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Evidence for bivariate systems: An empirical test of appetition and aversion across domains

Shelly L. Gable,[a,*] Harry T. Reis,[b] and Andrew J. Elliot[b]

[a] *UCLA Psychology Department, University of California, 4560 Franz Hall, Los Angeles, CA 90095-1563, Box 951563, USA*
[b] *University of Rochester, Department of Clinical and Sciences in Psychology, Meliora Hall, RC Box 270266, Rochester, NY 14627-0266, USA*

Abstract

Research in diverse domains of psychology has independently identified two behavioral systems, one concerned with obtaining positive outcomes, the other concerned with avoiding negative outcomes. This basic distinction, described in different domains of inquiry with varying terminology, may be integrated within a single appetitive–aversive systems model. The present research was designed to examine the viability of the appetitive–aversive distinction as an organizational construct underlying various particular measures and concepts. In four studies, individual difference measures from different domains were examined with exploratory (Study 1) and confirmatory (Studies 2–4) factor analyses. We expected and found that measures tapping sensitivity to rewards or positive outcomes would load on a common appetitive latent factor, whereas, measures tapping individual differences in sensitivity to punishment or negative outcomes would load a common aversive latent factor. Results strongly supported the hypothesized two-factor structure over alternative models and indicated that the latent appetitive and aversive variables accounted for about half the variance in the observed variables.
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1. Appetition and aversion across domains: An empirical test

Over the past few decades, researchers from seemingly diverse areas of psychology have recognized, either explicitly or implicitly, the existence of two distinct systems in human behavior, one appetitive and the other aversive (e.g., Cacioppo & Gardner,

* Corresponding author. Fax: 1-310-206-5895.
E-mail address: gable@psych.ucla.edu (S.L. Gable).

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1999; Carver, 1996; Fowles, 1994; Gray, 1990; Higgins, 1998; Lang, 1990; Miller, 1959; Schneirla, 1959). The appetitive system regulates responses to potentially rewarding stimuli and thereby serves as an approach-oriented system, whereas, the aversive system regulates responses to potentially punishing stimuli and serves as an avoidance-oriented system. Although these two behavioral systems have been given different names depending on the research programs in which they have emerged (e.g., approach/avoidance, positive/negative, discrepancy-reducing/discrepancy-enlarging, activation/inhibition), the basic appetitive/aversive distinction can be found in many research domains, such as motivation, attitude evaluation, personality, emotion, mood, and coping (e.g., Cacioppo, Gardner, & Berntson, 1997; Elliot & Church, 1997; Eysenck, 1967/1981; Moos, 1997; Watson, Clark, & Tellegen, 1988).

The emergence of a seemingly comparable appetitive–aversive distinction across discrete processes has not gone unnoticed, as evidenced by recent attempts to integrate theories and findings from independent research programs (e.g., Carver, 1996; Carver, Sutton, & Scheier, 2000). For example, Carver et al.'s (2000) broad review of several literatures concluded that approach behaviors and positive affect are managed by one regulatory system, whereas, avoidance behaviors and negative affect are managed by a separate regulatory system. Other authors, citing the rich history of the approach–avoidance distinction not only in humans but also in other species, have asserted that the distinction between appetition and aversion may be fundamental and innate (e.g., Elliot & Covington, 2001), a conclusion also supported by neurophysiological studies (e.g., Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). The present research is an empirical attempt to structurally integrate findings from several different domains of psychological inquiry within an appetitive–aversive systems model. That is, we sought to determine whether the similar dimensions that have emerged in different research domains might represent a meaningful commonality, suggesting the possibility of an underlying structural association, or whether it is simply an interesting but circumstantial parallelism. We have adopted a confirmatory factor analysis approach to examining the latent structure of various measures that, although tapping discrete constructs, may reflect a common distinction. Thus, the present work was intended to serve as a quantitative complement to more conceptually based integrations of the evidence concerning appetition and aversion.

1.1. The appetitive–aversive distinction in various research domains

Although interest has waxed and waned over the years, appetition and aversion have a long history in psychology (see Elliot, 1999; Higgins, 1998, for reviews). James (1890) wrote about pleasure as a reinforcer and pain as an inhibitor of behavior, and Pavlov (1927) described two types of reflexes, one orienting toward the stimulus and the other turning away from the stimulus, a description literally adopted as a manipulation by later researchers (e.g., Cacioppo, Priester, & Berntson, 1993). Schneirla (1959) documented the communality across diverse species of "towardness" (approach) and "awayness" (withdrawal), and suggested that these processes may have had evolutionary roots. Similarly, Miller's (1959, 1961) classic research on separate approach (appetitive) and withdrawal (aversive) learning processes pro-

duced graphical representations of their interplay in approach and avoidance conflict gradients. More recent research has seen the appearance of the appetitive–aversive distinction in domain-specific conceptualizations, examples of which we chronicle below. We note here that we based domain classifications (e.g., personality, motivation) on their most typical representation in the literature, and were employed for parsimony and are not intended as rigid classifications.

1.1.1. Affect

Studies of mood and affect have garnered considerable evidence that activated positive affect (PA) is conceptually and statistically distinct from activated negative affect (NA; Watson et al., 1988; Watson & Tellegen, 1985). High PA is characterized by elation, excitement, and enthusiasm, whereas, low PA is characterized by feeling dull and sluggish. Adjectives such as distressed, fearful, and hostile describe high NA, whereas, calm, placid, and relaxed represent low NA. Although the exact magnitude of the correlation between positive and negative affect has been debated (Feldman Barrett & Russell, 1998; Green, Goldman, & Salovey, 1993; Watson, Wiese, Vaidya, & Tellegen, 1999), the typical modest correlation between PA and NA (e.g., $r = -.28$; Diener, Smith, & Fujita, 1995) tends to be somewhat higher when measurement error is accounted for (e.g., $r = -.44$; Diener et al., 1995). Thus, although positive and negative affect are not entirely orthogonal, their covariation excludes the largest portion of each variable's variance, leaving considerable room for independence. Consistent with this idea, Watson and his colleagues (1999) have argued that PA is the subjective feeling experienced when a biologically based appetitive or approach system is activated, whereas, NA is the subjective feeling experienced when a biologically based aversive or avoidance system is activated.

1.1.2. Personality

In Eysenck's (1967/1981) model of personality structure, extraversion and neuroticism, two independent dimensions of personality, may be interpreted to represent appetitive and aversive functions, respectively. That is, individual differences in extraversion represent differing sensitivities of an appetitive system, whereas, individual differences in neuroticism reflect differing sensitivities of an aversive system. Although extraversion is often described in terms of sociability, recent research strongly suggests that reward sensitivity is at the core of this trait (Lucas, Diener, Grob, Suh, & Shao, 2000). Similarly, neuroticism may reflect the strength of an individual's emotional response to negative stimuli (Watson & Pennebaker, 1989); for example, people high on neuroticism react more strongly to a laboratory induction of negative mood than do people low on neuroticism (Larsen & Ketelaar, 1991). Similar interpretations may be applied to the independent neuroticism and extraversion dimensions of the "Big Five" theory of personality (McCrae & Costa, 1987).

