Available online at www.sciencedirect.com
SCIENCE DIRECT®

Biological Psychology 66 (2004) 51–62

BIOLOGICAL PSYCHOLOGY

www.elsevier.com/locate/biopsycho

Emotion and motivated behavior: postural adjustments to affective picture viewing

Charles H. Hillman*, Karl S. Rosengren, Darin P. Smith

Department of Kinesiology, University of Illinois at Urbana-Champaign, 213 Louise Freer Hall, 906 South Goodwin Avenue, Urbana, IL 61801, USA

Received 28 February 2003; accepted 26 July 2003

Abstract

Thirty-six participants (18 female, 18 male) viewed affective pictures to investigate the coupling between emotional reactions and motivated behavior. Framed within the biphasic theory of emotion, the three systems approach was employed by collecting measures of subjective report, expressive physiology, and motivated behavior. Postural adjustments associated with viewing affective pictures were measured. Results indicated sex-differences for postural responses to unpleasant pictures; an effect not found for pleasant and neutral picture contents. Females exhibited increased postural movement in the posterior direction, and males exhibited increased movement in the anterior direction, for unpleasant pictures. Subjective report of valence and arousal using the self-assessment manikin (SAM), and the startle eye-blink reflex were collected during a separate session, which replicated previous picture-viewing research. Specifically, participants rated pleasant pictures higher in valence and exhibited smaller startle responses compared to unpleasant pictures. Females also reported lower valence ratings compared to males across all picture contents. These findings extend our knowledge of motivated engagement with affective stimuli and indicate that postural responses may provide insight into sex-related differences in withdrawal behavior.

Keywords: Posture; Center of pressure, COP; Approach-withdrawal; Startle reflex; Behavior

1. Introduction

Darwin first described a relationship between emotion and posture in his observation of animals and humans (Darwin, 1872). Inherent in this observation is the functional link

* Corresponding author. Tel.: +1-217-244-2663; fax: +1-217-244-7322.
E-mail address: chhillma@uiuc.edu (C.H. Hillman).

0301-0511/$ – see front matter
doi:10.1016/j.biopsycho.2003.07.005

between varying motivational states of emotional reactivity and specific postural responses that reflect accompanying behavior. Contemporary theories of emotion subscribe to the concept that overt behavior is one of several reactions in an organism's repertoire that reflect underlying motivational states (see Elliot and Covington, 2001 for review). Yet few researchers have explicitly examined the relation between emotion and posture.

Emotion theorists have long examined motivated behavior using an approach-withdrawal model from many different perspectives including: neuroanatomical (LeDoux, 1995), psychophysiological (Davidson et al., 1990), personality (Elliot and Thrash, 2002), goal attainment (Forster et al., 1998), attitudes (Cacioppo et al., 1993), and social (Zajonc, 1998). Collectively, these findings have led Elliot and Covington (2001) to contend, "approach-avoidance is not just an important motivational distinction, but that it is fundamental and basic, and should be construed as the foundation on which other motivational distinctions rest" (p. 74).

One contemporary theory of emotion, the biphasic theory of emotion (Lang, 1985, 2000; Lang et al., 1997), contends that emotion is fundamentally organized around two basic motivational systems: appetitive and defensive (Lang, 2000). The appetitive system is responsible for approach behaviors and involves preservative actions that underlie pleasant reactions (Bradley et al., 2001a). The defensive system is responsible for withdrawal or avoidance behavior that is activated in the context of threat and underlies unpleasant reactions (Bradley et al., 2001a; Lang, 2000). These two systems are mediated by brain circuits that have evolved to organize behavior for the purpose of survival (Lang, 2000).

In this context, emotions are considered to be action dispositions that organize behavior along an approach-withdrawal dimension. The direction (i.e., approach-withdrawal) of an organism's reaction results from the affectively motivated significance of a stimulus with responses biphasically organized along two dimensions: hedonic valence (i.e., pleasant-appetitive motivation or unpleasant-defensive motivation) and arousal (degree of motivational activation; Bradley et al., 2001a; Lang, 1985). These responses reflect the organism's underlying emotional valence evaluation of the stimulus, which, in turn, prompts approach or withdrawal reactions. Lang (1968, 2000) proposed that emotions are motivational states of readiness that prime reactions through three different systems: expressive and evaluative language (i.e., verbal report), physiological changes mediated by the somatic and autonomic nervous system (e.g., expressive physiological changes such as facial electromyography—EMG), and behavioral sequelae. Although a preponderance of affective research has incorporated verbal report and expressive physiology, few studies have examined behavioral concomitants of emotional reactions.

