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Dimensions of Affect Relationships: Models and Their Integrative Implications

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This article presents data from a number of areas of psychology that have dealt with the issue of whether positive and negative affects are independent—the bivariate view—or whether they operate inversely from each other—the unidimensional, bipolar view. Both models have extensive empirical support. A more integrative view, the Dynamic Model of Affect (DMA), specifies conditions under which both bivariate and bipolar models are valid. It is tailored to analyzing both affect systems functioning concurrently. The DMA is reviewed and then extended to show how 3 major areas of research can begin to incorporate the more integrative framework of analyzing co-occurring types of affect.

Psychological science and practice are undergoing a major shift in focus in response to developments in "positive psychology" (Frederickson, 2001; Myers, 2000; Peterson, 2000; Ryff & Singer, 1998; Seligman, 1999; Taylor, Kemeny, Reed, Bower, & Grunewald, 2000). This newly emerging emphasis attempts to refocus psychological science and practice away from one-sided concentration on maladaptive, negative thoughts and behaviors to an openness to positive, affirming, resilience-enhancing aspects of human adaptation and well-being (Diener, 2000; Salovey, Rothman, Detweiler, & Steward, 2000; Seligman & Csikszentmihalyi, 2000).

With the newer developments, psychological science and practice now face the task of moving to a new level of analysis, the outlines of which are only now coming into focus. Rather than concentrating on only negative emotions, or only on positive emotions, psychologists are now beginning to investigate how both emotion systems operate conjointly. The co-occurrence of two foci, two emotion systems, presents a challenge to the science to bring to bear concepts and techniques to achieve a more integrative view of the human organism and perhaps other organisms as well.

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At this juncture, it is important to define the question further. We should know the nature of the relationship of positive and negative feelings if we are going to develop a better understanding of the processes of human learning and memory, build more powerful models of psychotherapy, and articulate more creative means of reducing vulnerability to stress and enhancing resiliency. Better approaches to human development and cognition, more precise and comprehensive understandings of mental health, and corresponding improvements in treatment and interventions will be more achievable if this fundamental issue is moved to the forefront of our science and practice.

Antecedent Research Traditions

Two productive research traditions concerning the relationships between positive and negative emotions have become well established, each with its own body of supportive research. However, the traditions yield opposite models, or nearly so, of how the affects relate to each other. One tradition posits that they are independent. This is the bivariate or uncorrelated bidimensional affect approach. The other tradition presumes that they are related, but inversely so. This is the bipolar or unidimensional affect approach. We first review research supporting each approach. Then we review briefly studies that support an integrative model, the Dynamic Model of Affect (DMA), that specifies the conditions under which both perspectives are valid. Linked conceptually with other ap-

proaches such as the behavioral activation model; the model of evaluative space proposed by Cacioppo, Gardner, and Berntson (1997, 1999); and the integration of behavioral activation dimensions of approach and avoidance (Carver & White, 1994) and activation and personality variables such as extraversion and neuroticism (Carver, Sutton, & Scheier, 2000), the DMA now makes it possible to achieve a genuinely integrative science of positive affect (PA) and negative affect (NA).

Any integration of these two seemingly contradictory bodies of research will necessarily have to be inferential to some degree. By and large, the studies we review here were not themselves originally intended to specifically compare the bipolar and the two-factor models. Although each approach has received support within a certain body of studies, most of them did not explicitly test the two models against each other, and hence they did not include measurement and methodological components to differentiate the approaches from each other, much in the line of the "experimentum crucium" tests generally believed to be the best method of cross comparing models. The exception to this general state is within the measurement-factor analysis traditions, where extensive investigations of the two approaches have been most compelling in their support of either of the two approaches. The research review we present here goes beyond verbal assessment techniques, however, and it is in these other sets of studies that crucial tests are lacking. Nevertheless, the integrative models we discuss in detail seem to conclude that it may well be misleading to consider the two traditions to be correct or incorrect per se. Our most general conclusion from this review is that psychological science is now ready to show the conditions in which both are valid, eliminating the need to have to draw an "either-or" conclusion.

Evidence for Bivariate (Independent) Affects

Physiological processes. Advances in positron emission tomography, electroencephalogram techniques, and functional magnetic resonance imaging (fMRI) have been used to examine brain activity of research participants exposed to positive and negative stimuli such as pictures and film clips. Davidson (Davidson, 1983, 1992; Davidson, Ekman, Saron, Senulis, & Friesen, 1990) has determined that although separate brain regions involved in each affect can be detected, other regions do not show differential responding. Lane, Reiman, Bradley, et al. (1997) and Lane, Reiman, Ahern, Schwartz, and Davidson (1997) reported that both positive and negative emotions were differentiated from reactions to neutral-toned stimuli and from each other in some brain regions. Cacioppo, Berntson, Larsen, Poehlmann, and Ito (2000) summarized a large body of literature and found, with only a few exceptions, that left hemispheric activity and right hemispheric activity are separably related to PA and NA, respectively. Zubieta et al. (2001) found that induced chronic pain activated the release of opioid receptors in distinctly different cortical and subcortical brain regions.

Knutson et al. (1998) found that biochemical processes also reflect affect decoupling; injecting healthy volunteers with a serotonin reuptake inhibitor (paroxetine) reduced NA but did not reduce PA. However, in a post hoc analysis, it was found that the baseline inverse relationships between PA and NA were reduced to nonsignificance following paroxetine treatments, demonstrating decoupling of the two affects (B. Knutson, personal communication, May 4, 1998).

Other aspects of biochemical effects on affective processes have implicated the role of dopamine. Dopaminergic activity in certain regions of the brain has been related to improved PA but has shown no relationship to NA (Cacioppo et al., 1999). A similar conclusion was drawn by Ashby, Isen, and Turken (1999) in their review of a number of studies in which they found no evidence for decreased levels of brain dopamine following stress, whereas positive affective and approach processes were correlated with dopamine levels.

The data from these studies are useful for several reasons. For example, they show the close connections among brain activity, neurohormones, and emotional reactivity. We return to this level of analysis in the next section. They are also useful in that they provide support for specific regional differences in the experiencing of PA and NA.

