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A Multi-Method Investigation of Approach and Avoidance Temperaments: Self-Report, Physiological, and Daily Diary Measures

John Thomas Dombrowski
College of William & Mary - Arts & Sciences

A Multi-Method Investigation of Approach and Avoidance Temperaments: Self-Report, Physiological, and Daily Diary Measures

John Thomas Dombrowski

Lynbrook, New York

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John Thomas Dombrowski

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Committee Chair
Associate Professor, Todd Thrash, Psychology
The College of William and Mary

Assistant Professor, Joanna Schug, Psychology
The College of William and Mary

Assistant Professor, Paul Kieffaber, Psychology
The College of William and Mary

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ABSTRACT

Approach and avoidance temperaments have gained recognition in personality research over the past decade; however, little has been done to understand their relationship with emotional reactivity processes and daily affective experience. The current study investigates the influence of these constructs on autonomic electrodermal activation during a picture-viewing procedure and on daily affect recorded over a fourteen-day diary collection. Self-reports, physiological responses, and daily diaries were collected from 170 participants. Correlation analyses examined the relationships between a new measure of approach and avoidance temperaments and previous temperament measures. Multi-level modeling analyses were employed for physiological and daily-diary analyses. Results revealed avoidance temperament moderation of the within-person relationship between negative images and SCRs but no approach moderation. Additionally, main effects of avoidance temperament on daily negative affect and approach temperament on daily positive affect were detected. Discussion focuses on understanding the interaction between personality individual differences, emotion processes, and daily affect and future directions for approach and avoidance research.

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This Thesis is dedicated to my parents and brother who never failed to remind me that important responsibilities require great persistence and thought but result in equal satisfaction and reward.

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A Multi-Method Investigation of Approach and Avoidance Temperaments: Self-Report, Physiological, and Daily Diary Measures

For the better part of the last half-century, personality psychologists have sought to identify the basic structures of personality, and theorists have used different models to describe the nature of dispositional differences. Among these diverse approaches to understanding the structure of personality, three approaches distinguish themselves from the others due to the breadth of theorizing and research conducted on them. These three models of personality are labeled the *trait adjective*, *affective disposition*, and *motivational systems* approaches. Each of these approaches, and others like them, identify and describe personality constructs that influence behavioral, emotional, cognitive, and physiological processes that give meaning to our environment and one's interactive role in it.

Although derived from different theoretical foundations, there are constructs from each of these approaches described as inherent sensitivities to positive and negative stimuli. The constructs of focus here are extraversion and neuroticism from the trait-adjective approach, positive and negative emotionality from the affective disposition approach, and behavioral activation and behavioral inhibition systems from the motivation systems approach. Extraversion, positive emotionality, and behavioral activation system are constructs that are sensitive to positive environmental stimuli. Neuroticism, negative emotionality, and behavioral inhibition system are constructs that are sensitive to negative environmental stimuli. Furthermore, researchers have found shared variance among like-valence constructs from these separate models of personality. Conceptual overlap has been identified between neuroticism-extraversion and negative emotionality-positive emotionality (e.g., Carver, Sutton, & Scheier, 2000), behavioral inhibition-behavioral activation and negative emotionality-positive emotionality (e.g., Carver & White, 1994), and neuroticism-extraversion and behavioral inhibition-behavioral activation (e.g., Carver et al., 2000). More recently, researchers have proposed that two higher-order factors are responsible for the shared variance found among these other constructs; they are labeled approach and avoidance temperaments (Elliot & Thrash, 2002).

Approach and Avoidance Temperaments

Like the constructs previously mentioned from trait adjective, affective disposition, and motivational systems approaches to personality, approach and avoidance motivations differ as a function of valence, that is the positivity or negativity of an environmental stimuli to which they react. For approach motivation, behaviors are directed or initiated by positive or pleasant events or possibilities, while avoidance motivated behaviors are directed or initiated by negative or unpleasant events or possibilities (Elliot, 1999). Approach and avoidance motivations are displayed throughout the hierarchy of personality constructs, with the goal construct receiving the greatest amount of attention from researchers (Elliot & Church, 1997; Elliot, 2006). However, theorists have recently begun to establish the approach and avoidance motivation distinction at the domain-general, trait-level of personality description.

Inspired by research indicating shared variance among constructs from trait adjective, affective disposition, and motivational systems approaches (see Carver et al., 2000, Carver & White, 1994), Elliot and Thrash (2002) found that higher-order factors, which have been labeled approach and avoidance temperaments, are responsible for the covariance found among like-valence constructs from the traditional approaches to personality theory. More specifically, approach temperament is best conceptualized as a hierarchical core construct responsible for shared variance between measures of extraversion, positive emotionality, and behavioral activation systems. Similarly, avoidance temperament may best be conceived as a higher-order underlying construct accounting for shared variance between neuroticism, negative emotionality, and behavioral inhibition systems (Elliot & Thrash, 2010 Study 4). Furthermore, approach temperament is conceptualized as a domain-general neurobiological sensitivity to positive stimuli that is characterized by a perceptual vigilance for, an affective reactivity to, and a behavioral predisposition toward these stimuli. Likewise, avoidance temperament is defined as a neurobiological sensitivity to negative stimuli, which is accompanied by a perceptual vigilance for, an affective reactivity to, and behavioral predisposition toward such stimuli (Elliot & Thrash, 2002).

The current study seeks to further examine approach and avoidance temperaments and their role as personality constructs. Three methods of measurement were employed for the current study in order to paint a broader understanding of these constructs. Specifically, self-report scales, physiological responses, and daily diary reports were assessed. These methods have previously been used to understand the role of constructs from trait-adjective, affective disposition, and motivation systems approaches of personality. I will review the literature on self-report measures that emphasize psychometric properties of their scales, as analyses of approach and avoidance temperaments scale will focus on displaying convergent and discriminant validity of scales. Additionally, I will review previous research that used physiological recording and daily diary methods to examine the role of personality constructs during emotional reactivity processes to positive and negative stimuli. These methods afford the opportunity to assess affective experiences across two very different measurements, which provides a greater understanding of emotion processes and personality constructs' interaction with them. I conclude with specific hypotheses of this thesis in light of the previously reviewed research.

Self-Reports in Personality

Since the beginning of empirical examinations of personality constructs, self-report has been one of the most commonly used methods of understanding the basic structures of personality. Eysenck's (1967) model of Extraversion and Neuroticism was one of the first theories to be empirically assessed through self-reports. Later, additional theorizing by Eysenck and colleagues (Eysenck & Eysenck, 1985) led to the inclusion of a third construct, Psychoticism, to the model, which is now known as the Big Three. The Big Three model has been assessed by several self-report scales including, but not limited to, the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1964) and Eysenck Personality Questionnaire – Revised (EPQ-R; Eysenck, Eysenck, & Barrett, 1985).

The trait-adjective approach has also received attention from the psychology community due to further theorizing (Costa & McCrae, 1980; McCrae & Costa, 1987). This new model, known as the Big Five, includes Extraversion and Neuroticism and three additional factors: Conscientiousness, Agreeableness, and Openness to

Experience. There is consensus among researchers that Extraversion and Neuroticism from the Big Five correspond to Eysenck's traits of the same names (Costa & McCrae, 1992a). Costa and McCrae's (1992b) NEO Five-Factor Inventory is a commonly used self-report measure to assess these five trait-adjective constructs.

The affective disposition approach has also benefited from the use of self-report methods. Theorists have given different names to the two main constructs (e.g. positive emotionality/temperament and negative emotionality/temperament) from this approach (see Tellegen, 1985; Watson & Clark, 1993); however, these dimensions of similar valence are believed to be analogous (Clark & Watson, 1999). They will be referred to as positive and negative emotionality for purposes of this thesis. Watson and Clark's (1993) General Temperament Survey is a true-false self-report questionnaire that is frequently used to assess these dimensions. Additionally, the motivation systems approach has been supported by self-report measurements. Using the theory of Gray (1970; 1987), Carver and White (1994) created the BAS and BIS scales to measure behavioral activation and inhibition systems. Other personality constructs have benefited from self-report measures, but these three traditional approaches to personality relate strongest to approach and avoidance temperaments.

Most recently, Elliot and Thrash (2010) created the Approach-Avoidance Temperament Questionnaire (ATQ) to directly assess individual differences along these separate dimensions. In a series of studies, the researchers modeled the hierarchical nature of approach and avoidance temperaments, demonstrated good test-retest reliability of the questionnaire, displayed the relationship to state-level achievement goals, and provided evidence that these constructs are not artifacts of response biases (Elliot & Thrash, 2002; 2010). The current study will examine the ATQ and newly developed Approach-Avoidance Temperament Questionnaire – Multiple Components (ATQ-MC) self-report scale, which has separate subscales for corresponding perceptual vigilance, affective reactivity, and behavioral predisposition processes that characterize the general temperaments.

Physiological Methods in Personality

Personality theorists have also employed physiological measures to further understand the role of personality constructs during emotion processing. Eysenck's (1967) Big Three model was one of the first theories to undergo investigation by physiological measurement. In their seminal paper, Coles and colleagues (1971) examined extraversion and neuroticism from the Big Three by recording tonic and response measures of electrodermal activity during a habituation procedure to auditory tones. They found that individuals with high neuroticism had a greater number of responses than individuals who scored low on neuroticism, and high neurotics took longer to habituate than low neurotics. Both extraversion and neuroticism were marginally related to latency of response but only moderately (Coles et al., 1971). This early evidence of personality factors' influence during emotion processing catalyzed greater investigation into their role during affective experiences.

