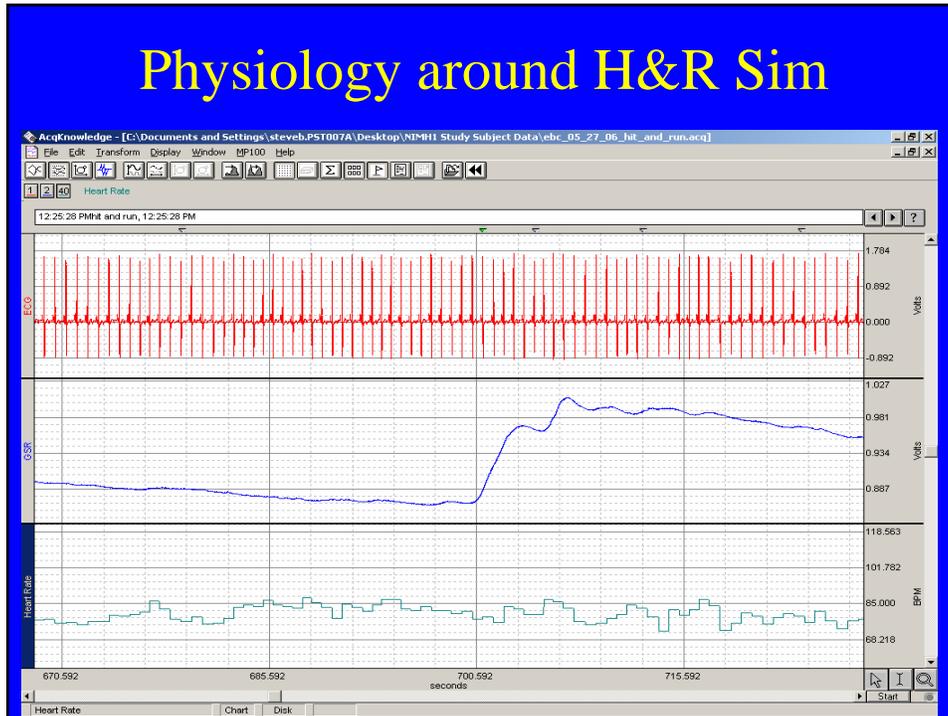
Baseline Physiology



Physiology around Snake Sim



Physiology around H&R Sim



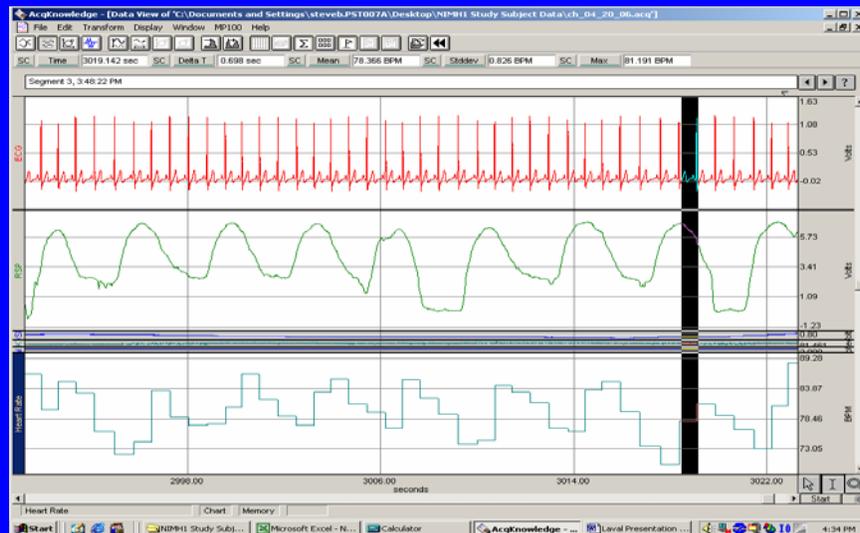
Summary of Data (n=20)

	<u>Pre</u>	<u>Post</u>
• Subjective rating of anxiety (0-100)	13.08	39.16**
• SCL_{max} (μ Siemens)	7.80	8.78**
• Heart rate (HR)	78.32	77.92
• Respiration	0.32	0.32

** $p < 10^{-11}$, two-tailed

Respiratory Sinus Arrhythmia (RSA)

- Respiration modulates heart rhythm, especially at sleep > rest > activity.
- Under parasympathetic control via vagus nerve.



30 sec of ECG, respiration (16 cpm) and HR (79.4 bpm) from 30 sec ending baseline. Note 0.7 sec lag.

Heart Rate Variability

	<u>Pre</u>	<u>Post</u>
• Mean Heart Rate (HR)	78.32	77.92
• Standard Deviation of HR	3.89	4.46*

*p=0.006, two-tailed

Comparison of SCL and HR Variability

- 4 sims/subject X 20 subjects = 80 sims
- **SCL** increased in post-stimulus period in 77/80 (96%) sims, $p=1.02 \times 10^{-12}$
- **HR Variability** increased in post-stimulus period in only 50/80 (63%) sims, $p=0.006$. Therefore, this is a small effect that emerges only in a large group.

Effect Size (ES)

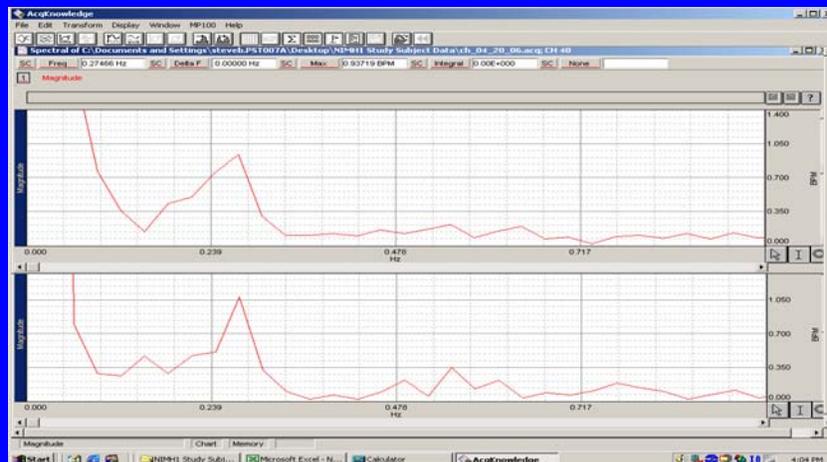
Standardized mean difference between groups.

A way of comparing group differences by normalizing to standard deviations.

$ES = (\text{mean of experimental group} - \text{mean of control group}) / \text{standard deviation}$

$$ES_{SCL} = 2.58, \quad ES_{HRV} = 0.33$$

Power Spectra (FFT) of HR



Sharp peak at 0.275 Hz from both pre and post baseline periods corresponding to resp. rate of ~ 16 breaths/min. This indicates resp. strongly modulates heart rate.

RSA Analysis

Ongoing, but so far no significant differences in power from 0.125-0.52 Hz between 30 sec pre and 30 post stimulus periods.

Effects of Movement

- Our study involved locking subjects in place for at least 10 seconds in order to force them to view the simulations.
- Recent data from A. Muhlberger et al. indicates that spider phobics who are able to freely move towards or away from virtual spiders on a wall show *SCL and HR* increases.

Conclusions

- Because of absence of significant change in HR, and only small ES in HR variability change, VR simulations across a variety of anxiety-provoking situations do not mimic real-life physiological responses to anxiety in either normal subjects, high anxiety patients, or phobics.
- This may have long-term implications for the effectiveness of VR training and treatment.
- We should study ways of performing VR studies that better mimic real world responses of people to anxiety.