Studies of life events. Another research tradition studies how each affect is influenced by more cognitive and behavioral variables such as

environmental or life events. In an early review of this literature, Zautra and Reich (1983) analyzed a set of 17 studies in which the frequency of occurrence of positive and negative life events had been measured separately and their relationships with positive and negative facets of mental health and well-being determined separately. With very few exceptions, studies showed that positive events tended to relate to positive aspects of well-being (e.g., PA and improved life satisfaction) but had few significant relationships with negative states such as depression and psychological distress. Negative events also exhibited a similar within-domain pattern. Gable, Reis, and Elliott (2000) reported identical data.

Watson, Clark, McIntyre, and Hamaker (1992) found that many varieties of social activity were associated with increased PA but were unrelated to NA. Warr, Barter, and Brownbridge (1983) found that the frequency of engaging in desirable life events was related to increased PA but not to NA, whereas the frequency of undesirable life events was related to increased NA but not to PA. In addition, van Eck, Berkhoff, Nicholson, and Sulon (1996) found that experiencing stressful events in daily living was related to increased salivary cortisol and increased NA, but PA was not related to either. Neurotransmitters appear to be differentially linked to separate affects, a result in line with the physiological data discussed earlier.

Factor-analytic studies. Contemporary controversy concerning the degree of independence of the affects can be traced to Bradburn and Caplovitz (1965; Bradburn, 1969). In a national survey, they found nonsignificant correlations between reports of positive feelings ("particularly excited or interested in something") and negative feelings ("depressed or unhappy"). Another body of studies has focused specifically on the relationships between PA and NA through factor-analytic analyses of their verbal dimensional structure per se. Watson and Tellegen (1985) and Watson, Clark, and Tellegen (1988), among others, have conducted extensive factor-analytic studies of a diverse range of affect adjectives, participant samples, and rotation techniques with the deliberate aim of creating independent assessments of PA and NA. The resulting instrument, the PANAS, now is in wide usage. Studies employing different rotational procedures also regularly produce the two independent factors (e.g., Diener, Larson, Levine, & Emmons, 1985; Watson & Clark, 1992; Zevon & Tellegen, 1982). We return to this literature later in the discussion of current thinking about the importance of measurement issues in assessing interaffect relationships.

Bipolar (Correlated) Affect Literature

Physiological processes. Although the bulk of the evidence appears to support a separable affect model (Cacioppo et al., 2000), as discussed earlier, there are some studies that show a certain degree of relatedness between them. Testosterone replacement therapy in men was found to relate to increased PA and reduced NA (Wang et al., 1996). Recent evidence on the brain neurohormone oxytocin has shown that it is involved in positive prosocial behaviors, such as maternal nursing and bonding, in human females and even in virgin laboratory rats. However, it has also been shown that individuals who maintain higher levels of oxytocin during an induced stressful situation exhibit higher oxytocin release, which is, in turn, related to a coincident suppression of stress-related cortisol (Turner, Altemus, Enos, Cooper, & McGuiness, 1999; Unvas-Moberg, 1997, 1998). These results suggest that this particular neurohormone is connected to both more positive (relaxation) and less negative (stress) response systems.

Fredrickson and Levenson (1998) assessed cardiovascular reactivity and recovery from the stress engendered by the presentation of fear-eliciting stimuli. After the stressful exposure, participants who had viewed a positive stimulus (film) exhibited a more rapid recovery of cardiovascular functioning than those who had viewed a neutral or a sadness-inducing film; the positive film's effects buffered the effects of the negative stimulus.

Studies of life events. Stone, Kennedy-Moore, and Neale (1995) found that social support and some forms of coping were related to affect coupling (reduced NA and increased PA). Lefebvre et al. (1999) assessed coping efficacy variables in chronic pain patients; higher efficacy was related to higher positive mood and lower negative mood. The investigators noted the clinical significance of this finding, suggesting that interventions designed to enhance efficacy may have the dual advantage of altering both moods in a more favorable direction. Van

Eck, Nicolson, and Berkhof (1998) used within-day experience sampling methodology to assess white-collar workers' self-reports of stressful daily events. The affects were found to be linked to the frequency of occurrence of those stressful events. Such occurrences led to increased NA and agitation as well as decreased PA. Participants' ratings of event uncontrollability enhanced those relationships. Lawton, DeVoe, and Parmelee (1995) found a similar cross-domain effect, and they also reported that greater levels of depression independently enhanced those relationships; more depressed nursing home residents reported more significantly enhanced event-affect relationships.

Factor-analytic studies. Early on, it was realized that methodological factors in the initial Bradburn data on independence of affects might be influencing the finding of decoupled affects. Bentler (1969) argued that acquiescence response set might artificially inflate the degree of positive relationship between the affects; if people have a tendency to respond yes (or no) to affect items, the more they do so, the more the correlations will be inflated toward a positive relationship. Controlling for frequency of responding, he found an uncontaminated significant inverse relationship, thus supporting a bipolar rather than a two-factor model of affect relationships. Later, Benin, Stock, and Okun (1998) performed maximum-likelihood goodness-of-fit tests from confirmatory factor analyses of the Bradburn items with unequal item weights and found significant inverse correlations of PA and NA scales. Similar to Bentler (1969), Green, Salovey, and Truax (1999) examined the role of measurement error in detail; when they methodologically and statistically controlled error of measurement, bipolarity appeared.

A number of investigators have extended these initial findings by focusing on the factorial structure of the adjectival descriptors used in affect measurement (e.g., Feldman-Barrett & Russell, 1998). Also involved are the degrees of activation present in the descriptors, from low ("calm" and "relaxed") to high ("excited" and "delighted"; Diener et al., 1985; Russell & Barrett, 1999). This dimension is important because ceiling and floor effects resulting from level of arousal may be attenuating interscale correlations (Schimmack, 2001). Bipolarity is most clearly demonstrated by a circumplex of affect and arousal when a representative sampling of emotion descriptors is used in measurement, with affect ranging from pleasant high activation to unpleasant low activation as one dimension and negative or unpleasant high activation to positive low activation (Russell & Carroll, 1999).