1.1.3. Cognitive evaluation

Evidence collected by Cacioppo and colleagues (e.g., Cacioppo & Gardner, 1993; Cacioppo et al., 1997) indicates that the positive and negative aspects of an attitude object are assessed via independent mechanisms. Attitude measurement traditionally

uses a single bipolar dimension (i.e., negative to positive). Cacioppo et al. (1997) suggest that a bivariate approach, in which the positive attributes of an object are evaluated by a mechanism functionally and stochastically separate from the mechanism that evaluates its negative attributes, may be more accurate. The output of these distinct systems is then integrated to yield an overall attitude. Among other advantages, this model helps differentiate attitudinal indifference from ambivalence.

1.1.4. Motivation

Several theories of motivation and behavioral self-regulation converge on the appetitive/aversive distinction. For example, in Carver and Scheier's (1990) model of self-regulation, some feedback processes attempt to reduce the discrepancy between informational input from the environment and the individual's internal reference (called discrepancy-reducing), whereas, other feedback processes attempt to enlarge this discrepancy (called discrepancy-enlarging). Carver (1996) has equated these two systems with approach and avoidance processes, respectively. Elliot has distinguished between approach and avoidance goals, examining these forms of self-regulation in terms of domain-general personal strivings (Elliot & Sheldon, 1998) and domain-specific achievement goals (Elliot & Church, 1997). Approach and avoidance goals have been linked to distinct antecedents and consequences (Elliot, 1999). Higgins's (1998) theory of regulatory focus also distinguishes between two independent forms of self-regulation, one focused on the promotion (attainment) of positive end-states, the other focused on the prevention of negative end-states.

Gray's (1987) neurobiologically based theory of motivation (see also Fowles, 1994) posits distinct appetitive and aversive motivation systems, referred to as the Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS), respectively. Gray's model, which is based on extensive animal research, supports the independence of these systems at the level of neurobiological mechanisms. (For example, Gray (1990) and LeDoux (1995) have suggested that the amygdala is involved in fear and withdrawal, whereas, the nucleus accumbens is active in approach behaviors.) BAS (the appetitive system) activates behavior in response to signals of reward and nonpunishment, whereas, BIS (the aversive system) inhibits behavior in response to signals of punishment, nonreward, and novelty. Gray's (1990, 1994) theory also links behavioral self-regulation to emotion: BAS activation is associated with hope and approach behaviors, whereas, BIS activation is linked to anxiety and avoidance behaviors.

1.1.5. Neurophysiology

Building on the work of Gray and others, several researchers have suggested that separate appetitive and aversive dimensions may have emerged in many areas of research because they express two underlying neurobiological systems in the brain (e.g., Davidson, 1992). Carver (1996) noted that "Although these two tendencies [approach and avoidance] are often layered across each other in the topography of behavior, they are conceptually distinct from each other. Being distinct, they may be managed by different structures in the nervous system." (p. 320).

Recent neurophysiological research has supported this proposition. For example, Sutton and Davidson (1997) found that Gray's BIS and BAS constructs were associated with different components of resting prefrontal asymmetry as measured with electroencephalographic (EEG) technology (see also Harmon-Jones & Allen, 1997). Subjects with higher BAS showed greater relative left prefrontal activation, whereas, those with higher BIS scores showed greater relative right prefrontal activation. Similarly, laboratory-induced motivational experiences may correspond to neural activity changes. In one study, reward contingencies were associated with left frontal activation, whereas, punishment contingencies were associated with right frontal activation (Sobotka, Davidson, & Senulis, 1992). The existence of two neurobiologically based functional systems may help explain why conceptually similar appetitive and aversive distinctions are represented in diverse phenomena.

1.2. Putting it together: Basic, functionally independent systems

In each of the research areas reviewed above, different starting points and diverse domains of inquiry support the same general distinction between two processes, one concerned with appetition and the other concerned with aversion. Of course, these observed two-factor structures differ among themselves in important ways and their seeming likeness may be nothing more than an interesting coincidence. However, it is also possible that their resemblance reflects a common underlying structure, one whose behavioral expression includes both commonalities and unique properties. The goal of the present research was to determine whether a common structure might underlie individual differences across several conceptual domains. Support for a two-factor appetitive–aversive structure would suggest that these two systems may represent a fundamental organization that influences more specific cognitive, affective, and behavioral processes. If such support is found, these more specific processes would be seen to possess important, heretofore not well-understood underlying commonalities with each other. Moreover, a common structure of separate appetitive and aversive systems would imply that, across diverse specific manifestations: (1) appetitive and aversive systems tend to be activated by different environmental stimuli; (2) appetitive and aversive processes may operate by different processes which are not merely mirror images of each other; and (3) appetitive and aversive processes are likely to be associated with different outcomes.

We recently published evidence in support of these three implications (Gable, Reis, & Elliot, 2000). In three studies of motivational predispositions and reactions to daily events, we found that the occurrence of daily negative events was strongly associated with increased NA, whereas, the occurrence of daily positive events was associated with increased PA. Furthermore, high BIS sensitivity (representing the aversive system) was associated with higher average negative affect, whereas, high BAS sensitivity (representing the appetitive system) was predictive of increased positive affect. Most importantly, the relationship between BIS–BAS and affect was characterized by different processes. The BAS–PA relationship

was described by differential exposure—high BAS individuals were more likely to seek out and initiate positive-affect producing events. On the other hand, the BIS–NA relationship was better explained by differential sensitivity—the higher an individual's BIS score, the greater their affective response to negative events.

Prior research has to some extent supported the proposed organization of various affective, personality, motivational, and attitudinal measures along the lines of appetite and aversion. For example, Lucas and Fujita (2000) found consistent connections between extraversion and positive affect, regardless of the method by which either was assessed. Jorm et al. (1999) obtained support for a two-factor distinction that differentiated BIS-negative affectivity from BAS-positive affectivity; Wilson and Gullon (1999) showed correlations between extraversion and PA, and neuroticism and NA accros the life span; and Carver and White (1994) found relationships between BIS and negative temperament and BAS and positive temperament. The present research goes beyond prior work by extending the range of variables to be examined, both in terms of the phenomena to be considered and the methods by which they are assessed. Such extensions are essential to make a compelling case for appetition and aversion as fundamental systems underlying a broad and diverse set of psychological domains.

