Journal of Research in Personality 45 (2011) 100–111

Contents lists available at ScienceDirect

Journal of Research in Personality

journal homepage: www.elsevier.com/locate/jrp

Better (or worse) for some than others: Individual differences in the positivity offset and negativity bias

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ARTICLE INFO

Article history:
Available online 16 December 2010

Keywords:
Personality
Affect
Negativity bias
Positivity bias

ABSTRACT

People tend to respond with more positive than negative affect to mildly emotional stimuli (i.e., *positivity offset*) and respond more strongly to very negative than to matched positive stimuli (i.e., *negativity bias*). In the current study, the authors examine individual differences in the positivity offset and negativity bias and demonstrate that both are stable over time and generalize across different kinds of stimuli (e.g., pictures, sounds, words, games of chance). Furthermore, the positivity offset and negativity bias are not redundant with traditional personality measures and exhibit differential predictive validity, such that both types of measures predict behavior in meaningful ways. Implications for a comprehensive understanding of affect and emotion and their relationship to physical and mental health are discussed.

1. Introduction

Different people often have different emotional reactions to the same event. Rather than being epiphenomenal, individual differences in emotional reactions can have remarkable effects on mental and physical health. When central Italy was rocked by a pair of earthquakes in 1997, for instance, individuals who were not directly affected but nonetheless experienced intense negative emotional reactions subsequently reported more illness and doctors' visits during the next 6 months than individuals who experienced less intense reactions (Solano et al., 2001). Similarly, Taylor, Kemeny, Reed, Bower, and Gruenewald (2000) found that optimistic terminally ill patients live longer and in better health than their pessimistic counterparts. These findings (e.g., Pennebaker & Francis, 1996; Ryff & Singer, 2003) and others suggest that how individuals respond to emotional events not only represents a stable behavioral tendency but may also have implications for well-being and health.

Broad personality dimensions have been found to contribute to individual differences in emotional responses. Costa and McCrae (1980) suggested that extraverts are more likely to experience positive affect; whereas neurotics are more likely to experience negative affect. Consistent with this hypothesis, extraverts report high levels of highly-arousing positive emotions (i.e., Positive Activation, PA; Watson & Tellegen, 1985) and neurotics report high levels of highly-arousing negative emotions (i.e., Negative Activation; NA). Gray (1971) argued that these effects are mediated by individual differences in the behavioral activation and inhibition systems, which guide behavior in the presence of rewards and punishments, respectively. Along these lines, Larsen and Ketelaar (1991) found that a positive mood-induction elicited greater emotional reactivity in extraverts, and a negative mood-induction elicited greater emotional reactivity in neurotics.

By revealing that individuals' scores on personality inventories predict their emotional reactivity, Larsen and Ketelaar's (1991) findings also point toward a new approach to measuring individual differences. The traditional approach is to use personality inventories that allow individuals to reflect on how often or to what extent they experience different affective states (e.g., PANAS; Watson, Clark, & Tellegen, 1988). An innovative and complementary approach is to use affective judgment tasks (i.e., measuring individuals' responses to emotional stimuli) to understand individual differences in terms of affective reactions in their own right. Such affective judgments reflect underlying processes and may therefore provide indirect measures of individual differences in affective processing.

In the current studies we consider how judgment-based measures of individual differences in affective processing may complement more traditional inventory-based measures of personality. Our approach is derived from the Evaluative Space Model (ESM; for reviews and discussion of the relationships between the ESM and other models of affective processing, see Cacioppo, Berntson,

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doi:10.1016/j.jrp.2010.12.001

Norris, & Gollan, in press; Cacioppo, Gardner, & Berntson, 1997, 1999; Norris, Gollan, Berntson, & Cacioppo, 2010), which suggests that the dimensions of positive and negative affect are separable. The ESM proposes distinct *activation functions* for positivity and negativity, where an activation function is a representation of the output of a system given linear input across the dynamic range of the system. Importantly, the ESM posits two asymmetries in the activation functions for positivity and negativity: first, the activation function for positivity has a higher intercept than the activation function for negativity (i.e., the *positivity offset*), resulting in greater positive than negative affect at low levels of affective input; and second, the activation function for negativity has a higher gain than the activation function for positivity (i.e., the *negativity bias*), resulting in stronger responses to very negative than to equally extreme positive affective input (see Fig. 1). The positivity offset and negativity bias are thought to be adaptive asymmetries in affective processing that have evolved to promote exploration in the absence of threat (i.e., the positivity offset) while maintaining vigilance for and robust mobilization of resources in response to potentially harmful stimuli (i.e., the negativity bias). The ESM provides a conceptual framework for beginning to understand individual differences in affective processing using judgment-based rather than inventory-based measures.

Thus, the primary goal of the current studies was to establish judgment-based measures of affective processing, with a focus on individual differences in the positivity offset and negativity bias. To demonstrate that individual differences in these features of the affect system are stable over time and result from general asymmetries in response to positive and negative stimuli rather than from specific reactivity to a particular class or modality of stimuli (e.g., pictures), we examined test–retest reliability over two weeks (Study 1) and a year (Study 1 Follow Up); and we measured responses to emotional pictures, sounds and words (Study 1) and games of chance (Study 2). We also sought to demonstrate that the positivity offset and negativity bias are functionally separable from traditional inventory-based measures of affective personality traits by examining correlations between our judgment-based measures and the most common affective personality inventories, including neuroticism and extraversion, Positive and Negative Activation (i.e., PANAS; Watson et al., 1988), and behavioral inhibition and activation (BIS/BAS; Carver & White, 1994). More importantly, we aimed to show that both inventory- and judgment-based measures predict behavior, but on different kinds of tasks. In sum, we hoped to demonstrate that judgment-based measures of the positivity offset and negativity bias are psychometrically valid, stable over time, and predict behavior above and beyond traditional measures of personality.

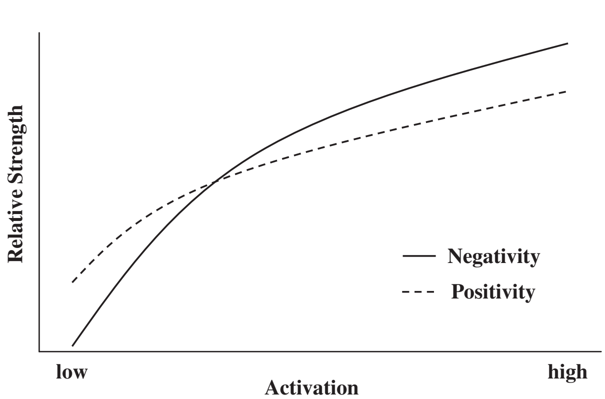

Fig. 1. Activation functions for positive and negative dimensions of affective processing; the *x*-axis represents affective input, whereas the *y*-axis represents output of the system. The ESM proposes that there are two asymmetries in affective processing: the *positivity offset* is the result of greater positive than negative affect at low levels of emotional input; the *negativity bias* is the result of stronger responses to negative than to equally extreme positive input. Figure modified from "Relationship Between Attitudes and Evaluative Space: A Critical Review, With Emphasis On the Separability of Positive and Negative Substrates," by Cacioppo and Berntson (1994).

Social psychologists have taken a similar approach to measuring attitudes. For instance, in addition to measuring participants' self-reported attitudes toward African Americans with traditional racism scales, Dovidio, Kawakami, Johnson, Johnson, and Howard (1997) measured individual differences in the extent to which pictures of African Americans inhibited evaluations of positive adjectives (e.g., "beautiful") and facilitated evaluations of negative adjectives (e.g., "awful"). Participants' scores on the explicit racism scales predicted racial bias in deliberative tasks (e.g., a jury decision-making task involving White and Black defendants). In contrast, their indirect measure predicted racial bias in spontaneous behavior (e.g., how often they looked at a Black conversation partner). Thus, people's feelings about outgroup members may differ from how they think they feel, and these two aspects of their attitudes predict different types of prejudiced behavior. Similarly, we reasoned that personality inventories and affective judgment measures would predict different aspects of affective behavior.