Of the prior research that has examined the behavioral response system, two different approaches have been explored. One approach manipulated postural set to evoke emotional responses. Specifically, Riskind and Gotay (1982) instructed participants to assume either a slumped physical posture or an expansive physical posture, and Duclos et al. (1989) had participants adopt postures characteristic of fear, anger, and sadness. In both studies participants were instructed to report emotional responses using subjective report inventories during or immediately following the specific posture manipulations. Although related to the topic of emotion and posture, these studies are not directly related to the present focus on approach-withdrawal behaviors, since postural manipulation was used to examine changes in specific emotional states without regard for the approach-withdrawal dichotomy.

Alternatively, Cacioppo et al. (1993) examined approach-withdrawal behavior by having participants engage in either isometric arm flexion (approach) or extension (withdrawal) while making attitudinal judgments. Collectively, results from these three studies suggested increased pleasant emotion when participants were placed in positive postural sets (e.g., arm flexion) and increased unpleasant emotion when participants assumed negative postural sets (e.g., arm extension).

The second approach examined reaction time (RT) to the onset of emotional pictures and viewing time (i.e., the length of time a participant voluntarily chooses to watch a picture) to study the relationship between emotional stimuli and motivated behavior. These studies have shown that when viewing novel pictures, participants exhibit delayed RT responses during more arousing relative to less arousing images, regardless of hedonic valence, suggesting that novel stimuli may utilize more attentional resources during encoding processes (Bradley et al., 1992; Lang et al., 1997). This effect was especially pronounced for highly arousing unpleasant stimuli (Lang et al., 1997). With regard to viewing time, participants have been observed to watch pleasant and unpleasant pictures longer than neutral ones (Hamm et al., 1995). Results from both studies indicate that these measures reflect behavioral concomitants of arousal, rather than hedonic valence.

In addition, sex-related differences in reactions to affective pictures have been reported (Bradley et al., 2001b). Generally, females react with a greater defensive set when viewing highly arousing unpleasant pictures (e.g., scenes of threat and mutilation), and males have displayed greater appetitive reactions to specific pleasant contents (e.g., erotica), when measured using expressive physiological and self-report measures. For example, in response to unpleasant pictures females exhibit greater modulation of the startle eye-blink reflex and report decreased valence and increased arousal, compared to males. Alternatively, males rate pleasant pictures higher in valence and arousal and respond with greater inhibition of the startle-blink reflex, relative to females (Bradley et al., 2001b). Sex-related differences have also been reported for other physiological measures such as skin conductance and facial EMG. Bradley et al. (2001b) point out that despite the fact that "cues that activate the appetitive and defensive systems should be potent for both men and women, who share survival risks ... differential activation of these motivational systems could arise". Accordingly, various biological and sociocultural hypotheses for sex-related differences in affective responding have been posited (Bradley et al., 2001b).

The purpose of the present study was to examine an alternative measure of behavior that has been used in the study of balance, changes in center of pressure (COP). COP serves as a summary measure of movement made above the surface of support. Balance is dependent upon the integration of information from proprioceptive, vestibular, and sensory systems (Redfern et al., 2001), and reflects the dynamic coupling of perception and action related to the regulation of movement (Bertenthal et al., 1997). COP is typically measured with a force platform. This device, usually a flat metal surface mounted over force transducers, measures changes in the forces exerted on the surface. These forces are used to calculate an overall COP. During quiet standing, COP has a limited range of movement (only a few cm) and is highly correlated with movement of the center of mass (COM). COP is traditionally examined separately for changes in movement in the anterior–posterior and medial–lateral directions. To date, few studies of postural control have examine postural responses to emotion-laden stimuli.

The goal of this study was to examine the influence that pictures, which varied in affective content, would have on postural behavior. It was hypothesized that COP would reflect approach-withdrawal behavior with unpleasant pictures prompting a shift in the COP away from the picture and pleasant pictures prompting a shift in the COP toward the picture, relative to neutral pictures. For the purpose of better understanding postural data, the startle eye-blink reflex and subjective reports of valence and arousal were also measured. Replicating previous research, it was hypothesized that pleasant pictures would elicit inhibition of the eye-blink reflex and higher valence and arousal ratings, and unpleasant pictures would elicit potentiation of the eye-blink reflex and lower valence and higher arousal ratings, compared to neutral pictures. Lastly, based on the findings of Bradley et al. (2001b), sex-differences were expected, such that females would exhibit responses across all measures that were indicative of greater withdrawal from unpleasant pictures and males would exhibit responses that were indicative of greater approach to pleasant pictures.