With the development of new and more precise physiological and neurological equipment, personality researchers have continued to examine the interaction between dispositional differences and emotion systems with improved designs. More recently, researchers have examined personality factors' influence on various indicators of attention and emotion processing, such as neuroticism on skin conductance recordings

(Norris, Larsen, & Cacioppo, 2007), BAS and BIS on heart rate, respiration, EMG, skin conductance, and event-related potential measures (Balconi, Brambilla, & Falbo, 2009; Balconi, Falbo, Conte, 2012), and innate temperaments' (e.g. novelty seeking and harm avoidance) and acquired characteristics' (e.g. cooperativeness and self-directedness) effect on skin conductance measures (Mardaga, Laloyaux, & Hansenne, 2006). The literature on the interaction of personality factors and emotion processing and response systems indicates that individual differences along certain personality dimensions influence the intensity of emotional experiences, for both positive and negative emotions.

These investigations into personality and emotion processing have benefited from several advances in physiological recording devices and standardized experimental stimuli. First, computerized recording of skin conductance measures has improved the accuracy of one of the most commonly used indicators of general emotional arousal (Dawson, Schell, & Filion, 2007). Experimental stimuli have also seen improvements, notably, visual stimuli. One set of such stimuli is the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005), which is a set of images that has standardized ratings of valence and arousal. These standardized ratings have been established using the self-assessment manikin (SAM; Lang, 1980). The images span a range of contents from highly negative and arousing (e.g. mutilation) to highly positive and arousing (e.g. erotic couples), with many topics in between, such as landscapes, animals, infants, emotional and neutral faces, household objects, and other differing emotional scenes. These images have been used to examine physiological responses during affective reactions to positive and negative stimuli, including EMG measures of corrugator and zygomaticus major muscles, heart rate recordings, skin conductance responses (SCR), and cortical activity as indicated by event-related potentials (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Codispoti, Sabatinelli, & Lang, 2001). For the current study, a range of IAPS images were selected based on valence and arousal ratings and image content, and they were viewed while SCRs were recorded to measure emotional arousal to positive and negative stimuli.

Recent research conducted by the current author and colleagues (Dombrowski, Thrash, Fuller, & Kieffaber; in preparation) has implemented SCR recording procedures during an image-presentation program to examine the interaction of approach and avoidance temperaments and physiological reactivity. High and low arousal positive (rewarding) and negative (threatening) experimental stimuli were selected from the IAPS database and shown to participants. Results indicated strong effects of rewarding and threatening images on SCR amplitude. Additionally, participants with high avoidance temperament experienced greater reactivity to highly threatening images than did low-avoidance participants. No symmetrical interaction was found between approach temperament and rewarding images. A similar procedure and set of analyses were used in the current study to examine approach and avoidance temperaments' role in physiological reactivity, measured through SCR amplitudes.

Daily Diary Methods in Personality

Due to advances in statistical modeling and increased efforts to better understand the interaction between personality constructs and daily events, daily diary methods have emerged as a set of valuable techniques to explore the influence of personality factors in individuals' daily lives. This method affords researchers the opportunity to separately examine the effects of top-down processes (e.g. effects of domain-general personality traits) and bottom-up processes (e.g. effects of daily events) on daily affect. Research indicates that daily affect is related to both positive and negative daily events in different domains, such as achievement, social, and work domains (Stone, 1987; David, Green, Martin, & Suls, 1997; Gable, Reis, & Elliot, 2000; Nezlek & Plesko, 2003; Timmermans, Van Mechelen, & Nezlek, 2009). In general, negative affect is positively related to negative daily events, and positive affect is positively related to positive events and inversely related to negative events. Results concerning the "buffer effect" of positive events on negative affect are inconsistent, though some research provides evidence for the effect (Nezlek & Allen, 2006; Longua, DeHart, Tennen, & Armeli, 2009).

Daily affect fluctuates not only as a function of daily events but also as a function of individual differences on personality dimensions. Several personality factors have been examined in relationship to daily positive and negative affect. Using hierarchical linear modeling, Gable and colleagues (2000) found that individuals with high BIS ratings experience more daily negative affect, experience less positive affect, and are affected more by negative events than individuals with lower BIS. BAS was related to greater daily positive affect, but did not predict negative affect and did not moderate the relationship between daily positive affect and positive events. Constructs of extraversion and neuroticism have also been examined in relationship to daily affect and events. Using standard regression analyses, David et al. (1997) did not find significant relationships between neuroticism and daily negative or positive affect; likewise, significant relationships were not detected between extraversion and daily positive or negative affect. Neuroticism was significantly related to undesirable (negative) daily events, but extraversion was not related to desirable (positive) events.

More recently, Longua and colleagues (2009) employed multilevel regression analyses to examine relationships between trait neuroticism and extraversion, daily negative affect, and daily events over a thirty-day diary collection. Both neuroticism and negative events predicted daily negative affect in expected directions; however, extraversion did not predict negative affect. Neuroticism interacted with negative events such that individuals with higher neuroticism were more reactive to negative events. There was also a three-way interaction between neuroticism, negative events, and positive events predicting negative affect. When researchers examined simple slopes analyses, individuals with low neuroticism (e.g. those one standard deviation below the mean), who experienced a high number of negative events and a high number of positive events, experienced less negative affect than those individuals who experienced few positive events. Longua and colleagues (2009) also reported a three-way interaction between extraversion, positive events, and negative events. Simple slopes analyses indicated that the relationship between negative events and negative affect is weaker for individuals with high extraversion (vs. low) when they experience more (vs. fewer) positive events. These analyses display an example of the "buffer effect" and, more generally, an example of the complex interaction between personality constructs and daily events during daily affective experience.

The swell of diary studies and advances in statistical models over the past two decades have provided many insights into the role of personality factors during the daily affective experience. The current study seeks to further illuminate these relationships by examining the role of approach and avoidance temperaments on daily positive and negative affect alongside the effects of daily positive and negative events. Daily diaries were collected over two weeks, during which daily affect and daily events were recorded, and multi-level modeling techniques were used to examine within-person (e.g. daily events) and between-person (e.g. approach and avoidance temperaments) effects on daily affect.

Summary and Hypotheses

Approach and avoidance temperaments have theoretical and statistical links to constructs from trait-adjective, affective disposition, and motivation systems approaches to personality (Elliot & Thrash, 2002; 2010). These models of personality have been explored through many different methods of psychological investigation including, but not limited to, self-report, physiological, and daily diary measurements. The current study employs these three methods to further examine approach and avoidance temperaments. Therefore, the specific hypotheses of this study can be outlined in three categories.

Self-Report Hypotheses. The hypotheses concerning self-reports of approach and avoidance temperaments are:

(H1): Convergent validity of approach and avoidance temperaments, assessed with the new ATQ-MC, will be displayed through correlations with previous measures of approach and avoidance temperaments, respectively.

(H2): Discriminant validity of approach and avoidance temperaments scales will be displayed through weaker correlations across temperament scales (e.g. ATQ-MC approach's relationship to a measure of avoidance temperament).

Physiological Hypotheses. Hypotheses concerning physiological reactions, as indexed by skin conductance responses (SCRs) are as follows:

(H3): Physiological reactivity, as indexed by SCR amplitude, to experimental stimuli will increase as an image's rating on reward (positive) and threat (negative) dimensions increases.

(H4): Furthermore, the between-person avoidance temperament variable will moderate the within-person relationship between reactivity and threat, such that higher avoidance temperament leads to greater reactivity.

(H5): Approach temperament will moderate the within-person relationship between reactivity and reward, such that higher approach temperament leads to greater reactivity.

Daily Diary Hypotheses. The hypotheses pertaining to daily affect, daily events, and the role of approach and avoidance temperaments on affect are:

(H6): On an average day, daily positive affect will increase as individuals experience more positive events.

(H7): On an average day, daily negative affect will increase as individuals experience more negative events.

(H8): The day-level (within-person) relationship between daily positive affect and daily positive events will be moderated by approach temperament (between-person), such that positive events are experienced more positively for individuals with higher approach temperament.

(H9): The day-level relationship between daily negative affect and daily negative events will be moderated by avoidance temperament, such that negative events are experienced more negatively for individuals with higher avoidance temperament.

Method

The following protocols were approved by the Institutional Review Board for human subjects of the College of William and Mary.

Participants

One hundred and seventy undergraduate students were recruited from an introductory psychology pool for the current study and were compensated with research credit hours for their participation. One participant withdrew from the study due to a concussion. Four participants were dropped from trait-level analyses due to invalid or incomplete entries leaving one hundred and sixty-six cases for analyses. For skin conductance response analyses, thirty-three participants were removed due to incomplete or no matching trait data and errors in electronic storage and retrieval of SCR recordings.

Procedure

Daily Measures Collection. Before beginning the two-week collection of the daily surveys, participants attended an informational meeting in a small group setting to learn about the study's procedure. After attending one of these meetings, participants were emailed two trait surveys, one of which contained approach and avoidance temperament scales and other personality measures.[1] Participants were instructed to complete these measures at their leisure over the following weeks. Next, daily surveys were administered every evening for the following two weeks via email. Participants' confidential daily data was collected and time-stamped by Qualtrics, an electronic survey portal. Emails were also sent out by researchers to remind participants to complete the daily surveys at the end of each day throughout the two weeks. Additionally, participants were allowed to complete another two daily surveys at the end of the two-week period, making the total daily surveys completed for some participants greater than fourteen entries.

