Psychophysiological Predictors of Subjective Ratings of Electrode Stimuli: The Contribution of Spinal and Supraspinal Reflexes

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Introduction
Psychophysiological reactions to noxious stimuli have been used to make inferences about pain. Despite this, there have been few attempts to assess the within-subject covariance between psychophysiological reactions and subjective experience using statistical techniques that adequately control for non-independence of within-subject data, but also examine group-level effects.

Objective
To use multilevel modeling to assess the relationship between psychophysiological and subjective ratings of electrode stimulation

Participants
50 Healthy Participants
- Characteristics: 18 Men, 32 Women; White non-Hispanic (72%), single (78%), and employed (64%), average age = 25 yrs (SD=8.27)
- $100$ compensation provided to completing

Exclusion Criteria:
- < 18 years of age
- Current acute illness
- Cardiovascular, neurological, and/or circulatory problems
- Recent use of experimental, antidepressant, anxiolytic, or antihypertensive medication
- Recent psychological trauma
- Skin lesions or scars on hands

Procedure: NFR Threshold and Pain Tolerance
NFR Threshold Assessment:
- Up-down staircase of electrical stimulations with variable stimulus interval of 8-12 s
- Stimuli started at 0 mA (current) and increased by 1.5 mA steps until a NFR was detected
- If no NFR was detected, the step size was increased by 0.5 mA steps
- A single ascending stimulus of 55 mA steps until the participant rated the stimulus as a 100 (maximum tolerable) on the pain rating scale, or until the 20 mA maximum was reached
- Only stimulations rated ≥23 were included in the analyses

Data Analysis
Multilevel modeling used to predict subjective ratings from psychophysiological variables:

1. First-level units were each of the 50 participants
2. Second-level units were each of the 50 participants
3. Each up-down staircase of electrical stimulations with variable stimulus interval of 8-12 s

Note:
Graphs depict regression lines for each psychophysiological predictor and subjective ratings for 15 randomly selected individuals. Both graphs indicate significant variation in the regression slopes, with small differences by sex.

Preliminary Results
The 50 participants contributed 1810 trials (mean participant = 36 trials, range 13-75) with 1224 trials selected for analysis because ratings were ≥25 (mean participant = 25, range 8-59) for Skin conductance data skewed, no log transformation

Results: Individual-Level Regression Slopes Between Predictors and Subjective Ratings

Psychophysiological Predictors

- Skin Conductance Response (SCR)
- Heart Rate Response (HR)
- Blink Reflex Magnitude (BR)
- Nociceptive Flexion Reflex (NFR)

- Multilevel model used to predict subjective ratings from psychophysiological variables
- First-level units were psychophysiological predictors (NFR, HR, SCR, BR)
- Second-level units were each of the 50 participants
- Initially, an intercept only model (no predictor) was conducted
- Next, 4 separate models were conducted with SCR, HR, NFR, or BR entered as a predictor
- Null model likelihood ratio test ($\chi^2$) suggested a better fitting model than the intercept only model
- Effect size ($\eta^2$) determined if the addition of a predictor significantly improved the model (highest to lowest $\eta^2$ from individual models)

Note:
Null model likelihood ratio test ($\chi^2$) suggested a better fitting model than the intercept only model

Results: Multivariate Predictor Models

- Skin Conductance Change (SCR) 11019.30 11029.30 N.S. 458.52 0.065
- Heart Rate Change 11090.61 11068.75 482.91 0.01
- Blink Reflex Magnitude 10500.61 10500.61 .065
- Nociceptive Flexion Reflex (NFR) 10677.68 10677.68 .318
- Skin conductance data skewed, no log transformation

Conclusions
- NFR, HR, and BR significantly predicted subjective ratings in individual models
- However, only NFR and BR were significant predictors in the multivariate model
- Results suggest tight coupling of spinal nociceptive processes and subjective evaluation (NFR explained 32% of variance)
- Supraspinal blink reflexes are also predictive of ratings, but to a lesser degree (78% variance explained, 9% additional variance over NFR)
- Participants sex did not moderate the relationship between NFR or BR and subjective ratings
- These methods can be used to test if psychophysiological factors (e.g. pain catastrophizing, mood, etc.) explain individual variation in slopes