2. Methods

2.1. Participants

Thirty-six undergraduate students (18 females, 18 males) from the University of Illinois at Urbana-Champaign participated in this study for extra course credit. Participants ranged in age from 18 to 24 years (M = 19.8, S.D. = 1.5). Data from two male participants were not included due to technical problems.

2.2. Apparatus and response measures

COP data were collected with a Kistler forceplate (9281B; Kistler Instruments, Winterthur, Switzerland) connected to an 8-channel amplifier (9861A; Kistler Instruments, Winterthur, Switzerland). Data were sampled at 200 Hz with a 15 Hz lowpass filter. Data collection was signaled by a key press and picture onset was marked by a 5 V signal that remained on for the picture duration. Data were collected using Bioware software supplied by Kistler. COP data were reduced using Neuroscan Edit software (Neuro Inc., El Paso, TX) by creating epochs of continuous data from picture onset through the 6 s picture period. Epoched data were baseline corrected using mean data from the 5 s period of quiet standing that occurred prior to the onset of the first picture in each block of 10 pictures. That is, one period of quiet standing at the beginning of each block was used for baseline correction for all 10 trials for a given picture category. Epochs were averaged into six 1 s periods within each valence for each participant and exported in ASCII format to SPSS 11.0.

The startle eye-blink reflex was recorded using a 32-channel Neuroscan Synamps amplifier and Acquire software (Neuro Inc., El Paso, TX). The startle probe consisted of a 50 ms burst of 95 dB white noise with instantaneous rise time. A prerecorded digital white noise sound stimulus was generated using Inquisit software. A Brüel and Kjær 2235 sound level meter (Brüel and Kjær, Nærum, Denmark) was used to calibrate the white noise. The eye-blink response to an acoustic startle probe was measured in accordance with published guidelines (Fridlund and Cacioppo, 1986) by recording EMG activity from the lower arc of the left orbicularis oculi muscle using two adjacent 4 mm Ag-AgCl electrodes (In Vivo

Metric, Ukiah CA) filled with Quik Gel (Neuro Inc., El Paso, TX). An 8 mm Ag-AgCl electrode placed on the left collarbone served as the ground. The raw EMG signal was amplified and bandpass filtered from 30 to 500 Hz (24 dB/octave), rectified, and integrated using Neuroscan Edit software. The eye-blink response was sampled at 2000 Hz from 50 ms prior to 250 ms after the onset of the acoustic startle probe. The mean EMG activity from the 50 ms period prior to the onset of the startle probe was used for baseline correction. Startle responses were scored off-line for peak magnitude and latency. The average startle response was recorded for each participant and affective category (i.e., pleasant, neutral, unpleasant). A z score was applied to startle data for each individual participant prior to statistical analysis with negative values indicating inhibition and positive values indicating potentiation.

A computerized version of the self-assessment manikin (SAM; Lang, 1980) was used to record subjective ratings of valence and arousal following the viewing of each picture. The SAM is an interactive computer graphic figure controlled by VPM software (Cook, 1994). For the valence dimension, the SAM ranges from a smiling, happy figure to a frowning, unhappy figure. For the arousal dimension, the SAM ranges from a sleeping, calm figure to an energetic, highly aroused figure. Participants used a joystick to indicate their ratings on a 0–20-point scale. The SAM was displayed on a 12 in. monitor 0.9 m from the participant and directly to the left of the 21 in. picture-viewing monitor. Previous picture-viewing research has found the SAM to be a valid and reliable measure of self-reported emotion (Bradley and Lang, 1994).

2.3. Stimulus materials and design

During two successive sessions participants viewed 60 pictures[1] (i.e., 20 pleasant, 20 neutral, 20 unpleasant) from the International Affective Picture System (IAPS; NIMH Center for the Study of Emotion and Attention, 1999) for 6 s each. Pleasant pictures included scenes of erotica and families; neutral pictures depicted scenes of household objects and neutral faces; and unpleasant pictures included scenes of mutilated and disfigured bodies, and attacking animals and humans. Stimulus presentation and timing was controlled with Inquisit software (Millisecond Software Inc., Seattle, WA).

In the first session, picture viewing occurred in a sound-attenuated, private room where participants were free from experimenter interaction. Participants stood on the force platform and viewed 60 IAPS pictures in blocked fashion, such that 10 pictures from each affective category (i.e., erotica, families, household objects, neutral faces, mutilation, and attack) were shown in succession with a variable 9–15 s ITI between pictures. Participants were given 2 min of seated rest following the completion of each block to minimize fatigue. Pictures were projected via an LCD projector and viewed on a white matte at a viewing distance of 1 m (63.6° viewing angle). Six counterbalanced picture orders were used to ensure that each category was shown equally often in each of the six possible position orders across participants.