In order for daily survey entries to be included in final analyses, each entry had to meet certain criteria to eliminate invalid or duplicate entries. First, daily surveys were included in final analyses if they were finished between between 8:00 pm and noon the following day (128 entries removed). Research indicates that concurrent reports of daily events and emotions and retrospective reports the following day are highly correlated (Kahneman et al., 2004). Entries were also dropped for the following reasons: no identifying email address (18 entries), incomplete (29 entries), completed

[1] Trait and daily survey collections for this study were part of a greater data collection of other trait-level and daily-level measures and cognitive tasks, which are not reported in this paper.

in less than two minutes (1 entry), started between 10:00 am and 8:00 pm and took longer than 500 minutes to complete (7 entries), and if duplicate entries were entered on the same day, in which the last entry was included (39 entries). Additionally, two researchers independently examined all daily entries and concluded that another 27 entries had to be eliminated due to quick completion (i.e., less than 3 minutes) and had suspicious patterns of repsonses across multiple scales (i.e., repeated answers, even across reverse coded items). From the remaining valid entries, five participants completed less than 5 daily surveys and each of their entries (24 entries) was removed to ensure reliable within-person analyses. In summary, 2036 entries were entered for within-person analyses, and 161 cases (participants) were entered for between-person analyses in final multi-level model analyses.

SCR Recording. Participants, after attending the preliminary information meeting, attended a one-hour laboratory session, during which they completed several cognitive tasks and a picture viewing and SCR recording procedure. Upon entering the lab, a researcher or research assistant instructed the participant to wash his or her hands with non-abrasive soap and water. This protocol is commonly recommended for recording SCRs, as it reduces error in recording due to extraneous variables such as the time since participants last washed their hands, which affects the amount of sweat on the hands (Dawson et al., 2007). When the participant returned to the lab, the researcher directed him or her to a private individual experimental room where he or she was seated in front of a computer monitor. First, the participant completed a series of cognitive tasks, which were part of another study (see Footnote 1). Once the participant completed these tasks, he or she rang a bell to indicate completion, upon which a researcher or research assistant entered the room to begin picture presentation and SCR-recording procedures.

In order to measure emotional arousal, changes of electrodermal activity (EDA), specifically SCRs, were recorded (Dawson et al., 2007). The participant had two disposable Biopac EL507 electrodes placed on the distal phalange of the index and middle fingers on the non-dominant hand to record SCRs to specific images. Electrodes were connected to leads, which connected to a Biopac GSR100c amplifier for SCR recording. SCRs were recorded in micromhos ($\mu\mho$) and collected at a 50 Hz sampling rate. The GSR100c amplifier recorded SCRs with an onsite low-pass filter of 1.0 Hz and an offsite zero phase shift butterworth filter with a high-pass filter of 0.01 Hz (12db/octave), which was implemented by MATLAB.

After the participant was connected to the Biopac amplifier, the researcher told the participant to find a comfortable position in the chair and minimize movement during the picture presentation, began the picture-presenting program and then left the experimental room. Picture presentation was automated and randomized by MATLAB for each participant. First, a one-minute baseline was recorded while a fixation cross was presented on the screen to calibrate the amplifier to the participant and to familiarize the participant to the electrodes. After the baseline, the participant saw two final slides of instructions informing them that the images were about to be presented, with a fixation cross separating each image presentation. Timing of image presentation and inter-stimulus intervals was adapted from Norris, Larsen, and Cacioppo (2007), such that images were presented for six seconds each and separated by a fixation cross for six seconds. Stimuli-specific SCRs take relatively long to detect (between 1-3 seconds after stimulus presentation), so it is believed that the extended time course that was used allowed for accurate recordings of the full change in EDA (Dawson et al., 2007). The participant saw all 144 images following this picture presentation procedure.

An additional set of 5 low-arousing positive images (selected from the IAPS database) was presented at the end of every picture presentation session. These images were inserted at the end of the experimental session to abate any lingering negative emotions that may have been elicited from the previous experimental images. Researchers did not select these images as part of the 144 experimental stimuli and did not include them for theoretical reasons, therefore subsequent analyses exclude these 5 low-arousing positive images.

Measures and Materials

Approach and Avoidance Temperaments. Approach and avoidance temperaments were measured using the newly developed Approach-Avoidance Temperament Questionnaire – Multiple Components (ATQ-MC). This scale is an extension of an initial measure of approach and avoidance temperaments (see Elliot & Thrash, 2010) in that it directly measures both approach and avoidance temperaments and has additional subscales that assess separate neurobiological and behavioral sensitivities to each construct's respective stimuli. The ATQ-MC has three subscales for each approach and avoidance temperament: perceptual vigilance, affective reactivity, and behavioral predisposition. Three items compose each subscale. All general and specific subscales will be examined in correlational analyses. Examples of affective reactivity items are "I respond very strongly to good experiences" (approach;

α = .81) and "I feel negative emotions very deeply" (avoidance; α = .80). Examples of the perceptual vigilance items are "I am always on the lookout for positive opportunities and experiences" (approach; α =.75) and "I always seem to be alert to negative events that might occur" (avoidance; α = .67). Lastly, examples of behavioral predisposition items are "When I want something, I feel a strong desire to go after it" (approach; α = .74) and "When a situation might become threatening, I feel like leaving right away" (avoidance; α = .76).

Participants responded to items on a 7-point scale (1 = *Strongly Disagree*, 4 = *Neither Agree nor Disagree*, 7 = *Strongly Agree*). Items were summed across each three-item subscale to get temperament component scales. To generate general indices of each approach and avoidance temperament, responses were summed across the three subscales for each approach (α = .86) and avoidance (α = .81) temperament separately.

Approach and avoidance temperaments were also assessed using the previously studied and validated ATQ (Elliot & Thrash, 2010). This scale is composed of twelve items, six that measure general approach temperament and six that measure general avoidance temperament. Participants responded to items on a 7-point scale (1 = *Strongly Disagree*, 4 = *Neither Agree nor Disagree*, 7 = *Strongly Agree*). Examples of items are "When I want something, I feel a strong desire to go after it" for approach and "By nature, I am a very nervous person" for avoidance. Items were summed across their respective scales to compute general indices of approach (α = .76) and avoidance (α = .79) temperaments.

Daily Positive and Negative Affect. Daily positive and negative affect were assessed using a circumplex model of emotions (e.g., Feldman, Barrett, & Russell, 1998). According to the circumplex model, affect can be described along two dimensions, valence (positive or negative) and arousal (activated or deactivated). For each emotion, participants were instructed to report how strongly they felt that emotion that day using a 7-point scale (1 = *Did not feel this way at all,* 7 = *Felt this way very strongly*). Participants indicated their positive activated (PA) emotions by reporting how enthusiastic, alert, happy, proud, and excited they were. To report positive deactivated (PD) emotions, participants rated how calm, peaceful, relaxed, contented, and satisfied they felt. Participants indicated their daily negative activated (NA) emotions by rating how stressed, embarrassed, upset, tense, and nervous they were. To indicate negative deactivated (ND) emotions, participants reported how depressed, disappointed, sluggish, bored, and sad they felt.

Daily Events. In order to assess daily events, thirty-six items were selected from the Daily Event Schedule (DES; Butler, Hokanson, & Flynn, 1994), the Objective/Subjective Event Checklist (Seidlitz & Diener, 1993), and additional items from Gable, Reis, and Elliot (2000). Following the method of Gable and colleagues (2000), daily events were characterized by valence (positive or negative) and domain (social or achievement) categories. Participants reported on daily events using the following scale: 0 = *Did not occur*, 1 = *Occurred but not important*, 2 = *Occurred and somewhat important*, 3 = *Occurred and pretty important*, 4 = *Occurred and extremely important.* 9 statements evaluated positive social events (e.g., "Had especially good interactions with friend(s) or acquaitance(s)."), 8 statements evaluated positive achievement events (e.g., "Made progress toward an assignment/task that has a deadline."), 9 statements evaluated negative social events (e.g., "Had a disagreement or conflict with a friend, boyfriend/girlfriend, or family member."), and 10 statements evaluated negative achievement events (e.g., "Fell behind in course work or work duties."). General positive and negative daily events scales were computed by collapsing across achievement and social domains. Importance of daily events was calculated by averaging the importance ratings of their respective items. Positive and negative daily event frequency variables were also created by coding responses 0 if the event did not occur and 1 if the event did occur (regardless of importance). Items were then summed across their respective scales.

Pictorial Stimuli. One hundred and forty-four pictures were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005). Images were selected to cover a range of positive and negative stimuli with varying arousal ratings, such that an equal amount of low-arousal and high-arousal positive and negative images were sampled. Each image was also selected according to its content, which fell into one of twelve categories: Babies, Nurturance, Food, Intimate Couples, Romantic Couples, Erotic Couples, Illness, Loss, Contamination, Animal Threat, Human Threat, and Mutilation. Each content category was composed of eight images. These content themes were selected for their previous success in emotion elicitation and because of their evolutionary significance. Images within a category were matched according to standardized valence and arousal ratings. A complete list of images can be found in Appendix A.

Figure 1 displays the valence-by-affect distribution of the IAPS images, organized by negative, neutral, and positive groups. The selected images cover a wide range of ratings across valence and arousal dimensions, and their U-shaped pattern reflects the distribution of the greater IAPS database (Bradley & Lang, 2007). Figure 2 displays the distribution of content-category group means, with colored mean-markers for valence groups. As expected, the means from the content categories cluster into distinguishable low-arousal positive and negative groups and high-arousal positive and negative groups. Table 1 displays the means for the general positive and negative groups, the five arousal-valence categories, and the twelve content categories.

SCR Data Preparation

SCR amplitudes for individual pictures were computed relative to a baseline preceding each image presentation (i.e. the fixation cross inter-stimulus interval). A window of analysis of 1-6 seconds post-stimulus presentation was determined for subsequent SCR deflection analyses. Filtered SCR amplitudes were identified as the points at which fifty percent of the area is covered below the SCR deflections. This amplitude reading was then transformed into a z-score (relative to the participant's own variability). Before general statistical and multi-level analyses were conducted, individual SCR outliers to specific images were identified. Outliers were identified within a subject with values that were greater than two and half times the interquartile range below and above the first and third quartiles, respectively. This procedure identifies extreme outliers with the added benefit of not changing the quartile means. Multi-level modeling analyses were performed on the remaining SCRs for each subject.