We refer to these systems as functionally independent to reflect their independent activation and operation, although it is likely that their behavioral manifestations are inversely related to some degree. As shown by Cacioppo et al. (1997), the outward displays of these two systems may depend on physical and environmental constraints that limit expression of two underlying systems to a single bipolar response. For example, organisms can either approach or withdraw from a stimulus at any given moment, regardless of the underlying positivity and negativity of their attitudes toward the stimulus. Furthermore, because feedback mechanisms between these two systems are likely to exist, the reciprocal relationship between them may also vary according to environmental conditions. For example, Zautra, Potter, and Reich (1998) have argued that under high stress, the separate affect systems may merge functionally (i.e., high negative affect dampens the positive affect system) in order to reduce uncertainty and conserve resources. Thus, the appearance of bipolarity may at times mask the functional separateness of the appetitive and aversive systems.

1.3. Hypotheses for the present research

In the present set of four studies, we sought to determine whether a common structure underlies the various manifestations of the appetitive–aversive distinction reviewed above. Participants completed an array of individual difference measures representing distinct domains of psychological research and methodological variations. These data were examined with confirmatory factor analysis (CFA), a method well-suited to the identification of higher-order structures underlying covariances among a series of manifest variables. With CFA, it is possible to determine whether the imposition of a higher-order structure, represented in latent variables, can account for the observed pattern of covariation, and if it does,

which of several possible models best fits the observed data. We expected that one set of measures would reflect a latent factor representing appetitive processes, whereas, a second set of measures would tap a latent factor representing aversive processes. The specific measures were chosen to represent personality, affect, and motivation, classified a priori as "appetitive" or "aversive" on theoretical grounds. Measures assessing an individual's orientation to the presence (or absence) of positive environmental features were considered appetitive, whereas, measures assessing an individual's orientation to the presence (or absence) of negative environmental features were considered aversive. The heterogeneity of these measures not withstanding, we hypothesized that a common two-factor structure would emerge; that this structure would distinguish appetitive variables from aversive variables; and that this structure would fit the data better than other plausible structures (e.g., single-variable models; groupings based on research domain). We also incorporated several methodological variations in order to demonstrate that the appetitive–aversive distinction would emerge even when common method variance works against it. Finally, we again note that measures were classified into domains (e.g., personality, motivation) based on their most typical representation in the literature. Domain classifications were used for parsimony and are not intended as rigid classifications.

Data collection procedures for Studies 1–4 were similar. Undergraduate participants enrolled in introductory personality courses in four different semesters, completed individual difference measures during multiple sessions held at different times during the semester. Each study at minimum included measures from the domains of personality, motivation, and affect. We used exploratory principal components analysis in Study 1 to examine the viability of our model. Studies 2–4 were analyzed with confirmatory factor analysis.

2. Study 1

2.1. Method

2.1.1. Participants and procedure

Participants were 202 undergraduates, of whom 191 (73 men and 118 women) provided complete data. Participants ranged in age from 17 to 36 ($M = 20.3$) and received course extra credit in exchange for participation. Participants completed the general motivation and personality measures in a large session held before class, and completed the affect measures approximately a week later during smaller out-of-class sessions. Scales from the same measure (e.g., the PA and NA scales of the PANAS) were administered during the same session.[1]

[1] The data in Studies 1 and 2 were collected in the context of a larger project and a portion of these data were also used in Elliot and Sheldon (1998), and Elliot et al. (1997) to investigate a conceptually distinct set of issues. Specifically, the BIS/BAS scales used here in Study 1 were also used in Elliot and Sheldon (1998), and the EPQ scales used here in Study 2 were also used in Elliot et al. (1997).

2.2. Measures

2.2.1. Affect

Participants were asked to respond to the 20-item PANAS (Watson et al., 1988) on a 1–5 scale assessing how they felt over the past week. Ten items (e.g., interested, excited, and inspired) measured positive affect (PA), and 10 items (e.g., distressed, jittery, and hostile) assessed negative affect (NA). In our model, PA represents appetitive emotion and NA represents aversive emotion. The scales were reliable ($\alpha = .88$ for both scales).

2.2.2. General motivation

General motivation was measured with Carver and White's (1994) BIS/BAS scales, which tap individual differences in sensitivities of the behavioral activation (BAS) and behavioral inhibition (BIS) systems. This measure is based on Gray's conceptualization of the aversive and appetitive motivational systems, respectively, and has 20 items. A single subscale consisting of seven items assesses BIS sensitivity. The remaining 13 items comprise three subscales reflecting BAS sensitivity: reward-responsiveness (five items that describe positive responses to the occurrence of reward); drive (four items that assess the willingness to approach positive outcomes); and fun-seeking (four items that reflect the willingness to try new things). All three subscales are relevant to BAS dispositions (i.e., appetitive motivation), have been shown to reliably form the BAS measure, and are typically combined in the literature (Carver & White, 1994; Jorm et al., 1999). We, therefore, combined all 13 items to yield a total BAS score. Reliability of BIS and BAS scales was adequate, ($\alpha = .79$ for BIS, .81 for BAS).

2.2.3. Personality

The short-form of the Eysenck Personality Questionnaire (EPQ; Eysenck, Eysenck, & Barrett, 1985) was used to measure neuroticism (N) and extraversion (E). Participants responded "true" or "false" to 24 statements (e.g., "Do you tend to keep in the background on social occasions?" and "Do you like mixing with people?"). Twelve items each were summed to form the EPQ-E and EPQ-N scales.

3. Results and discussion

Although we expected that an appetitive factor, comprising PA, BAS, and EPQ-E, and an aversive factor, comprising NA, BIS, and EPQ-N, would emerge, in this first study we wanted to examine the viability of our classifications and model with a less restrictive procedure than CFA. In exploratory factor analysis (EFA), the number of latent variables is not specified and the relationship between the observed variables and factors is not prespecified. Accordingly, the six scales were subjected to a principal-components factor analysis with oblimin rotation. Oblimin rotation was used to allow for the possibility of a correlation between the appetitive and aversive dimensions.

This analysis yielded two principal components with eigenvalues greater than one, accounting for 64.6% of the variance. The first and second factor accounted for 38.6% and 26.0% of the total variance, respectively. As Table 1 shows, BIS, NA, and EPQ-N had factor loadings greater than .79 on the first (aversive) factor and negligible loadings (< .20) loadings on the second factor. BAS, PA, and EPQ-E had factor loadings greater than .61 on the second (appetitive) factor and weaker loadings (< .36) on the first factor. The two factors were negatively but weakly correlated with each other, $r = -.09$. In short, this EFA supported our hypothesis that two factors, consisting of the aversive and appetitive measures, respectively, would be obtained. The modest negative correlation between them indicated that these two factors are largely independent.

