Hostility and facial affect recognition: Effects of a cold pressor stressor on accuracy and cardiovascular reactivity

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Abstract

The effects of hostility and a cold pressor stressor on the accuracy of facial affect perception were examined in the present experiment. A mechanism whereby physiological arousal level is mediated by systems which also mediate accuracy of an individual's interpretation of affective cues is described. Right-handed participants were classified as high hostile (N = 28) or low hostile (N = 28) using the Cook Medley Hostility Scale. The high-hostile group met joint selection criteria. Only high-hostile participants who showed cardiovascular reactivity to the cold pressor, with systolic BP change exceeding the group mean were included. Groups were further subdivided into cold pressor and non-cold pressor test conditions. It was predicted that high-hostile men, relative to low-hostile men, would show decreased perceptual accuracy when presented with happy, angry, and neutral facial configurations within the left visual field (LVF). Results indicated that high-hostile men were less accurate than low-hostile men in the LVF. Further, pre-stress accuracy scores in the high-hostile men were similar to the post-stress accuracy scores of the low-hostile men. The lateralization of affective function and the role of physiological arousal in affective facial perception are discussed.

Keywords: Hostility; Emotion; Neuropsychology; Health; Facial affect perception; Cold pressor stressor; Cardiovascular arousal

1. Introduction

Hostility has been strongly correlated with the development of cardiovascular disease (CVD). The heightened arousal level and high degree of physiological reactivity present in the hostile disposition make hostility one of the most problematic affective constructs associated with CVD. High-hostile individuals are at heightened risk for CVD because they demonstrate heightened cardiovascular lability (Davis, Matthews, & McGrath, 2000) and are more likely to engage in behaviors that put them at risk for CVD (Calhoun, Bosworth, Siegler, & Bastian, 2001). Hostility has been associated with myocardial infarction and has signifi-

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were shown to have a negative emotional perceptual bias in the visual processing of faces (Harrison & Gorelczenko, 1990). Neutral faces were more likely to be identified as angry by high-hostile individuals. This perceptual bias was restricted to the left visual field (LVF), suggesting increased activation of right posterior cerebral systems in high-hostile participants. Whereas the purpose of earlier projects was to investigate response time and perceptual bias as a function of cerebral laterality, the purpose of the current investigation was to extend this line of research through measurement of the accuracy of facial affect recognition as a function of hostility level. Indications of perceptual bias in the LVF of high-hostile participants (Harrison & Gorelczenko, 1990) suggest that accuracy may be impaired as well.

Hostility has been defined as a multidimensional construct with behavioral and physiological correlates. Behaviorally, hostility is described as an attitude that motivates aggressive behavior towards objects and people (Spielberger et al., 1985). Physiologically, hostility has been associated with the chronic over activation of the sympathetic nervous system (Keefe, Castell, & Blumenthal, 1986) leading to heightened arousal levels.

Neuropsychological attempts to explain the manifestations of hostility have indicated that hostility may be the result of altered functioning within the right hemisphere. Significant evidence supports the contention that emotion, especially negative, originates within the right hemisphere (e.g., Borod, 1992; Borod, Bloom, Brickman, Nakhutina, & Curko, 2002; Heilman, 1997). Davidson (1992) concluded that the right hemisphere is associated with negative, withdrawal related emotions, while the left hemisphere is associated with positive, approach related emotions. Heilman (1997) describes a neurological model for emotional experiences. In this model the right hemisphere is described as the primary area for emotions as a result of its propensity to mediate arousal level. Heilman (1997) lists valence, arousal, and motor activation as the three components of emotional experience. Valence is mediated by the frontal lobes, positive valence in the left and negative valence in the right hemisphere. The parietal lobes, especially the right parietal lobe, are critical to arousal or activation.