An Emerging Consensus

Although these differing perspectives in the factor-analytic approach have been thought to be opposites, investigators on both sides of the issue have sought common ground to resolve these different approaches (Diener, 1999; Green et al., 1999; Russell & Barrett, 1999; Tellegen, Watson, & Clark, 2000; Watson, Wiese, Vaidya, & Tellegen, 1999). Differences remain, but an emerging consensus appears to be that a strict bifurcation of the emotions is to some considerable degree an artifact of how they are measured with pencil-and-paper test and affect-assessing adjectives. Moving around a circumplex of affect and arousal can in principle lead to many different degrees of resultant affect relationships (Russell & Barrett, 1999; Russell & Carroll, 1999; Watson & Tellegen, 1999).

Also, Watson et al. (1999) have reconceptualized their central dimensions of PA and NA as being more validly defined as positive activation and negative activation, indicating the loading of their own PANAS adjectival descriptors on high levels of activation. Delimiting their measurement to higher levels of activation and not assessing low activation reduced the apparent inconsistencies in affect measurement techniques employed by various investigators. On the other hand, the review of many different methodologies and levels of analysis (neurological, biochemical, and behavioral) presented earlier shows that more than just the selection of particular verbal responses is involved in the relationships of the affects. Many different forms of cognition and behavior produce bivariate or bipolar relationships. Thus, both are useful descriptive models, but it is possible that a superordinate perspective could incorporate these models, specifying when each would be viable. We next describe our work that has attempted to establish that perspective.

A Dynamic Model of Affect Relationships

We have developed and tested a model that offers one way to integrate both the bivariate and bipolar models of affect relationships. In our initial statement of the DMA (Zautra, Potter, & Reich, 1997), the importance of understanding the role of *contextual factors* in feelings and emotions was emphasized. Affect does not operate in a vacuum, and people's reports of their feelings are closely linked to their environment. They process information about that environment, and they process information about their (emotional) reactions to that environment. This *information-processing* model regards processing as residing on a continuum from simple, unitary, undifferentiated, and unidimensional on up to complex, highly differentiated, and multidimensional. The differentiating factor in determining processing simplicity-complexity is the degree of uncertainty the person feels resulting from recent stressful events. Low stress allows complex information processing, but stressful events place demands on the system, raising uncertainty and threatening current adjustment. Attentional resources become concentrated on the immediate demand, narrowing attention and reducing processing capacity; discrimination is simplified, and generalization is expanded. Consequently, the DMA predicts that, under high stress, PA and NA tend toward collapse into a simple bipolar dimension with highly inversely coupled affect.

Concepts and approaches similar to ours have suggested a converging framework. The classic article by Easterbrook (1959) on reduction of perceptual and cognitive processing under stress is a comprehensive original statement of the approach. Ursin and Olff (1993), Paulhus and Lim (1994), and Linville (1985, 1987) have argued for similar processing. Linville's work is of particular significance to the DMA. She has assessed the information-transmission complexity of participants' categorizations of self-descriptive terms, as have other researchers (Cohen, Pane, & Smith, 1997). In the latter studies, this variable was related to participants' reports of recent stressful events and their affective responses to laboratory manipulations of positive and negative experiences (success-failure). More complex participants were less likely to show symptoms of depression and physical health symptoms as their levels of stress increased. This represents support for a buffering hypothesis according to which self-complexity moderates the effects of stressful events on depression and health symptomatology. Neither Linville nor Cohen et al. reported interaffect correlations, so the degree of correlation between PA and NA cannot be determined from these studies, but the line of reasoning they followed is very compatible with our own.

As we briefly mentioned in the introduction, the work of Cacioppo and colleagues has considerable overlap with our model. Their Model of Evaluative Space (MES) also can account for both independence and bipolarity of the affects by consideration of the location of a given stimulus in evaluative space. Briefly, any given stimulus is regarded as eliciting affective responding in one of two separate affect systems, positive or negative. That responding in turn is related to one of two separate activation systems, a behavioral approach system and its antecedent PA or a behavioral avoidance system and its antecedent NA.

But the approach and avoidance systems act as gradients of activation, and it is readily possible for a given stimulus to elicit both simultaneously; overt evidence of this simultaneous activation would be shown in the form of inversely related affects. The stimulus may only elicit one, however, with an overt manifestation of one affect being elicited with no simultaneous activation of the other, separable affects. This model suggests that "affect is primary," in the original language of Zajonc (1980), and the operation of separable approach and avoidance systems is based on Gray's analysis of neural systems and emotional processes (Gray, 1987, 1991).

The MES is supported by a wealth of evidence involving basic neurochemical and brain anatomical processes (Cacioppo & Berntson, 1994; Cacioppo et al., 1997, 1999, 2000). Recently the model has produced especially impressive results in being able to show that, in fact, people do experience both positive and negative feelings ("mixed feelings") simultaneously when responding to certain types of life event conditions, such as seeing a bittersweet movie or ending a college semester (Larsen, McGraw, & Cacioppo, 2001).

The DMA and the MES share fundamental agreement on the basic organic underpinnings of how the affects relate; both make reference to

the evolutionary or survival mechanisms underlying affective reactivity per se. The DMA specifies that, under stress, information-processing capacity is reduced as the organism is under the pressure of coping with a stressful event. Stress is thought of as arising from a threat to well-being, and information processing is narrowed to aid successful coping with the stressor; this shrinks positive information processing in the service of enhancing negative reactivity to cope with the stressor. This process is evolutionarily selected to enhance survival potential.

The MES similarly postulates that approach tendencies and avoidance tendencies may well be operating independently but that we are the offspring of organisms whose avoidance systems became fully engaged to deal with survival-threatening events, forcing out approach tendencies until the threat of the stressor is removed. Both models thus point to evolutionarily successful adaptation mechanisms as basic to the functioning of positive and negative affective systems. The fact that separable brain regions for these tendencies have been located by fMRI techniques makes the integration of these models particularly exciting for future research (e.g., Davidson et al., 1990; Lane et al., 1997b).

We now turn to studies that we have conducted exploring the DMA. We discuss them chronologically in the order in which they were conducted.

Preliminary Studies

Empirical tests of the DMA approach have employed a wide variety of participant samples and assessment techniques. In our more recent work, we have concentrated on Watson, Clark, and Tellegen's PANAS as our major measure of the relationship between PA and NA, largely because it is necessary to assess the relationship with a scale that does not, a priori, measure them as bipolar and therefore inversely correlated. We have used the 20-item balanced version with equal numbers of items assessing PA and NA. The shortcomings of the original scale have been well discussed earlier in this article as well as in the general literature (e.g., Cacioppo et al., 1999). The scale nevertheless has consistently detected predicted relationships across a number of different conditions and variables, so the data to be reported may be thought of as providing preliminary support; of course, however, there is a need for further investigations of verbal scales to assess PA and NA.

