No Shock, Predictable Shock, Unpredictable Shock (NPU) Task: Psychometric Properties of Startle and Corrugator Potentiation

Jesse T. Kaye, Austin D. Kayser, Susan E. Schneck, Daniel E. Bradford, & John J. Curtin
Department of Psychology, University of Wisconsin – Madison

Study Objectives

No Shock, Predictable Shock, Unpredictable Shock (NPU) task is a translational psychophysiology task developed to examine affective processes in response to acute vs. potential threats. This task has been proposed as a model paradigm to evaluate these Negative Valence System constructs within the National Institute of Mental Health Research Domains Criteria (RDoC) initiative. This task must possess sound psychometric properties if is to meaningfully contribute to the study of individual differences in the context of the RDoC.

We designed the current study to comprehensively evaluate key psychometric properties of **startle and corrugator response potentiation** in the NPU Task.

1) Effect size and stability: We examine the strength and stability of startle/corrugator potentiation (e.g., unpredictable shock vs. no-shock) by quantifying its effect size and testing for an effect of study visit (visit 1 vs. 2).

2) Internal consistency: We examine split-half reliability using Spearman-Brown corrected Pearson correlations between odd and even trials to quantify internal consistency within subjects.

3) Temporal stability: We examine temporal stability using Pearson correlations between study visit 1 and study visit 2 to quantify the stability of individual differences in responses over one week.

Methods & Measures

- Participants (N=128, 64 female) completed three tasks at two study visits separated by one week.
- Participants first completed the Resting State task followed by the NPU task.
- The startle and corrugator responses are measures of negative affective reactivity that are modulated by emotional stimuli (e.g. potentiated by threat).
- The eyeblink startle response was measured with Ag/AgCl EMG sensors over the orbicularis oculi muscle. Acoustic startle probes (50ms, 102dB) were presented at 4.5s post-cue onset (8-12/condition). Startle response was quantified as the peak magnitude 20-100ms post-probe onset.
- The frown response was measured with EMG sensors over the corrugator supercilii muscle during 0-4500ms post-cue onset (10-12/condition).

Quantification Approach
We quantified startle and corrugator response with two common methods.

Startle Response

1) **Raw scores:** Mean startle response (microvolts) for each condition during cues.
2) **Standardized scores:** We used trial level raw startle response (i) to calculate participant's (j) raw startle response mean (M_j) and standard deviation (SD_j) across their trials in the task.
   T-Startle$_{ij}$ = ((RawStartle$_{ij}$ – M_j) / SD_j) * 10 + 50

Corrugator Response

1) **Raw scores in time domain:** Mean corrugator response in microvolts for each condition during 0-4500ms post-cue onset.
2) **Power scores in frequency domain:** Mean corrugator response as power in the 28-200Hz band for each condition during 0-4500ms post-cue onset.

No Shock, Predictable Shock, Unpredictable Task

Predictable Shock Block (Acute Threat)

Unpredictable Shock Block (Potential Threat)

= Electric Shock to Fingers

Predictable shock:
Shock occurs during cues only

Unpredictable shock:
Shock occurs at any time.

- This task manipulates participants' affect by administering mild electric shocks under predictable and unpredictable (vs. neutral, no-shock) conditions.
- Participants viewed blocks of a series of 5 second colored square cues. Both shock and no shock conditions counterbalanced within- & between-subjects.
- To control for individual differences in shock sensitivity, participant's maximum tolerated shock at 1st study visit is used during the NPU task at both visits.
- **Startle/Corrugator potentiation** = shock cues minus no shock cues (not displayed)

NPU Task: Corrugator Potentiation

	Raw Scores in Time Domain		Power in Frequency Domain	
Effect Size & Stability	Visit 1	Visit 2	Visit 1	Visit 2
Predictable Potentiation	.15 [.02, .28]*	.18 [.06, .29]*	.015 [-.002, .031]	.020 [-.001, .040]
Unpredictable Potentiation	.17 [.06, .27]*	.18 [.08, .28]*	.024 [.007, .040]*	.020 [.002, .038]*
Internal Consistency	Visit 1		Visit 1	
Predictable Potentiation [b]	.45 [.20, .63]*		-.25 [-.49, .09]	
Unpredictable Potentiation [b]	-.18 [-.45, .17]		-.64 [-.75, .-47]	
Temporal Stability	Visit 1 to Visit 2		Visit 1 to Visit 2	
Predictable Potentiation	.51 [.35, .64]*		.35 [.17, .51]*	
Unpredictable Potentiation [b]	.27 [.09, .44]*		.00 [-.19, .19]	

Effect sizes reported as microvolts (time domain) and power (frequency domain). Internal consistency and temporal stability reported as correlation coefficients. Confidence Intervals in brackets [95% CI].
* Significant (non-zero) effect size or correlation ($p < .05$)
[b] Significant difference ($p < .05$) in internal consistency or temporal stability between quantification methods.