Specifically, we hypothesized that inventory-based (i.e., explicit) measures of emotional traits would predict more deliberative, self-reflective behaviors (e.g., how individuals describe themselves, how individuals predict their responses in hypothetical situations), whereas judgment-based (i.e., implicit) measures of emotional traits, however, ought to predict more spontaneous, automatic behaviors (e.g., physiological responses, attention to emotional stimuli). To examine the first part of this hypothesis, we employed a modified version of the Twenty Statement Test (TST; Kuhn & McPartland, 1954), in which participants listed 20 self-descriptive adjectives. We predicted that inventory-based measures of emotional traits would predict the number of traits listed, such that generally positive individuals (e.g., high PA, high extraversion) would list more positive traits and generally negative individuals (high NA, high neuroticism) would list more negative traits.

To examine the second part of our hypothesis, we adapted an incidental learning task (i.e., the Spatial Affect Task; Crawford & Cacioppo, 2002) that indexes the extent to which individuals *incidentally* learn the relationship between spatial location and emotional content of stimuli (ranging either from neutral to extremely unpleasant or neutral to extremely pleasant). We predicted that individuals with a high negativity bias, who respond more strongly to unpleasant stimuli, would learn the relationship between negativity and spatial location better than those individual with a low negativity bias. Individuals with a high positivity offset, who respond positively to neutral stimuli (i.e., effectively truncating the range of emotional content for stimuli ranging from neutral to extremely positive), would learn the relationship between positivity and spatial location *worse* than those individuals with a low positivity offset.

The differential predictive validity of inventory- and judgment-based measures of emotional traits does not imply that one type of measure is more valid than the other. Indeed, our argument is that incorporating judgment-based measures into studies of emotional traits will contribute to a more comprehensive understanding of the consequences of such traits for behavior.

In an initial study of individual differences in the positivity offset and negativity bias, Ito and Cacioppo (2005) asked participants to indicate how they felt about a set of pictures selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). Ito and Cacioppo (2005) found support for both a positivity offset (i.e., stronger responses to mildly pleasant than to mildly unpleasant pictures) and a negativity bias (i.e., stronger responses to extremely unpleasant than to extremely pleasant pictures) across all participants. Furthermore, individual differences in the positivity offset and negativity bias were normally distributed, stable over the course of a week, and predictive of judgments on an impression formation task. For instance, individuals with a high negativity bias formed more negative impressions of target individuals who performed both negative (e.g., ‘‘Sam stole vegetables from his neighbor's garden'') and positive (e.g., ‘‘Sam gave back extra change at the supermarket'') behaviors.

Although this study provided preliminary evidence for the existence and psychometric validity of individual differences in the positivity offset and negativity bias, its results are limited in important ways. First, the negativity bias and positivity offset were measured based solely on responses to emotional pictures; whereas both are predicted to be general affective asymmetries that should be observed in responses to all emotional stimuli (e.g., pictures, sounds, words, gamble outcomes, life events). Second, test–retest reliability was limited to one week; whereas the positivity offset and negativity bias are thought to be stable personality characteristics. Third, predictive validity was limited to the negativity bias; whereas both judgment-based measures are thought to predict behavior, and are hypothesized to predict different behaviors than do traditional inventory-based measures.

In two studies, we replicated and extended previous findings on individual differences in the positivity offset and negativity bias. In addition to replicating findings that most individuals exhibit both a positivity offset and a negativity bias in their responses to affective stimuli and that individual differences exist in the magnitude of both the positivity offset and the negativity bias, we extended the test of temporal stability from a 1-week interval (Ito & Cacioppo, 2005) to include assessments separated by 2 weeks (Study 1) and a year (Study 1 Follow-up). More importantly, however, we tested several novel hypotheses:

Hypothesis 1: The positivity offset and negativity bias are general asymmetries in affective processing and will therefore emerge in judgments of stimuli that differ in modality and type (e.g., pictures, sounds and words [Study 1] and games of chance [Study 2]).

Hypothesis 2: Our judgment-based measures of individual differences in affective processing (i.e., positivity offset and negativity bias) are distinct (i.e., exhibit discriminant validity) from traditional inventory-based measures (e.g., BIS/BAS, neuroticism and extraversion).

Hypothesis 3: Both judgment-based and inventory-based measures predict behavior on different types of tasks and provide complementary approaches to the understanding of individual differences in emotional processes.

2. Study 1

In Study 1 individuals rated their positive and negative affective reactions to a variety of pictures, sounds, and words at multiple time points. Participants also completed a variety of inventory-based measures of affective dimensions of personality.

3. Method

Participants were female students at the University of Chicago who were paid for their time. Of the 72 eligible participants that were recruited, 7 failed to complete all sessions, resulting in a sample of 65. In addition, some tasks were not completed by all participants; degrees of freedom are adjusted accordingly.

3.1. Overview

Participants completed an orientation session and two experimental sessions: the orientation session occurred 1–2 weeks prior to the first experimental session and the two experimental sessions were separated by about two weeks ($M = 15.35$ days). During the orientation session, participants received a tour of the lab, gave oral and written informed consent, completed a set of questionnaires, and viewed instructions and sample trials for each task. During the experimental sessions, participants received an overview of the procedures, had sensors attached to collect psychophysiological data (see Larsen, Norris, & Cacioppo, 2003; Norris, Larsen, & Cacioppo, 2007), and were then seated in a reclining chair in a sound attenuated, electrically shielded, and dimly lit room. Visual stimuli were projected on a white wall.

3.2. Affective judgment tasks

3.2.1. Materials

Pictures were drawn from the IAPS (Lang et al., 1999); sounds from the International Affective Digitized Sounds (IADS; Bradley & Lang, 1999b); and words from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999a). Stimuli were chosen by dividing each collection into 11 categories on the basis of their normative valence ratings, and randomly drawing 6 stimuli from each category, yielding sets of 66 pictures, sounds, and words (Table 1).[1]

3.2.2. Procedure

Pictures, sounds, and words were presented as separate tasks. Audiovisual instructions informed participants that they would see (or hear) stimuli that differed in emotional content, that they should attend to each stimulus for the entire time it was presented, and should think about how each stimulus made them feel. Each trial consisted of a 3 s fixation point, 6 s stimulus presentation, 3 s fixation point, and two self-paced ratings. First, participants rated their positive and negative reactions to the stimulus using the evaluative space grid, a 5×5 grid that allows for independent assessments of positivity (horizontal axis) and negativity (vertical axis; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009). Participants are instructed to move the mouse to one of the cells in the grid to indicate their positive and negative feelings. The *x*- and *y*-coordinates of responses provide scores on two 5-point unipolar scales, ranging from 0 (*not at all positive* or *not at all negative*) to 4 (*extremely positive* or *extremely negative*), which reflect independent measures of positivity and negativity. Second, participants rated how arousing they found the stimulus on a 9-point scale ranging from 1 *(low arousal)* to 9 *(high arousal)*.

The same stimuli were presented in different random orders in Session 1 and Session 2; all participants viewed the stimuli in the same order within a session. Task order in Session 1 was words, pictures, then sounds; in Session 2, sounds, pictures, then words.

3.3. Personality inventories

To examine the independence of our judgment-based measures and traditional inventory-based measures (Hypothesis 2), we selected a set of personality surveys that assess emotional processes.

[1] IAPS stimuli numbers: 1052, 1121, 1274, 1660, 1710, 1750, 1930, 2050, 2057, 2208, 2340, 2661, 2800, 3100, 3130, 3160, 3250, 3261, 3400, 4000, 4004, 4230, 4302, 4520, 4534, 4571, 4598, 4641, 4656, 4680, 4770, 4800, 5300, 5731, 5910, 5920, 5971, 5972, 6150, 6260, 6561, 6610, 6930, 7002, 7006, 7010, 7050, 7217, 7430, 7460, 7600, 8060, 8080, 8185, 8210, 8260, 8311, 8370, 8460, 8501, 9102, 9500, 9520, 9560, 9570, and 9810. IADS stimuli numbers: 105, 106, 109, 110, 111, 112, 113, 116, 120, 130, 132, 133, 152, 171, 201, 202, 205, 206, 215, 216, 220, 221, 226, 230, 251, 252, 261, 262, 280, 290, 292, 310, 319, 320, 322, 325, 351, 353, 358, 360, 361, 380, 400, 403, 420, 422, 425, 500, 501, 502, 602, 625, 700, 701, 702, 706, 708, 709, 711, 722, 725, 730, 802, 810, 815, and 826. ANEW stimuli numbers: 005, 016, 069, 077, 112, 152, 167, 198, 206, 212, 241, 261, 301, 335, 337, 385, 391, 393, 394, 403, 423, 424, 433, 435, 437, 438, 447, 456, 472, 478, 482, 486, 498, 503, 530, 541, 549, 570, 571, 573, 638, 644, 664, 675, 677, 682, 683, 731, 734, 743, 757, 758, 759, 772, 777, 829, 845, 854, 878, 884, 890, 897, 908, 958, 964, and 979.