[1] The following pictures from the IAPS were used: pleasant—2070, 2080, 2165, 2260, 2311, 2340, 2341, 2360, 2391, 2660, 4002, 4180, 4210, 4232, 4250, 4460, 4510, 4520, 4531, 4572, 4607, 4652, 4659, 4670, 4800; neutral—2200, 2210, 2214, 2215, 2190, 2516, 2271, 2280, 2440, 2570, 7000, 7002, 7004, 7009, 7030, 7050, 7060, 7090, 7150, 7175; unpleasant—1050, 1120, 1201, 1300, 1930, 3000, 3010, 3053, 3060, 3064, 3080, 3110, 3130, 3150, 3170, 6230, 6250, 6260, 6313, 6350.

The second session occurred immediately after the first and included startle reflex and SAM measurement. Pictures were presented on a 21 in. monitor at a viewing distance of 0.9 m (25.9° viewing angle). Pictures were grouped into 12 blocks of five pictures per category such that each of the six picture categories were shown in two blocks. For each picture category the first block was shown during the first half of the picture order, and the second block was shown during the second half of the picture order. Two different picture orders were used across participants, which reversed the first and second block for each category. The first and second sessions were purposely not counterbalanced to minimize habituation effects on postural responses since this measure was the primary focus of the study. Given that startle reflex and SAM measures were collected to add further support for postural findings, habituation effects on these measures were not a primary concern. Regardless, both startle reflex and SAM data replicated previous picture-viewing research (Lang et al., 1997).

During 48 pictures (8 of the 10 pictures per category), and eight intertrial-intervals (ITI), participants received a startle probe, which was presented at 2, 3, or 4 s following the onset of a picture. These startle times are consistent with previous startle research (e.g., Bradley et al., 1993). Probes were presented binaurally using calibrated telephonic TDH-49 headphones. Across participants and picture orders, the startle probe was counterbalanced to ensure that all pictures were probed equally often.

2.4. Procedure

Upon signing the university-approved informed consent, participants were asked to stand in stocking feet on the force platform in their normal, comfortable stance with their arms at their sides. They were informed that they would be viewing pictures on the screen in front of them and that they were to view each picture for the entire time that it was visible. Three practice trials were administered and participants then viewed the six blocks of 10 pictures.

Immediately following the completion of the first session, participants were seated in a comfortable chair and prepared for psychophysiological measurement. Impedance for the startle reflex and ground electrodes was below 10 kΩ for all participants. Headphones were placed on the participants, the lights were dimmed, and they were given a few moments to acclimate to the room.

Participants were then instructed that pictures would appear on the computer screen in front of them and that the pictures were to be viewed the entire time that they were presented. Participants were informed on the use of the SAM and notified that brief, occasional noises presented over the headphones were to be ignored. Following the instructions, three practice trials were presented. Pictures were then presented for 6 s each with a randomly determined ITI lasting 6, 9, or 12 s. Following each picture, participants rated the picture using the SAM along the dimensions of valence, arousal, and dominance.

2.5. Statistical analysis

For COP data, participants' responses were analyzed using a 2 (sex: male, female) × 3 (valence: pleasant, neutral, unpleasant) × 6 (time: 0–1, 1–2, 2–3, 3–4, 4–5, 5–6 s) mixed-design ANOVA with repeated measures on the latter two factors. Greenhouse–Geisser correction was employed to correct for violations of sphericity. Two separate analyses were conducted to examine participants' responses in the anterior–posterior direction and the medial–lateral direction. No effects were expected in the medial–lateral direction because movement in this direction is orthogonal to the approach-withdrawal movements expected in response to the pictures. Thus, movement in the medial–lateral direction served as a control.

Separate analyses were conducted for the startle eye-blink reflex, the SAM valence ratings, and the SAM arousal ratings. For each of these analyses a 2 (sex: male, female) × 3 (valence: pleasant, neutral, unpleasant) mixed-design ANOVA with Greenhouse–Geisser correction was used. For all analyses, post hoc tests were conducted using univariate ANOVAs and paired samples *t*-tests with Tukey's HSD. The alpha level was set at $P = 0.05$ for all analyses.