Multi-Level Data Preparation for SCR and IAPS Image Analyses: Operationalizing Reward and Threat Dimensions

For multi-level analyses, the Level 1 (or within-person) relationship between individual SCRs and picture ratings was computed relative to each image's place on newly created dimensions of reward and rhreat. Between-person (Level 2) variables included general approach and avoidance scales. New dimensions of reward and threat were created, so that Level 1 and Level 2 relationships could be analyzed on separate dimensions for positive and negative stimuli as opposed to shared dimensions of valence and arousal. These separate dimensions also correspond to the distinct theoretical sensitivity of approach and avoidance temperaments to positive and negative stimuli, respectively (Elliot & Thrash, 2002; 2010).

In order to determine dimensions of reward and threat, separate best-fitting regression lines were computed from the neutral images through the positive and negative images, respectively. The equation for the reward dimension is Arousal = -1.217 + .927*Valence, and the equation for the threat dimension is Arousal = 7.824 - .8909*Valence, where Arousal and Valence correspond to original dimensions from the IAPS database. Each reward and threat equation was then set equal to the other in order to determine the point of intersection. Next, each image's point along the newly created dimensions was defined. Following the rules for determining the distance between a point and a line, the negative reciprocal of each dimension's slope ($-1/m$) was computed, and then each image's position was inserted, based on the Valence × Arousal space, into these new equations for perpendicular lines. Finally, using the

Pythagorean theorem, the distance of each image along each reward and threat dimension was computed to get a score for each image on the different dimensions.

Results

Means and descriptive statistics (M = 18.78 years of age; 85 females) for temperament, daily affect, daily event, and SCR variables are displayed in Table 2. Descriptive statistics and correlational analyses for temperament variables were generated using SPSS 21.0 (IBM Corporation, 2012). Correlational analyses used a larger sample size (n = 166) of approach and avoidance temperament variables than multi-level modeling analyses. Due to the nested nature of both SCR data and daily diary data, Hierarchical Linear Modeling (HLM) techniques (HLM 7.01; Raudenbush, Bryk, & Congdon, 2013) were used for these sets of analyses. HLM creates independent estimates of relationships among constructs at the lower level (within persons) and models them at the upper level (between persons) as a random effect using maximum likelihood estimation. The descriptive statistics for SCR amplitude, threat and reward dimensions, daily events, and daily affect were generated by HLM reports.

Correlations

Correlations for the ATQ, ATQ-MC, and approach and avoidance sub-scales are presented in Table 3. This analysis allows examination of the first two hypotheses (H1 and H2). As can be seen in Table 3, general approach temperament variables (AP2010 and APMC) correlated strongest with each other and approach component variables (e.g. the sub-scales). Likewise, general avoidance temperament variables (AV2010 and AVMC) correlated strongest with each other and avoidance component variables. The strong correlations between approach variables indicate convergent validity among them, and strong correlations among avoidance variables indicate the same. Weak or insignificant correlations were also found across approach temperament and avoidance temperament variables. This weak and inconsistent pattern of correlations between approach and avoidance variables provides support for discriminant validity of each scale. Overall, correlation analyses provide support for both H1 and H2.

SCR-Temperament HLM Analyses

For the following SCR-temperament analyses, individual experimental stimuli trials were nested within persons. The within-person relationship between physiological reactivity (e.g. amplitude of SCRs) and positive and negative experimental stimuli (e.g. IAPS images) and the between-person effects of approach and avoidance temperaments were examined following this unconditional model:

Level 1: $\text{amplitude}_{ij} = \beta_{0j} + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + u_{0j}$

where β_{0j} refers to the intercept (e.g. the participant's SCR amplitude on an average trial), γ_{00} represents the average reactivity of the entire sample of participants, r_{0j} represents variance within participants (e.g. variance due to changes in trials), and u_{0j} represents residual variance in intercepts (e.g. variance due between-person effects). The unconditional model also allowed examination of the distribution of variance between Level 1 and Level 2 equations. Within-person effects accounted for the majority of variance (>98%), while between-person effects account for very little (<2%).

In Step 1 of this HLM analysis, main effects of reward and threat dimensions were examined. Reward and threat variables were entered in the Level 1 equation grand mean centered. Additionally, effects of gender were tested. A dummy coded variable was created, with males being coded "1" and females being coded "2". This "sex" variable was entered grand mean centered in Level 2 equations. Step 1 is represented by the following set of equations:

Level 1: amplitude$_{ij}$ = $\beta_{0j} + \beta_{1j}$(reward) + β_{2j}(threat) + r_{0j}

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}$(sex) + u_{0j}

$\beta_1 = \gamma_{10} + \gamma_{11}$(sex) + u_{1j}

$\beta_2 = \gamma_{20} + \gamma_{21}$(sex) + u_{2j}

A linear main effect of reward ($\gamma_{10} = 0.3070$, $p < .001$) and threat ($\gamma_{20} = 0.3909$, $p < .001$) was indicated, such that higher levels of image Reward and Threat led to increased SCR. There was no main effect of gender, nor did it moderate the relationships between reward and SCRs, and threat and SCRs.

In Step 2, main effects of approach and avoidance temperaments were assessed. Approach and avoidance variables from Elliot and Thrash's (2010) ATQ scale were selected for these analyses. These variables have a definite factor structure, have been validated (see Elliot & Thrash, 2010), and have been tested in similar previous analyses (Dombrowski et al., in preparation). Approach and avoidance temperament variables were entered grand mean centered in Level 2 equations. The Level 1 equation remained the same, while the Level 2 equations now become:

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}$(sex) + γ_{02}(approach) + γ_{03}(avoidance) + u_{0j}

$\beta_1 = \gamma_{10} + \gamma_{11}$(sex) + u_{1j}

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + u_{2j}$$

No main effects for either approach or avoidance temperaments were found, and main effects for reward and threat remained significant.

Moderation of linear effects was tested in Step 3. Interaction terms (one for approach temperament and one for avoidance temperament) were inserted in Level 2 equations for effects of reward and threat dimensions. The following equations represent the HLM model in Step 3:

$$\text{Level 1: amplitude}_{ij} = \beta_{0j} + \beta_{1j}(\text{reward}) + \beta_{2j}(\text{threat}) + r_{0j}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + \gamma_{12}(\text{approach}) + \gamma_{13}(\text{avoidance}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + \gamma_{22}(\text{approach}) + \gamma_{23}(\text{avoidance}) + u_{2j}$$

No moderation effects were indicated in this new model, and all previous reward and threat main effects remained significant.

In Step 4, the quadratic or curvilinear relationships between reward and threat dimensions and SCRs were examined. Quadratic terms were grand mean centered and entered in the Level 1 equation. The following model, with trimmed error terms (e.g. error terms that were not significant were removed), was tested in Step 4:

$$\text{Level 1: amplitude}_{ij} = \beta_{0j} + \beta_{1j}(\text{reward}) + \beta_{2j}(\text{threat}) + \beta_{3j}(\text{reward}^2) +$$

$$\beta_{4j}(\text{threat}^2) + r_{0j}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + u_{0j}$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex})$$

$$\beta_3 = \gamma_{30} + \gamma_{31}(\text{sex})$$

$$\beta_4 = \gamma_{40} + \gamma_{41}(\text{sex}) + u_{4j}$$

where reward^2 and threat^2 terms represent quadratic effects. No main effect for quadratic reward and threat terms was found, and linear main effects for reward and threat dimensions remained significant. There was a sex × threat interaction (γ_{21} = 0.2625, $p < .05$), such that females experienced greater SCRs to more threatening images than males did. No other significant effects were detected.

In Step 5, the final step of the analysis, moderation of curvilinear SCR-reward and SCR-threat relationships was tested with approach and avoidance temperaments. The same approach and avoidance terms from Step 3 were entered grand mean centered and resulted in the following model:

$$\text{Level 1: amplitude}_{ij} = \beta_{0j} + \beta_{1j}(\text{reward}) + \beta_{2j}(\text{threat}) + \beta_{3j}(\text{reward}^2) + \beta_{4j}(\text{threat}^2) + r_{0j}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + \gamma_{12}(\text{approach}) + \gamma_{13}(\text{avoidance}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + \gamma_{22}(\text{approach}) + \gamma_{23}(\text{avoidance})$$

$$\beta_3 = \gamma_{30} + \gamma_{31}(\text{sex}) + \gamma_{32}(\text{approach}) + \gamma_{33}(\text{avoidance})$$

$$\beta_4 = \gamma_{40} + \gamma_{41}(\text{sex}) + \gamma_{42}(\text{approach}) + \gamma_{43}(\text{avoidance}) + u_{4j}$$

where Level 2 equations have been trimmed of insignificant error terms. Table 4 provides a summary of relevant coefficients from the final model. Linear effects of reward and threat dimensions were the strongest predictors in the final model. There were no main effects of person-level variables of sex, approach, and avoidance. Several effects were trending towards significance, and should be noted. There was a marginally significant curvilinear relationship between amplitude and threat (γ_{40} =

0.0619, p = .082), such that reactions to increasingly threatening images increased exponentially, across participants. Sex was a marginally significant (γ_{21} = 0.2524, p = .083) moderator of the linear amplitude-threat relationship, such that females, on average, reported higher SCRs to increasingly threatening images. Avoidance was a marginally significant (γ_{43} = 0.0101, p = .060) moderator of the curvilinear threat-amplitude relationship, such that individuals with higher avoidance temperament (vs. lower) experienced exponentially greater SCRs to increasingly threatening images. Figure 3 displays the avoidance temperament moderation of the curvilinear interaction between threat and avoidance. In summary, the results provide evidence in support of H3 and H4 but no evidence to support H5. The marginally significant moderation of the curvilinear threat-amplitude relationship by Avoidance replicates results from previous research conducted in the same laboratory (Dombrowski et al., in preparation).