Table 1
Mean normative valence ratings and mean normative arousal ratings for all stimulus categories.

Category	Pictures (IAPS)		Sounds (IADS)		Words (ANEW)	
	Valence	Arousal	Valence	Arousal	Valence	Arousal
Very unpleasant	1.52 (0.25)	6.53 (0.60)	2.29 (0.13)	7.19 (0.79)	1.50 (0.03)	6.81 (0.66)
Quite unpleasant	2.31 (0.22)	6.04 (0.73)	2.73 (0.21)	7.12 (0.79)	2.15 (0.03)	5.88 (0.69)
Moderately unpleasant	2.91 (0.11)	5.89 (0.76)	3.31 (0.14)	5.90 (0.84)	2.85 (0.03)	4.84 (1.41)
Somewhat unpleasant	3.59 (0.20)	5.61 (1.03)	3.95 (0.27)	5.84 (0.41)	3.58 (0.03)	5.46 (0.60)
Mildly unpleasant	4.40 (0.17)	4.90 (1.15)	4.50 (0.13)	5.13 (0.94)	4.31 (0.03)	4.56 (0.57)
Neutral	5.01 (0.06)	2.70 (0.44)	5.05 (0.09)	4.65 (1.28)	5.00 (0.00)	3.72 (0.48)
Mildly pleasant	5.59 (0.11)	4.70 (1.35)	5.59 (0.09)	4.30 (0.66)	5.71 (0.02)	5.26 (0.65)
Somewhat pleasant	6.39 (0.22)	5.29 (0.68)	6.18 (0.11)	5.40 (0.83)	6.43 (0.03)	4.86 (0.57)
Moderately pleasant	7.11 (0.17)	5.25 (0.66)	6.48 (0.40)	5.39 (1.67)	7.14 (0.02)	4.30 (1.13)
Quite pleasant	7.69 (0.11)	6.47 (0.59)	7.21 (0.11)	5.90 (0.78)	7.84 (0.03)	6.48 (1.43)
Very pleasant	8.45 (0.18)	4.92 (0.63)	7.84 (0.28)	6.16 (0.99)	8.51 (0.04)	6.38 (0.90)

Note. Standard deviations are presented in parentheses. Normative valence ratings are based on a bipolar scale ranging from 1 (*very unpleasant*) to 9 (*very pleasant*), midpoint 5 (*neutral*); normative arousal ratings are based on a scale ranging from 1 (*low arousal*) to 9 (*high arousal*).

Among those surveys chosen, some measured negativity or avoidant/inhibitory behavior, some measured positivity or approach-oriented behavior, and some measured both types of emotional processes using separate subscales. Participants completed the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), which measures depressive symptomotology; Behavioral Inhibition System/Behavioral Activation System Scales (BIS/BAS; Carver & White, 1994); Big 5 Personality Factors, Extraversion and Neuroticism subscales (Big 5, E and N; Goldberg, 1992); Life Orientation Test – Revised (LOT-R; Scheier, Carver, & Bridges, 1994), which measures dispositional optimism; Positive and Negative Affect Schedule (PANAS; Watson et al., 1988); and the Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985), which measures subjective well-being.

3.4. Predictive validity tasks

3.4.1. Adjectives Task

To measure deliberative, self-reflective emotional processes, we used an adapted Twenty Statements Test (TST; Kuhn & McPartland, 1954). Each participant listed 20 adjectives that described herself; then indicated whether each adjective was a positive, negative, or neutral trait. Dependent variables for this task were the total numbers of self-categorized negative and positive traits listed.

3.4.2. Spatial Affect Task

To measure spontaneous, automatic affective processing, we used the Spatial Affect Task (Crawford & Cacioppo, 2002), which consists of a learning phase and a testing phase. During the learning phase, participants viewed a series of IAPS pictures as they appeared at different locations on the screen. Pictures ranged from neutral to very unpleasant (Session 1) or neutral to very pleasant (Session 2), and were chosen such that the valence means for the two sets were comparably distant from the neutral point of the valence scale, and that the arousal means for the two sets did not differ.[2] Each of 28 pictures was presented 6 times in one of 16 possible locations. Spatial distributions were constructed so that across each set there was a moderate correlation ($r = .50$) between normative valence and coordinates of one dimension of spatial location (Session 1: *y*-coordinates, such that very unpleasant pictures tended to appear at the top of the screen; Session 2: *x*-coordinates, such that very pleasant pictures tended to appear at the right of the screen). There was no correlation between valence and the irrelevant dimension of space ($r = .00$). Participants viewed all 168 presentations in a randomly generated sequence; each was displayed for 1.5 s and followed by a blank screen for 0.5 s. Participants were asked to think about how each picture made them feel.

During the testing phase, participants predicted the spatial locations of novel pictures. They were told that these new pictures were going to be included in the next version of the study and asked where they thought each of these new pictures would appear in the updated version. On each trial, one of 16 test pictures (ranging from neutral to very unpleasant in Session 1 and from neutral to very pleasant in Session 2)[3] appeared in the lower left corner of the screen; participants clicked on the location where they thought the picture would appear. We derived a measure of each participant's perception of the correlation between picture valence and the relevant dimension of space by computing two Pearson correlation coefficients: first, between the normative valence ratings of the test pictures and the *y*-coordinates of participants' responses in Session 1; second, between the normative valence ratings of the test pictures and the *x*-coordinates of participants' responses in Session 2.

3.5. Year follow-up study

Approximately a year after the completion of the original study, participants were invited to return to the lab for an additional experimental session. Twenty-eight participants[4] returned for the follow-up study, in which they completed a second version of the affective judgments task (involving pictures only) and a set of personality inventories. The affective judgments task was identical to those in the original study, but included a different set of pictures chosen such that very unpleasant and very pleasant pictures were

[2] IAPS numbers for stimuli in the negative training set: 1019, 1101, 2221, 2221, 2276, 2516, 2722, 3100, 6010, 6241, 6242, 6530, 6838, 7004, 7130, 7175, 7234, 7590, 8231, 9101, 9102, 9102, 9290, 9340, 9400, 9400, 9433, and 9830. IAPS numbers for stimuli in the positive training set: 1340, 2310, 2331, 2345, 4534, 4535, 4603, 4613, 5455, 5875, 5990, 7170, 7260, 7270, 7282, 7284, 7400, 7430, 7480, 7500, 7620, 7830, 8031, 8130, 8162, 8320, 8380, and 8600.

[3] The positive and negative test sets each contained 16 images not used in the training sets (negative test set: $M = 3.27$, $SD = 1.15$; positive test set: $M = 6.69$, $SD = 1.04$). IAPS numbers for stimuli in the negative test set: 1300, 2205, 2210, 2214, 2682, 2690, 2751, 3061, 3063, 3110, 3220, 7006, 9010, 9300, 9490, and 9912. IAPS numbers for stimuli in the positive test set: 2058, 2160, 2260, 4274, 4532, 4601, 5700, 5740, 7090, 7237, 7289, 7340, 7502, 8190, 8250, and 9156.

[4] Although a larger sample would have been preferable, it is worth noting that the follow-up study was never mentioned during the original study and was conducted approximately a year after most participants had completed the original study. It is expected that some of the original 65 participants graduated during the course of the year and additional participants left for other reasons or were unreachable (i.e., had changed their address). Thus, we believe that a 43% success rate for returning participants is explicable and reasonably representative; although it is worth mentioning that statistical tests for the follow-up study have less power due to the smaller sample size. We conducted analyses to test differences in the positivity offset, negativity bias, and personality inventories between the subset of participants who returned for the follow-up and those that did not. Only one difference emerged; follow-up participants were more optimistic (as measured by the LOT-R) than participants who did not return for the follow-up study, $F(1, 63) = 5.44$, $p = .023$. The two groups did not differ on our primary measures of the positivity offset and negativity bias.