With particular concern to hostility, dysfunction in the ability to inhibit posterior systems (i.e., the temporo-parietal region) by anterior systems (i.e., the prefrontal and orbital-frontal lobes) within the right hemisphere gives rise to both hostile behavior and heightened physiological arousal. The orbital-frontal cortex and its connections to the limbic system may play a regulatory role over anger in hostility (Lieberman & Benson, 1977; Tonkonogy & Geller, 1992). Orbital-frontal disinhibition of the amygdala produces physiological changes associated with anger and aggression (Damasio & Anderson, 1993). Disinhibition would likely occur when frontal capacities are taxed or limited. Shapiro et al. (2000) advocate that impaired function in the prefrontal cortex, be it from a lesion or metabolism as measured by regional cerebral blood flow (rCBF), is associated with hostile behaviors. Several case studies using quantitative electroencephalography (QEEG) (e.g., Demaree & Harrison, 1996; Everhart & Harrison, 1995) suggest that among high-hostile individuals there is dysfunctional anterior to posterior regulation of cerebral systems that increases the likelihood of the expression of the characteristics of hostility. Additional support of altered right hemispheric functioning in high hostiles was found by Demaree and Harrison (1997), who showed an increase in heart rate (HR) and right cerebrum activation in response to pain stress among high-hostile individuals.

The described right hemisphere model of hostility also has implications for cerebral regulation of HR and systolic blood pressure (SBP). A differential rate of right hemisphere activation occurring with increases in HR and SBP has been indicated in several experiments (Hachinsky, Oppenheimer, Wilson, Guiraudon, & Cechetto, 1992; Heller, Lindsay, Metz, & Farnum, 1990; Oppenheimer, Gelb, Girvin, & Hachinski, 1992; Wittling et al., 1998). Using emotionally positive or negative films, Wittling et al. (1998) demonstrated an increase in SBP during right cerebrum (left hemispace) presentation. Increases in the Galvanic skin response (GSR) on the left hemibody have also been found in participants contracting facial muscles depicting emotional faces (Herridge et al., 1997). Regulation of HR and SBP may also be compromised in high-hostile individuals with altered right hemispheric functioning. Indeed this relationship has been noted in several experiments (e.g., Demaree & Harrison, 1997; Shapiro, Sloan, Bigger, Bagiella, & Gorman, 1993; Sloan et al., 1994; Williamson & Harrison, 2003). High hostiles generally display heightened HR and SBP in response to stress (Demaree & Harrison, 1997; Shapiro et al., 1993; Sloan et al., 1994; Williamson & Harrison, 2003). Lane and Schwartz (1987) describe a relationship whereby emotional arousal may induce more sympathetic activity in individuals who demonstrate more cerebral lateralization. If we look at measures of hostility as measuring relative right hemisphere activation in an individual (i.e., more right lateralized cerebral organization) we would expect to see high-hostile participants exhibiting heightened sympathetic tone leading to increases in HR and SBP in response to emotional stimuli. Conversely, these increases may be due to diminished parasympathetic output.

The physiological arousal and negative bias in a hostile individual serve to induce chronic cognitive and physiological behaviors that affect performance. In affective perception tasks, a bias toward negativity is likely to occur, due to evidence of the right hemisphere's
role in negative emotion (Adolphs, Jansari, & Tranel, 2001; Borod et al., 2002; Davidson, 1993).

In the current experiment, high-hostile and low-hostile participants were asked to identify three different categories of affective facial configurations that were presented tachistoscopically. Facial affect literature suggests that impairments in facial affect perception occur as a result of lesions in the posterior right hemisphere, right orbitofrontal and right frontal opercular regions (Adolphs, Damasio, Tranel, & Damasio, 1996; Adolphs, Damasio, & Tranel, 2002; Borod, 1992; Keane, Calder, Hodges, & Young, 2002). Thus, the facial affect perception should prove to be a valuable measure to test the right hemisphere model of hostility. The primary focus of the experiment was the relationship between arousal level and perception in hostiles.

Only men were recruited for participation in order to increase the homogeneity of the experiment. Considerable evidence suggests that sex differences in emotional processing and laterality exist between men and women (e.g., Crews & Harrison, 1994; Harrison, Gorelzenko, & Cook, 1990; Higgins & Harrison, 1999; Hiscock, Perachio, & Inch, 2001; Ley & Bryden, 1979). To avoid confounding results the exclusion of women was necessary.

**Hypotheses.** The hypotheses were as follows: (1) both groups will show a LVF advantage for the accuracy in emotional facial recognition, (2) high-hostile men will be less accurate at identifying affect in the LVF relative to low-hostile men, and (3) low-hostile men will demonstrate decreased accuracy in emotional facial recognition in the high arousal, post-cold pressor stress condition.

2. Method

2.1. Participants

Participants were recruited from the undergraduate psychology pool. The participants first completed a screening session, where they were administered the Coren, Porac, and Duncan laterality questionnaire (Coren, Porac, & Duncan, 1979), a neurological screening and medical history form, and the Cook Medley Hostility Scale (CMHS) (Cook & Medley, 1954).

