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Full Length Article

Back off! The effect of emotion on backward step initiation

Daniëlle Bouman, John F. Stins*

Department of Human Movement Sciences, Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam Movement Sciences, The Netherlands

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ABSTRACT

The distance regulation (DR) hypothesis states that actors are inclined to increase their distance from an unpleasant stimulus. The current study investigated the relation between emotion and its effect on the control of backward step initiation, which constitutes an avoidance-like behavior. Participants stepped backward on a force plate in response to neutral, high-arousing pleasant and high-arousing unpleasant visual emotional stimuli. Gait initiation parameters and the results of an exploratory analysis of postural sway were compared across the emotion categories using significance testing and Bayesian statistics. Evidence was found that gait initiation parameters were largely unaffected by emotional conditions. In contrast, the exploratory analysis of postural immobility showed a significant effect: highly arousing stimuli (pleasant and unpleasant) resulted in more postural sway immediately preceding gait initiation compared to neutral stimuli. This suggests that arousal, rather than valence, affects pre-step sway. These results contradict the DR hypothesis, since avoidance gait-initiation in response to unpleasant stimuli was no different compared to pleasant stimuli.

1. Introduction

A core aspect of emotions is that they mobilize energy and direct behavior to attain a certain goal. Arguably the most basic motivational systems are reflected in approach and avoidance behaviors (e.g., Vernazza-Martin, Longuet, Damry, Chamot, & Dru, 2015). These directional motivations manifest themselves in goal-directed motor behaviors, such as whole body displacement. For example, a desirable object in the immediate vicinity might induce forward leaning and/or initiation of forward locomotion, in order to decrease the distance between the self and the object. Many studies (see below) have found a clear link between emotions and whole body directional behaviors. In the literature three paradigms are often used: quiet standing (e.g., Horslen & Carpenter, 2011), initiation of a single step in a particular direction (Stins & Beek, 2011), and locomotion (Naugle, Joyner, Hass, & Janelle, 2010). In general, pleasant items tend to facilitate forward body displacements ('approach'), whereas unpleasant items tend to facilitate backward body displacements ('avoidance')[1] but also sometimes postural 'freezing', i.e., immobility (e.g. Azevedo et al., 2005). In the current experiment we adopt the second paradigm, i.e. initiation of a step in a particular direction. This paradigm allows for recording the kinematic profile of directional movements in response to an affective stimulus, and thus for a rich characterization of how such movements are organized in space and time (e.g., Gélat, Coudrat, & Le Pellec, 2011; Naugle et al., 2010; Roelofs, Hagenaars, & Stins, 2010). As such, the paradigm provides an interesting merger between the field of experimental psychology and biomechanics.

* Corresponding author at: Department of Human Movement Sciences, Van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands.
E-mail address: j.f.stins@vu.nl (J.F. Stins).

[1] A notable exception is anger; this unpleasant affective state tends to facilitate approach, arguably in order to confront an opponent (e.g., Carver & Harmon-Jones, 2009).

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Even though the coupling between emotion and whole-body displacement is not disputed, several theoretical perspectives exist that attempt to explain the nature of this relationship. Beatty, Cranley, Carnaby, and Janelle (2016) identified five different theoretical frameworks to explain how emotional states affect the initiation of goal directed movements. One of the key findings of their meta-analysis was that there was empirical evidence for most of these frameworks, but with different effect sizes. The authors made several recommendations for empirical and conceptual future research. For present purposes we focus on one of the frameworks thus identified, namely the Distance Regulation (DR) perspective. This perspective states that the change in physical proximity of the actor to the outside world underwrites approach and avoidance behavior (e.g., Markman & Brendl, 2005), and we aim to test a specific prediction derived from this perspective. Approach is defined as a decrease in distance between the actor and the stimulus, while avoidance is defined as an increase in distance. Beatty et al. (2016) framed it thus: 'the real (or perceived) distance, and subsequent distance change of an individual relative to the locus of emotional stimuli influences motor behavior.'(p. 238). An obvious prediction of the DR perspective would be that pleasant (appetitive) stimuli motivate a decrease in distance, whereas unpleasant stimuli motivate an increase in distance. The gait initiation paradigm, whereby participants physically increase or decrease the distance between themselves and the stimulus, therefore seems ideally suited to test specific predictions derived from the DR perspective.