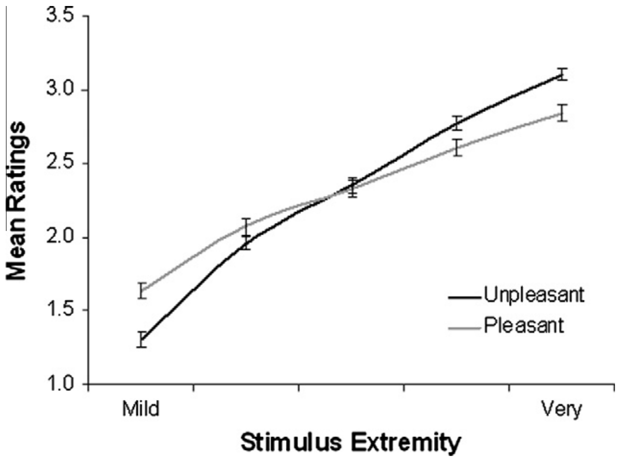

Fig. 2. Valence (unpleasant, pleasant) interacted with stimulus extremity in Study 1, such that responses were stronger to mildly pleasant than to mildly unpleasant stimuli (i.e., the positivity offset) and were stronger to very unpleasant than to very pleasant stimuli (i.e., the negativity bias), *ps* < .001.

matched not only on extremity but also on normative arousal ratings.[5] In addition to 7 very unpleasant, 7 very pleasant, and 7 neutral pictures, participants also viewed 20 filler stimuli. Following the pictures task, participants completed the Big 5 subscales for Extraversion and Neuroticism (Goldberg, 1992); the BIS/BAS scales (Carver & White, 1994); the PANAS (Watson et al., 1988); and the Curiosity and Exploration Inventory (Kashdan, Rose, & Fincham, 2004), a measure of trait exploratory behavior.

4. Results

First, we sought to replicate previous findings showing that most individuals exhibit both a positivity offset and a negativity bias in their responses to affective stimuli. The ESM predicts that the functioning of both a positivity offset and a negativity bias is evident in an interaction between valence (positivity and negativity) and extremity of input, such that at low levels of emotional input positivity outweighs negativity and at high levels of emotional input negativity outweighs positivity (Fig. 1). To examine this prediction, we conducted a 2(session: first, second) $\times$ 3(stimulus type: pictures, sounds, words) $\times$ 2(valence: unpleasant, pleasant) $\times$ 5(stimulus extremity: extending from mildly emotional to very emotional) repeated measures general linear model (GLM) on Evaluative Space Grid ratings (i.e., negative ratings of unpleasant stimuli; positive ratings of pleasant stimuli). The predicted valence $\times$ stimulus extremity interaction was significant, $F(4, 61) = 40.43$, $p < .001$ (see Fig. 2). Follow-up tests indicated that responses to mildly pleasant stimuli ($M = 1.63$) were stronger than responses to mildly unpleasant stimuli ($M = 1.31$), $p < .001$; whereas responses to very unpleasant stimuli ($M = 3.10$) were stronger than responses to very pleasant stimuli ($M = 2.84$), $p < .001$. Thus, our results replicate prior research showing a positivity offset and a negativity bias in responses to affective stimuli.[6]

Next, we sought to replicate results indicating that individual differences exist in the magnitude of both the positivity offset and the negativity bias, such that although most individuals exhibit these asymmetries, they are normally distributed in the population. An individual difference measure of the positivity offset was calculated as the difference in positive ratings and negative ratings of normatively neutral stimuli (i.e., P–N), consistent with the ESM's prediction that at low levels of input to the affect system, positivity will outweigh negativity (Norris et al., 2010). An individual difference measure of the negativity bias was measured as the difference in negative ratings of very unpleasant stimuli and positive ratings of very pleasant stimuli (i.e., N–P), again consistent with the ESM's prediction that at relatively high levels of input to the affect system, negativity will outweigh positivity (Norris et al., 2010). For each participant, individual differences in the positivity offset and negativity bias were derived separately for the three tasks and for both sessions. Importantly, these measures are calculated using different stimuli; this method produces conceptually independent measures that also allow us to examine the relationship between the positivity offset and negativity bias.[7]

We examined whether most participants exhibited a positivity offset and negativity bias using aggregate measures collapsed across sessions and tasks.[8] One sample *t*-tests indicated that on average, both the positivity offset ($M = 0.27$) and the negativity bias ($M = 0.26$) were greater than zero, $t(64) = 5.89$ and 6.46, $ps < .001$. Fig. 3a shows that 49 of 65 participants exhibited a positivity offset, indicating greater positive than negative affect in response to neutral stimuli. Similarly, 55 of 65 participants exhibited a negativity bias, indicating stronger responses to very negative stimuli than to equally positive stimuli. As shown in Fig. 3a, the positivity offset and negativity bias were uncorrelated, $r(63) = -.18$, $p = .14$, suggesting that they are independent features of affective processing.

To replicate and extend previous findings regarding the temporal stability of the positivity offset and negativity bias, we examined test–retest correlations across experimental sessions separated by two weeks. Correlations along the diagonal in Table 2 indicate that both the positivity offset and negativity bias exhibited moderate temporal stability over a 2-week interval; the median test–retest correlation for the positivity offset was $r(63) = .54$, and for the negativity bias, $r(63) = .56$, $ps < .001$. Therefore, the positivity offset and negativity bias are somewhat stable over time and appear to represent individual differences in affective processing rather than state-dependent responses.

Hypothesis 1: Generalizability of the Negativity Bias and Positivity Offset

The first novel hypothesis that we sought to test concerned the generalizability of the positivity offset and negativity bias. The ESM suggests that the positivity offset and negativity bias

[5] IAPS stimuli numbers: 1230, 1850, 1900, 1942, 2110, 2190, 2209, 2216, 2312, 2590, 2700, 3190, 3230, 3301, 4100, 4532, 4536, 4606, 5740, 5890, 5990, 6010, 6570, 6571, 7000, 7004, 7100, 7175, 7289, 7330, 7390, 7502, 7950, 8190, 8496, 9040, 9110, 9180, 9253, 9400, and 9440.

[6] Other effects were significant in this omnibus GLM; in this limited space we focus on the interaction of primary theoretical interest. It is important to note, however, that the 4-way interaction between session, stimulus type, valence, and stimulus extremity was significant, $F(8, 57) = 3.63$, $p = .002$. To examine the critical valence $\times$ stimulus extremity interaction for each session and stimulus type, we conducted 2(valence) $\times$ 5(stimulus extremity) GLMs on ratings of pictures, sounds and words separately for Session 1 and Session 2; the valence $\times$ stimulus extremity interaction was significant at $p < .001$ in each of these six analyses.

[7] The ESM conceptualizes the positivity offset and negativity bias as differences in slopes and intercepts of the activation functions for positivity and negativity, so it makes sense that slopes and intercepts from regression equations have been used to index the positivity offset and negativity bias in a previous study (Ito & Cacioppo, 2005). When observations are constrained to finite scales (e.g., rating scales), however, steeper slopes impose lower intercepts. In other words, slopes and intercepts are algebraically dependent. For instance, an individual with a relatively steep activation function for negativity would also have a relatively low intercept for negativity. Thus, those who are quantified as having a strong negativity bias would also be quantified as having a strong positivity offset. In other words, this makes it difficult to investigate the relationship between the positivity offset and negativity bias, or their independent effects on behavior. By calculating differences in emotional reactivity at low and high levels of stimulus intensity, we developed measures of the positivity offset and negativity bias that allow for a thorough examination of their relationship and their behavioral consequences.

[8] Measures were aggregated for this statistical test in order to increase reliability and for the sake of brevity. One sample *t*-tests conducted on raw measures (i.e., for each task and session) revealed similar results; median tests for the positivity offset and negativity bias, $ts(64) = 4.32$ and 3.11, respectively, $ps < .01$.