The Coren, Porac, and Duncan laterality questionnaire was used to determine sufficient right hemibody preference. The questionnaire is a 13 item self-report inventory. Scores range from +13, for complete right lateral preference, to −13, for complete left lateral preference. Participants scoring +6 or above were included in the experiment.

The neurological screening and medical history consisted of a questionnaire to assess neurological trauma and major medical disorders. It served as exclusionary criteria. Participants who reported uncorrected visual impairments, neurological damage, or major medical issues (e.g., cardiac problems, nervous system problems) were excluded.

The CMHS was used as a grouping variable. The CMHS is a 50 item true/false questionnaire that measures aspects of hostility. It has been shown to be a valid indicator of hostility in previous research. It has been correlated with CVD and is the most common measure of hostility (Contrada & Jussim, 1992). The CMHS was chosen due to its usefulness in predicting adverse medical (Miller, Smith, Turner, & Guijarro, 1996) and psychological outcomes (Contrada, 1994). Individuals who scored 15 or below on the CMHS were classified as low hostile, while individuals who scored 20 or above were classified as high hostile.

Twenty-eight participants met the criteria on the laterality measure, the neurological screening and medical history, and scored in the low-hostile range of the CMHS. These participants composed the low-hostile group.

Sixty-four participants met the screening criteria for entrance into the high-hostile group (i.e., were right-handed with no major neurological or medical issues and scored 20 or above on the CMHS) and were eligible for the second phase of screening for the high-hostile group. These individuals were administered a second screening where HR, SBP, and diastolic blood pressure (DBP) were measured during three consecutive 45 second cold pressor tests. One participant was excluded during this phase as a result of not being able to keep his hand in the ice water for 45 s. The mean change for SBP was 13.3 mmHg. Participants whose change score exceeded the mean (14 mmHg or more) were included in the hostile group. Thirty-two participants met these joint criteria. Twenty-eight of them were randomly selected to match the number of low hostiles.

Seven participants were excluded due to scores of 16–19 on the CMHS. Seven more were excluded due to scores on the laterality questionnaire or the neurological screening and medical history questionnaire (i.e., not strongly right-handed or diagnosed with a learning disability or mental illness).

2.2. Apparatus

During the experimental phase, participants were seated in a sound attenuated chamber in a chair facing a flat white screen. The screen was 2.67 m in front of the participant and the center was marked with a black dot 1.47 m above the floor and at the participant’s eye level. The cold pressor stimulus was also located within this chamber. The experimenter and the programming and recording equipment were located in a separate room. Participants were monitored through a one-way observation window and prompted via an intercom.
2.2. Physiological

An automated digital blood pressure unit (IBS, SD-700A) was utilized to measure HR, SBP, and DBP. A preset inflation pressure setting of 170 mmHg was used for all participants. Exhaust rate was set at 3 mmHg/s.

2.2.2. Perceptual

Sixty slides (20 happy, 20 angry, and 20 neutral) were selected from Ekman and Friesen’s (1978) pictures of facial affect. The slides were prepared with the stimulus face appearing in either the RVF or the LVF and were mounted with the stimulus face 3° of visual angle from the center. The outside edge of the stimulus was 12° from center (see Sergent, 1982). The slides were divided into 5 sets of 12 slides. Each set included 2 LVF happy, angry, and neutral faces and 2 RVF happy, angry, and neutral faces in random order. This resulted in 10 slides per affect category and visual field. The order of presentation was counterbalanced across all participants by group. A constant illumination tachistoscope (Lafayette Instruments 42011) was used for presentation. Each trial consisted of a .02 s presentation of the face.

2.2.3. Cold pressor

A cold pressor stressor was used. Water was maintained at 0°C (range +3°C) in a small ice cooler. A mercury thermometer was used to measure water temperature.

2.3. Procedure

The 56 eligible participants were invited back to complete the experimental phase. Participants were seated and completed an informed consent form. The experimenter assigned the high-hostile and low-hostile participants into either the cold pressor or the non-cold pressor groups in an alternating counterbalanced fashion. Arm circumference was measured to determine cuff size. The participant’s left arm was fitted with the blood pressure cuff.

