



## The effect of choice on the physiology of emotion: An affective startle modulation study

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### ABSTRACT

The affective startle modulation task has been an important measure in understanding physiological aspects of emotion and motivational responses. Research utilizing this method has relied primarily on a 'passive' viewing paradigm, which stands in contrast to everyday life where much of emotion and motivation involves some active choice or agency. The present study investigated the role of choice on the physiology of emotion. Eighty-four participants were randomized into 'choice' ( $n = 44$ ) or 'no-choice' ( $n = 40$ ) groups distinguished by the ability to choose between stimuli. EMG eye blink responses were recorded in both anticipation and stimulus viewing. Results indicated a significant attenuation of the startle magnitude in choice condition trials (relative to no-choice) across all picture categories and probe times. We interpret these findings as an indication that the act of choice may decrease one's defensive response, or conversely, lacking choice may heighten the defensive response. Implications for future research are discussed.

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### 1. Introduction

A robust literature has consistently demonstrated that the startle response is modulated by foreground stimulus. Specifically, when viewing affectively negative stimuli, participants' startle responses are potentiated relative to neutral, and while viewing positive pictures, startle responses are attenuated relative to neutral. This task, termed the affective startle modulation (ASM), has been a particularly helpful tool in both basic research on the processes of emotion and motivation (Dichter et al., 2002; Gard et al., 2007; Sabatinelli et al., 2001) and in research with a variety of clinical populations, including schizophrenia, depression, and specific phobias (e.g. Curtis et al., 1999; Grillon, 2008; Kring et al., 2011; Patrick, 1994; Pissioti et al., 2003; Schlenker et al., 1995; Taiminen et al., 2000; Volz et al., 2003).

To our knowledge, research using ASM has only utilized a 'passive' viewing paradigm, in which the emotional foreground stimulus is chosen randomly for participants. Participants in ASM studies have not had choice or control over the stimuli they experience. In contrast to this, much of the emotion experienced in daily life has an inherent element of choice. Basic experiences of success, failure, goal-attainment, frustration, interpersonal conflict, and intimacy often have an element of choice or agency. In fact, very few emotional experiences are devoid of agency or choice in some way.

Research in social psychology and behavioral economics has highlighted the importance of choice on important psychological factors including motivation, performance, and satisfaction. For example, Self-determination theory has long posited that the availability of choice results in positive motivational and performance outcomes (Deci, 1980; Deci and Ryan, 1985; Ryan and Deci, 2000). When an individual feels some sense of control over his or her environment there is a related increase in the experience of intrinsic motivation (Patall et al., 2008). Studies on employee work-place autonomy and self-determination have found a significant relationship with task-related motivation (Deci et al., 1989). Conversely, more rigorously controlled work environments (i.e., limited choice) resulted in decreased levels of employee motivation. Related work on learned helplessness has demonstrated that motivation and learning suffer when a perceived lack of control exists (Seligman, 1975). The existence of choice has also been shown to moderate the experience of subjectively aversive stimuli. In studies involving eating unappetizing foods or administering electrical shock, participants with an element of choice reported experiencing these events as less unpleasant than their no-choice counterparts (Zimbardo et al., 1965). Additionally, findings of increased effort (Becker, 1997), perceived competence (Kernan et al., 1991), and enjoyment of tasks (Swann and Pittman, 1977) are all moderated by the presence of personal choice. In sum, these findings illustrate the importance of investigating the relationship between choice and the experiences of emotion and motivation.

Our goal with the current study design was to investigate the moderating effect of choice on the emotion experience of affective

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stimuli utilizing the ASM as a physiological measure. We created 'choice' and 'no-choice' conditions in a typical ASM design and defined choice as the participant's ability to have a measure of control over the picture stimuli presented. We also included an anticipatory period, utilized in other ASM designs, to investigate whether the effect of choice would impact the anticipation of the stimulus (e.g. Dichter et al., 2002; Patrick and Berthot, 1995; Sabatinelli et al., 2001). We added this condition in order to investigate the temporal course of emotion as it relates to choice (Davidson, 1998), and anticipation (Knutson et al., 2007, 2008). Our hypotheses were as follows: 1) During picture viewing the startle response in both choice and no-choice conditions will replicate the pattern reported in previous studies, with potentiation in trials of negative stimuli and attenuation in trials of positive stimuli. Although no previous studies have used choice as a variable in ASM designs, we have no reason to believe that approach and avoidance motivation systems will not be active in the choice condition (as they are in no choice conditions). 2) During anticipation of stimuli, the startle response in both the choice and no-choice conditions will replicate previous research with potentiation in anticipation of both positive and negative pictures. 3) We predict a general dampening of the startle response in the choice condition compared to the no-choice condition. Our rationale for this hypothesis is that previous research has found that the intensity of the startle response is negatively associated with approach motivation activation (e.g. Bradley et al., 2001a; Gard et al., 2007). As images become more approach related, the startle response diminishes. Recent research has shown that choosing behavior and anticipation of choice activates neural substrates implicated in approach motivation (Knutson et al., 2007, 2008). Thus, we believe having choice may decrease one's startle response. Related to this, one interpretation of the social-psychological research reviewed above is that choice is generally associated with increased approach motivation, and thus, we would expect a decreased startle response in the choice condition.

## 2. Materials and methods

### 2.1. Participants

Participants were 84 undergraduate students (68 female; mean age = 25.4 years) randomly assigned into the choice ( $n = 44$ , 33 female, mean age = 26.61,  $SD = 10.64$ ) and no-choice ( $n = 40$ , 35 female, mean age = 23.97,  $SD = 6.58$ ) conditions. Neither age differences ( $F(1,82) = 1.8$  ns) nor gender distribution ( $\chi^2 = 1.39$ , ns) was significantly different between the two groups. Participants received course credit for their efforts.

