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Effects of approach-avoidance related motor behaviour on the startle response during emotional picture processing

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ABSTRACT

Motivational states may be induced by affective foreground stimulation or via proprioceptive feedback by certain postures or body movements. In the present study, we addressed the question of an interaction between basic motor actions and the valence of visual stimuli in an affective modulation of startle paradigm: is the potentiation for aversive and the attenuation for pleasant stimuli more pronounced when the muscles for a congruent approach or avoidance action are activated? Thirty-four volunteers (20 female) watched emotional pictures on a computer screen while simultaneously contracting the flexor vs. extensor muscles of the upper arm. After 3–4 s, an acoustic startle stimulus (105 dB, binaural, instantaneous rise time) was presented via headphones. Arm movement interacted with picture valence: flexion, compared to extension, increased affective startle modulation ($F = 4.32$, $p < 0.05$). This result suggests integration and not simple summation of postural and body movement effects on startle reflexivity.

1. Introduction

In contrast to traditional cognitivst positions, recent studies were able to demonstrate that proprioceptive, bodily feedback has cognitive, motivational and attitudinal implications (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Performing certain movements or adapting certain body positions can influence evaluative judgments (Neumann, Förster, & Strack, 2003). Equally, the execution of certain movements is facilitated when they are congruent to internal psychological states. The theoretical framework to explain these effects, commonly referred to as "embodiment", assumes a correspondence between the physical acts and some psychological function: expressing a smile-like gesture corresponds to a cheerful mood (Niedenthal, 2007), expansive posture to a powerful attitude (Huang, Galinsky, Gruenfeld, & Guillory, 2011), flexion of the arm to perform a pulling movement corresponds to approach and, vice versa, the extension to avoidance motivation (Neumann & Strack, 2000). In contrast to an amodal, cognitive perspective on the human mind, embodiment, assumes that high-level, mental processes depend on activations of certain lower level motor systems, which is known as the "motor process hypothesis" (Cacioppo, Priester, & Berntson, 1993).

Beyond the effects that were demonstrated in behavioural and self-reported outcome measures, these embodied manipulations were able to alter physiological variables associated with specific psychological states (for a review, see: Price, Peterson, & Harmon-Jones, 2012). For instance, adopting a dominant vs. submissive posture directly affected the saliva cortisol and testosterone levels, endocrinal measures which are associated with the power motive (Carney, Cuddy, & Yap, 2010). Leaning forward vs. reclining backward in a laboratory chair induces changes in brain potentials that have been associated with approach, or respectively avoidance motivation (Harmon-Jones & Peterson, 2009; Price & Harmon-Jones, 2011).

The flexion and extension of the arm is associated with motivational implications: while flexion is coupled with consumption and pulling appetitive objects towards oneself, extension is commonly interpreted to reflect avoidance movement. The corresponding paradigm was initially implemented in an experiment by Cacioppo

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et al. (1993) to activate the approach-avoidance motivational system. Recently it was shown that the startle eye blink response was modulated in such a way that arm flexion attenuates and extension potentiates the response when no further foreground stimulation was provided (Thibodeau, 2011).

The paradigm of affective startle modulation has been developed and validated by exposing participants to emotional foreground stimuli of various modalities, such as pictures (Vrana, Spence, & Lang, 1988), music (Roy, Mailhot, Gosselin, Paquette, & Peretz, 2009) or odours (Miltner, Matjak, Braun, Diekmann, & Brody, 1994), followed by an intense acoustic stimulus. The startle response is potentiated with aversive and attenuated with pleasant foreground stimulation, which has been explained with the concept of "motivational priming" (Lang, 1995). Assuming that emotion reflects a "readiness for action" (Frijda, 1987), negative emotions will activate defensive, avoidance-related response systems while positive emotions activate appetitive, approach-related responses. The startle probe can be conceptualized as a defensive, slightly negative stimulus. When this startle probe is preceded by an emotional foreground stimulus, either an approach- or avoidance response will be primed, depending on the valence of the stimulus. In case of a congruency in response motivation, i.e. when the foreground is negative, the resulting response is facilitated; a mismatch following positive stimuli will result in an attenuation of the response.

Our study extended the design of Thibodeau to the domain of affective startle modulation. Participants had to sit in front of a desk and press with their flat hand against the upper or lower side of that desk, which contracted either the extensor vs. flexor muscles of the upper arm. These two movements were combined with the display of positive, neutral or negative images on a computer screen.

Our objective was to investigate the question of how motivational congruency between the activation of basic muscles that are related to approach or avoidance movements and foreground stimulus valence affect the startle response. The interpretation of attitudinal effects in terms of simple muscle activation has been challenged in recent studies. Centerbar and Clore (2006) proposed that the effect is related to compatibility between the executed action and stimulus valence: congruent responses should result in more positive evaluations. Other studies reported reduced processing of emotional stimuli when the congruent action had to be performed, which was explained by affective blindness towards response-compatible stimuli (Eder & Klauer, 2009). We hypothesize that the startle magnitude reflects the compatibility between stimulus valence and action: startle attenuation (neutral vs. positive stimuli) and potentiation (neutral vs. negative stimuli) should both be enhance by approach-related movements. In other words, if flexion decreases the psychological distance between the object and the person, it should increase the effect of emotional foreground stimuli when contrasted with extension.