2.3.1. Cold pressor condition

The experiment began with the stimulus screen illuminated in a dark room. The following instructions were presented:

In this part of the study you will have to make decisions concerning faces you will see on the screen. The presentation of the faces will be brief and either to the left or right of the black dot. The presentation of the face will be preceded by a tone (the tone is sounded). We ask that upon hearing the tone you focus on the black dot because the face will be presented soon afterward. After the presentation of the face, please decide quickly if it appeared to be happy, angry, or neutral (meaning not happy or angry). You will have 30 s to respond. When you have made your decision, please state it clearly. Try to respond as accurately as possible.

There is an intercom located behind you if you need to contact us. We will remind you to fixate on the black dot during the test. In order to test your ability to function under pressure, you will be asked to submerge your left hand in ice water prior to the presentation of the faces. Your blood pressure will be taken prior to this. This pattern will be repeated five times. Any questions?

Following these instructions, a SBP, DBP, and HR were recorded. The participants then submerged their left hand in the ice water for 30 s. T. The participants removed their hand after 30 s and placed it on the edge of the container. The tachistoscopic task was initiated by a 2000 Hz, 55 dB SPL, (A-scale) tone located behind the subject after the first cold pressor trial. The slide set (12 slides) was presented twice, resulting in the presentation of 24 total slides. The tone was sounded for 1 s prior to the presentation of each slide. A period of 5–10 s occurred after the participant responded and before the next tone was sounded. HR and BP were measured again following the termination of the slide presentation. This procedure was carried out four more times, for a total of five cold pressor trials and five slide presentations. Before the slides were presented, the participant was reminded to focus on the black dot in each of the presentations. Following the last slide presentation HR and BP were measured a final time.

2.3.2. Non-cold pressor condition

The non-cold pressor condition was carried out in the same way as the cold pressor condition except that the cold pressor was removed from the laboratory and the following instructions were utilized:

In this part of the study you will have to make decisions concerning faces you will see on the screen. The presentation of the faces will be brief and either to the left or right of the black dot. The presentation of each face will be preceded by a tone (the tone is sounded). We ask that upon hearing the tone you focus on the black dot because the face will be presented soon afterward. After the presentation of the face, please decide quickly if it appeared to be happy, angry, or neutral (meaning not happy or angry). You will have three seconds to respond. When you have made your decision, please state it clearly. Try to respond as accurately as possible. There is an intercom located behind you if you need to contact us. We will remind you to fixate on the black dot during the test. Prior to the presentation of each of the five sets of faces, your blood pressure will be taken. Any questions?

The experimenter measured the HR and BP of the participant and the presentation of the slides began. The slides were presented in the same manner as in the cold pressor condition. Each set was presented twice, resulting in the presentation of 24 slides on each of five trials. As in the cold pressor condition, participants were reminded to focus on the black dot at the beginning of each presentation and a 1 s tone was sounded prior to the presentation of each slide. Heart and BP were measured at the end of each presentation of the slide set.
Following the experimental phase, participants in both conditions were debriefed and the blood pressure cuff was removed.

3. Results

Data were analyzed with a four-factor, mixed-design analysis of variance (ANOVA) with the fixed or between-subjects factors of group (high-hostile and low-hostile) and condition (cold pressor and non-cold pressor), and the repeated or within-subjects factors of visual field (LVF and RVF), and facial affect category (happy, angry, and neutral). This approach produced six scores per subject with a possible range of 0–20 correct scores. Significance levels were computed with conservative degrees of freedom (Greenhouse & Geisser, 1959) and found to be equivalent to univariate and mixed-model approaches. Post hoc comparisons were performed with Tukey’s Honestly Significant Difference (HSD) (α = .05). Post hoc comparisons of the contributions of each level of the Group, Condition, Affect Category, and Visual Field variables were performed with individual ANOVAs. Examination of each variable in the overall analysis was performed using the Bartlett Box F homogeneity-of-variance test. All variables were non-significant (α = .05 (3, 4867)).

There was a significant three-way Group × Visual Field × Affect Category interaction [F(2, 104) = 4.99, p < .01; see Fig. 1]. As expected, high hostiles showed a different pattern of accuracy than low hostiles in the assessment of the three categories of facial affect. Post hoc comparisons revealed that high hostiles consistently performed less accurately than low hostiles when facial configurations were presented in the LVF. However, in the RVF they only showed less accuracy in the assessment of neutral faces and were more accurate in the assessment of angry and happy faces as compared to the low hostiles.