In the next three studies, we subjected our hypothesis to more formal tests with CFA. In each study, as displayed in Table 2, we included three pairs of variables, one each from the domains of affect, motivation, and personality. To examine the possibility that our results might depend on method variance, each study included a methodological variation. Study 2 used a trait measure of affect (rather than the state measure of Study 1). Study 3 dropped BIS/BAS in favor of the Multi-Motive

Table 1
Factor loadings from principal components analysis

Scale	Principal components	
	1. Aversion	2. Appetition
Behavioral inhibition (BIS)	**.82**	.11
Negative affectivity (NA)	**.79**	.05
Neuroticism (NEO-N)	**.83**	−.20
Behavioral activation (BAS)	.34	**.80**
Positive affectivity (PA)	−.36	**.61**
Extraversion (NEO-E)	−.08	**.76**

Note. Principal components analysis with oblimin rotation. Correlation of factors 1 and 2 = −.09. $n = 198$.

Table 2
Measures administered in Studies 2–4

Measure	Affect	Motivation	Personality	Other
Study 2	PANAS-Trait	BIS/BAS scales	EPQ (N and E)	
Study 3	PANAS-State	Multi-Motive Grid scale	NEO (N and E)	Coping scales (approach and avoidance)
Study 4	PANAS-State	Self-report achievement and affiliation motives	NEO (N and E)	Temperament (positive and negative)

Note. PANAS: Positive and Negative Affectivity Scale (Watson et al., 1988); BIS/BAS: Behavioral Inhibition and Activation Scales (Carver & White, 1994); Multi-Motive Grid Scale (MMG; Schmalt, 1999); EPQ: Eysenck's Neuroticism and Extroversion scales (Eysenck et al., 1985); NEO: Five factor personality scale (NEO-FFI; Costa & McCrae, 1992).

Grid Scale, a semi-projective motive measure, and replaced the EPQ with the NEO. Study 4 also used the NEO, but substituted self-report, content-specific measures of the achievement, and affiliation motives. Additionally, Studies 3 and 4 sought to extend the empirical test by including an additional pair of variables. In Study 3, we added measures of coping style, whereas, in Study 4 temperament measures were included. Thus, each of the three remaining studies incorporated at least one methodological variation and two of the studies also incorporated an additional construct. In these three studies, we also compared the hypothesized two-factor structure to alternative models: a bipolar unidimensional model and models based on common method variance.

4. Studies 2–4

4.1. Method

4.1.1. Participants

All participants were undergraduates enrolled in introductory personality psychology and participated for course credit. Measures (e.g., the PANAS, the EPQ) were administered in sessions held prior to the start of the lecture class, in smaller out-of-class sessions, or as part of take-home assessments. One or two measures were collected in each session and approximately 7–10 days separated sessions. In Study 2, complete data were obtained from 194 participants (86 men and 108 women) ranging from 17 to 45 years of age ($M = 20.6, SD = 3.6$). In Study 3, 148 participants (63 men and 85 women) provided complete data, ranging in age from 17 to 35 years of age ($M = 19.64$, $SD = 1.9$). Finally, 167 people (59 men and 108 women) participated in Study 4.

4.2. Measures

4.2.1. Affect

As in Study 1, individual differences in the tendencies to experience positive and negative affect were measured with the 20-item PANAS (Watson et al., 1988). In Study 2, participants responded to each PANAS adjective on a 1–5 scale according to how they "generally or typically feel." Reliability was good: $\alpha = .87$ for PA and .84 for NA. Studies 3 and 4 used a state rating of affect, in which participants indicated the degree to which each emotion had been experienced "during the past week." Reliability was good: for PA, α's = .88 (Study 3) and .85 (Study 4), and for NA α's = .88 in both Studies 3 and 4. PA was classified as appetitive and NA was classified as aversive.

4.2.2. Personality

Study 2 used the Revised EPQ (Eysenck et al., 1985) to measure neuroticism and extraversion, as in Study 1. Reliability was good, $\alpha = .84$ for extraversion and .85 for neuroticism. In Studies 3 and 4, neuroticism and extraversion were measured with

the N and E scales from NEO Personality Inventory (NEO–FFI; Costa & McCrae, 1992). Participants responded to 24 items (12 each for neuroticism, NEO-N, and for extraversion, NEO-E) on a 1 (strongly disagree) to 5 (strongly agree) scale. The NEO-E was classified as appetitive and the NEO-N was classified as aversive. Both scales had good reliability in both Studies 3 and 4, α's = .83 and .80, respectively, for NEO-E, and .85 in both studies for NEO-N.

4.2.3. Motivation

Study 2 used the same general motivation measure as Study 1, Carver and White's (1994) BIS/BAS scales. Reliability was good, α's = .86 for BIS and .82 for BAS. Study 3 used a new semi-projective measure developed by Schmalt (1999), the Multi-Motive Grid (MMG). The MMG, which measures motivation in the areas of affiliation and achievement, contains 14 ambiguous pictures, each followed by a series of descriptive statements. Participants indicated whether or not (i.e., "yes" or "no") the statement described the way they would think or feel in the depicted situation (e.g., "being afraid of being boring to others" and "feeling confident of success at this task"). The MMG produces two scales each for achievement and affiliation: Hope for Success (hSucc), Fear of Failure (fFail), Hope for Affiliation (hAff), and Fear of Rejection (fRej). Each scale was based on responses to 12 statements and showed good reliability (α's ranged from .68 to .80). The hSucc and hAff scales were classified as appetitive and combined into an MMG-Hope motivation scale ($\alpha = .80$). The fFail and fRej scales were classified as aversive and combined into an MMG-Fear motivation scale ($\alpha = .80$).

In Study 4, self-report measures were used to assess individual differences in appetitive and aversive motivation in the affiliation and achievement domains. Appetitive affiliation motivation was measured with Jackson's (1974) Need for Affiliation scale, which has 16 statements in true–false format. Sample items include "I go out of my way to meet people" and "I am quite independent of the people I know" (reverse-scored). Its reliability was good, $\alpha = .80$. Aversive affiliation motivation was measured with Mehrabian's (1976) Fear of Rejection scale. This scale has 24 items, responded to on a 1–9 scale. Reliability was good, $\alpha = .78$. Higher scores indicate more fear of rejection.

Appetitive achievement motivation was measured with the Work and Family Orientation scale (WOFO; Spence & Helmreich, 1983). The WOFO contains 19 statements and a 1–5 response scale with higher numbers indicating more agreement. Sample items include "I like to work hard" and "There is satisfaction in a job well done." The WOFO overall need for achievement score, derived from two subscales (work-mastery and competitiveness), was used in the present study. The WOFO had good reliability, $\alpha = .81$. Aversive achievement motivation was measured with the 27-item Fear of Failure scale (Herman, 1990), using a 1–5 (disagree to agree) response format. Sample items include "When I start doing poorly at a task, I feel like giving up," and "I try to avoid failure at all costs." Reliability was good, $\alpha = .83$.

