STRESSFUL EVENTS AND INFORMATION PROCESSING DISPOSITIONS MODERATE THE RELATIONSHIP BETWEEN POSITIVE AND NEGATIVE AFFECT: IMPLICATIONS FOR PAIN PATIENTS[1]

Phillip T. Potter, Alex J. Zautra, and John W. Reich
Arizona State University

ABSTRACT

Relationships between positive affect, negative affect, and pain were analyzed as a prospective function of stressful events in a sample of rheumatoid arthritis patients and as a cross-sectional function of an information processing disposition in persons with fibromyalgia. Positive affect and negative affect were statistically separate factors overall in both samples. In addition, negative affect and pain were related across all conditions. However, positive affect and negative affect were more negatively correlated during stressful periods and more negatively correlated for patients who processed information in a more simplistic fashion. Also, positive affect predicted pain during stressful times and did so for patients who processed information more simplistically as well. These data suggest positive affect and negative affect are unique factors whose interrelation and external correlates are not static.

(**Ann Behav Med** 2000, *22*(3):191–198)

INTRODUCTION

Self-ratings of health and well-being are used frequently as tools to assess and evaluate change in quality of life (QOL) for persons with chronic illness. Our expectations for how these QOL assessments operate arise in part from our implicit models about the nature of the positive and negative states which underlie ratings of emotion. One important debate about these models concerns the valence of affective states: whether affects are best represented as a "univariate" or "bivariate" phenomenon (1–6). The univariate view contends that positive and negative affect constitute a single dimension, to be measured on one continuum anchored by negative affect at one pole and positive affect at the other (7,8). In contrast, a bivariate view posits that positive and negative affect are two distinct variables residing on separate measurement continua, each anchored by the absence of that particular affect at one pole and extreme levels of that affect at the other (9).

We address the univariate versus bivariate debate by presenting supportive data for both instances and then pose the affect question in a different manner. We ask the question, "Under what environmental and intrapersonal conditions are affective states univariate and under what conditions can affect be considered bivariate?" Our integrated model suggests that the relationship between positive affect and negative affect varies both within persons as a function of stressful life events and between persons as a function of information processing styles. In turn, the degree of the relationship between affective states impacts the fluctuating experience of other affectively charged variables, specifically pain from chronic disease.

In support of the bivariate model, factor analytic procedures have provided evidence that affect is produced through the interaction of several statistically unique factors (3,5,6,10–13). The two most predominant of these factors have been termed positive affect (PA) and negative affect (NA). Together, PA and NA regularly account for between one-half and three-quarters of the variance in standard mood checklist inventories (5). In addition, these factors appear to be statistically separable from one another, with reported NA–PA correlations ranging from −.12 to −.23 (12), with somewhat higher negative correlations having been reported for the chronically ill (14) and for older adults (15). Neuropsychological studies have been consistent with the presence of bivariate affects, identifying unique neuroanatomical underpinnings (2). Data suggest that NA and PA are regulated in different regions of the brain (16–18). These findings have gained further support through the use of technologically advanced brain imaging procedures such as positron emission tomography (19,20).

NA and PA have also demonstrated unique external correlates across a wide range of psychological domains. For example, neuroticism relates to NA, whereas PA correlates more prominently with extraversion (21). PA and NA separately relate to adult psychiatric diagnoses of anxiety and depression (22,23). Creative problem-solving and enhanced pattern recognition are facilitated by PA induction but unrelated to NA changes (24). Academic successes meet with PA increases, whereas failures only impact NA states (25). Not surprisingly, PA and NA display separate physical health and illness correlates as well. PA is more often associated with protective health activities such as exercise (26), whereas NA predicts physical symptoms (27).

Nevertheless, many researchers have argued that affect is univariate. Green, Goldman, and Salovey (4) found that correlated errors between measures of PA and NA obscured a moderately high inverse correlation between latent scores. Others have reported that bivariate affects are a product of the assessment interval, with the timing of data collection producing either univariate or bivariate factors (3,28).

Despite their differences, the univariate and bivariate viewpoints share common ground in the belief that the correlation between latent PA and NA is a constant. However, data suggest this "constancy" assumption may be incorrect. Diener and Iran-Nejad (29) used mood induction procedures to demonstrate that affective intensity moderated the correlation between affective states. They found a nonsignificant or somewhat modest negative correlation between PA and NA at moderate or low levels of intensity, and significantly higher inverse correlation at high intensity levels.

---

[1] Preparation of this manuscript was supported in part by a biomedical grant from the Arthritis Foundation, entitled Interpersonal Stress and Arthritis.

Reprint Address: P. T. Potter, Department of Psychology, Box 871104, Arizona State University, Tempe, AZ 85287-1104.

Thus, affective intensity may be important to understanding the PA–NA relationship. Unfortunately, intensity is internal to the affective system and therefore does not provide mechanisms of influence that are independent of the system.