Post hoc analysis of the data exclusively from the high-hostile group yielded a significant effect for Affect Category [F(2, 54) = 64.63, p < .001] and a significant interaction of Visual Field × Affect Category [F(2, 54) = 5.20, p < .01]. High hostiles did not show a main effect for Visual Field [F(1, 27) = 3.31, p = .08]. Post hoc analysis of the data exclusively from the low-hostile group yielded a significant main effect for Visual Field [F(1, 27) = 23.17, p < .0001] and Affect Category [F(2, 54) = 72.69, p < .0001]. Low hostiles did not demonstrate a significant interaction effect for Visual Field × Affect Category [F(2, 54) = 1.17, p = .17].

Post hoc analysis by affect category showed that the angry affect was the only affect category to produce a significant Group × Visual Field interaction [F(1, 52) = 8.81, p < .01]. Significant main effects of Visual Field were found for happy affect [F(1, 54) = 4.10, p < .05] and neutral affect [F(1, 54) = 29.8, p < .0001] but not angry affect.

Furthermore, a significant overall interaction was found for Group × Visual Field [F(1, 52) = 6.74, p < .05; see Fig. 2]. High hostiles showed better overall accuracy than low hostiles in the RVF. However, low hostiles showed better overall accuracy than hosts in the LVF.

The Visual Field × Affect Category interaction was significant [F(2, 104) = 5.63, p < .01; see Fig. 3]. Neutral facial configurations were recognized as “neutral” significantly more often in the LVF than in the RVF.

The main effect of Visual Field was significant [F(1, 52) = 23.01, p < .001, mean LVF = 15.44, mean RVF = 14.42] as expected. This effect was confirmed with a post hoc analysis using Tukey’s HSD (α = .05). In general, subjects were more accurate with facial configurations presented in the LVF. Post hoc analysis, however, showed this effect was primarily due to the low-hostile group.

Finally, Affect Category was significant [F(2, 104) = 140.13, p < .0001, mean number correct: happy = 17.66,
angry = 11.86, and neutral = 15.19] with each category of affective facial configuration being significantly differentiated from the other two. For all groups, happy faces were recognized at the most accurate level, followed by neutral faces and then angry faces. Post hoc comparisons performed with Tukey's HSD (α = .05) on Affect Category confirmed this significance.

A non-significant trend was noted in the Group x Visual Field x Cold Pressor interaction [F(1, 52) = 3.68, p = .061; see Fig. 4]. The interaction of Cold Pressor x Visual Field was also non-significant. However, examination of the low-hostile group yielded a significant main effect for Visual Field [F(1, 26) = 26.64, p < .0001]. Also, a significant interaction effect was found for Cold Pressor x Visual Field [F(1, 26) = 5.05, p < .05] for this group.

Further post hoc examination of this group showed that within the non-cold pressor condition there was a significant main effect of Visual Field [F(1, 26) = 8.65, p < .01] and a significant interaction effect of Group x Visual Field [F(1, 26) = 15.77, p < .001]. Within the Cold Pressor condition, only a significant interaction effect of Group x Visual Field [F(1, 26) = 9.72, p < .01] was noted.

4. Discussion

This experiment was designed to examine the effects of physiological arousal on the perceptual accuracy of high-hostile and low-hostile men presented with affective facial configurations in the LVF or RVF. Participants were divided based on hostility level. Counterbalanced assignment to a cold pressor or non-cold pressor condition was used. This resulted in four experimental subsets: high hostile/cold pressor, high hostile/non-cold pressor, low hostile/cold pressor, low hostile/non-cold pressor. Participants were assessed on the accuracy of identification of happy, angry, and neutral faces in the RVF or LVF.

The significant three-way interaction of Group x Visual Field x Affect Category indicates that, as theorized, high-hostile men do differ in the right cerebral mediation of affect functions as compared to low-hostile men. Low hostiles were more accurate in the assessment of the affective faces presented in their LVF than those presented in their RVF for all three of the affect categories. However, high hostiles demonstrated this pattern of LVF superiority only in the perception of neutral faces. Commensurate levels of accuracy were demonstrated with the presentation of happy faces in both visual fields for hostile men. In the presentation of angry faces, high hostiles exhibited a higher level of accuracy in their RVF. High hostiles performed significantly better than low hostiles only when angry or happy faces were presented in the RVF. Only during the presentation of happy faces in the LVF did high hostiles and low hostiles perform similarly. Low hostiles were consistently better than hostiles within each other affect category and visual field, providing further evidence of altered right hemisphere function in high hostiles in response to affective stimuli.