In the studies discussed subsequently, the aims of the separate projects were to assess PA and NA and their interrelations. This led to the use of a wide range of methodologies and assessment techniques and procedures. The time frames that participants were instructed to use in judging their affect varied widely across these studies, from within-day to daily, weekly, or even monthly judgment time frames. Thus, the measurement of temporal factors in the participants' judgments of their affects represented in these studies provides a realistic range of assessments. The high degree of agreement across the different studies suggests that the studies tapped a stable set of relationships, lending confidence in the results.

Positive events in college students' lives. Reich and Zautra (1981) tested a model of how life events influenced reports of psychological distress and positive adjustment and well-being in 141 college students. Frequency of positive life events was assessed to determine the effects of these events on measures of positive and negative states of adjustment. The frequency variable was experimentally manipulated with three levels of treatment: instructions to engage in 2 self-chosen positive events, instructions to engage in 12 such positive events, and a no manipulation control. As predicted, it was found that the groups who engaged in 2 or 12 positive events reported higher positive well-being than nontreated controls. On average, neither group reported a change in psychological distress, supporting the bivariate model. However, the participants also reported on the frequency with which they had been experiencing negative stressful events in the recent past. With that variable included as a predictor variable, a cross-over effect supporting bipolarity was found: Participants who had been experiencing greater numbers of stressful negative events but who had engaged in 12 positive events reported a significant decrease in psychological distress. The affects became inversely coupled under conditions of higher levels of stress, as the DMA predicts.

Stressful events in women with rheumatoid arthritis. As part of a longitudinal study of stressful events and mental health in chronic pain patients (reported in Zautra et al., 1997), a

sample of 41 female rheumatoid arthritis patients responded over a period of 12 weeks to scales assessing stress, level of pain, PA, and NA. Each participant reported the number of stressful and positive events she experienced weekly, and these weekly scores clustered into "low" and "high" negative weeks and "low" and "high" positive weeks. The correlation between PA and NA was tested for each combination. For low negative weeks the correlation was weak, but for high negative weeks the correlation was very strongly inverse ($-.56$, $p < .001$). The data suggest that it is in periods of high stressful events that the correlations between PA and NA become significantly inverse (bipolar). Interestingly, as we would predict, during low stress weeks there was no significant correlation between pain and PA, but during high stress weeks the correlation became significant ($-.60$, $p < .001$).

Field and laboratory studies of affect correlations. Samples of older adults who had recently experienced the major life stressor of bereavement or physical disablement were compared with age- and gender-matched controls in a study conducted by Zautra, Reich, Davis, Nicolson, and Potter (2000). On the PA-NAS, the stress groups exhibited a significantly higher inverse correlation than the controls, who, in turn, showed no significant correlation at all. In a laboratory manipulation of stress (the task of delivering a speech), PA and NA were assessed four times during the experiment: before the stressful task, immediately after it, and twice during the recovery phase (at 40 and 60 min). The results are displayed graphically in Figure 1. As shown there, the relationship between PA and NA became significantly inverse only at the point immediately following the stressor ($r = -.32$, $p < .01$); PA and NA were independent before the task and during longer term recovery.

To control for measurement errors in this study that could have influenced these relationships (Green, Goldman, & Salovey, 1993), we subjected the data to confirmatory factor analysis. Three parcels of items were constructed and used as indicators of latent constructs for PA and NA and for pretask and posttask stress, and the correlations between these latent variables were estimated through the use of structural equation methods. As shown in Figure 2, the correlations between latent factors were more inverse following stress induction, as revealed by significant reduction in goodness of fit when these correlations were constrained to be equal: $\chi^2(1)$ change $= 7.90$, $p < .01$.

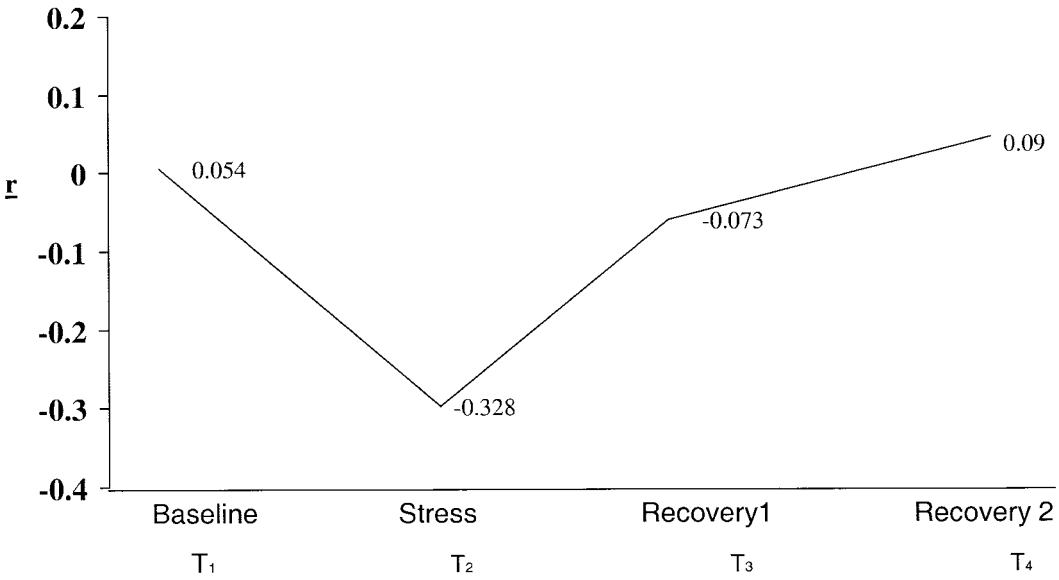

Figure 1. Correlations between positive and negative affect over time (T).