Daily Diary Analyses

For daily diary analyses, daily events and affect were nested within-persons. Separate hierarchical models were tested for daily positive and daily negative affect. Daily positive-activated (dpa) affect and daily negative-activated (dna) affect variables were selected as outcome variables for their respective models. The within-person relationship between daily affect and daily events and the between-person effects of approach and avoidance temperaments were examined using the following unconditional model(s):

Level 1: $\text{dpa/dna}_{ij} = \beta_{0j} + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + u_{0j}$

where β_{0j} refers to the intercept (e.g. the participant's daily positive or negative affect on an average day), γ_{00} represents the average daily positive or negative affect of the entire sample of participants, r_{0j} represents error within participants (e.g. variance due to daily experience), and u_{0j} represents residual variance in intercepts (e.g. variance due between-person effects). The model predicting 'dpa' is examined first. The composition of variance between Level 1 and Level 2 equations was more evenly distributed than in SCR-Temperament analyses. Within-person effects accounted for approximately 51%, and between-effects accounted for the remaining variance, slightly less than 49%.

Daily Positive Affect. In Step 1 of the model, effects of daily events on daily positive affect were tested. Daily positive and daily negative event composite (collapsed across social and achievement domains) importance ratings were entered group-mean centered as Level 1 predictors. These variables are labeled 'posev' and 'negev', respectively. Effects of gender were also tested, and the variable created in the same fashion as the 'sex' variable in SCR-Temperament analyses was used again. Therefore, the Step 1 model is represented as:

Level 1: $\text{dpa}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{posev}) + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + u_{0j}$

$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + u_{1j}$

$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + u_{2j}$

Main effects of posev ($\gamma_{10} = 0.9241$, $p < .001$), negev ($\gamma_{20} = -0.5163$, $p < .001$), and sex ($\gamma_{01} = -0.3583$, $p < .05$) were indicated in this model, such that 'dpa' increased as the importance of positive events increased, 'dpa' decreased as the importance of negative events increased, 'dpa' was generally higher for males.

In Step 2, main effects of approach and avoidance temperament were examined. The same temperament variables from SCR-Temperament analyses were used. Approach and avoidance terms were entered grand mean centered at Level 2. Thus, the following model is tested:

$$\text{Level 1: dpa}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{negev}) + r_{0j}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + u_{2j}$$

A main effect of approach was detected ($\gamma_{02} = 0.0760$, $p < .001$) such that individuals with higher approach temperament had, on average, greater levels of daily positive affect. Effects of posev, negev, and sex also remained significant.

Step 3, the final step, of this HLM analysis tested moderation effects of approach and avoidance temperaments on the posev-dpa and negev-dpa relationships. Variables were entered into this final model following the centering procedures from Steps 2 and 3. The final model is displayed as follows:

$$\text{Level 1: dpa}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{negev}) + r_{0j}$$

$$\text{Level 2: } \beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + \gamma_{12}(\text{approach}) + \gamma_{13}(\text{avoidance}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + \gamma_{22}(\text{approach}) + \gamma_{23}(\text{avoidance}) + u_{2j}$$

Table 5 displays a summary of relevant reported coefficients from the final model. Approach and avoidance temperaments did not significantly (p's > .100) moderate either posev-dpa or negev-dpa relationship. There were significant main effects of posev and negev Level 1 variables and approach and sex Level 2 variables. Therefore, person *j*'s daily positive-activated affect (on the *i*th day) is predicted by the individual's gender (sex, γ_{01}), approach temperament score (γ_{02}), positive events importance rating weighted by its coefficient (β_1), negative events importance rating weighted by its coefficient (β_2), and error. Positive affect was also negatively predicted by avoidance (avoidance, γ_{03}), although the coefficient did not reach typical standards for significance ($p = .06$)

Daily Negative Affect. Next, a series of multi-level models examined daily changes of negative affect (dna) and the effects of within-person and between-person variables. Analyses followed the same unconditional model as dpa analyses (with dna substituted as the outcome variable). Decomposition of the total model variance was approximately the same as the dpa model variance, with between-person accounting for 48.7% and within-person accounting for 51.3% of the total variance.

Like analysis of daily positive affect, Step 1 of this analysis first examined the effects of daily positive and negative events (also collapsed across domains). Level 1 (posev and negev) and Level 2 (sex) variables were entered according to the centering procedures from daily positive affect models. The Step 1 model is displayed as follows:

Level 1: $\text{dna}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{negev}) + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + u_{0j}$

$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + u_{1j}$

$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + u_{2j}$

Main effects were found for posev (γ_{10} = -0.2316, $p < .001$) and negev (γ_{20} = 1.2477, $p < .001$), such that 'dna' decreased as the importance of positive events increased and increased as the importance of negative events increased. A main effect of sex was marginally significant (γ_{01} = 0.1418, $p = .056$) such that females, on average, experienced more daily negative affect.

In Step 2, main effects of approach and avoidance temperaments were tested. Approach and avoidance terms were entered grand mean centered. The Step 2 model is represented as:

Level 1: $\text{dna}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{negev}) + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$

$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + u_{1j}$

$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + u_{2j}$

A main effect of avoidance (γ_{03} = 0.0598, $p < .001$) was detected, such that higher avoidance ratings predicted a higher average of daily negative affect; however, there was no significant effect ($p > .250$) for approach. Effects of posev and negev remained significant, but the sex effect dropped below typical standards of significance ($p > .350$).

The final step, Step 3, of the model tested Approach and Avoidance moderation of dna-posev and dna-negev relationships. Variables were entered into this final model following the centering procedures from Steps 2 and 3. The Level 1 and Level 2 equations for the final model are:

Level 1: $\text{dna}_{ij} = \beta_{0j} + \beta_1(\text{posev}) + \beta_2(\text{negev}) + r_{0j}$

Level 2: $\beta_0 = \gamma_{00} + \gamma_{01}(\text{sex}) + \gamma_{02}(\text{approach}) + \gamma_{03}(\text{avoidance}) + u_{0j}$

$$\beta_1 = \gamma_{10} + \gamma_{11}(\text{sex}) + \gamma_{12}(\text{approach}) + \gamma_{13}(\text{avoidance}) + u_{1j}$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(\text{sex}) + \gamma_{22}(\text{approach}) + \gamma_{23}(\text{avoidance}) + u_{2j}$$

Table 6 displays the relevant coefficients from the final step of the model. Neither approach nor avoidance terms moderated relationships between daily event and daily negative affect. Main effects for Level 1 posev and negev variables and the Level 2 avoidance term remained significant in this final model. Therefore, person j's daily negative-activated affect (on the ith day) is predicted by the individual's avoidance temperament score (γ_{03}), positive events importance rating weighted by its coefficient (β_1), negative events importance rating weighted by its coefficient (β_2), and error.

In summary of both 'dpa' and 'dna' models, support was found for H6 and H7, but no evidence was found in support of H8 and H9. Additionally, each model detected main effects of temperament that were not specified in the hypotheses, yet corroborate with results from previous research examining personality constructs and daily affect. Specifically, higher levels of general approach temperament predicted a higher average of daily positive affect. Similarly, higher levels of general avoidance temperament predicted higher averages of daily negative affect.

Discussion

The current study examined approach and avoidance temperament constructs using self-report, electrodermal, and daily diary measurement methods. Approach and avoidance systems have garnered attention in personality research over the past two decades, but most of this attention has been paid to the goal-level constructs (Elliot, 1999; Elliot, 2006). Recent theorizing and research, however, has identified approach and avoidance constructs at the trait-level conception of personality (Elliot & Thrash, 2002; 2010). The general aim of the current study was to better understand the validity and utility of assessing approach and avoidance constructs at the domain-general, biologically based trait-level of the personality structure. The three-measurement method approach of this study afforded the opportunity to assess psychometric and theoretical issues surrounding the use of approach and avoidance temperaments measures in personality research. Specifically, this study tested the convergent and discriminant validities of a new multiple-components self-report scale of approach and avoidance temperaments (H1 and H2), the role of these temperaments in physiological reactivity to positive and negative stimuli (H4 and H5), and how approach and avoidance temperaments, along with daily events, influence the daily affective experience (H8 and H9). A summary of results for approach and avoidance measures is provided, and implications for their use in research are discussed. Limitations of the current study and future directions for approach and avoidance temperament research are also addressed.

Summary and Implications

Relationship of Approach and Avoidance Temperaments to Each Other and other Trait-Level Personality Constructs. Correlation analyses examined a new multiple component measure of approach and avoidance temperaments by testing its relationship with a previous measure of the same temperaments. The pattern of strong and positive correlations between groups of approach temperament variables and between avoidance variables indicates convergent validity for each of the newly developed approach and avoidance general scales. Additionally, weak or insignificant correlations across approach and avoidance scales provide support for the discriminant validity of these scales. These analyses replicate results from another study, which analyzed a larger set of correlations examining the same approach and avoidance temperament measures and measures of constructs from the trait-adjective, affective disposition, and motivational systems approaches (Dombrowski et al., in prep). These results confirm the nature of approach and avoidance temperaments and their relationship to traditional trait-level constructs within personality research. Like the initial set of studies investigating approach and avoidance temperaments (see Elliot & Thrash, 2002; 2010), the newly developed ATQ-MC could benefit greatly from a structural equation model that maps the relationship between hierarchical approach and avoidance temperaments and trait-level constructs from other theories of personality.