These results provide evidence that the facial affect perception of high-hostile men is compromised or differs in comparison with low-hostile men when stimuli are presented in the LVF. It is important to note, however, that high hostiles did not demonstrate generalized difficulty with facial affect perception across all visual field and affect categories. High hostiles were more accurate than low hostiles when presented with angry and happy faces in their RVF. However, in the neutral affect category high hostiles demonstrated a consistent LVF advantage and were less accurate than low hostiles in both visual fields, regardless of the cold pressor condition. Thus, confirmatory evidence for the hypothesized group differences in assessing neutral affective faces was obtained.

Fig. 3. Accuracy within the happy, angry, and neutral categories in the RVF and LVF.

Fig. 4. Accuracy of facial affect perception pre- and post-cold pressor stressor in the RVF and LVF among high- and low hostiles.
Paradoxical evidence in assessment of angry faces was found. Research has previously found a LVF bias in perception of angry affective stimuli. In this experiment, high hostiles were found to be more accurate in assessing angry faces in the RVF, as compared to the left visual field. In comparison with the low-hostile group, high hostiles had a higher accuracy for angry faces in the RVF. This could indicate that both the right and left cerebrums of high-hostile men function differently than low hostiles, such that heightened activity in one hemisphere produces a change in the other.

The fact that happy faces were more accurately identified across visual fields in each group lends support to the idea that positive affect is less lateralized than negative affect. A previous experiment demonstrated that the presentation of positively valenced faces produced more accurate and faster reaction times relative to the presentation of negatively valenced faces (Demakis, Harrison, & Campden, 1993). Our results combined with these data lend support to the idea that happy faces are qualitatively distinctive from other categories of affect.

Interestingly, cold pressor presentation produced a non-significant trend toward decreased performance accuracy for faces in the LVF in the low-hostile group. Thus, reliable effects did not support the prediction, that low-hostile men under high arousal conditions would show decreased accuracy in the LVF. Treating the low hostiles as a control group, it was proposed that during arousal or stress, performance patterns would emulate those of high-hostile individuals. This notion could be deduced from predictions based on dynamic laterality and Davidson’s diathesis/stress model (1993). According to Davidson, asymmetrical anterior activation is associated with an individual’s propensity to experience positive or negative emotions, given the requisite environment. In the current investigation, the cold pressor could have induced altered activation in the right cerebrum of non-hostile men and influenced their performance such that it modeled the performance of high-hostile individuals. Altered right cerebral activation might be predicted because the cerebral hemispheres respond differently to arousal related stimuli. In our experiment, the predicted decline in accuracy in low hostiles with heightened arousal was not supported.

Two important conclusions can be drawn from this study. High-hostile individuals’ cognitive efficiency at facial affect perception tasks is decreased in accuracy relative to that of low hostiles. This may be a function of alteration within the right cerebral system as discussed in Section 1. This finding extends the previous line of research on laterality, visual response times, and LVF negative bias reported previously (Harrison & Gorelenko, 1990). In addition, the research relates to a functional cerebral systems analysis of emotional processing in high- and low-hostile groups where visual (Harrison & Gorelenko, 1990), auditory (Demaree & Harrison, 1997), somatosensory (Herridge et al., 1997), motor (Demaree et al., 2002), and premotor (Williamson & Harrison, 2003) differences have previously been reported from our laboratory. The previous data suggest that differential processing across modalities exists in high hostiles relative to low hostiles. The current experiment demonstrates yet another modality (accuracy in identifying facial affect) where differences in high- and low hostiles exist.

The second conclusion is that the effects of arousal on high hostiles may be small. Analyses of the cold pressor effects yielded only a non-significant trend. This may be due to the fact that high-hostile participants are already in a state of higher arousal. It is also possible that previous exposure to the cold pressor during the prescreening phase diminished its ability to produce significant changes in arousal during the testing phase in the high-hostile group. However, differences in efficiency on perceptual affect accuracy can be seen in low hostiles who are aroused or stressed. Future research in this area should investigate how arousal and stress alter performance and how an altered arousal system in the right hemisphere interacts with the left hemisphere to produce changes in cognitive appraisals and physiological states.

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