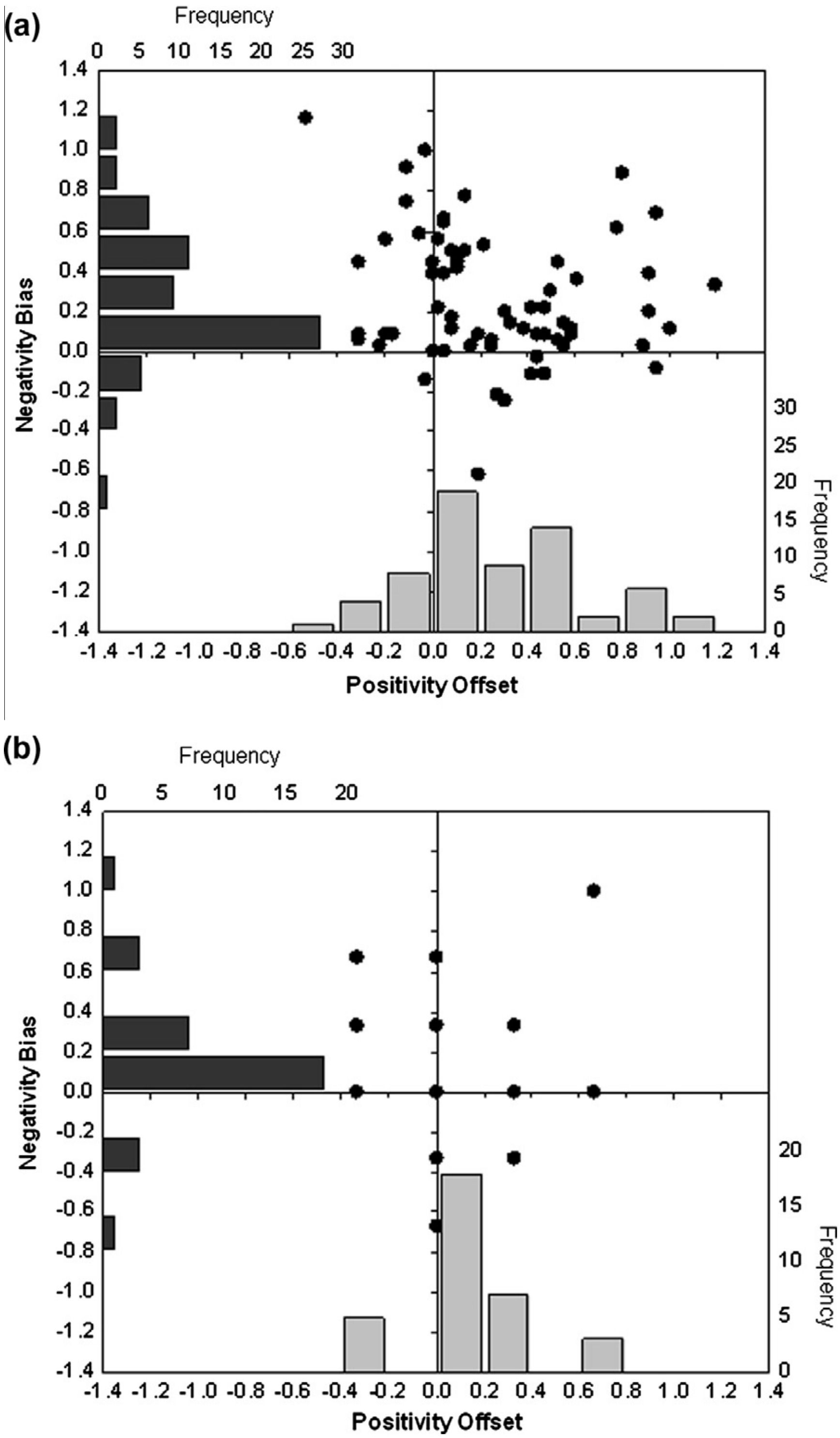

Fig. 3. Histograms of the aggregate measures of the negativity bias and positivity offset and a scatterplot depicting their relationship in Study 1 (3a) and Study 2 (3b). Most participants exhibited a negativity bias in both studies. The negativity bias and positivity offset were uncorrelated, $r(63) = -.18$ in Study 1 (3a) and $r(31) = .05$ in Study 2 (3b), $ps > .10$.

are general asymmetries in affective processing and will therefore emerge in judgments of stimuli that differ in modality and type, such as pictures, sounds and words. We examined the generalizability of the positivity offset and negativity bias by correlating measures of the positivity offset and negativity bias obtained from judgments of pictures, sounds and words, collapsed across sessions. Table 2 shows that both the positivity offset and the negativity bias generalized across tasks; the median cross-task correlation for the positivity offset was $r(63) = .46$, $p < .001$, and for the negativity bias, $r(63) = .30$, $p = .015$. Thus, the positivity offset and negativity bias are general asymmetries in affective processing that correlate across different stimulus types and modalities.

Hypothesis 2: Discriminant Validity of Judgment-based and Inventory-based Measures of Affective Processes

Table 2
Test–retest and cross-task correlations of the positivity offset and negativity bias.

Measure	1	2	3	4	5	6
	(n = 65)					
Positivity offset						
1. Pictures	(.54*)	.31*	.46*	−.03	−.06	−.20
2. Sounds		(.78*)	.54*	−.09	−.19	−.06
3. Words			(.52*)	−.02	−.17	−.14
Negativity bias						
4. Pictures				(.70*)	.30*	.17
5. Sounds					(.32*)	.40*
6. Words						(.56*)

Note. Test–retest correlations are presented in parentheses.
* $p < .05$.

The second novel hypothesis that we sought to test in Study 1 concerned the relationship between our judgment-based measures of affective processing (i.e., positivity offset, negativity bias) and inventory-based measures (e.g., extraversion, neuroticism, BIS/BAS). Two of nine personality inventories were significantly correlated with the positivity offset: individuals with strong positivity offsets also scored higher on the Satisfaction with Life Scale (SWLS), $r(63) = .38$, $p = .002$, indicating greater levels of subjective happiness; and scored lower on the Neuroticism subscale of the Big 5, $r(61) = -.33$, $p < .05$ (Table 3). The negativity bias was not significantly correlated with any of the personality inventories. Thus, individual differences in the positivity offset and negativity bias are not redundant with inventory-based measures of affective dimensions of personality.

Hypothesis 3: Differential Predictive Validity of Judgment-based and Inventory-based Measures of Affective Processes

Finally, we predicted that although both judgment-based and inventory-based measures will predict behavior, they will do so for different types of tasks and will therefore provide complementary approaches to the understanding of individual differences in affect. We hypothesized that inventory-based measures would be better predictors of how individuals describe themselves on the Adjectives Task; whereas the judgment-based measures of the positivity offset and negativity bias would be better predictors of implicit learning on the Spatial Affect Task.

We first sought to determine whether inventory-based measures predicted self-reflective behavior – specifically, how individuals describe themselves on the Adjectives Task. Individuals with more positive affective styles – those who report being more optimistic, experiencing more positive affect, responding more strongly to rewards and generally being happier – may focus on their positive features and list more positive self-descriptive traits. On the other hand, pessimistic individuals – those who report being more pessimistic, experiencing more negative affect, responding more strongly to punishments, and generally being less happy – may focus on their negative features and list more negative self-descriptive traits. Pearson correlations between scores on inventory-based measures and the numbers of positive and negative traits listed on the Adjectives Task revealed that the BDI, BAS, BIS, E, N, LOT, PA, and SWLS predicted the number of positive and/or negative adjectives that participants listed (see Table 4). Participants with lower self-reported levels of traits associated with positive emotional functioning and higher self-reported levels of traits associated with negative emotional functioning listed more negative adjectives about themselves; whereas individuals with higher self-reported levels of positive traits and lower self-reported levels of negative traits listed more positive adjectives about themselves. Furthermore, only one correlation between the judgment-based measures and the Adjectives Task was significant; participants with a low positivity offset tended to list more negative personal attributes, $r(59) = -.30$, $p = .02$.

None of the inventory-based measures, however, predicted performance on the Spatial Affect Task (see Table 4). Next, we examined whether judgment-based measures (i.e., negativity bias, positivity offset) predicted implicit learning on the Spatial Affect Task. Individuals with a high, relative to low, negativity bias are more sensitive to increases in negativity and may therefore map negative stimuli across a larger range, making them especially proficient at learning the correlation between negativity and spatial location. In contrast, individuals with a high, relative to low, positivity offset respond positively to neutral stimuli and therefore map positive stimuli across a smaller range, making them *less*

Table 4
Pearson correlations between reactivity measures, personality inventories, and Predictive Validity Tasks.

	Adjectives Task		Spatial Affect Task	
	Negative traits	Positive traits	$r_{\text{Neg \& } y}$	$r_{\text{Pos \& } x}$
Judgment-based measures				
Negativity bias	.15	−.09	.28*	.01
Positivity offset	−.30*	.07	.04	−.28*
Inventory-based measures				
BDI	.36*	−.40*	−.18	−.03
BAS	−.40*	.26*	−.16	.12
BIS	.31*	−.36*	−.05	.08
Extraversion (E)	−.50*	.45*	.03	.06
Neuroticism (N)	.33*	−.25*	−.09	.12
Optimism (LOT-R)	−.32*	.45*	.20	.19
Negative affect (NA)	.25	−.22	−.20	.08
Positive affect (PA)	−.31*	.09	.06	−.19
Satisfaction with life (SWLS)	−.41*	.47*	.15	−.04

* $p < .05$.