NPU Task: Startle Potentiation

	Raw Scores		Standardized Scores	
Effect Size & Stability	Visit 1	Visit 2	Visit 1	Visit 2
Predictable Potentiation	36.1 [29.8, 42.4]*	36.9 [30.3, 43.6]*	9.5 [8.4, 10.5]*	10.2 [8.9, 11.4]*
Unpredictable Potentiation [a]	26.5 [21.5, 31.4]*	22.9 [18.8, 27.0]*	7.5 [6.6, 8.5]*	6.5 [5.6, 7.4]*
Internal Consistency	Visit 1		Visit 1	
Predictable Potentiation [b]	.81 [.72, .87]*		57 [.37, .70]*	
Unpredictable Potentiation	.64 [.48, .76]		.52 [.31, .67]*	
Temporal Stability	Visit 1 to Visit 2		Visit 1 to Visit 2	
Predictable Potentiation	71 [.60, .79]*		.58 [.44, .69]*	
Unpredictable Potentiation [b]	.71 [.60, .79]*		.49 [.33, .62]*	

Effect sizes reported as microvolts (raw scores) and t-scores (standardized scores). Internal consistency and temporal stability reported as correlation coefficients. Confidence Intervals in brackets [95% CI].
* Significant (non-zero) effect size or correlation ($p < .05$)
[a] Significant ($p < .05$) study visit effect for raw score quantification method.
[b] Significant difference ($p < .05$) in internal consistency or temporal stability between quantification methods.

Resting State Task

- This task involves a period of time characterized by the absence of other explicit manipulations or potent experimental stimuli, often conducted at "baseline".
- General startle reactivity during this task has been suggested to index individual differences in defensive reactivity within the Negative Valence System domain of the RDoC.
- Participants viewed a fixation cross while 9 startle probes were presented at random intervals. No other distracting stimuli were presented (e.g., shocks).
- General startle reactivity was calculated as the mean raw startle response during the Resting State Task.

	Raw Scores	
Effect Size & Stability	Visit 1	Visit 2
General Startle Reactivity [a]	.87.3 [75.7, 98.8]*	72.5 [61.5, 83.5]*
Internal Consistency	Visit 1	
General Startle Reactivity	.95 [.93, .97]*	
Temporal Stability	Visit 1 to Visit 2	
General Startle Reactivity	.89 [.85, .92]*	

Effect sizes reported as microvolts. Internal consistency and temporal stability reported as correlation coefficients. Confidence Intervals in brackets [95% CI].

* Significant (non-zero) effect size or correlation ($p < .05$)
[a] Significant ($p < .05$) study visit effect for raw score quantification method.

Conclusions

- The psychometric properties of startle potentiation in the NPU task were good. Predictable and unpredictable startle potentiation appear well-suited for both single administration and longitudinal or other research designs with multiple administrations (pre- post-designs, cross-over drug vs. placebo designs). Startle potentiation in the NPU task represents a model RDoC paradigm to tap dimensional individual differences in acute versus potential threat constructs.
- NPU task corrugator potentiation appears adequate to detect predictable and unpredictable threat reactivity. However, concerns with internal consistency and temporal stability may limit the utility of corrugator in this task.
- General startle reactivity during the Resting State task possesses admirable internal consistency and temporal stability within subjects. It is well suited for experiments that require single or repeated administration. Its high reliability provides a solid foundation for its use as a covariate in analyses of startle modulation/potentiation . Its trait-like temporal stability suggests that it may have use as a dispositional measure of defensive system reactivity.
- Quantification as raw scores (microvolt units) in the time domain generally yields superior psychometric properties than alternative approaches for both startle and corrugator measures.

Funding was provided by grants to Jesse Kaye from NSF (DGE 0718123) and NIAAA (F31 AA022845) and John Curtin from NIDA (R01 DA033809).

Poster available at http://dionysus.psych.wisc.edu

Email: jtkaye@wisc.edu