3. Results

3.1. Postural sway

The ANOVA for COP movement in the anterior–posterior direction revealed a 2-way interaction of sex × valence, $F(2, 64) = 3.7$, $P = 0.03$, $\varepsilon = 0.96$ (see Fig. 1), that was superceded by a 3-way sex × valence × time interaction, $F(10, 320) = 2.5$, $P < 0.05$, $\varepsilon = 0.40$. Post hoc tests indicated that female participants exhibited greater movement away from unpleasant pictures across time; an effect not found for male participants (see Fig. 2). Specifically, a marginal sex × valence interaction was observed during the second time period ($F(2, 64) = 2.7$, $P < 0.08$, $\varepsilon = 0.96$) that became increasingly significant across the third, fourth, fifth, and sixth time periods, F's $(2, 64) \geq 3.8$, $P \leq 0.03$, $\varepsilon \leq 0.94$. Follow up *t*-tests (with Tukey's HSD) of sex for each valence category revealed that differences were confined to unpleasant pictures, with females exhibiting greater movement away from the pictures, $t(1, 33) \geq 2.3$, $P \leq 0.03$. Analyses in the medial–lateral direction revealed no significant main effects or interactions.

3.2. Startle reflex

A main effect for valence was observed, $F(2, 64) = 5.5$, $P < 0.01$, $\varepsilon = 0.87$, with participants exhibiting inhibition of the startle reflex during pleasant pictures and potentiation of the blink reflex during unpleasant pictures, relative to neutral pictures (see Table 1). Follow up *t*-tests (with Tukey's HSD) revealed that unpleasant pictures elicited larger startle responses than pleasant and neutral pictures, t's $(1, 33) \geq 2.4$, $P \leq 0.02$. However, startle magnitude did not differ between pleasant and neutral categories ($P = 0.24$). No sex effects were observed.

3.3. Self-assessment manikin (SAM)

3.3.1. Valence ratings

Analyses revealed a main effect for sex, $F(1, 32) = 4.5$, $P < 0.05$, with males (M = 9.8, S.E. = 0.18) rating the pictures (across all categories) as more pleasant than females (M =

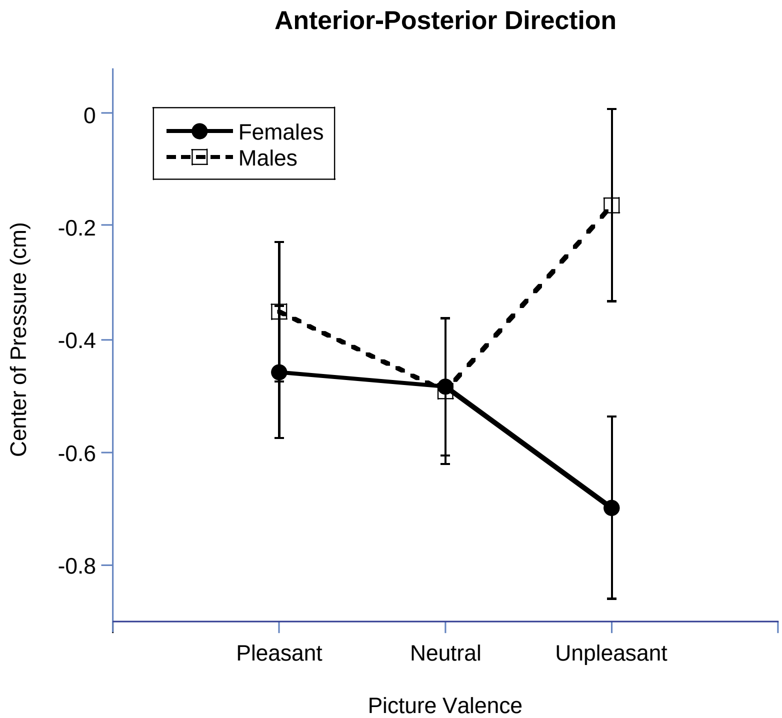

Fig. 1. Center of pressure movement (cm) in the anterior–posterior direction for females and males across the three picture valence categories. Positive values indicate COP movement in the anterior direction and negative values indicate COP movement in the posterior direction. A zero value would indicate no change in COP.

9.3, S.E. = 0.17). A Valence main effect was also observed, $F(2, 64) = 217.0$, $P < 0.001$, $\varepsilon = 0.70$. Post hoc analyses indicated that all three categories were significantly different from each other, t's $(1, 33) \geq 11.2$, $P < 0.001$. Valence ratings were highest for pleasant pictures and lowest for unpleasant pictures, with neutral pictures falling in-between (see Table 1).