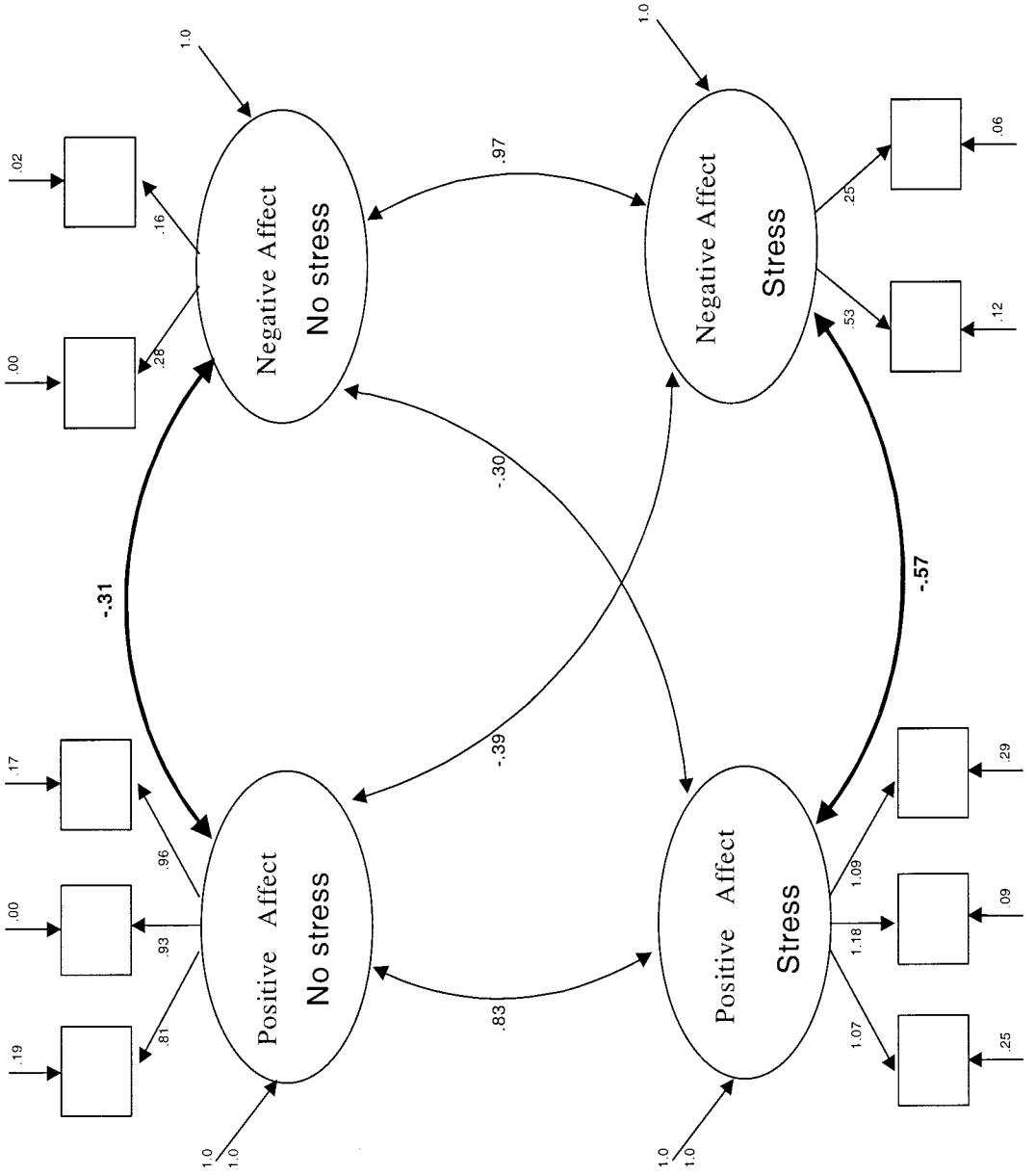

Figure 2. Confirmatory factor analysis model of positive and negative affect before and after stress induction.

Cognitive simplicity-complexity and affect correlations. We have analyzed data on two samples of participants in which we directly assessed the role of cognitive simplicity in the bipolar-bivariate nature of the relationship between PA and NA. Both are reported in Reich, Zautra, and Potter (2001). It was predicted in both analyses that cognitively simpler participants would be more likely to report a significant inverse relationship than more complex participants. We used the Thompson, Naccarato, and Parker (1989) Personal Need for Structure Scale (PNS; Neuberg & Newsom, 1993; Neuberg, West, Judice, & Thompson, 1997), a 12-item scale assessing two factors of simple cognitive structures and the PANAS to measure PA-NA correlation. The PNS empirically consists of two correlated but independent factors: Desire for Structure and Reactions to Lack of Structure.

Our first sample comprised 67 college students who responded to both instruments. For both factors of the PNS, higher simplicity participants had significantly higher inverse correlations than low simplicity participants, who showed no significant correlations at all. The second test of our model involved a sample of 120 female chronic pain patients taking part in a longitudinal assessment spanning 12 weeks. They responded to the PNS, the PANAS, and weekly measures of pain and stressful life events. Thus, this study gave us a measure both of stress and of cognitive simplicity. Again, the high simplicity participants demonstrated a significant inverse correlation, whereas the more complex participants did not. One major new finding was generated by the study. The DMA suggests that people under stress will move toward greater cognitive simplicity. This study was able to test that effect by comparing the PNS cognitive simplicity scores between the college student sample in the first study and the same variable in the chronic pain sample, because both samples had completed the PNS. The results were as predicted: The chronic pain sample scored significantly higher on cognitive simplicity than the college students. Even though the PNS was developed as a trait measure of cognitive simplicity, the DMA prediction that the chronic pain sample would score as more cognitively simple is particularly strong support for the model.

Cognitive simplicity, pain, and affect correlation. Potter, Zautra, and Reich (2000) studied the combined effects of the stresses of ill health and trait cognitive simplicity (PNS) in a study of how PA relates to NA and pain reports. In a study of 112 female patients with chronic pain (rheumatoid arthritis), there was no correlation between pain and PA among participants low in cognitive simplicity (more complex); however, among the cognitively simpler participants, pain correlated with PA ($r = -.60$, $p < .001$), as predicted by the DMA.

Workplace stress and the emotions. Zautra, Berkhof, and Nicolson (in press) used experience sampling methodology (Csikszentmihalyi & Larson, 1987) to assess stressful events and PA and NA in 85 male white-collar workers in six Dutch industries and government agencies. The participants responded 10 times daily for 5 consecutive days. This method allowed hierarchical linear modeling to trace the relationship of the affects within individuals and across time, accounting for the stressfulness of momentary events. As predicted by the DMA, times of greater work stress were related to a significantly greater inverse PA-NA correlation than moments of less stress.