Temperament and Affective Reactivity. Approach and avoidance temperaments are believed to be two neurobiological systems, one responsive to positive stimuli and the other to negative stimuli. A product of this neural wiring and physiological sensitivity is that this stimuli-specific response pattern should be indicated across different measurements, including but not limited to behavioral responses, emotion-processing mechanisms, and cognitive processes. Affective reactivity, as measured by skin conductance responses, and the influence of approach and avoidance temperaments were assessed during the viewing of positively and negatively arousing visual stimuli. Research has already begun to investigate the influence of personality dimensions on physiological and neurological systems that respond to emotional stimuli. Neuroticism has been shown to moderate the relationship between valence of unpleasant stimuli and SCR amplitudes and recovery times (Norris et al., 2006). Similarly, research indicates that BAS and BIS influence the relationship between pleasant and unpleasant pictures, respectively, and several physiological and neurological indicators of emotional arousal, including skin conductance (Balconi et al., 2009, 2012).

Using images selected from the IAPS catalog (Lang et al., 2005), the current study investigated the role of approach and avoidance temperaments during the viewing of emotional stimuli. Unlike previous research into personality dimensions' effect on psychophysiological measures of emotional arousal, this study employed multi-level modeling (MLM) techniques to analyze the relationship between electrodermal responses and temperament variables. MLM allows for more accurate modeling of variance and error at both the within- and between-person levels than traditional general linear model analyses (Nezlek, 2011). The results indicate that the between-person level avoidance temperament variable moderated the within-person relationship between SCRs and threatening images. This follows with previous research using neuroticism and behavioral inhibition system dimensions (Norris et al., 2006; Balconi et al., 2009; 2012).

This finding is even more impressive given the distribution of variance as indicated from the unconditional model from SCR-Temperament analyses. Most of the variance in reactivity (e.g. amplitude) was due to within-person factors, that is, the characteristics of IAPS images along Reward and Threat dimensions. Indeed, main effects of Reward and Threat dimensions were the strongest predictors of SCR amplitude. This attests to the sound experimental design of the study's SCR procedures. Moreover, the effect of avoidance temperament on the Threat-Amplitude relationship was detected, despite the little variation due to between-person effects. Although this effect did not reach conventional standards for significance ($p = .060$), a previous investigation with a larger sample size ($n = 214$) also examining approach and avoidance temperaments, which used the same visual stimuli and image-viewing procedure, detected the same moderation effect that met traditional standards of significance ($p < .01$). Therefore, research seems to support the idea that higher avoidance temperament can lead to greater physiological reactivity to increasingly threatening stimuli. Although the effect is small in the laboratory, the cumulative effect for an individual over the course of a few weeks, months, years, and so on, could have detrimental outcomes on trait-level distress and anxiety.

Although an effect of avoidance temperament was indicated, no significant effect of approach temperament on the Reward-Amplitude relationship was found. Some considerations from previous research and this study's design may explain why no such interaction was found. Past research conducted by Fowles (1988) has analyzed the connections between psychophysiology and psychopathology from a motivational approach. Using Gray's (1987) theorizing on physiology and anxiety-proneness as an outline, he reviewed several studies in which the influence of BAS and BIS is tested during reward and punishment tasks. Results indicated that BIS was more sensitive during punishment and non-reward tasks as measured by nonspecific skin conductance changes while BAS motivation did not respond through the same measurement during reward tasks. However, heart rate was influenced only by appetitive motivation, that is BAS, while no cardiac change was attributable to aversive motivation (e.g. BIS). More recently, research using IAPS stimuli and physiological recordings has found that appetitive motive systems have a clear pattern of initial cardiac deceleration and subsequent acceleration to pleasant stimuli, while defensive motivation initiated cardiac deceleration to unpleasant stimuli but no following acceleration (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Codispoti, Sabatinelli, & Lang, 2001). SCRs for both appetitive and aversive motivation systems were largest for the highest arousing pictures (i.e. erotica and mutilation), with little to no differentiation among low-arousing pleasant and unpleasant images (food and loss). Startle blink responses have shown attenuation during the presentation of pleasant images, but unpleasant images provoked a greater startle blink. Thus, it appears that different motivational systems measured through different physiological indicators will display varying sensitivities to their respective stimuli. Future investigations into approach and avoidance temperaments' influence on physiological and neurobiological systems should include a series of autonomic indicators including SCR, heart rate changes, startle blink responses, and facial EMG patterns in response to range of pleasant and unpleasant stimuli.

The design of this study is also noteworthy when considering the results and their implications, as it differs from other investigations on the interaction between personality and emotional experiences. This is the first study, to the author's knowledge, that specifically investigated approach and avoidance temperaments. Though each temperament has connections to constructs from trait-adjective, affective disposition, and motivational systems approaches to personality, one would not expect the results from the current study to be identical to results from previous research examining personality constructs and electrodermal activity (e.g. Norris et al., 2006; Balconi et al., 2009; Balconi et al., 2012).

Additionally, the IAPS stimuli selected for this study, and the subsequent Reward and Threat dimensions created from them, differ from previous research. Most previous research has examined reactivity as a function of valence or arousal, whereas the current study examined the effect of separate dimensions of Reward and Threat. These dimensions were created because they allowed proper tests of theoretically separate approach and avoidance temperaments along two distinct continuums. These new Reward and Threat dimensions also correlated very strongly ($r > .99$) with a 45 degree rotation of the valence and arousal axes from the IAPS database, which is a close approximation of the theoretical space and relationship between valence and arousal for constructs of positive affect and negative affect (Watson, Clark, & Tellegen, 1988; Bradley & Lang, 2007). Future research concerning personality constructs and their influence during affective reactivity processes should carefully consider the valence and arousal characteristics of its stimuli and how these relate to theoretical conceptualizations of positive and negative affect.

Temperament and the Daily Affect Experience. The current study also examined the influence of approach and avoidance temperaments on daily affect and how these temperaments interact with daily events. These analyses also implemented multilevel modeling techniques. First, daily positive and negative events predicted daily positive and negative affect in the expected directions. Experiencing more positive events predicted increases in daily positive affect, and experiencing more negative events predicted increases in negative affect. Results also indicate effects of temperament, such that approach temperament predicts higher average levels of daily positive affect and avoidance temperament predicts higher average levels of daily negative affect. Approach and avoidance temperament did not, however, affect individuals 'reactivity', per se, to positive and negative events, respectively. Therefore, approach and avoidance temperaments appear to influence the mean level of daily positive and negative affect, respectively, on an average day, but do not interact with daily events to predict change in affect on a day-to-day level. Some considerations from previous theorizing on these temperaments and other approach and avoidance motivational constructs may explain the lack of a Level 1 and Level 2 interaction between daily events and temperaments.

Previous research on daily affect and personality constructs from trait-adjective (e.g. neuroticism and extraversion) and motivational systems (e.g. BAS and BIS) approaches indicates that trait-level constructs can influence the daily affective experience. In general, trait-level sensitivities (e.g. extraversion and BAS) to positive stimuli predict higher levels of mean daily positive mood and affect (David et al., 1997; Gable et al., 2000). Similarly, dispositional sensitivities (e.g. neuroticism and BIS) to negative stimuli predict higher levels of mean daily negative mood and affect (David et al., 1997; Longua et al., 2009; Gable et al., 2000). The results concerning approach and avoidance main effects from daily diary analyses indicate a similar relationship between these temperaments and daily affect. The results concerning trait-level moderation of the daily event-daily affect relationship are less consistent. Constructs measuring dispositional sensitivities to aversive stimuli, such as neuroticism and BIS, appear to have a more consistent effect on the affective reactions to daily negative events than trait factors concerning appetitive systems have on reactions to daily positive events (Gable et al., 2000; Longua et al., 2009).

Additionally, approach and avoidance temperaments, although related to, are different than the constructs from the other models of personality structure. In fact, both temperaments are conceptualized as hierarchical core factors responsible for shared variance among appetitive (approach) and aversive (avoidance) constructs from trait-adjective, affective disposition, and motivational system approaches (Elliot & Thrash, 2002; 2010). Thus, the higher-order level at which approach and avoidance temperaments are conceptualized creates additional 'psychological distance' between the temperaments under examination and the situational factor (e.g. daily affect) that is being measured. The additional 'distance' may lessen the impact of these trait-level predictors on proximal, situational outcome measures. Therefore, approach and avoidance motivations, as assessed by temperaments, may not be predictive of daily positive and negative affect; however, approach and avoidance mechanisms may influence daily affect at another level of analysis, for example, at state- or goal-level constructs (Elliot & Church, 1997; Elliot, 1999; Elliot, 2006).

Limitations and Future Directions

The current study has contributed to the existing literature on the use and importance of approach and avoidance temperaments in personality psychology, but some limitations of its design should be discussed. First, the current study only examined correlations among new and previous approach and avoidance constructs. Although previous research, using measurement and structural models (see Elliot & Thrash, 2002; 2010), has demonstrated approach and avoidance temperaments' relationship with other constructs from traditional theories of personality, more research is needed to determine these temperaments' relationship with other vital personality constructs, such as self-esteem, life satisfaction, impulsivity/constraint, anxiety, and depression.

Secondly, the physiological measurements of the current study were limited to skin conductance responses, specifically amplitudes. This measurement was chosen for its history in psychophysiology as an indicator of emotional arousal (Dawson et al., 2007) and its ease of interpretation (e.g. greater amplitude of response equals greater affective reactivity). Additional electrodermal measures, such as onset and offset latencies, early vs. late epochs (see Norris et al., 2006), and recovery times, may provide further evidence for the role of approach and avoidance temperaments on autonomic processes. Unforeseen errors in the recording of physiological data also resulted in a reduced sample size, which reduced the statistic power of the analyses. Previous research using the same SCR procedures and a sample size more than 50% greater than the current one detected a significant effect of avoidance temperament on the Threat-Amplitude relationship (Dombrowski et al., in prep.). Therefore, even though evidence supports this moderation effect by avoidance temperament, the effect in the laboratory may be difficult to detect, though its influence in real-world environments could be pervasive over time.