Table 1
Means (S.D.) for females and males for the startle-blink reflex (z score) and subjective ratings of valence and arousal (measured along a 0–20 point scale) for each picture category

Measure	Picture category					
	Females			Males		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Startle-blink reflex	−0.14 (0.3)	−0.04 (0.2)	0.13 (0.3)	−0.09 (0.2)	−0.06 (0.2)	0.1 (0.3)
SAM valence	13.9 (2.0)	10.3 (0.8)	3.6 (2.2)	14.7 (2.3)	9.9 (0.6)	4.8 (2.0)
SAM arousal	10.3 (1.9)	6.6 (2.1)	14.8 (2.8)	11.7 (3.2)	6.3 (3.3)	14.4 (2.1)

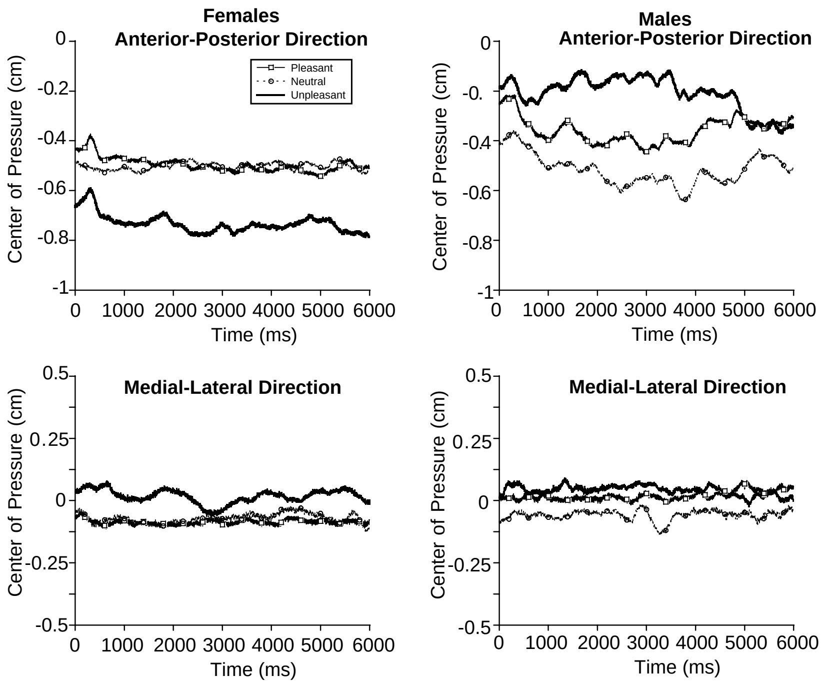

Fig. 2. Grand averaged waveforms for females and males across the three picture valence categories in the anterior–posterior and medial–lateral directions. Positive values indicate COP movement in the anterior direction and negative values indicate COP movement in the posterior direction. A zero value would indicate no change in COP.

3.3.2. Arousal ratings

Analyses revealed a valence main effect, $F(2, 64) = 100.0$, $P < 0.001$, $\varepsilon = 0.88$. Post hoc analyses indicated that pleasant and unpleasant pictures were rated as more arousing than neutral pictures, t's $(1, 33) \geq 9.4$, $P < 0.001$. In addition, unpleasant pictures were rated as more arousing than pleasant pictures, $t(1, 33) \geq 6.0$, $P < 0.001$. No sex effects were found (see Table 1).

4. Discussion

The current findings extend the literature on approach-withdrawal behavior to include emotion-evoked postural movements, as well as replicate previous self-report and startle reflex measures during affective picture viewing. Startle-blink responses were smallest for pleasant pictures and largest for unpleasant pictures, with responses to neutral pictures falling in-between. SAM data revealed that participants rated pleasant pictures with increased valence and arousal, and unpleasant pictures with decreased valence and increased arousal compared to neutral pictures. Further, these findings support those of Bradley et al. (2001b) in which sex-differences were not observed for the startle reflex, but were found for subjective reports of valence. Interestingly, sex-differences emerged in participants' COP movement while viewing unpleasant pictures. That is, females moved progressively away from the pictures. In contrast, males exhibited only modest posterior movement to unpleasant pictures. Thus, the COP data during affective picture viewing provides support for the relationship between motivated affective reactions and withdrawal behavior.

