Affective Picture Viewing Task: Psychometric Properties of Startle and Corrugator Modulation

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Study Objectives

The Affective Picture Viewing task manipulates participants' affect by presenting unpleasant, pleasant, and neutral pictures from the International Affective Picture System (IAPS). This task has been proposed as a paradigm to evaluate Negative and Positive 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 modulation** in the Affective Picture Viewing Task.

1) Effect size and stability: We examine the strength and stability of startle/corrugator modulation (e.g., unpleasant or pleasant vs. neutral) 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 Affective Picture Viewing task.
- The startle and corrugator responses are measures of affective reactivity that are modulated by emotional stimuli (e.g. potentiated by threat, possibly attenuated by pleasant stimuli).
- The eyeblink startle response was measured with Ag/AgCl EMG sensors over the orbicularis oculi muscle. Acoustic startle probes (50ms, 102dB) were presented at 3-5s post-cue onset (8 per 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 0-3000ms post-cue onset (12 per condition).

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

Startle Response

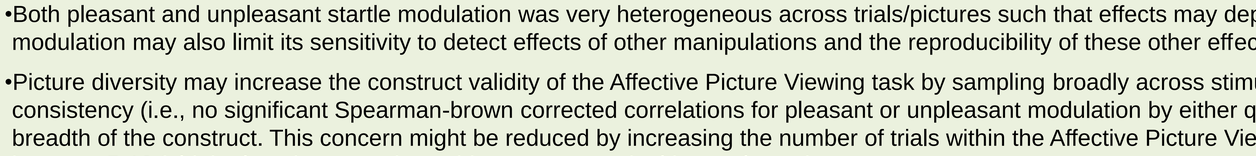
1) **Raw scores:** Mean startle response (microvolts) for each condition during cues.
2) **Standardized scores:** We used trial level raw startle response (i) to calculate participant's (j) raw startle response mean (M_j) and standard deviation (SD_j) across their trials in the task.
   T-Startle$_{ij}$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

Corrugator Response

1) **Raw scores in time domain:** Mean corrugator response in microvolts for each condition during 0-3000ms post-picture onset.
2) **Power scores in frequency domain:** Mean corrugator response as power in the 28-200Hz band for each condition during 0-3000ms post-picture onset.

Affective Picture Viewing Task

Picture Block



- This task manipulates participants' affect by presenting unpleasant, pleasant, and neutral pictures from the International Affective Picture System (IAPS).
- Participants viewed 36 different pictures (set) at each study visit comprising 12 pleasant, 12 unpleasant and 12 neutral pictures. Pictures were displayed for 6s each in blocks.
- Picture condition order was counterbalanced within- & between-subjects and picture set order was counter balanced between-subjects.

Two within-subject condition contrasts:

- **Pleasant startle modulation** = pleasant minus neutral pictures
- **Unpleasant startle modulation** = unpleasant minus neutral pictures

Corrugator Modulation

	Raw Scores in Time Domain		Power in Frequency Domain	
Effect Size & Stability	Visit 1	Visit 2	Visit 1	Visit 2
Pleasant Modulation	-.01 [-.13, .11]	.04 [-.10, .19]	-.006 [-.027, .015]	.006 [-.029, .041]
Unpleasant Modulation	.72 [.54, .91]*	.83 [.60, 1.05]*	.101 [.062, .139]*	.135 [.094, .177]*
Internal Consistency	Visit 1		Visit 1	
Pleasant Modulation [b]	.21 [-.14, .45]		-.46 [-.63, -.22]	
Unpleasant Modulation	.54 [.33, .68]*		.44 [.20, .62]*	
Temporal Stability	Visit 1 to Visit 2		Visit 1 to Visit 2	
Pleasant Modulation	.20 [.02, .36]*		.30 [.12, .46]*	
Unpleasant Modulation	.56 [.42, .67]*		.54 [.39, .66]*	

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.

Startle Modulation

	Raw Scores		Standardized Scores	
Effect Size & Stability	Visit 1	Visit 2	Visit 1	Visit 2
Pleasant Modulation [a]	-4.2 [-5.8, -2.5]*	1.6 [-4.0, 0.7]	-1.5 [-2.3, -0.7]*	-0.1 [-1.0, 0.7]
Unpleasant Modulation [a]	6.3 [4.4, 8.2]*	8.1 [6.3, 9.9]*	3.1 [2.3, 4.0]*	4.9 [4.0, 5.8]*
Internal Consistency	Visit 1		Visit 1	
Pleasant Modulation [b]	.16 [-.17, .41]		-.10 [-.38, .23]	
Unpleasant Modulation	0.7 [-.25, .35]		.14 [-.20, .41]	
Temporal Stability	Visit 1 to Visit 2		Visit 1 to Visit 2	
Pleasant Modulation	-0.1[-.19, .18]		.08 [-.10, .26]	
Unpleasant Modulation	.50 [.35, .63]*		.40 [.24, .54]*	

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 standardized score quantification method.
[b] Significant difference ($p < .05$) in internal consistency or temporal stability between quantification methods.

Conclusions

- Mean pleasant and unpleasant startle modulation across study visits was significant for both raw and standard score quantification methods, but the effect sizes varied substantially and displayed poor internal consistency.
- Corrugator modulation to unpleasant pictures displayed adequate internal consistency and temporal stability and appears well suited to measure affective processes in this task. Conversely, there is serious concern about the use of pleasant picture corrugator modulation in the affective picture viewing task given its poor psychometric properties.
- Unpleasant pictures appear to produce more robust modulation of both startle and corrugator that persists over study visits relative to pleasant pictures in this task. Pleasant pictures may not be useful for situations that require repeated task administration due to small/null effects for subsequent administrations and the absence of any temporal stability across measures. A number of studies have now consistently demonstrated poor psychometric performance of startle/corrugator modulation to pleasant pictures, which raises serious concerns regarding the conclusions that can be drawn about pleasant picture responding for either measure (Bradley et al., 2001; Larson et al., 2000, 2005; Manber et al., 2000).
- Both pleasant and unpleasant startle modulation was very heterogeneous across trials/pictures such that effects may depend on a few key pictures. As such, picture selection may be very important. Poor internal consistency for startle modulation may also limit its sensitivity to detect effects of other manipulations and the reproducibility of these other effects across studies.
- Picture diversity may increase the construct validity of the Affective Picture Viewing task by sampling broadly across stimuli that elicit affect. However, when startle modulation in the Affective Picture Viewing task displays essentially no internal consistency (i.e., no significant Spearman-brown corrected correlations for pleasant or unpleasant modulation by either quantification method), concerns about picture selection and reproducibility become more fundamental than sampling the breadth of the construct. This concern might be reduced by increasing the number of trials within the Affective Picture Viewing task, though the Spearman-Brown prediction formula suggests that the number of trials would need to be increased between 5-13 fold the length we used to achieve even marginal internal consistency.
- Psychometric properties appear relatively consistent across quantification approach for both startle and corrugator response in this task.

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