Table 3
Correlations between inventory-based and judgment-based measures of affective dimensions of personality. NB = negativity bias; PO = positivity offset.

	2	3	4	5	6	7	8	9	NB	PO
(n = 65)[a]										
1. Depressive symptoms (BDI)	.04	.55*	−.31*	.62*	−.64*	.44*	−.05	−.47*	.10	−.19
2. BAS		.12	.56*	.07	.14	−.16	.27*	.15	−.19	.09
3. BIS			−.23	.63*	−.46*	.35*	−.04	−.28*	.07	−.08
4. Extraversion (E)				−.31*	.42*	−.12	.40*	.38*	−.13	.01
5. Neuroticism (N)					−.55*	.43*	−.08	−.48*	.12	−.33*
6. Optimism (LOT-R)						−.37*	.13	.75*	−.02	.17
7. Negative affect (NA)							.28*	−.27*	.08	-.22
8. Positive affect (PA)								.18	−.16	.22
9. Satisfaction with life (SWLS)									.04	.38*

Note. Positivity offset and negativity bias measures are collapsed across sessions and tasks. Scales that were administered in both sessions are collapsed across sessions.
[a] Except for correlations involving Extraversion (E) and Neuroticism (N), for which N = 63.
* $p < .05$.

proficient at learning the correlation between positivity and spatial location.

Providing a within-participants replication of Crawford and Cacioppo (2002), participants showed an overall negativity bias on the Spatial Affect Task, such that they learned the relationship between negativity and space ($M = .39$) better than the relationship between positivity and space ($M = .22$), $t(54) = 2.95$, $p = .005$. More importantly, participants with a high negativity bias learned the correlation between negativity and space better than individuals with a low negativity bias, $r(55) = .28$, $p = .034$ (see Table 4, Fig. 4); and participants with a high positivity offset learned the relationship between positivity and space to a lesser degree than did participants with a low positivity offset, $r(56) = -.28$, $p = .035$. Further, consistent with the functional separability of positivity and negativity, the positivity offset did not predict performance on the negative version of the task, $r(55) = .04$, $p = .77$, and the negativity bias did not predict behavior on the positive version of the task, $r(56) = .01$, $p = .95$ (see Fig. 4).

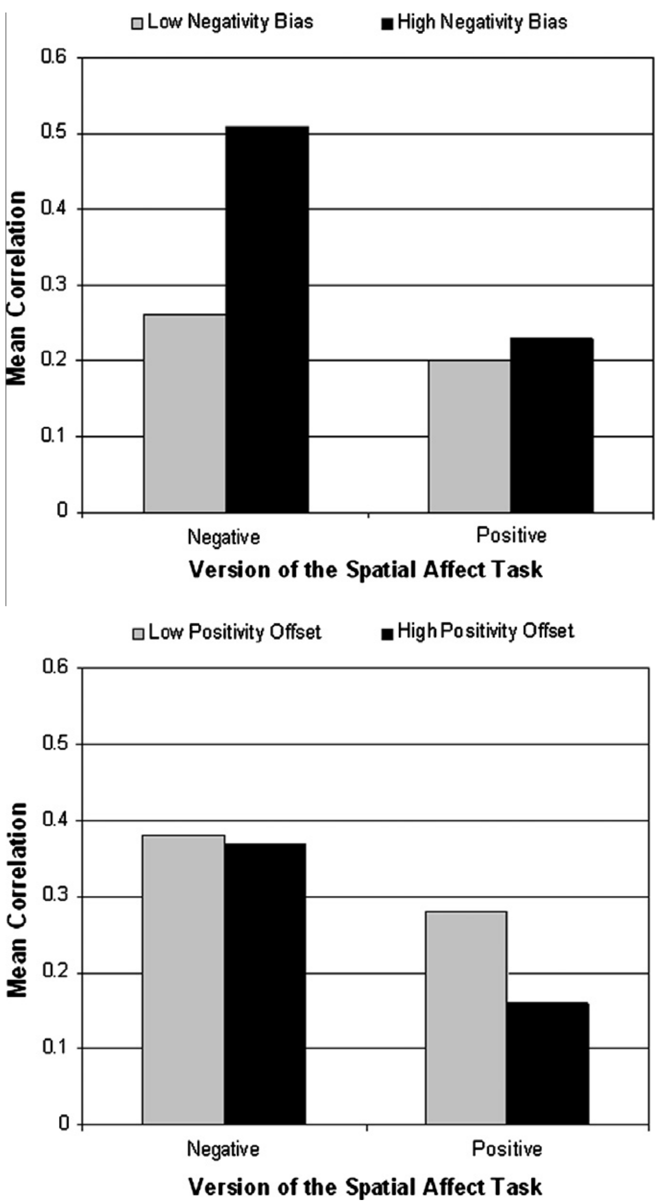

Fig. 4. The negativity bias (top panel) and positivity offset (bottom panel) predict behavior on the Spatial Affect Task. All participants viewed neutral to very unpleasant pictures in Session 1 and neutral to very pleasant pictures in Session 2. Results are presented as median splits for ease of interpretation.

4.1. Follow-up: replication of the positivity offset and negativity bias

At the 1-year follow-up, participants exhibited both a positivity offset, $t(27) = 5.13$, $p < .001$, and a negativity bias, $t(27) = 6.64$, $p < .001$, in their responses to emotional pictures.[9] Furthermore, both the positivity offset and the negativity bias exhibited significant temporal stability over a 12-month test–retest interval, $rs(26) = .31$ and $.37$, $p = .055$ and $.03$, respectively. Finally, as in the initial testing period, the positivity offset and negativity bias were not significantly correlated with each other, $r(26) = .01$, nor with any of the inventory-based measures used in the follow-up study, median $r(26) = -.01$, all $ps > .10$. In sum, results from the follow-up study replicated and extended our original findings regarding the psychometric properties of the positivity offset and negativity bias.

5. Discussion

Results from Study 1 replicate previous findings (Ito & Cacioppo, 2005) showing that individuals respond more strongly to mildly pleasant than to mildly unpleasant stimuli (i.e., a positivity offset), and respond more strongly to very unpleasant than to very pleasant stimuli (negativity bias). Extending these findings, the positivity offset and negativity bias were observed regardless of the type or modality of stimulus (pictures, sounds, words), and in fact correlated across different kinds of stimuli, suggesting that the positivity offset and negativity bias are general affective processing asymmetries. Furthermore, individual differences in both the positivity offset and negativity bias were somewhat stable over time, whether across 2 weeks or a year. Taken together, these psychometric characteristics support our conclusions that the positivity offset and negativity bias are stable, general individual differences in affective reactivity.

The identification of stable individual differences in positivity offset and negativity bias is especially interesting because they were found to predict different behaviors than predicted by traditional inventory-based personality measures. The positivity offset and negativity bias were generally unrelated to traditional personality measures, suggesting that our judgment-based measures may be indexing a different aspect of individual differences in emotional processes. More importantly, whereas inventory-based measures predicted behavior on a self-reflective task (i.e., how participants described themselves with twenty adjectives); the judgment-based measures of the positivity offset and negativity bias predicted behavior on a task requiring the incidental learning of a relationship between space and affect.

Finally, Study 1 showed that the negativity bias and positivity offset are uncorrelated and functionally independent. Importantly, this independence of the negativity bias and positivity offset allowed us to investigate their differential effects on behavior, leading to the finding that the negativity bias predicts better learning of negative contingencies, whereas the positivity offset predicts worse learning of positive contingencies. It is worth noting that inventory-based measures of affective processes did not exhibit the same independence in predicting behavior; personality scales measuring positive emotional traits (e.g., PA, SWLS) and negative emotional traits (NA, BDI) were equally predictive of behavior on the Adjectives Task, such that participants with lower levels of positive traits and higher levels of negative traits listed more negative adjectives, whereas participants with higher levels of positive traits and lower levels of negative traits listed more positive adjectives. Thus, researchers interested in studying the differential

[9] Because all analyses in the follow-up study and in Study 2 constitute replications from Study 1, one-tailed tests are used throughout.

consequences of negative and positive emotional traits for behavior may find judgment-based measures useful.