Given that the largest change in COP movement was observed during unpleasant picture contents, it appears that postural adjustments related to emotion may be more reactive for stimuli that motivate withdrawal responses. Previous COP research supports this notion. Maki and Mcllroy (1996) examined the influence of physiological arousal, attentional distraction, and state anxiety on changes in posture. Increased leaning in the anterior direction was found only for individuals that reported higher levels of autonomic/somatic state anxiety. That is, participants that scored lower in state anxiety did not display any postural changes. Within high state anxious individuals, increased leaning in the forward direction was observed during a math task that affected attention and arousal (Maki and Mcllroy, 1996). The other three tasks, which affected attention (i.e., listening to a "neutral-stress" passage), arousal (i.e., listening to white noise), or neither (i.e., no task control) had no effect on posture (Maki and Mcllroy, 1996). Maki and Mcllroy (1996) suggested that the increased leaning may reflect generalized arousal to stress and relate to early preparation for rapid gait initiation preceding the "fight or flight" response (Crenna and Frigo, 1991; Obrist et al., 1970).

In the current dataset, affective responses to pleasant and neutral pictures were similar between sexes, with differences arising only for unpleasant pictures. The fact that unpleasant pictures prompted increased COP movement in the posterior direction for females is consistent with the findings of Bradley et al. (2001b) indicating that females have a broad disposition to react with a greater defensive set during unpleasant, highly arousing pictures. Further, males' tendency to respond to unpleasant pictures with decreased COP movement in the posterior direction may reflect biological or sociocultural influences. Specifically, differences in size and strength or cultural shaping may mediate differential responses to threatening stimuli between the sexes (Bradley et al., 2001b). These sex-related differences in response to unpleasant pictures corroborate the observed differences in subjective reports of valence, in which females reported overall lower hedonic valence than males. In other words, the subjective report and COP data suggest that unpleasant pictures activate the defensive system more intensely in females, relative to males.

However, only support for withdrawal behavior was found for COP data, because approach behavior was not observed for pleasant pictures. It is possible that methodological constraints accounted for the lack of approach behavior. Specifically, given the short distance (1 m) between participants and the viewing screen, and the large visual angle (63.6°), participants may have been forced to moved in the posterior direction to attend to the entire pictorial cue. This may have interfered with any approach behavior. In addition, the appetitive contents selected for this study may also have not been adequate to prompt approach behavior. Couples engaging in sexual situations (i.e., erotica) may not promote the same approach motivations as attractive opposite-sex nudes. That is, same- and opposite-sex nudity, which comprised the erotic pictures, may engage the approach system less substantially than pictures of opposite-sex nudes alone. Lastly, the other pleasant content included scenes of babies and families, which are rated less arousing than sexual content, and thus, may not have been sufficiently arousing to prompt motivated approach behavior. More research into motivated COP changes associated with pleasant stimuli is necessary to better understand postural changes associated with appetitive motivations.

4.1. Summary

Replicating previous findings, both males and females exhibited attenuation of the startle-blink reflex to pleasant pictures and potentiation of the startle reflex to unpleasant pictures compared to neutral pictures. Also replicating previous research, subjective appraisals of pictures yielded increased reports of valence and arousal to pleasant pictures and decreased reports of valence and increased reports of arousal to unpleasant pictures, relative to neutral pictures.

Females exhibited increased movement away from unpleasant pictures compared to males. The addition of the measurement of COP movement, novel to this paradigm, provides support for the biphasic theory of emotion, which posits a relationship between affective reactivity and motivated approach-withdrawal behavior. The current data also support existing picture-viewing research (Bradley et al., 2001b), suggesting that females react with greater defensive motivation than males. Future research measuring emotionally-evoked postural changes is needed to further examine the relationship between pleasant stimuli and postural response. The extension of this research to both clinical affective disorders and individual differences in emotional reactivity may be beneficial to the increased understanding of motivated behavior.

Acknowledgements

This work was supported in part by a University of Illinois Research Board Award to Charles H. Hillman and Karl S. Rosengren.

References

Bertenthal, B.I., Rose, J.L., Bai, D.L., 1997. Perception-action coupling in the development of visual control of posture. Journal of Experimental Psychology: Human Perception and Performance 23, 1631–1643.

Bradley, M.M., Lang, P.J., 1994. Measuring emotion: the self-assessment manikin and the semantic differential. Journal of Behavioral Therapy and Experimental Psychiatry 25, 49–59.

Bradley, M.M., Greenwald, M.K., Petry, M., Lang, P.J., 1992. Remembering pictures: pleasure and arousal in memory. Journal of Experimental Psychology: Learning, Memory, and Cognition 18, 379–390.

Bradley, M.M., Cuthbert, B.N., Lang, P.J., 1993. Pictures as prepulse: attention and emotion in startle modification. Psychophysiology 30, 541–545.

Bradley, M.M., Codispoti, M., Cuthbert, B.N., Lang, P.J., 2001a. Emotion and motivation I: defensive and appetitive reactions in picture processing. Emotion 1, 276–298.