To create across-domain composite scores, z-scores were computed for each of the four scales and then summed for the two aversive motivation scales (Fear of Rejection and Fear of Failure) and for the two appetitive motivation scales (Hope for

Affiliation and Need for Achievement). Reliabilities of these combined scales were also good, α's = .85 for fear motivation and .77 for hope motivation.

4.2.4. Coping

The Coping Responses Inventory (CRI; Moos, 1988) was used to assess coping response styles in Study 3. The CRI has 48 questions regarding the management of important problems and events, and yields scores for approach coping (COPING-Approach) and avoidance coping (COPING-Avoid).[2] Examples of approach coping include "Do you talk with a friend about the problem?" and "Do you think of different ways to deal with the problem?" Examples of avoidance coping include "Do you try to forget the whole thing?" and "Do you keep away from people in general?" Participants were asked to indicate how they usually respond to a stressful event or important problem using a 1 "not at all" to 4 "fairly often" response format. Approach coping was classified as an appetitive variable and avoidance coping was classified as an aversive variable. The COPING-Approach and COPING-Avoid scales had good reliability, α's = .87 and .73, respectively.

4.2.5. Temperament

The General Temperament Survey (GTS; Watson & Clark, 1993) was used to assess positive and negative temperament in Study 4. The GTS has 55 statements and a true–false response scale. Examples from the positive temperament scale are "I get excited when I think about the future" and "I can easily find ways to liven up the day." Examples of the negative temperament scale are "I am often nervous for no reason" and "I am often troubled by guilt feelings." The positive and negative scales showed good reliability, α's = .88 and .89, respectively. Positive temperament was classified as appetitive and negative temperament was classified as aversive.

5. Results

5.1. Data analytic strategy

Our theorizing stipulates that a model with two latent variables, one each representing the appetitive and aversive systems, should fit the data reasonably well. In each study we first examined the adequacy of this model. Next, we examined whether this model accounted better for the obtained data than alternative theoretical models: A unidimensional bipolar model (i.e., one that runs from negative to positive) and a method-model (i.e., one that includes both measures from the same instrument). All CFAs were conducted using maximum likelihood (ML) estimation procedures. For each model the $\chi^2, \chi^2/df$ ratio, and goodness of fit index (GFI) were reported for model evaluation. We also computed the comparative fit index

[2] The approach and avoidance scales can be subdivided into eight subscales, four approach and four avoidance. These distinctions were not relevant to the present research.

(CFI), an incremental fit index that is relatively robust to small sample size with ML estimation (Bentler, 1990). Root mean square error of approximation (RMSEA) was also used to evaluate model fit on the basis of discrepancies between the observed correlations and the model-reproduced correlations; RMSEA favors more parsimonious models. Although there are no established absolute cut-offs, we employed the rule of thumb that models with fit indices (GFI and CFI) below .90 and χ^2/df ratios greater 3 can be improved (Carmines & McIver, 1981). Browne and Cudeck (1993) recommend that models with RMSEA greater than .10 can be improved, and those with RMSEA value of .08 or less demonstrate a reasonable fit to the data.

5.2. Study 2

Study 2 formally evaluated the two-factor model structure suggested by the exploratory analyses of Study 1. EPQ-E, PA, and BAS were modeled as indicators of a latent appetitive variable and EPQ-N, NA, and BIS were modeled as indicators of a latent aversive variable. Results are shown in Fig. 1(a). The hypothesized model fit the data well, $\chi^2_{(8)} = 17.05$, $p = .03$, $\chi^2/df = 2.14$, GFI = .97, CFI = .97;

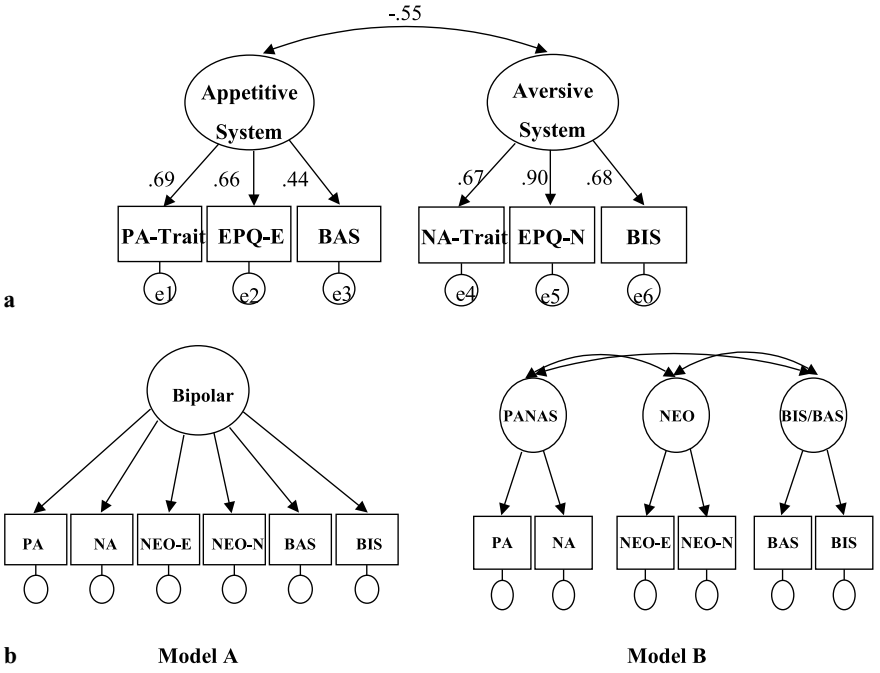

Fig. 1. (a) Study 2 Theoretical Model Results. *Note*. $N = 194$, $\chi^2_{(8)} = 17.05$, $p = .03$, χ^2/df ratio = 2.1, GFI = .97, CFI = .97, RMSEA = .08. (b) Two alternative models. *Note*. Model A represents a one-factor or bipolar representation. Model B represents a domain or measure based model. Both models fit the data poorly. See text for details.

RMSEA = .08. Each indicator loaded significantly on the predicted latent variable.[3] The two latent variables were significantly negatively correlated, $r = -.55$, which is larger than the correlation between any individual pair of appetitive and aversive raw scale scores. (Because the model controls for measurement error, estimates of the correlation between the latent variables tend to be larger than correlations among the observed scales.) This value is similar to previous research (e.g., Diener et al., 1995; Green et al., 1993; Watson et al., 1999).