Role of depression and anxiety. The DMA postulates that a deficit in information-processing complexity (commonly stress induced) is a central mechanism whereby the affects become inversely related. According to this type of model, because stress has negative consequences, information processing under stress would play a causal role in slanting attention away from positive states and toward negative states, resulting in an inverse correlation between them. Barlow, Chorpita, and Turovsky (1996) discussed such attentional shifts in states of anxiety and described the close relationship between anxiety and depression. The latter is often found to result from an earlier state of anxiety. However, although both states involve high levels of negativity, Barlow et al. suggested that PA is a differentiating variable. It plays little role in anxiety, but is suppressed in depressive states. Watson and Kendall (1989) made a similar suggestion. It is this deficit in PA attendant with increased NA that characterizes the difference between anxiety and depression; this may explain the inverse PA-NA linkage under conditions of depression proposed by Barlow et al. They provided no direct data on

the relationship between PA and NA under high conditions of depression or anxiety.

To explore this issue further, Williams, Peeters, and Zautra (2001) analyzed depression, anxiety, and PANAS scores from a sample of 230 community mental health center patients seeking treatment for anxiety and mood disorders. Samples with primary diagnoses of each condition were drawn, and confirmatory factor analyses created composite PA and NA variables. The relationship between these variables was tested in goodness-of-fit models in which both variables were included. As predicted, the PA-NA correlations were significant for the anxiety group but not for the depressed group, suggesting that the anxiety component of stressful experiences is a central factor bringing the affects into an inverse relationship. This finding is not in obvious agreement with the proposals of Barlow et al. (1996), and the issue clearly is in need of further investigation.

Implications for Psychological Science and Practice

In overview, the literature we have discussed appears to show evidence for the presence of shifting relationships between the PA and NA systems. Both independence and bipolar models find support at the levels of physiological processing and person-event relationships. Although methodological factors have been shown to be significant determinants of interaffect relationships, we suggest in this article that substantive factors also have significant effects: An integrative approach requires that both systems be assessed within a model that allows for the co-occurrence of PA and NA. Independence and bipolarity may occur depending on other variables such as stress and information-processing simplicity, either as experimentally manipulated or individual-differences variables. The simple question of the degree of relationship should now be expanded to incorporate the role of other variables, a suggestion made succinctly by Cacioppo et al. (1999): "What are needed are psychological models of the affect system that do not merely speculate about mediating psychological processes but that instead specify them in detailed, empirically meaningful ways" (p. 850). We now present several suggestions along those lines.

Implications for Cognition and Information Processing

Although there are many ramifications of this new approach, we find three topics to be very promising as pivot points for establishing new areas of activity for psychology. The stress-affect nexus is central to an expanded model of cognition and information processing. Two decades ago, Bower (1981) investigated mood effects on memory, and a significant body of research has developed from those roots. Mood congruence is now a well-established phenomenon: superior learning and memory for positive and negative stimuli congruent with induced positive and negative mood, respectively. More recently, Forgas and Vargas (2000) have developed an affect infusion model defining the process whereby mood and other affectively loaded processes infuse and systematically alter information-processing variables. Clore, Schwarz, and Conway (1994) proposed that mood is itself mentally treated as information per se. Research on both approaches shows alterations in such processing variables as latency and affect congruence when moods and emotions are elicited by experimental conditions.

Evidence from decades of cognitive and information-processing research has consistently shown that affective processes such as mood and emotion are significant influences on both encoding and retrieval processes. What has not been shown to date is the extent to which the elicitation or presence of one emotion influences, or is influenced by, the presence of another (inversely) related emotional state. Yet, a range of independent, positively related and inversely related emotions are present at some level during each aspect of human functioning, infusing all forms of information processing in "the real world." The challenge for psychological researchers is to develop methodologies equal to the complexities of these co-occurring processes.

At a deeper level, the contrasts among models reflect differences in approach to the issue, that is, differentiations between the top-down approach and the bottom-up approach. The top-down approach is one that emphasizes cognitive processes in the understanding of emotions. This approach, exemplified by the research of Schachter and Singer (1962) and the early work of Lazarus (1991), views emotion primarily as a

consequence of cognitive labels we place on aroused states. The bottom-up approach, supported by the work of Davidson (1992) and LeDoux (1996), posits that PA and NA experiences are primary and even at times independent of cognitive judgments. The top-down approach is a model of judgments about emotions, whereas the bottom-up approach is an activation model, with its strengths in the neuroscience of motivation. Neither approach alone can claim to be comprehensive in modeling the dynamics of emotion (Cacioppo et al., 1999).

Seen in the context of the univariate and bivariate approaches, these models suggest that the key to developing an integrative perspective may reside in considering the context in which emotions are felt or judged by an individual. Davidson (2000a) suggested that one context is set by the individual's own affective style: People vary in their extent of prefrontal activation, and consequently experience chronic levels of positive or negative affective styles. Other context effects might be expected to appear with investigation of ongoing chronic negative or positive daily experiences and their subsequent effects on positive and negative affectivity (e.g., Zautra et al., 2000). Although including context effects will make analytical models more complicated, it seems clear that such significant sources of variance require greater attention in future studies.

Implications for Models of Motivation

Separating emotions and moods from motivational processes is fraught with complications, but a simple distinction between activation and feeling states can act as a guideline for advancing the stress-affect relationship approach described here. Cacioppo and his colleagues (Cacioppo & Berntson, 1994; Cacioppo et al., 1997, 1999) have developed a model of the interactions among the neural substrates of emotion. They suggested that organisms have evolved separate activating and inhibiting behavioral systems. The accompanying affects can be conceptualized as separate systems that can operate independently or inversely depending on their degree of reciprocal or nonreciprocal activation. Other investigators (e.g., Depue, Krauss, & Spoont, 1987; Watson et al., 1999) agree with the earlier formulation of Fowles (1987) that affect systems should be considered in terms of basic motivation systems of approach and avoidance.