2. Methods

2.1. Participants

Thirty-four undergraduate students (20 female) participated in this study (mean age: 23.7 y, SD = 2.8) for course credits. Participants were excluded for any acute or persistent medical or psychiatric diseases and current or past hearing problems (e.g., tinnitus). All participants gave their written informed consent and were compensated with course credit for participation.

2.2. Procedure

Participants were seated in a laboratory chair in front of a height-adjustable table. Pressure sensitive, low-profile pads were placed on top and underneath the table on the left and right hand side in fixed positions. The 19 inch computer monitor was placed at a distance of 30 cm from the front edge of the table. Upon entering the laboratory, the participant was told to find a comfortable seating position and

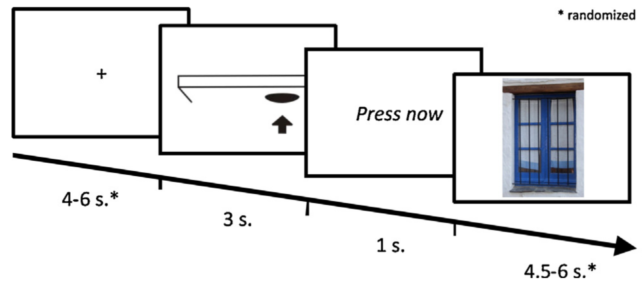

Fig. 1. Experimental protocol.

instructed about the upcoming task. The experimenter demonstrated the task and had the participant reproduce the movement to ensure proper understanding. After the electrodes for EMG recording were attached and a headphone was put on, the experimenter left the room.

Before the start of the actual experiment, the instructions were again presented in written form. This was followed by eight habituation trials, in which startle stimuli were presented with randomized inter-trial intervals (ITI) of 4–6 s in the absence of any task or visual stimulation.

The experiment consisted of 60 trials that were structured in four separate blocks. The type of movement (flexion vs. extension) and image valence were pseudo-randomised within a block; the use of the left vs. right hand was varied between blocks. Blocks were separated by a short break to provide a rest for the participant and indicate which hand to use in the upcoming block. The experiment was to be continued by button press of the participant.

In the beginning of each trial, the participant had to gaze at a fixation cross in the centre of the screen. The cross was followed by an instruction screen that indicated which type of movement the participant had to perform, i.e. flexion or extension. This screen appeared for 3 s and was succeeded by a 1 s cue screen, which was the signal for the participant to initiate the movement (see Fig. 1).

The participant had to apply the pressure throughout the presentation of the image screen, which was displayed with a randomized duration of 4.5–6 s. After that, the hand had to be placed in a resting position. The other hand, i.e. the hand which was not used in the current block, was resting on the participant's lap. For extension, the participant had to push with the flat hand downward against the upper side of the table, the palm of the hand faced downward. The inverse movement was required for flexion: pushing against the underside of the table with the palm facing upward. For both conditions, the palm of the hand had to be placed on the specified pad and mild pressure had to be applied. This moderate tension had to be sustained until the image disappeared. The arm was slightly bent, with the forearm held in a parallel position to the table (see Fig. 2).

With a randomized stimulus onset asynchrony (SOA) of 3–4 s after image onset, a startle stimulus appeared in 80 percent of the trials.

2.3. Apparatus and materials

2.3.1. Stimulus display

The stimuli were presented on a 19 inch flat screen monitor (1024 × 768 resolution, 150 Hz refresh rate). The monitor was positioned at a distance of 60 cm from the participant's eyes. Images were presented centrally, in an upright position (image dimension: 407 × 600 pixel) against a white background.

2.3.2. Visual stimuli

Forty photographic images of unpleasant, neutral, and pleasant scenes were used. Unpleasant images depicted scenes of threat, disgust, and mutilation, neutral pictures displayed scenes and objects such as household items or furniture, pleasant images depicted sport scenarios and erotic nudes. The pictures were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) and from pre-rated image sets used in previous studies (Deuter, Schilling, Kuehl, Blumenthal, & Schachinger, 2013; Lass-Hennemann et al., 2010, 2011). The selection of images was based on previous ratings of valance and arousal. To evaluate the experimental manipulation, each image was rated on these two dimensions by the participants at the end of our study.[1]

[1] Each valence category consisted of 20 images. Of the negative images, 12 were related to disgust/mutilation and 8 depicted violence/threat scenes. The neutral images all depicted objects, such as household items, furniture, clothes etc. Of the positive images, 11 depicted erotic scenes, the remaining 9 depicted sport scenes and cute children/kitten. Image codes from the IAPS repository – neg: 1930, 3053, 3061, 3062, 3120, 3168, 3266, 9301, 9326, 9405, 9410, 9582; ntr: 7004, 7006, 7009, 7025, 7026, 7031, 7035, 7040, 7052, 7090, 7100, 7175, 7185, 7186, 7217, 7235, 7504. The non-IAPS images will be provided upon request.