Finally, concerning daily diary collections, one specific method (e.g. end-of-day entries) for completing daily measures was implemented in the current study. Experience sampling methods or the day reconstruction method (Kahneman et al., 2004) may prove useful in the study of approach and avoidance temperaments and daily experiences, as these techniques may reduce error in recall at the end of the day. Additionally, the daily events that were measured, although common for the sample of participants that was used in the current study, do not assess the effect of more arousing and meaningful events (e.g. break-up with boyfriend/girlfriend, family illness, new job/job promotion, etc.). Special attention should also be paid to the role of approach and avoidance temperaments with these more significant life events, which can drastically alter affect and behaviors in individuals.

The opportunities for future research on approach and avoidance temperaments are vast in number and diverse in content, thus, certain directions of investigation should also be acknowledged. Trait-level relationships between approach and avoidance temperaments, as assessed by either the ATQ or ATQ-MC, and other personality constructs, such as trait affect, well-being, depression and anxiety, and self-regulation need to be explored. Concerning the temperaments' relationship with physiological responses, future research would benefit from measuring other physiological systems, such as cortical asymmetry (Koven, 2004), EMG activity of corrugator and zygomaticus major muscles (Bradley, Codispoti, Cuthbert, & Lang, 2001), heart rate, and respiration during the presentation of emotional stimuli. Also, more research examining trait-level temperament relationships with state- and day-level constructs are needed. Previous research has demonstrated the precursor-nature of approach and avoidance temperaments to achievement goals (see Elliot & Thrash, 2010) and how they both predict performance, however, other outcome variables besides performance need to be examined.

The current study employed a multi-method assessment of approach and avoidance temperaments and their influence on psychophysiological responses and daily affective experiences. The results from this study indicate that these constructs can be reliably and validly measured and do have effects on physiological reactivity systems and mean levels of daily affect. The current study is only a critical first step, however, in the greater pursuit of a more comprehensive understanding of approach and avoidance temperaments' role in the hierarchical structure of personality and their interaction with affective, behavioral, and cognitive systems.

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Table 1.

Mean Arousal and Valence Ratings of Experimental IAPS Stimuli

Arousal-Valence Group	Content Category	*n*	Arousal Rating	Valence Rating
High-Negative		24	6.214 (.530)	2.748 (.761)
	Animal Threat	8	6.254 (.430)	3.590 (.254)
	Human Threat	8	5.871 (.547)	2.771 (.387)
	Mutilation	8	6.518 (.447)	1.884 (.157)
Low-Negative		24	4.941 (.392)	2.686 (.504)
	Illness	8	5.148 (.438)	2.379 (.374)
	Loss	8	4.877 (.230)	2.576 (.342)
	Contamination	8	4.799 (.430)	3.103 (.508)
Negative		48	5.578 (.792)	2.717 (639)
Neutral		48	3.149 (.420)	4.952 (.388)
Positive		48	5.500 (.864)	7.033 (.466)
Low-Positive		24	4.773 (.365)	7.175 (.558)
	Babies	8	4.980 (.353)	7.484 (.517)
	Nurturance	8	4.594 (.333)	7.401 (.322)
	Food	8	4.746 (.341)	6.640 (.396)
High-Positive		24	6.226 (.538)	6.890 (.299)
	Intimate Cpls.	8	6.260 (.376)	6.771 (.276)
	Romantic Cpls.	8	5.776 (.534)	7.068 (.281)
	Erotic Couples	8	6.643 (.308)	6.831 (.286)

Table 2.

Descriptive Statistics for Trait, Daily, and Skin Conductance Measures

Measure Type	Scale/SCR Unit	*n*	M	SD	Minimum	Maximum
Trait						
	APMC	166	46.74	6.82	20.0	63.0
	APPV	166	15.86	7.80	6.0	21.0
	APAR	166	15.68	3.00	4.0	21.0
	APBP	166	15.20	2.68	7.0	21.0
	AVMC	166	42.57	7.80	20.0	63.0
	AVPV	166	14.25	2.96	7.0	21.0
	AVAR	166	13.61	3.84	4.0	21.0
	AVBP	166	14.71	3.32	5.0	21.0
	AP2010	166	31.23	4.71	12.0	41.0
	AV2010	166	25.65	6.48	9.0	39.0
Daily						
	Pos. Evt. Mean	2037	1.09	0.63	0.0	3.63
	Neg. Evt. Mean	2037	0.58	0.56	0.0	3.37
	Pos. Freq.	2037	7.68	3.87	0.0	17.00
	Neg. Freq	2037	5.14	4.56	0.0	19.00
	PA-Activated	2037	3.87	1.21	1.0	7.00
	NA-Activated	2037	2.90	1.22	1.0	6.60
SCR						
			M		SD	
					Between	Within
	Amplitude (μ℧)	18874	-1.23		1.462	11.46
	Reward	19320	0.00		0.00	1.570
	Threat	19320	0.00		0.00	1.782

Table 3.

Correlations for Approach and Avoidance Temperament Variables

Trait	AP 2010	AV 2010	AP MC	AV MC	AP PV	AP BP	AP AR	AV PV	AV BP
AP2010	---								
AV2010	.256 **	---							
APMC	.878 ***	.216 **	---						
AVMC	.352 ***	.817 **	.327 ***	---					
APPV	.736 ***	.090	.846 ***	.223 **	---				
APBP	.675 ***	.172 *	.775 ***	.243 **	.485 ***	---			
APAR	.765 ***	.260 **	.858 ***	.335 **	.636 ***	.455 ***	---		
AVPV	.259 **	.457 ***	.169 *	.680* **	.139	.123	.155*	---	
AVBP	.292 ***	.562 ***	.337 ***	.695 ***	.287 ***	.224 **	.320 ***	.346 ***	---
AVAR	.262 **	.818 ***	.241 **	.816 ***	.098	.204 **	.282 ***	.309 ***	.482 ***

Table 4.

Final Step Multilevel Analysis Predicting SCR Amplitude

Predictor Level	Predictor	Coefficient	Std. Error
	Intercept (γ_{00})	-1.4176**	0.2572
Level 1			
	Reward (γ_{10})	0.2595*	0.0900
	Threat (γ_{20})	0.3132**	0.0697
	Reward^2 (γ_{30})	0.0381	0.0536
	Threat^2 (γ_{40})	0.0619^t	0.0354
Level 2			
Main Effects			
	Sex (γ_{01})	0.1407	0.5303
	Approach (γ_{02})	0.0058	0.0554
	Avoidance (γ_{03})	0.0117	0.0448
Moderators			
	Sex (γ_{21})	0.2524^t	0.1457
	Avoidance (γ_{43})	0.0101^t	0.0053

Table 5.

Final Step Multilevel Analysis Predicting Daily Positive-Activated Affect

Predictor Level	Predictor	Coefficient	Std. Error
	Intercept (γ_{00})	3.8607**	0.0626
Level 1			
	POSEV (γ_{10})	0.9254**	0.0534
	NEGEV (γ_{20})	-0.5197**	0.0629
Level 2			
Main Effects			
	Sex (γ_{01})	-0.4281*	0.1340
	Approach (γ_{02})	0.0803**	0.0153
	Avoidance (γ_{03})	-0.0204^{t}	0.0108
Moderators			
	Approach (γ_{12})	-0.0196	0.0137
	Avoidance (γ_{13})	0.0119	0.0086
	Approach (γ_{22})	0.0233	0.0139
	Avoidance (γ_{23})	-0.0089	0.0110

Table 6.

Final Step Multilevel Analysis Predicting Daily Negative-Activated Affect

Predictor Level	Predictor	Coefficient	Std. Error
	Intercept (γ_{00})	2.9121**	0.0625
Level 1			
	POSEV (γ_{10})	-0.2358**	0.0529
	NEGEV (γ_{20})	1.2527**	0.0807
Level 2			
Main Effects			
	Sex (γ_{01})	0.1175	0.1291
	Approach (γ_{02})	0.0150	0.0144
	Avoidance (γ_{03})	0.0608**	0.0106
Moderators			
	Approach (γ_{12})	0.0079	0.0123
	Avoidance (γ_{13})	0.0044	0.0090
	Approach (γ_{22})	-0.0021	0.0154
	Avoidance (γ_{23})	-0.0111	0.0136

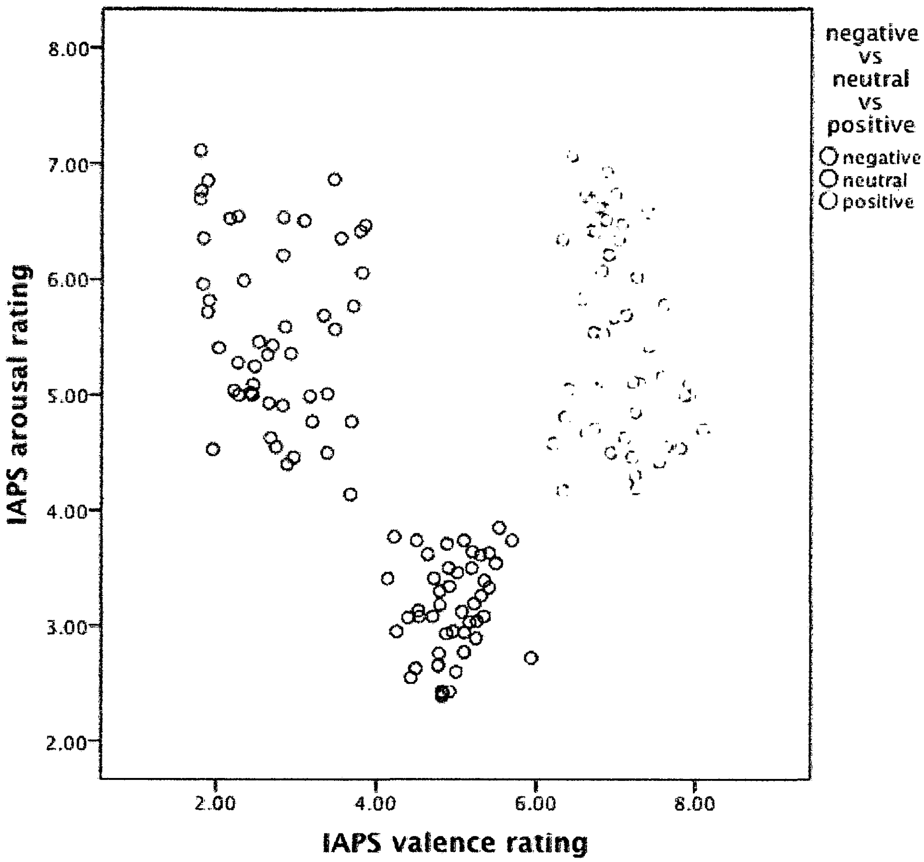

Figure 1. Scatter-plot of all IAPS images sampled. Each individual point represents a specific IAPS image's place within the valence X arousal space, according to standardized ratings (Lang et al., 2005).