The implications of such a model are just now being explored. Davidson (2000a, 2000b) has summarized studies linking brain activation with PA and NA. Employing the behavioral activation/inhibition scale (BAS/BIS) of Carver and White (1994), Sutton and Davidson (1997) found that higher levels of left-sided prefrontal anterior cortex activity (BAS) are related to higher levels of PA on the PANAS, whereas higher levels of right-sided cortical activity (BIS) are related to higher levels of NA. Gable et al. (2000) showed that high BAS activity was related to greater PA levels, whereas greater BIS activation was related to greater NA. Cross-factor relationships, interestingly, were not significant.

Although this suggests (Davidson, 2000b) that the affect systems are relatively separate owing to their strong associations with left and right prefrontal areas involved in approach and avoidance, nevertheless neural activation may both enhance the time course of PA and shorten that of NA. This suggests, in turn, that a major component of affective activity is emotional regulation, the ability to temper emotional reactivity in the face of arousing (and perhaps stressful) conditions. Such an approach is, ultimately, contextual, indicating the need for simultaneous consideration of multiple sources of input and complex regulation of the interaction of various neurological and hormonal systems operating simultaneously. This more integrative view is congruent with the model we have proposed. This complex linkage of emotions, stress, and cortical motivational systems offers the promise of a genuinely integrative approach to mind and body interactions.

Implications for Models of Therapy

When a person seeks help, how would an integrated model of emotions suggest the psychologist to intervene? Many conventional therapeutic approaches depend on the assumptions that affect states are unidimensional, that negative affective states such as depression and psychological distress should be the focus of the intervention, and that the underlying structure of affect states is fixed and does not change. Treatments based on a unidimensional model first identify the source of distress and then

apply techniques that will maximize the person's chances of recovery.

The focus of much current therapeutic work is cognitive-behavioral (DeRubeis & Crits-Cristoph, 1998). In these models, affects are seen as the outcomes of a complex interplay of a number of related cognitive processes, including appraisals of threat or challenge from environmental events, attributions concerning the causes of negative and positive life events, perceptions of control, and a sense of efficacy in one's ability to cope successfully with life's difficulties. In an effort to reduce NA, much attention is focused on ways of thinking that are maladaptive (Beck, 1967). Some therapists suggest increasing positive activities (pleasant events; Lewinsohn, Redner, & Seeley, 1991; MacPhillamy & Lewinsohn, 1982). Others focus on coping with negative and stressful life events (Barlow et al., 1996; Meichenbaum, 1977). Even the new wave of positive psychology discussed in the introduction encourages a shift to treatment of positive emotions but does not, in and of itself, suggest ways in which both positive and negative aspects of emotional life are to be considered together in an integrative new model.

Indeed, there is even evidence that unidimensional models of how cognitions influence affect are not always accurate. Modification of maladaptive cognitions ("negative thinking") does appear to be highly effective in reducing psychological distress, but it may not aid in the promotion of positive affective health. Further, enhancing positive cognitions may not reduce NA. Goodhart (1985) assessed the value of positive thinking in coping with stressful events and found that such thinking had no value for reducing negative feeling states. Felton and Revenson (1984) and Zautra et al. (1995) found that active forms of coping, such as problem solving, primarily increase PA and do not reduce NA. Folkman (1997) reported similar findings among individuals who had partners with AIDS (see also Folkman & Moskowitz, 2000). Unidimensional models do not have the foundation with which to account for outcomes that vary along multiple affective dimensions. A more integrative view would encompass both higher levels of PA and lower levels of NA as beneficial to well-being.

Recent research is exploring what might be called "uncoupling," the separating of the affects which, as we have shown, tend to become inversely coupled under stress. Uncoupling should allow the person freer access to positive feelings and healthful emotional states such as psychological resilience, even in the presence of stress. Redirecting clinical practice to manipulate affect relationships appears to be a fruitful avenue for investigation. Some attempts along these lines are now appearing. For instance, Fredrickson and Levenson (1998) induced high levels of stress in research participants and then immediately followed that stress with stimuli eliciting PA. The high levels of cardiovascular reactivity, including increased heart rate, peripheral vasoconstriction, and systolic and diastolic blood pressure, that occurred in response to the stressor returned to resting levels significantly more rapidly among participants exposed to (vs. not exposed to) the follow-up positive stimuli. Fredrickson and Levenson described such a process as "undoing."

Related to this line of reasoning, research on mood clarity is now beginning to show great promise for elucidating affect relationships (Salovey & Mayer, 1990). Zautra, Smith, Affleck, and Tennen (2001) have investigated this issue. Mood clarity, a facet of emotional intelligence (Salovey & Mayer, 1990; Salovey, Mayer, Goldman, Turvey, & Palfai, 1995), reflects one's ability to identify one's emotional state, the emotional states of others, and the degree to which people believe that they are clear about what they are feeling. Such a variable is, of course, directly relevant to the issue of the separation of the affects, and was investigated by Zautra et al. (in press). They studied the relationship between NA and pain, in the context of PA and stress, in a patient sample of women with rheumatoid arthritis. Mood clarity was shown to moderate these relationships. Patients with greater assessed mood clarity, and the resulting enhanced ability to detect moods, showed less inverse overlap of PA and NA.

Kabat-Zinn (1982) has suggested another approach to emotional processes: mindfulness. Ordinarily, people undergoing stressors engage in hypervigilance and other anticipatory fear responses. NA tends to dominate cognitive processes to the exclusion of positive emotions; in our DMA framework, we think that the coupling becomes the problem. To uncouple the emotions and restore affective health, the person must be induced to "let go" of attempts to

find the answer, solve the problem, or eliminate the pain. Kabat-Zinn encouraged acceptance of the stress and the negative cognitions, an active, dynamic assertion of possession of the negative states. In an important sense, such acceptance lowers the stress response and, in so doing, may uncouple positive feelings, allowing for a less constricted emotional life. A recent review of the evidence on mindfulness-based stress reduction therapies by Bishop (2002) finds limited but encouraging support.

Developments along the lines of mindfulness and emotional intelligence and the DMA offer the promise of a unique but powerful blending of various strands in therapy. Mindfulness is a new and promising approach to cognitive dynamics, and integrating concepts such as mindfulness specifically, and emotional intelligence more generally, opens up entire new vistas for therapeutic intervention. It also opens an avenue for the issues involved in both the bivariate and bipolar approaches to be formally investigated in psychotherapy. Enabling people to better understand and respond to their affective experiences, especially under stress, seems a particularly promising avenue for further exploration.