### 2.2. Materials

One hundred eighty digital images were selected from the International Affective Picture System (IAPS, Lang et al., 2008). Thirty-six pictures for each of the five stimulus categories (threat, victim, erotic, action, and neutral<sup>1</sup>) used in previous studies (e.g. Bradley et al.,

2001a; Dichter et al., 2010; Gard et al., 2007) were selected based upon published self-report arousal values. Categorization of threat images was defined as images depicting an imminent threat to the viewer (e.g., barking dog, coiled snake, aimed weapon). Victim images were defined as depicting injuries and the aftermath of violence committed upon others. Action images were of exhilarating physical activities (e.g., sky-diving, skiing). Erotic images depicted intimate scenes of nude and semi-nude heterosexual couples. Consistent with previous research, primary analyses were conducted on valence categories (negative, neutral, positive), with threat and victim stimuli composing the negative image set and action and erotic composing the positive image set.

Visual and auditory stimuli were controlled by E-Prime v1.2 (Psychological Software Tools, Pittsburgh, PA) installed on a Pentium III class desktop PC, and displayed on a 15 in. LCD at a viewing distance of approximately 0.5 m. All behavioral responses, including picture selection and self-report data, were captured using the PC keyboard and recorded by the E-Prime software.

Acoustic startle probes were digitally generated white noise bursts 50 ms in duration, with instantaneous rise and fall times, amplified to 105 dB and presented binaurally through Sennheiser HD 490 headphones.

### 2.3. Design

During each trial participants were presented with a screen containing three thumbnail pictures (small, low-resolution preview images) numbered 1 through 3, all from the same picture category (e.g., threat, action, etc.). A between-subject design was utilized to ensure enough trials were presented within each cell of the study while minimizing subject burden and fatigue. Participants in the choice condition used the corresponding number keys to select the picture they preferred to view in full-screen size. Participants in the no-choice condition were asked to look at the three picture options for four seconds, but were not able to choose between them. The term 'chosen picture' shall be used throughout this description to refer to either the picture selected by the participant in the choice condition, or the picture randomly selected in the no-choice condition. Presented thumbnail pictures were 4 cm by 6 cm.

Following the thumbnail screen, participants viewed a blank screen for 4 s (the anticipation period) followed by the full sized chosen image, presented for 6 s. Two digital versions of the Self-Assessment Manikin (SAM) scale (Lang, 1980) were used to assess self-reported valence and arousal experience of the chosen picture. A 5 s inter-trial interval followed each trial.

Each session consisted of 63 individual trials. The first three trials for each participant were identical habituation trials included to allow the subjects to habituate to the aversive startle probe, and were therefore excluded in the data analysis. Each of the remaining 60 trials presented the participant with three images from one of the five image categories. The image category changed from trial to trial, but the images within any single trial were all compiled from the same image category. The image sets were predetermined based upon published valence and arousal scores (Lang et al., 2008) and their presentation order was randomized during each session. The position of the pictures on the screen was randomized during each trial. No pictures were repeated at any point during the session.

The randomization and blocking methods employed ensured the following: (a) participants encountered exactly three sets of each picture category during each quarter of the study session, (b) The order of sets within each block was randomized for each participant, (c) The presentation order of the three pictures within each set was randomized for each trial, (d) participants encountered exactly six occurrences of each startle probe condition (anticipatory, picture presentation, and no-startle—so that participants would not begin to predict the probe) during each quarter of the study session, and (e)

<sup>1</sup> IAPS image slide numbers used in this study organized by image category. Positive-Action: 8030, 8185, 8179, 8160, 8186, 8178, 8370, 8490, 8080, 8400, 8180, 5629, 8475, 8341, 8200, 8034, 8190, 8191, 8300, 8170, 5626, 8161, 8499, 8251, 8193, 8192, 5470, 8116, 8210, 5460, 8260, 5450, 8340, 8496, 8090, 8021. Positive-Erotic: 4800, 4659, 4670, 4664, 4681, 4810, 4652, 4683, 4695, 4660, 4687, 4608, 4658, 4694, 4656, 4607, 4651, 4672, 4647, 4689, 4677, 4669, 4666, 4676, 4690, 4611, 4680, 4643, 4649, 4770, 4653, 4599, 4645, 4650, 4609, 4641. Neutral: 7009, 5500, 7030, 7234, 5520, 7053, 7205, 7140, 7100, 5530, 7235, 5510, 7224, 7233, 7050, 5731, 7059, 7025, 7040, 7035, 7705, 7090, 7150, 7041, 5740, 7060, 7217, 7000, 7490, 7006, 7080, 7020, 7031, 7004, 7010, 7175. Negative-Threat: 6230, 6350, 6510, 6313, 1120, 6260, 2811, 1050, 1931, 1300, 1321, 6250, 1052, 1525, 1932, 6370, 1930, 6315, 6312, 1201, 1114, 6360, 1040, 1070, 1113, 1200, 1022, 6212, 1302, 1310, 6243, 1110, 1051, 6410, 1090, 6213. Negative-Victim: 3000, 3005, 3080, 3170, 3010, 3060, 6550, 9410, 3069, 3500, 3130, 3053, 3400, 3071, 3120, 6540, 3530, 3266, 3068, 3030, 3110, 9252, 3102, 3150, 9635, 6560, 9921, 3100, 3064, 3140, 3063, 3250, 6530, 6022, 9405, 6021.

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