Furthermore, the independence of the negativity bias and positivity offset in predictions of behavior may shed light on the processes that underlie emotional disorders, such as depression and anxiety. For example, Shook, Fazio, and Vasey (2007) have shown that individuals that display a negative learning bias in attitude formation exhibit more depressive symptoms, consistent with our suggestion that the negativity bias may have consequences for affective disorders (Norris et al., 2010), as well as the more general idea that performance-based measures may provide a more efficient route to the prediction of psychopathology (MacLeod, 1993).

6. Study 2

Although Study 1 provided evidence that individuals tend to exhibit asymmetries in how they process positive and negative stimuli, a number of issues remain. First and most importantly, we used normative ratings of pleasant and unpleasant pictures, sounds, and words to ensure they were matched with respect to their extremity. Such emotional stimuli, however, do not have objective values and may differ on dimensions not matched in the current study (e.g., luminance, content; but see Norris & Cacioppo, 2010). Thus, we sought to replicate findings from Study 1 using emotional stimuli with clear objective value – monetary outcomes (see Taylor, 1991). Harinck, Van Dijk, Van Beest, and Mersmann (2007) found that emotional responses were stronger when games of chance (e.g., a coin toss) result in very small wins (e.g., €0.10 or €0.20) than in equally small losses, consistent with the functioning of a positivity offset. In addition, Harinck and his colleagues (2007) replicated typical loss aversion findings at higher levels of outcomes, such that large losses (e.g., €50) produce stronger emotional responses than do large wins. We adapted their paradigm to examine individual differences in the positivity offset and negativity bias using stimuli with objectively matched values.

A second potential issue with Study 1 is the use of the Evaluative Space Grid for indexing emotional responses. Although the ESG has been well-validated (Larsen et al., 2009), one might argue that observed asymmetries are simply a product of this new measure that allows for independent ratings of positivity and negativity. To address this issue in Study 2, we simply asked participants to indicate the *intensity* of their responses to each outcome without indicating the valence of those responses (McGraw, Larsen, Kahneman, & Schkade, 2010). Replicating findings from Study 1 using this new dependent measure would further strengthen our claims that the positivity offset and negativity bias are processing asymmetries that emerge in responses to multiple stimuli, and are not merely due to stimulus selection or measurement biases.

7. Method

Thirty-three (23 female) undergraduates at Dartmouth College participated for money ($10/h) or course credit. All participants gave informed consent according to the Committee for the Protection of Human Subjects at Dartmouth.

7.1. Coin toss task

Following Harinck et al. (2007), participants were told that they would either win or lose money based on the toss of a coin. Instructions for the task read: "Imagine that you are placing bets on the outcomes of a series of coin tosses. In other words, suppose you have a certain amount of money ($10) riding on a coin toss - heads you win $10, tails you lose $10. How would you feel if you LOST $10 on the bet?" On each trial participants were told to imagine that they had a bet riding on a coin toss and were then told whether the toss came up heads (i.e., a win) or tails (a loss). The experiment had a 2(outcome: loss, gain) x 8(magnitude: $1, $5, $10, $25, $50, $75, $100, $150) design, with both factors manipulated within participants.[10] After each trial participants responded to the question "How strong of an effect does the coin toss have on your emotions?" using a 5-point scale ranging from *no effect* (1) to *a very large effect* (5).

7.2. Personality inventories

Personality measures were chosen to both replicate and extend findings from Study 1. Participants completed the Affect Intensity Measure (AIM; Larsen, 1984), which measures intensity of emotional responses without regard to valence; BIS/BAS (Carver & White, 1994); Big 5 Personality Factors, all subscales (Big 5; Goldberg, 1992); LOT-R (Scheier et al., 1994); PANAS (Watson et al., 1988); SWLS (Diener et al., 1985); Spielberger State/Trait Anxiety Scale (STAI; Spielberger, Gorsuch, & Lushene, 1970); and the UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980).

8. Results

As in Study 1, the ESM predicts that the functioning of both a positivity offset and a negativity bias is evident in an interaction between valence (positivity and negativity) and extremity of input, such that at low levels of emotional input positivity outweighs negativity and at high levels of emotional input negativity outweighs positivity (Fig. 1). We conducted a 2(outcome: loss, gain) × 8(magnitude: $1, $5, $10, $25, $50, $75, $100, $150) GLM on intensity ratings from the coin toss task to examine this interaction. The main effect of magnitude was significant, $F(7, 26) = 100.63$, $p < .001$, and indicated that intensity ratings increased as a function of magnitude of outcome (all pairwise comparisons significant at $p < .01$). More importantly, the outcome × magnitude interaction was significant, $F(7, 26) = 2.76$, $p = .028$. Follow-up *t*-tests indicated that the intensity of winning $1 ($M = 1.75$) outweighed that of losing $1 ($M = = 1.67$), $p = .05$; whereas the intensity of losing $150 ($M = 4.75$) outweighed that of winning $150 ($M = 4.64$), $p = .03$. For each participant we calculated a positivity offset as the intensity of responses to $1 wins minus $1 losses; and the negativity bias as the intensity of responses to $150 losses minus $150 wins. As expected, individual differences in the positivity offset and negativity bias were again uncorrelated, $r(31) = .05$, $p = .78$ (see Fig. 3b), replicating Study 1. Finally, individual differences in the positivity offset and negativity bias as calculated on the coin toss task were not correlated with any of the personality inventories, all $ps > .05$, providing further evidence that our judgment-based measures of emotional responses are independent from traditional self-reflective measures.

9. Discussion

In Study 2 we both replicated and extended our previous findings regarding individual differences in the positivity offset and negativity bias. Using stimuli with objectively matched values (i.e., gains and losses of set amounts), we again found evidence that positivity outweighs negativity at low levels of affective input (e.g., loss/gain of $1) and that negativity outweighs positivity at higher levels of affective input (e.g., loss/gain of $150). The use of stimuli

[10] Note that this is a departure from Harinck et al. (2007) who manipulated outcome between participants. We were required to manipulate outcome within participants in order to examine individual differences in responses to gains versus losses.

with objectively equivalent values supports our claim that these affective asymmetries are not due to differential input to the affect system; arguably, a gain of $5 and a loss of $5 are simply the same input ($5) presented to different underlying systems (those of positivity and negativity, respectively). Rather, the positivity offset and negativity bias are differences in the output of the affect system. Furthermore, the replication of findings from Study 1 using a different response scale (i.e., intensity ratings instead of the Evaluative Space Grid) argues that observed asymmetries are not merely measurement artifacts and in fact are observed regardless of the response format. In sum, the positivity offset and negativity bias are robust asymmetries in affective processing that emerge in responses to different types of stimuli (e.g., pictures, sounds, words, games of chance) that have been matched on extremity, and are not specific to particular measurement approaches.

10. General discussion

The current studies demonstrated that individuals on average exhibit both a positivity offset and a negativity bias in their responses to affectively evocative stimuli (see also Cacioppo et al., 1997; Ito & Cacioppo, 2005). In other words, people tend to feel somewhat more positive than negative about very mildly emotional stimuli, potentially facilitating approach behavior and motivating exploration of the world around them; whereas people tend to feel somewhat more negative about very unpleasant stimuli than they feel positive about very pleasant stimuli, which protects them from danger by promoting both vigilance for and strong responses to aversive stimuli. Furthermore, we have shown that there are robust individual differences in the magnitudes of both the positivity offset and negativity bias that generalize across different types of stimuli; are somewhat stable over time, including up to a year test–retest interval; and predict behavior in meaningful ways.