Implications for Research Methodology

Research at this more complex integrative level requires more complex designs, in that at least two variables have to be included in data analyses. Provision for multiple variable assessment must be incorporated into the design even before the study begins. We describe next what we think are minimum necessary design and statistical considerations that must be mastered to respond adequately in the new environment we have discussed here. All other standard considerations for designs and analyses of course still apply (e.g., random assignment when possible, adequate sample size and statistical power, and tests of distributional properties).

Independent measurement. There may be some reason to employ bipolar measurement, such as in the semantic differential (Osgood, Suci, & Tannenbaum, 1964), but in cases in which independence of affect variables (e.g., positive and negative events and approach-avoidance processes) is not automatically presumed, adequate measurement requires separation of each dimension. In the format of standard emotion or mood measurement, this means that each descriptive term should be assessed as varying from "not at all" or "none" (or some such zero level) on up to "a great deal" or "frequently." Intervariable correlations can be assessed after the fact and not automatically forced into bipolarity by the use of descriptors that are automatically the inverse of each other, as in the semantic differential scale (Osgood et al., 1964).

As discussed earlier, the PANAS is constructed so that bipolarity is not automatically forced onto the data. Positive and negative events are naturally assessed separately, but in those cases in which participants rate their reactions to events, positive and negative reactions should be assessed on independent scales. In physiological measurement (e.g., assessing brain region activity), separate measures of brain activity have to be instrumented for separate measurements. Overall, in most cases independence should be presumed and assessed accordingly.

Enriched methodologies. The core methodology employed in the vast majority of studies of interaffect relationships traditionally has involved intensity ratings of moods or emotion on imposed equal-unit scales of adjectival descriptors. Sometimes simple counts of frequencies of positive and negative mood occurrences are also employed. These objective measures impose strict metrics on participants' responses, creating mathematically regularized assessments of feeling states.

However, very recently, new methodologies are appearing (new to psychological research, at any rate). Variously described as qualitative research (as opposed to quantitative), narrative method, personal life stories, and so forth, these methods involve allowing participants to engage in more open-ended reports of their lives and their emotional states. Written diaries (cf. Pennebaker, 1995) and structured interviews with tape recordings of responses (Mankowski & Rapoport, 2000) are two main methodologies. The verbal output of these reports is coded and assessed, quantitatively or qualitatively, by judges trained to search for the themes under investigation. These techniques bypass the more direct quantitative treatments built into traditional techniques, but they gain a great deal more ecological validity. Future research on the complex interactions among the affects may

well gain by expanding methodologies to include such techniques.

One recent example in which narrative self-evaluations were used to assess affects, including their interrelations, was a study by Bauer and Bonanno (2001) investigating emotional reactions to spousal bereavement. Emotion narratives acquired in open-ended responding were coded for frequencies of positive and negative self-evaluations. Those scores were, in turn, used as predictors of longer term adaptation to the loss. Interestingly, negative self-evaluations per se were not significantly linked to poorer adaptation over time. In contrast, positive self-evaluations were predictors of better outcomes. However, it was the co-occurrence of positive and negative evaluations that proved to be the superior predictor. In fact, the combination of five positive feelings to one negative feeling was the most effective predictor of better adjustment.

The subtlety of feeling states is difficult to assess. However, the flexibility and inherent validity of narrative methodology, joined with sophisticated quantitative techniques, appear to be what is needed to capture the co-occurring emotion states experienced by people in their daily lives.

Data-analytic strategies. Historically, the standard method for assessing interaffect relations has been through the use of Pearson correlation coefficients (i.e., correlating PA and NA scores). This method has been critically reviewed and has been shown to be limited in its utility (Russell & Carroll, 1999). Because the classic Pearsonian approach is usually used to test for covariation across individuals, it only provides information on agreement in relative rankings across the two affect scores. Regressing one affect's scores on the other affect's scores is an alternative approach but is identical in being tied to across-person covariation. Differences in the sizes of the correlation or beta coefficients are then tested for significance of difference (or difference from zero for a single group). Group statistics provide only a general answer to the question, and mean levels of the two variables are obscured in the analyses, even though it is important to determine whether mean levels of these variables have changed as a function of stressful experiences.

A more precise approach in assessing interaffect relationships would be to determine how PA and NA relate when people are in a stressful situation as opposed to not in a stressful situation (or, in the DMA, when they are at lower vs. higher levels of information-processing complexity), an intraperson question. In principle, of course, the Pearsonian approach can be used to assess within-person/across-situation affect relationships, but a more comprehensive approach is now available, and it has been used in studying affect relationships.

Hierarchical linear modeling (Bryk & Raudenbush, 1992; Singer, 1998) allows assessment of both within-person and between-person relationships as long as a reasonable number of assessment periods are used to provide multiple measures of the dependent variables. Zautra, Smith, Affleck & Tennen (2001) recruited 175 chronic pain patients to respond to weekly diaries reporting on their PA and NA and stressful events (along with other variables including mood clarity; see earlier discussion of this study) for 12–20 weeks. Within-person equations showed that the PA and NA variables were significantly inversely correlated among those with lower levels of mood clarity but not among those higher in mood clarity. In a second study involving a sample of 89 women with primary fibromyalgia syndrome, women's daily diary ratings showed that PA and NA were significantly inversely correlated on days of higher levels of physical pain but not on days of lower levels. This result was predicted from the DMA. Gable et al. (2000) similarly used measures within individuals over time; in that study, hierarchical linear modeling analyses revealed clear evidence of BAS-PA and BIS-NA relationships and no evidence of crossover effects.

In overall evaluations of hierarchical linear modeling techniques from these types of study, it is clear that this methodology places higher demands of assessment on participants. However, the gain in design strength and analytic possibilities renders hierarchical linear modeling a cutting-edge tool for the types of assessments discussed here. The technique is now sufficiently well established to encourage its further use in extending our understanding of affective processes and their related variables.

Summary

A deep study of the relationships between PA and NA reveals a complex but rich, heuristic

array of variables and processes. The implications of these relationships for moving forward the science and practice of psychology seem nearly boundless at this point. Following the path of analyzing affect relationships appears to be a fruitful area for future investigation.

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