Bradley, M.M., Codispoti, M., Sabatinelli, D., Lang, P.J., 2001b. Emotion and motivation II: sex differences in picture processing. Emotion 1, 300–319.

Cacioppo, J.T., Priester, J.R., Berntson, G.G., 1993. Rudimentary determinants of attitudes II: arm flexion and extension have differential effects on attitudes. Journal of Personality and Social Psychology 65, 5–17.

Center for the Study of Emotion and Attention (CSEA-NIMH), 1999. The International Affective Picture System (Digitized Photographs). The Center for Research in Psychophysiology, University of Florida, Gainesville, FL.

Cook III, E.W., 1994. VPM reference manual. Author.

Crenna, P., Frigo, C., 1991. A motor program for the initiation of forward oriented movements in humans. Journal of Physiology 437, 635–653.

Darwin, C., 1872. The Expression of Emotion in Man and Animals. Murray, London.

Davidson, R.J., Ekman, P., Saron, C., Senulis, J., Friesen, W., 1990. Approach-withdrawal and cerebral asymmetry: emotional expression and brain physiology. Journal of Personality and Social Psychology 58, 330–341.

Duclos, S.E., Laird, J.D., Schneider, E., Sexter, M., Stern, L., Van Lighten, O., 1989. Emotion-specific effects of facial expressions and postures on emotional experience. Journal of Personality and Social Psychology 57, 100–108.

Elliot, A.J., Covington, M.V., 2001. Approach and avoidance motivation. Educational Psychology Review 13, 73–92.

Elliot, A.J., Thrash, T.M., 2002. Approach-avoidance motivation in personality: approach and avoidance temperaments and goals. Journal of Personality and Social Psychology 82, 804–818.

Forster, J., Higgins, E., Idson, L., 1998. Approach and avoidance strength during goal attainment: regulatory focus and the 'goal looms larger' effect. Journal of Personality and Social Psychology 75, 1115–1131.

Fridlund, A.J., Cacioppo, J.T., 1986. Guidelines for human electromyographic research. Psychophysiology 23, 567–589.

Hamm, A.O., Cuthbert, B.N., Globisch, J., Vaitl, D., 1995. Fear and the startle reflex: blink modulation and autonomic response pattern in animal and mutilation fearful subjects. Psychophysiology 34, 97–107.

Lang, P.J., 1968. Fear reduction and fear behavior: problems in treating a construct. In: Schlien, J. (Ed.), Research in Psychotherapy III. APA, Washington DC.

Lang, P.J., 1980. Behavioral treatment and bio-behavioral assessment: computer applications. In: Sidowski, J.B., Johnson, J.H., Williams, T.A. (Eds.), Technology in Mental Health Care Delivery Systems. Ablex, Norwood, NJ, pp. 119–137.

Lang, P.J., 1985. The cognitive psychophysiology of emotion: fear and anxiety. In: Hussain, A., Tuma, Maser, J. (Eds.), Anxiety and the Anxiety Disorders. Erlbaum, Hillsdale, NJ, pp. 131–170.

Lang, P.J., 2000. Emotion and motivation: attention, perception, and action. Journal of Sport and Exercise Psychology 22, S122–S140.

Lang, P., Bradley, M.M., Cuthbert, B.N., 1997. Motivated attention: affect, activation, and action. In: Lang, P.J., Simons, R.F., Balaban, M.T. (Eds.), Attention and Orienting: Sensory and Motivational Processes. Erlbaum, Hillsdale, NJ.

LeDoux, J., 1995. Emotion: clues from the brain. Annual Review of Psychology 46, 209–235.

Maki, B.E., Mcllroy, W.E., 1996. Influence of arousal and attention on the control of postural sway. Journal of Vestibular Research 6, 53–59.

Obrist, P.A., Webb, R.A., Sutterer, J.R., Howard, J.L., 1970. The cardiac somatic relationship: some reformulations. Psychophysiology 6, 569–587.

Redfern, M.S., Yardley, L., Bronstein, A.M., 2001. Visual influences on balance. Journal of Anxiety Disorders 15, 81–94.

Riskind, J.H., Gotay, C.C., 1982. Physical posture: could it have regulatory or feedback effects on motivation and emotion? Motivation and Emotion 6, 273–298.

Zajonc, R., 1998. Emotion. In: Gilbert, D., Fiske, S., Lindzey, G. (Eds.), The Handbook of Social Psychology, fourth ed. McGraw-Hill, New York, pp. 591–632.