Some studies have directly contrasted approach and avoidance related movement patterns within the same design (e.g. Stins et al., 2011; Yiou, Gendre, Deroche, & Le Bozec, 2014), while others have studied only forward (i.e., approach) gait initiation (e.g. Stins, van Gelder, Oudenhoven, & Beek, 2015a; Stins, Van Gelder, Oudenhoven, & Beek, 2015b) with affective stimuli. Even though humans typically move forward when approaching a desirable item or attractive person, the reverse situation, i.e., moving backward so as to avoid something unpleasant or unattractive, has not been sufficiently studied. We know of four studies that not only included a condition involving forward stepping but also a condition involving backward stepping in response to emotion-eliciting images. We will discuss all four below, focusing specifically on the subset of data relating to backward gait initiation (GI). To anticipate, results involving forward GI tend to show the effects in the expected direction, i.e., facilitation of forward GI with pleasant compared to unpleasant items, but the reverse pattern with backward GI is not so clear cut and therefore deserves further study.

The first study to adopt forward and backward GI with emotional pictures was conducted by Stins and Beek (2011), who used pleasant and unpleasant images adopted from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005). Participants were tested in either the congruent condition (step forward when seeing a pleasant picture; step backward when seeing an unpleasant picture) or the incongruent condition (step forward when seeing an unpleasant picture, step backward when seeing a pleasant picture). Thus, when a picture was shown, participants had to categorize it as pleasant or unpleasant, and respond according to the instructions. When analyzing forward and backward stepping separately, the authors found clear effects of emotion on the efficiency with which forward gait was initiated, but no effects when backward GI was considered. That is, backward GI was equally fast with pleasant and unpleasant pictures. Stins et al. (2011) performed a similar experiment but with happy and angry faces. In the congruent blocks, participants had to step forward when categorizing a face as being happy and backward when categorizing it as being angry. In the incongruent blocks, this mapping was reversed. Similar to Stins and Beek (2011), no effect of emotion on reaction time was found when only backward steps were considered; RTs were equally fast in response to both types of facial expressions. A third study was done by Yiou et al. (2014). Participants had to first mentally classify a picture as either pleasant or unpleasant. Then, according to instructions and emotion, they had to step forward with either the preferred leg or (in another condition) the non-preferred leg. In other conditions participants had to select a leg and step in the backward direction. All participants performed both the congruent (forward-pleasant) and incongruent (forward-unpleasant) conditions. Looking at the subset of data involving backward stepping, Yiou et al. (2014) found no effects of emotion on the time to initiate a step in the required direction. The only kinematic parameter that showed a significant effect in backward stepping was the center of mass velocity at the time of swing foot-off: the velocity was lower in response to pleasant compared to neutral pictures. In a fourth study by Stins, Lobel, Roelofs, and Beek (2014) instructions were to step forward or backward depending on the gender of a face (which could be either happy or angry). Again, the authors found no effect of emotion on backward stepping; in this study also forward GI was unaffected by the emotional expression. However, it is important to note that the emotion of the stimuli was task-irrelevant, as participants had to base their response (forward or backward stepping) on the gender.

The general picture that emerges from these studies is that the effects of emotion are more prominent for forward stepping than for backward stepping. This asymmetry deserves further investigation since it is unclear why DR would hold only for approach-like behaviors (easier GI toward pleasant compared to unpleasant stimuli), but not for avoidance-like behaviors (backward GI). The observation that forward and backward stepping in response to affective stimuli yields asymmetric behavioral patterns could be due to various factors. For example, there could be an inherent asymmetry in the motor control of forward vs. backward stepping, independent of emotion. This asymmetry is in fact evident in the respective kinematic profiles of the step patterns of the studies described previously. To illustrate, Stins and Beek (2011) found that forward steps were larger compared to backward steps, regardless of the emotional content of the stimulus. In addition, Stins et al. (2011) found that participants stepped backward faster compared to forward, again regardless of emotional content. Both the peak velocity and the movement times were faster in backward stepping. Furthermore, Stins et al. (2014) found that participants made a larger step forward than backward, regardless of the emotional content of the stimuli. From a more psychological perspective, it has also been suggested that backward stepping is less automatized than forward stepping since visual guidance is mostly absent in backward stepping (Stins et al., 2011). This may induce the need for additional cognitive effort to parameterize the step, making the step less automatized compared to forward stepping.

However, at this stage it is premature to conclude that emotion does not affect backward stepping for the following two reasons. First, in all previous studies participants had to mentally classify the stimulus before initiating a step, since their response depended on the (emotional) content of the stimulus. This setup may impose additional constraints on the working memory of participants, thereby potentially obscuring subtle biomechanical markers of avoidance tendencies in backward stepping. Note that in three recent