Both the positivity offset and the negativity bias were generally unrelated to more traditional inventory-based measures of affective dimensions of personality (e.g., neuroticism, optimism). Although on one hand this pattern of results demonstrates the discriminant validity of our judgment-based measures (e.g., the negativity bias is not simply a manifestation of neuroticism), it raises the question of why more convergence was not observed. First, it is worth noting that the two significant relationships that emerged between our judgment-based measures and inventory-based measures are consistent with predictions: the positivity offset was positively correlated with scores on the Satisfaction with Life scale and was negatively correlated with Neuroticism. Second, much existing research suggests that – for multiple reasons – convergent relationships between more implicit (i.e., judgment-based) and explicit (inventory-based) measures may not be expected. In the race bias literature, few studies have found strong relationships between implicit and explicit measures. Dovidio and his colleagues (1997) reported correlations between response latency measures of bias and explicit prejudice that ranged from nonsignificant (Studies 1 and 3; median $r = .03$) to moderate (Study 2; median $r = .42$). Similarly, the Implicit Association Test (IAT; Greenwald et al., 1998), a widely-used response latency-based implicit measure, has been shown to be unrelated to explicit self-report measures (e.g., Greenwald et al., 1998), but also to be strongly related (Greenwald et al., 2003; $r = .86$). The moderating factor of these relationships appears to be that of social desirability: when participants report on attitudes toward Blacks or other social groups for whom society has dictated acceptable responses, relationships between implicit and explicit measures tend to be weak; whereas when participants report on attitudes that are not subject to such biases (e.g., preference for a political candidate; Greenwald et al., 2003), relationships can be much stronger. Although we do not believe that social desirability concerns are driving the lack of observed relationships between judgment- and inventory-based measures in the current studies, it is likely that the absence of strong relationships may be in part attributable to the nature of the measure. As we have previously argued, inventory-based measures reflect deliberative, self-reflective responses (e.g., how individuals describe themselves, how individuals predict their responses in hypothetical situations), whereas judgment-based measures reflect spontaneous, automatic responses (e.g., physiological responses, attention to emotional stimuli). Thus, it is not surprising that inventory- and judgment-based measures of affective dimensions of personality show so little convergence.

More importantly, the current study demonstrated the differential predictive validity of judgment-based and inventory-based measures, such that the positivity offset and negativity bias predicted the incidental learning of an association between affect and spatial location; whereas personality inventories predicted the extent to which individuals described themselves with positive and negative traits. Importantly, judgment-based measures did not generally predict performance on the Adjectives Task and inventory-based measures did not predict performance on the Spatial Affect Task, suggesting that both types of measures account for unique variance. These results indicate that inventory-based measures may predict responses on tasks that require introspection, self-reflection, or explicit memory retrieval; whereas judgment-based measures may predict performance on tasks that more directly tap affective processes, including attentional biases (Pratto & John, 1991; Öhman, Flykt, & Esteves, 2001) and implicit memory, in addition to incidental learning (Crawford & Cacioppo, 2002). In other words, both how we feel and how we think we feel contribute to behavior and can therefore shed light on individual differences in emotion.

The current studies also demonstrate the correlative and functional independence of the positivity offset and negativity bias. The positivity offset and negativity bias were uncorrelated in all studies and predicted different aspects of incidental learning on the Spatial Affect Test. Whereas the negativity bias predicted learning the spatial location of negative stimuli, the positivity offset predicted poorer learning of the spatial location of positive stimuli. Importantly, the negativity bias did not predict learning on the positive version of the Spatial Affect Task and the positivity offset did not predict learning on the negative version of the Spatial Affect Task, indicating that these two constructs are functionally independent.

Individuals characterized by a large negativity bias rate neutral stimuli similarly but rate very negative stimuli more extremely than individuals characterized by a small negativity bias. That is, the larger individuals' negativity biases are, the larger the range across which they map neutral to negative stimuli. Accordingly, the larger the negativity bias, the better the incidental learning of the spatial location of negative stimuli. Individuals characterized by a large positivity offset, in contrast, rate neutral and weak stimuli more positively but strongly affective stimuli comparably to individuals characterized by a small positivity offset. Thus, the larger individuals' positivity offsets are, the smaller the range across which they map neutral to positive stimuli. Accordingly, the larger the positivity bias, the poorer the incidental learning of the spatial location of positive stimuli. If the negativity bias and positivity offset reflected only rating biases rather than differences in affective reactivity, then the observed differences in incidental learning would not be expected.

Recent research by Williams and her colleagues (2010) has begun to explore the possible genetic mechanisms contributing to individual differences in the negativity bias, as well as more general neural responses to emotional stimuli. Specifically, they examined the effects of the catechol-O-methyltransferase (COMT) Val108/158Met polymorphism, which is involved in dopamine and norepinephrine catabolism, on brain function using functional magnetic resonance imaging (fMRI). More COMT Met alleles predicted increased activation of regions associated with emotional reactivity (e.g., amygdala, basal ganglia, medial prefrontal cortex [PFC]) to unmasked fear faces, and decreased activation of the same regions to unmasked happy faces. This pattern of neural activity predicted a greater negativity bias (measured via a battery of inventories), which in turn predicted greater depression, anxiety, and stress. The authors conclude that the COMT Met allele may modulate patterns of neural activation in response to emotional (and, notably, differently for negative and positive) stimuli, giving rise to a negativity bias, which may ultimately predispose individuals to affective disorders like depression and anxiety. This initial research hints at a possible genetic mechanism contributing to the negativity bias; additional studies are necessary to understand environmental contributions, as well as gene-environment interactions. Finally, given the functional independence of the negativity bias and positivity offset, other neuromodulatory gene polymorphisms may affect the magnitude of the positivity offset and should be examined in future studies.

The work by Williams and her colleagues is also notable in that it sheds some light on the possible neural systems underlying biases in affective processing, which may ultimately contribute to our understanding of the processes involved in the negativity bias and positivity offset. The involvement of the limbic system (e.g., amygdala) in emotional responses is well-documented (cf. Davis & Whalen, 2001) and increased basal ganglia activity in response to negative stimuli (e.g., fear faces) is consistent with greater motor control and motivation when responding to a potentially harmful (versus beneficial) stimulus. Research using event-related brain potentials (ERPs) has also unveiled potential processes implicated in the negativity bias. In particular, Smith and his colleagues (Smith, Cacioppo, Larsen, & Chartrand, 2003) have shown a negativity bias as early as 120 ms post-stimulus onset, such that unpleasant pictures elicit a larger P1 component than do equally extreme and arousing pleasant pictures. A similar pattern has been observed for the P200 component, such that unpleasant stimuli elicit higher amplitude and shorter latency P200s than do neutral and pleasant stimuli (Carretié, Mercado, Tapia, & Hinojosa, 2001). Both the P1 and the P200 are components of the ERP waveform associated with attentional processes; thus, the negativity bias emerges quite early in affective information processing. Additional studies using measures such as fMRI and ERPs will further elucidate the mechanisms underlying the negativity bias and positivity offset, as well as individual differences in each.

Finally, our results are consistent with recent theoretical developments regarding the Model of Evaluative Space, and the affect system more generally. We have recently argued that one functional characteristic of the affect system is that of affective calibration (Norris et al., 2010). Specifically, to maintain flexibility in multiple contexts and ecological niches, the affect system may have evolved to function in ways similar to the visual system, such that affective processes may adapt to differing emotional contexts much as the eye adapts to contexts differing in brightness. When entering a darkened room from a bright summer day the pupil must adjust (i.e., dilate) to the new environment in order to remain sensitive to small changes in light. This adjustment is performed automatically, and allows us to catch enough light to sustain vision; but also comes at a cost, as image quality is sacrificed. According to the ESM's recalibration postulate (Norris et al., 2010), the affect system performs the same kind of calibration as a function of different emotional contexts (see Kahneman, 1999, for a similar argument). Supportive evidence comes from the large literature documenting contrast effects in affective judgments and recent evidence for contrast effects in facial electromyographic activity (Larsen & Norris, 2009). In combination with the positivity offset and negativity bias, recalibration will ensure that an individual remains curious with respect to novel stimuli but vigilant for aversive stimuli regardless of whether the environment as a whole is generally safe and familiar or dangerous and unknown. One functional consequence is that the affect system will "calibrate" to produce both of these biases, regardless of the actual emotional tenor of a situation. Although the findings that the average participant in our studies demonstrated a positivity offset and negativity bias do not provide direct tests of the recalibration postulate, they are consistent with it.

In sum, individual differences in affective processing may have broad implications for cognition and cognitive biases, mental and physical health, and physiological and neural functioning. Importantly, judgment-based measures may reveal effects that are independent from – and complementary to – those ascribable to inventory-based measures. Using these converging approaches to study the structure and function of personality may further illuminate individual differences in affect and emotion.

Acknowledgment

The authors thank Mika Uehara and the members of the University of Chicago and Dartmouth College social neuroscience laboratories for their invaluable assistance in data collection; and Ann Chu for assistance with statistical analyses. This research was supported by National Institute of Mental Health Grant No. P50 MH52384-01A1.

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