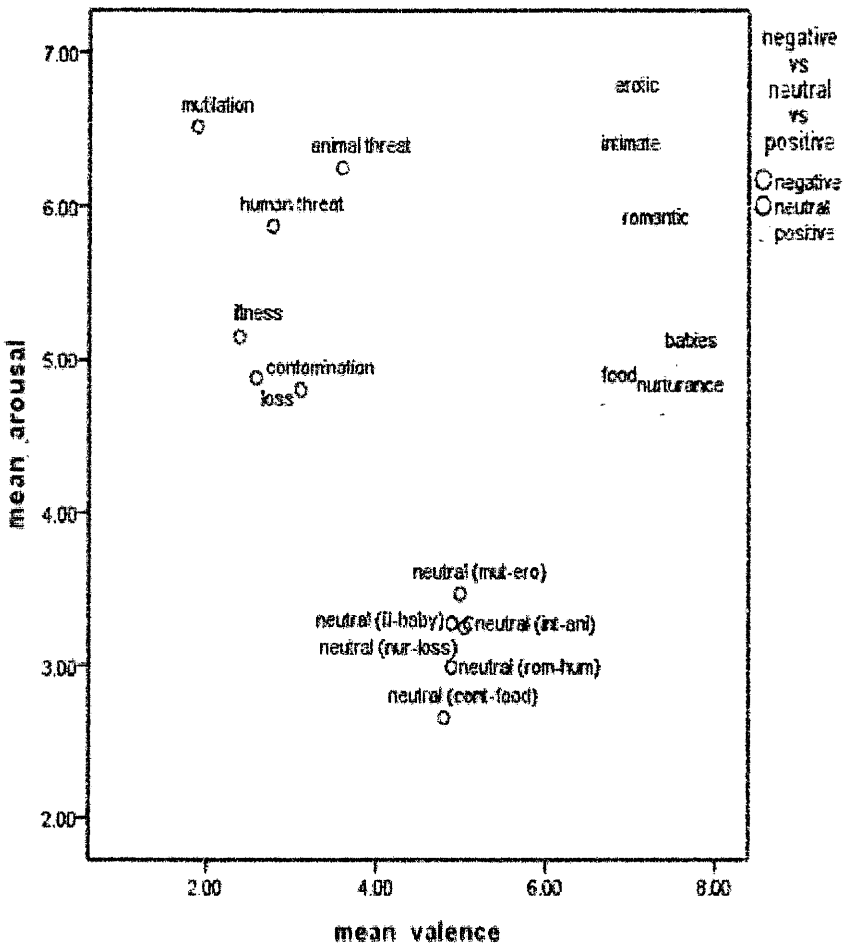

Figure 2. Scatter-plot of content category means. Each individual point represents the group mean for each content category, with three separate colors indicating its positive, negative, or neutral valence. The categories also cluster into low- and high-arousal groups within each valence group.

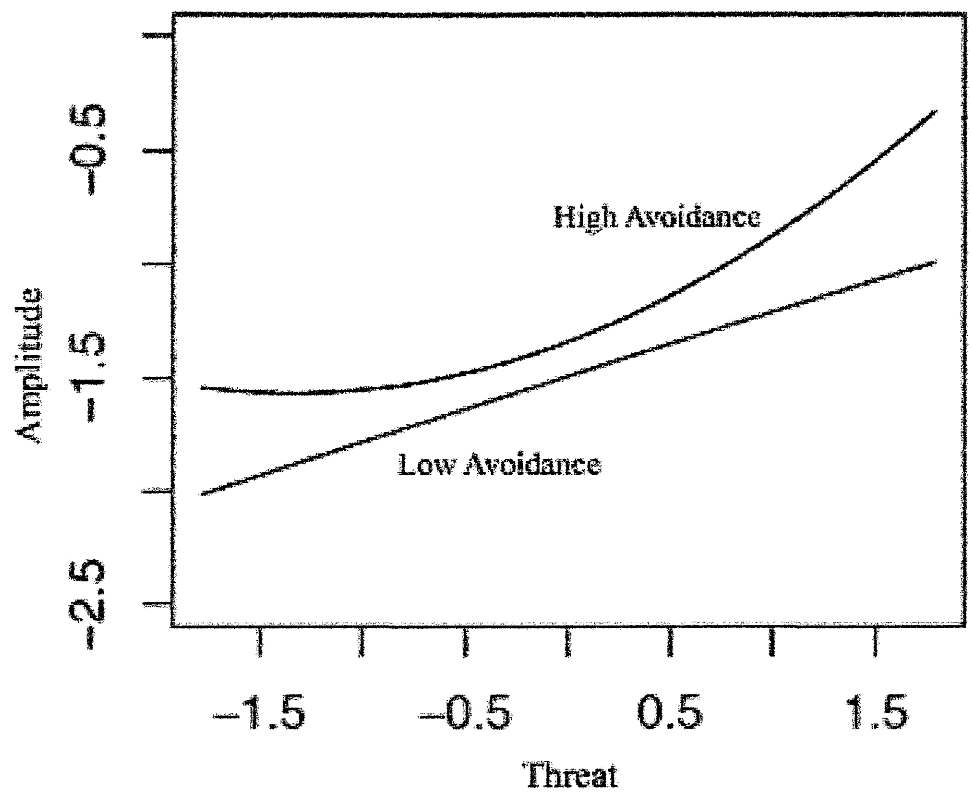

Figure 3. Graph of avoidance moderation of the quadratic relationship between threat and SCR amplitude with only Threat and Avoidance variables entered as predictors. The lines above represent the quadratic moderating effects of avoidance temperament (Black line: Low Avoidance; Red line: High Avoidance) on the relationship between Threat and Amplitude. Amplitude, Threat, and temperament variables were entered grand mean centered into the MLM.

Appendix A.

IAPS Image Numbers: 1050, 1113, 1201, 1220, 1270, 1301, 1525, 1930, 1932, 2038, 2053, 2057, 2058, 2071, 2080, 2102, 2141, 2150, 2152, 2160, 2165, 2190, 2191, 2200, 2205, 2210, 2214, 2215, 2221, 2224, 2272, 2276, 2280, 2303, 2305, 2311, 2331, 2344, 2345, 2357, 2372, 2381, 2383, 2385, 2391, 2393, 2396, 2397, 2440, 2441, 2455, 2480, 2485, 2487, 2491, 2493, 2495, 2499, 2514, 2516, 2570, 2579, 2595, 2620, 2700, 2710, 2745.1, 2799, 2840, 2890, 2900, 3016, 3060, 3068, 3071, 3110, 3140, 3150, 3160, 3225, 3230, 3300, 3350, 4571, 4599, 4601, 4607, 4608, 4609, 4610, 4626, 4650, 4651, 4652, 4653, 4656, 4659, 4660, 4664, 4670, 4676, 4680, 4681, 4687, 4689, 4694, 4695, 4800, 6242, 6243, 6250, 6555, 6560, 6561, 6571, 6830, 7041, 7060, 7100, 7217, 7233, 7250, 7260, 7280, 7291, 7351, 7359, 7450, 7460, 7475, 7491, 7700, 7705, 8497, 9210, 9290, 9301, 9320, 9341, 9373, 9390, 9415, 9421, 9435

Appendix B. Notes for Tables

1) Table 1. Values in parentheses () are standard deviations

2) Table 2. "APMC" = Approach Temperament Multiple Components"; "APPV" = Approach – Perceptual Vigilance; "APAR" = Approach – Affective Reactivity; "APBP" = Approach – Behavioral Predisposition'; "AVMC" = Avoidance Temperament Multiple Components; "AVPV" = Avoidance – Perceptual Vigilance; "AVAR" = Avoidance – Affective Reactivity; "AVBP" = Avoidance – Behavioral Predisposition; "AP2010" = Approach Temperament from 2010 ATQ scale; "AV2010" = Avoidance Temperament 2010 ATQ; "Pos. Evt. Mean" = Mean Importance of Daily Positive events; "Neg. Evt. Mean" = Mean Importance of Daily Negative events; "Pos. Freq." = Frequency of Positive events; "Neg. Freq." = Frequency of Negative events; "PA-Activated" = Positive Affect-Activated; "NA-Activated" = Negative Affect Activated

3) Table 3. Variable names are the same as those in Table 2. *** = $p < .001$; ** = $p < .01$; * = $p < .05$

4) ** = $p < .001$; * = $p < .01$; ^{t} = marginally significant terms; (γ_{40}, $p = .082$); (γ_{21}, $p = .083$); (γ_{43}, $p = .060$)

5) ** = $p < .001$; * = $p < .01$; ^{t} = marginally significant terms; (γ_{03}, $p = .060$)

6) ** = $p < .001$