5.2.1. Alternative models

The first alternative model tested was unidimensional, as depicted in Fig. 1(b) (Model A). This model proposed that appetitive scales lie at one end of a continuum and aversive scales at the other (i.e., that sensitivity to desired outcomes and states necessarily implies the absence of sensitivity to nondesired outcomes and states, and vice versa). A one-factor model was constructed in which all eight observed variables served as indicators of a single latent variable. The fit of this model was poor, $\chi^2_{(9)} = 56.47$, $p < .001$, $\chi^2/df = 6.27$, CFI = .83; RMSEA = .17. Moreover, the fit of this model was significantly worse than the fit of the hypothesized two-factor model, $\Delta\chi^2_{(1)} = 39.32$, $p < .001$. Thus, the one-factor model should be rejected in favor of the predicted two-factor model.

A second model based on measurement domains was then constructed, based on the possibility that measures coming from a single instrument and representing a single construct (i.e., personality, motivation, or affect) might provide a better structure for the observed correlations. An example of this domain-based model is shown in Fig. 1(b) (Model B). The alternative model tested consisted of three latent variables, one each for affect (i.e., the PANAS), personality (i.e., EPQ), and motivation (BIS/BAS). The latent variables were left free to covary. Although this model is theoretically identified, it was empirically underidentified, indicating an extremely poor fit to the data (Bollen, 1989). Thus, the measurement or domain-based model, was also rejected. In sum, the specified theoretical model received better support than either alternative model.

5.3. Study 3

Our goal in Study 3 was to test the hypothesized two-factor model with different measures of personality and motivation, and to extend the conceptual reach of the model to incorporate a new variable, coping style. General motivation was assessed with the MMG, a semi-projective measure, combining the affiliation and achievement subscales to create a general motivation score. Personality was assessed by the NEO-FFI. Thus, the MMG-Hope scale, approach-coping, state PA, and

[3] In order to scale latent variables, one indicator (i.e., observed variable) on each latent variable is constrained to 1 in the unstandardized solution. Significance tests are calculated using unstandardized parameters, and, therefore, are not available for the scaled indicators. The neuroticism and extraversion measures were used to scale the latent variables in each model.

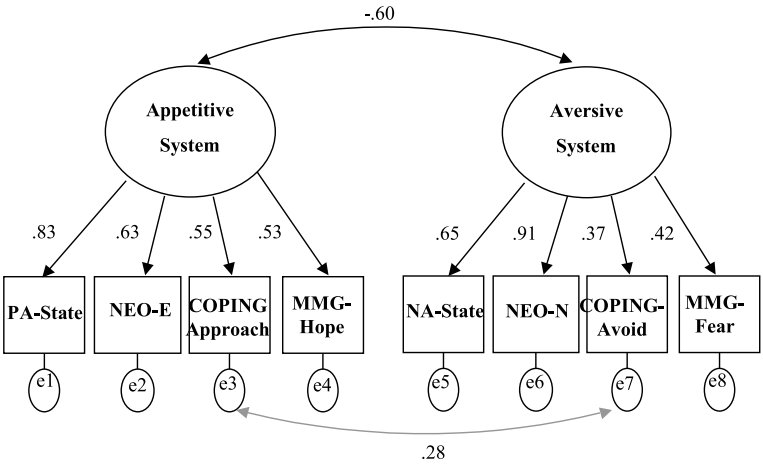

Fig. 2. Study 3 Theoretical Model Results. *Note*. $N = 148$, $\chi^2_{(18)} = 31.50$, $p = .03$, χ^2/df ratio $= 1.75$, GFI $= .95$, CFI $= .95$, RMSEA $= .07$.

NEO-E were modeled as indicators of the appetitive latent variable, whereas, the MMG-Fear scales, avoidance-coping, state NA, and NEO-N were modeled as indicators of the aversive latent variable. Error terms for the two coping scales were allowed to covary.[4] The results are shown in Fig. 2. As hypothesized, each indicator loaded significantly on the appropriate latent variable and the data fit the model well, $\chi^2_{(18)} = 31.50$, $p = .03$, $\chi^2/df = 1.75$, GFI $= .95$, CFI $= .95$; RMSEA $= .07$. As in Study 2, the two latent variables were significantly negatively correlated, $r = -.60$, and, as expected, the error terms of the two coping variables were significantly correlated, $r = .28$.

5.3.1. Alternative models

The hypothesized two-factor model was compared to the same two alternative models as in Study 2. Again, the one-factor model fit the data poorly, $\chi^2_{(19)} = 83.98$, $p < .001$, $\chi^2/df = 4.42$, GFI $= .86$, CFI $= .77$; RMSEA $= .15$; and provided a significantly worse fit than the hypothesized model, $\Delta\chi^2_{(1)} = 52.48$, $p < .001$. Also as in Study 2, the domain-based model (Fig. 1(b), Model B) produced an inadmissible solution and was, therefore, rejected. We also tested one additional alternative model, based on method of data collection. The MMG scales were modeled as indicators of one latent variable representing semi-projective measures, and the remaining measures were modeled as indicators of a second latent variable, representing self-report methods. This alternative model also fit the data quite poorly,

[4] The coping measure instructed respondents to indicate how often they use each coping strategy to deal with a "stressful event" or "important problem." We expected error terms for the approach and avoidance scales to be correlated because responses depend on the type of stressor accessible to the participant and the frequency of stressful events experienced.

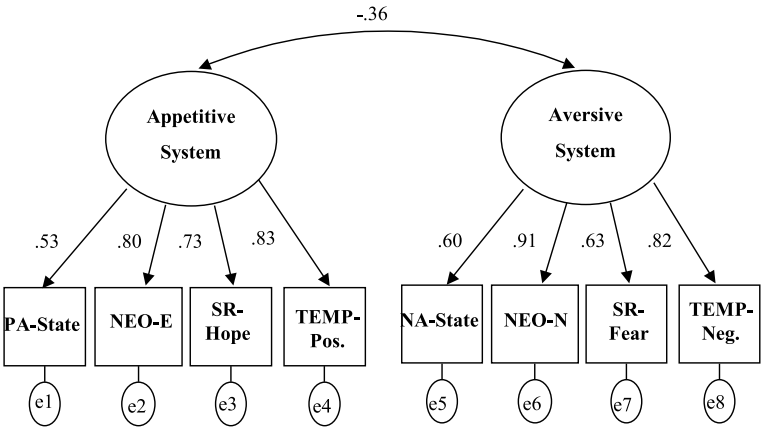

Fig. 3. Study 4 Theoretical Model Results. *Note*. $N = 167$, $\chi^2_{(19)} = 45.29$, $p < .01$, χ^2/df ratio $= 2.38$, GFI $= .94$, CFI $= .95$, RMSEA $= .09$.

$\chi^2_{(18)} = 99.97$, $p < .001$, $\chi^2/df = 5.26$, GFI $= .83$, CFI $= .71$; RMSEA $= .17$, which was significantly worse than the hypothesized model, $\Delta\chi^2_{(1)} = 68.47$, $p < .001$.

5.4. Study 4

The goal of Study 4 was to test the hypothesized model with a more diverse set of self-report motive measures geared specifically toward two content areas, achievement and affiliation, and also to extend the model to a new content area, temperament. The four motivation measures (hope for affiliation and achievement, fear of rejection and failure) were designed separately by different investigators, unlike the other measures in these studies (e.g., N and E are subscales of the EPQ or NEO; PA and NA are subscales of the PANAS). As with the MMG, we combined the achievement and affiliation measures to arrive at a general motivation score. Positive temperament, self-reported hope, NEO-E, and state PA were classified as appetitive indicators, whereas, negative temperament, self-reported fear, NEO-N, and state NA were classified as aversive indicators.[5] As shown in Fig. 3, all of the indicators loaded significantly on their predicted latent variable, and the fit of the model to the data was acceptable, $\chi^2_{(19)} = 45.29$, $p < .01$, $\chi^2/df = 2.38$, GFI $= .94$, CFI $= .95$; RMSEA $= .09$. The two latent variables were again significantly correlated, $-.36$, $p < .05$.

5.4.1. Alternative models

As in the previous two studies, the one-factor model fit the data poorly, $\chi^2_{(20)} = 227.93$, $p < .001$, $\chi^2/df = 11.40$, GFI $= .71$, CFI $= .61$; RMSEA $= .25$. This

[5] Eight participants failed to complete the temperament scales. Missing data for these eight subjects were substituted using the sample mean. The model was also run using only participants with complete data and yielded nearly identical results.

was a significantly worse fit to the data than the hypothesized two-factor model, $\Delta\chi^2_{(1)} = 182.64$, $p < .001$. Also as in the previous studies, a domain-based model produced an inadmissible solution, and was, therefore, rejected.

5.5. Meta-analysis of latent variable correlation

The correlation between the appetitive and aversive latent variables varied across the three studies. We used meta-analytic procedures (Rosenthal & Rosnow, 1991, pp. 505–506) to estimate the combined effect size across studies. The model-estimated correlations between the appetitive and aversive latent variables from each study were first converted to Fisher's *z*'s, then averaged, and the result was converted back to *r*. The average correlation between the two latent variables was −.51, indicating that approximately 25% of the variance in the appetitive latent variable corresponds (negatively) to variance in the aversive latent variable. In interpreting this estimate, it is important to recall that latent variable correlations are typically greater than correlations between manifest indicators of the same variables.

5.6. Variance accounted for in observed variables

Because each manifest variable was an indicator of only one latent variable, it is possible to estimate the amount of its variance that the latent construct accounts for. These values represent the percentage of variance in the observed variable that is shared with all other indicators of that latent variable. The squared path coefficients from the appropriate latent variables to each manifest variable provide these values and are listed in Table 3. The percentages vary from a low of 13% (avoidance coping in Study 3) to a high of 83% (NEO-N); the median value was 46%. Although there is considerable variation across measures and across studies, the average percentage of variance accounted for by the aversive latent variable was 52% and the average percentage of variance accounted for by the appetitive latent variable was 45%. Thus, the indicators of each latent variable, on average, had approximately half of their variance in common.

5.7. Summary of results: Studies 2–4

All three studies provided good support for the hypothesized two-factor model. Regardless of the measures employed, and regardless of the specific constructs included, in each study the predicted two-factor, appetitive–aversive model fit the data well, and significantly better than alternative models. The method-based alternative model tested in Study 3 did not fit the data well, indicating that the method of data collection (i.e., self-report and semi-projective) did not account for as much variance in the observed variables as did the hypothesized model. The domain-based models tested in each study provided extremely poor fits, producing non-positive definite matrices. Although there are many possible causes of a non-positive definite matrix in SEM (Wothke, 1993), the most likely explanations herein are model misspecifica-

Table 3
R^2 for observed variables in Studies 2–4

Variable	Study 2	Study 3	Study 4
Indicators of the aversive latent variable			
Negative Affect (NA)	.45	.42	.36
EPQ-Neuroticism	.81		
NEO-Neuroticism		.83	.83
Behavioral Inhibition (BIS)	.46		
Self Report-Fear			.53
MMG-Fear		.18	
Coping-Avoid		.13	
Temperament-Negative			.67
Indicators of the appetitive latent variable			
Positive Affect (PA)	.48	.70	.28
EPQ-Extraversion	.43		
NEO-Extraversion		.40	.64
Behavioral Activation (BAS)	.19		
Self-Report-Hope			.53
MMG-Hope		.28	
Coping-Approach		.30	
Temperament-Positive			.69

Note. Numbers are percentage of variance accounted for by the latent variable. Blank cells indicate the measure was not used in the study.

tion or empirical underidentification. Finally, in each study, the hypothesized two-factor model provided significantly improved fit over a unidimensional model.

The average correlation between the latent appetitive and aversive variables across the four studies was −.51, indicating a moderate inverse relationship. This negative correlation notwithstanding, the two-factor model provided a better fit than did the single-factor (i.e., bipolar) model, supporting the independence of the appetitive and aversive dimensions at the level of underlying structure.

6. Discussion

Recent conceptual integrations encompassing diverse literatures (e.g., Carver et al., 2000) have suggested the possibility that the perception of, and reaction to, positive environmental cues are managed by an underlying appetitive regulatory system, whereas, the perception of, and reaction to, negative environmental cues are managed by an underlying and separate aversive regulatory system. The present research attempted to provide empirical support for the existence, generality, and distinctiveness of these two functional systems by demonstrating that they may underlie individual differences in a variety of behavioral domains. Our results consistently supported this hypothesis. Across four studies, we found that measures relevant to appetitive stimuli shared common variance with one another, as did measures relevant to aversive stimuli, and that these two sets of measures may be modeled best as independent, internally coherent dimensions.

In Study 1, the structure of individual difference measures was explored and a two-factor structure emerged in which the appetitive and aversive measures loaded on separate factors. These results supported the appetitive–aversive classification system that was used in the subsequent confirmatory analyses. Study 2 evaluated the basic model using the same measures as in Study 1: Trait measures of personality (E and N), affect (PA and NA), and general motivation (BAS and BIS) were modeled as indicators of appetitive and aversive latent variables. In Studies 3 and 4, the measures representing the core domains were varied and additional constructs were added. A state version of the PANAS, assessing affect during the past week, was substituted for the trait PANAS; the NEO-FFI was used to measure neuroticism and extraversion instead of the EPQ; and several alternate measures of motivation (including one using a semi-projective format) were employed. The added constructs were coping styles in Study 3 and temperament in Study 4. Regardless of measure, time frame, format, construct specificity, and content, the two-factor model was supported better than alternative models in all studies. Overall, results clearly support the existence of functionally independent higher-order systems that cut across the domains of affect, personality, motivation, temperament, and coping strategies.

Our results do not imply that these diverse measures from different construct domains are assessing the same thing. Complex, multi-faceted constructs such as affect, personality, and motivation differ among themselves in important ways, and we do not mean to suggest that a single variable, latent or otherwise, is sufficient to represent any of them. (Recall that on average the latent variables accounted for only about half of the variance in each scale.) Rather, our results should be read as suggesting that common elements—perhaps including access to the same biopsychological mechanisms—may contribute to varying extents to the operation of these (and presumably other) psychological processes. Thus, processes such as emotion, personality, and motivation may reflect a complex blend of unique elements along with common underlying elements, one of which is represented in the appetitive–aversive distinction. Recognition of common roots and structural similarities across constructs may facilitate cross-pollination of research from diverse domains, and possibly more parsimonious models of human psychological functioning.

Our results suggest that an appetitive system and its corresponding processes may organize behavior, motivation, and affect regarding positive and rewarding stimuli, whereas, an aversive system and its corresponding processes may organize behavior, motivation, and affect regarding negative and punishing stimuli. The organizational independence of these two systems demonstrated herein, combined with the functional independence documented by Cacioppo et al. (1997), implies that a person's level of sensitivity in one system has little direct bearing on their level of sensitivity in the other system, leading to many possible combinations of appetitive and aversive sensitivities across people (Carver & White, 1994). Important questions about co-action and interaction of these two functionally independent systems remain to be considered and investigated (Cacioppo et al., 1997). For example, high levels of sensitivity of both systems may be expressed in ambivalent behavior, affect, and motivation, whereas, low levels of both may produce indifference. On the other hand, and consistent with our finding of a negative correlation between the appetitive

and aversive latent variables, high levels of either sensitivity may dampen the other. This possibility represents a dispositional version of the process of reciprocal inhibition in intense momentary affect (e.g., Zautra et al., 1998), whereby intense emotions of a positive or negative valence inhibit expression of the other valence.

Further attention is also needed to address questions about how dispositional sensitivities interact with momentary activation of these systems. Most of our measures pertained to the former, but it should be clear that people possess both sensitivities to varying degrees, and that over and above individual differences, environmental circumstances (i.e., the presence or absence of potentially rewarding or punishing stimuli) differ in the extent to which they activate either or both systems. Just how dispositional sensitivities trigger, exacerbate, or attenuate momentary responses to particular stimuli is an important question for future research. Chronic accessibility of one system, for example, may increase the likelihood or relative strength of its momentary activation by ambiguous stimuli.

6.1. Implications

Earlier we outlined three implications that would emerge if support was found for general appetitive and aversive behavioral systems. The first is that appetitive and aversive systems are activated by different environmental stimuli. Thus, research that targets negative or threatening events or stimuli will likely be investigating aversive processes, and research targeting positive or rewarding events will likely be investigating appetitive processes. Because these systems are independent rather than opposing ends of a single spectrum, findings from one system should not be generalized to the other. For example, criticism and conflict in close relationships should not be considered as the converse of validation and harmony. Because negative social exchanges tend to be studied more than positive social exchanges are studied (Reis & Gable, 2003; Rook, 1984), the need to devote more attention to appetitive social interactions is suggested.

Second, given independence, the appetitive and aversive systems may function through discrete mechanisms. For example, in terms of biopsychological mechanisms, hostile marital interactions are associated with increased endocrine reactivity (e.g., Kiecolt-Glaser, Glaser, Cacioppo, & Malarkey, 1998), whereas, affectionate exchanges are associated with increased oxytocin levels (Carter, 1992; Uvnaes-Moberg, 2000).[6] Furthermore, Gable et al. (2000) provided evidence that dispositional reward sensitivity (BAS) engenders greater positive affect by means of enhancing the likelihood that positive events will occur (differential exposure), whereas, dispositional sensitivities to negative events create negative affect by increasing the magnitude of response to those negative events that do occur (differential reactivity).

Third, it seems likely that appetitive and aversive processes will be associated with different outcomes. For example, the appetitive system tends to be associated with po-

[6] These two biological systems clearly interact. For example, HPA reactivity inhibits oxytocin production, whereas, oxytocin may reduce the harmful effects of cortisol. Nevertheless, the systems operate in a functionally distinct manner.

sitive affect, whereas, the aversive system tends to be associated with negative affect (e.g., Berry & Hansen, 1996; Clark & Watson, 1988; Gable et al., 2000; Higgins, Shah, & Friedman, 1997). These findings are consistent with models of affect that posit two valence-based bipolar dimensions of affect (e.g, Cacioppo et al., 1997; Watson & Tellegen, 1985; Zautra et al., 1998); and highlight a functional explanation for the existence of these two affective dimensions (i.e, positive and negative affect as outcomes of appetitive and aversive systems). Moreover, to the extent that these two systems underlie a broad range of psychological processes, it will be fruitful to distinguish as a matter of course outcomes defined by the presence or absence of positive features from outcomes defined by the presence or absence of negative features. Gable and Reis (2001) outlined implications of this distinction for close relationships research, for example suggesting that appetitive processes may be connected to passion and growth, whereas, aversive processes may be connected to safety and security. Thus, the presence of passion need not connote a feeling of safety, and similarly, concerns for security need not imply the absence of passion. This distinction appears to parallel Bowlby's (1982) proposition that attachment security and exploration represent distinct, although interrelated, functional systems. Recognition that appetitive and aversive outcomes may be the product of separate response systems may provide a more complete picture of certain psychological phenomena.

6.2. Limitations

Limitations of this set of studies include the reliance on undergraduate student samples of comparatively modest size (i.e., less than 200 per study). Furthermore, several of the measures used similar response formats, although administration at separate sessions across periods of up to four weeks and the inclusion of diverse formats, such as the semi-projective motivation assessment, is likely to have minimized response consistency effects. Another limitation concerns the range of measures. For example, we did not include other facets of personality, such as Agreeableness or Conscientiousness, which limits the discriminant validity of current research. And, our analysis was limited to individual difference measures of affect, personality, motivation, coping, and temperament. We believe that other psychological constructs reflect the basic appetitive–aversive distinction, but this conjecture remains to be established empirically.

7. Concluding comment

Carver et al. (2000) commented that "... approach and avoidance processes are ubiquitous in human behavior, triggered by the myriad and ever-changing cues of incentive and threat that surround us" (p. 747). The present research has indicated that this basic distinction may serve as a general organizing construct underlying a variety of more specific dispositional processes in the areas of emotion, motivation, and personality. Such an organization may represent one of the parsimonies inherent in nature. That is, the evolution of natural systems is such that diversity and

complexity evolve by elaborating upon preexisting fundamental building blocks. If so, this research suggests that the appetitive–aversive distinction may represent one such fundamental building block of human nature.

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