One moderating variable external to the affective system may be a change in stressful life events. Historically, stressful life events have been studied predominantly as direct predictors of negative affective states (30), with PA measures de-emphasized, and NA–PA correlations functionally ignored as potential criteria. Taylor (31), in a comprehensive review of the differing effects of positive and negative life experiences on PA and NA, provided convincing evidence that those effects were asymmetrical. Positive life events typically predicted PA, but did not produce changes in NA. Negative life events, on the other hand, demonstrated more pervasive effects. Stressful events not only directly impacted NA but occasionally lowered average PA levels (32–34). In sum, the data do not fully support either a constant univariate or constant bivariate approach.

A Model of Dynamic Bivariate Affects

We have developed a theoretical model, which focuses on the information processing demands associated with stressful events and the differing aspects of affect. Bivariate affects pose a rather resource-expensive set of informational requirements. For instance, separate affective registers would be necessary for incoming stimuli and perhaps even separate motive systems for learning and for mounting adaptive responses to those varying inputs. Independent affects should produce a cognitive environment conducive to maximum information processing, such that knowledge of the level of one affect provides no information as to the level of the other affect, and further, responses in one affective domain do nothing to change the affect level of the other domain (35). Such a complicated register explains the ability to independently evaluate and comprehend both the positive and negative valenced aspects of any single stimulus or situation, allowing us to more thoroughly and adaptively process the precise nature of our environment and the response demands our environment places upon us.

However, under stressful conditions, the adaptive pressures for speed and simplicity of cognitive processing likely override any benefits derived from a slower and more differentiated response to nonthreatening stimuli. A convergence of separate affective systems would decrease cognitive uncertainty and produce faster judgments as to adaptive behaviors necessary to survive a stressful situation (2). This theoretical operation is supported by neurocognitive literature suggesting that positive and negative affective systems are regulated by separate neurosystems (17), but rely extensively on neuronal feedback loops to function at optimal levels during stress (36). Linville (37) described a dynamic system whereby normally unrelated cognitive processes become highly correlated under stressful circumstances, such that the cognitive data space shrinks substantially as evidenced by narrowing of attention, increased difficulty in forming complex judgments, and more unified responses to environmental input (38). Thus, under stress, an affective and cognitive milieu is created which increases the probability of rapid, self-preserving decisions (39). If affect is indeed primary in this process (39,40), we would expect to find more bivariate affects when an individual was not stressed, but more univariate affect when that person was under stress.

Given a modifiable relationship between affects, we reasoned that external relations should also be susceptible to these modifications and differences. One particular correlate, pain, held considerable promise for our purposes. The subjective experience of pain varies considerably across time and between individuals (41,42). Pain also has a distinct affective component (43), making it a logical candidate for influence by affective changes and differences. Under normal conditions, NA relates to pain (44,45) but PA does not (26). However, we predicted the shrinking data space includes pain, such that the correlation between NA and pain increases when processing demands are extreme. In addition, a significant PA–pain relationship might emerge under those conditions, and we predicted that such would be the case.

STUDY 1

The within-person hypothesis that normally bivariate PA and NA would statistically converge to approximate a univariate affective system under stress was tested on a sample of women with rheumatoid arthritis (RA), a disease of chronic, progressive joint deterioration due principally to autoimmune processes. A static bivariate model of affect has received support in two recent RA studies (14,45). However, neither effort examined variability in the relationship between affects as a function of stressful circumstances.

METHOD AND MEASURES

Participants

Study participants were 41 married female RA patients recruited from the practice of a local rheumatologist. These women's average age was 54.5 years (SD = 9.8). An average participant completed a high school education and had an annual family income between $25,000 and $30,000. Patients were required to be on a stable medical regimen. Each participant was mailed a questionnaire to measure demographics and neuroticism. The women were assessed once a week for up to 12 consecutive weeks, responding to telephone interviews which consisted of measures of negative affect, positive affect, stressful life events, positive life events, and arthritis pain estimated over the previous 7 days.

Neuroticism

This personality feature is often believed responsible for between-persons differences in the reaction to stressful events (46). An even broader argument suggests that neuroticism accounts for a spurious relationship between stressful events, affective responses, and symptom outcomes (47). Therefore, we felt it wise to assess this variable and account for it where possible.

A 6-item Neuroticism scale was mailed and completed before weekly interviews began. This is a subscale from a 12-item questionnaire validated as an assessment device for the measurement of neuroticism and extraversion (48). Participants responded either "yes" or "no" to each of six personality descriptive sentences. Internal consistency taken from the current sample was .72, which is adequate given the binomial response scale.

Affect

The Positive and Negative Affect Schedule (PANAS) (12) was administered during the weekly interviews. Participants rated the extent to which they felt each of 10 positive and 10 negative mood adjectives over the past 7 days, using a unipolar response scale (1 = *very slightly or not at all* to 5 = *extremely*). The mean score for each domain was calculated, creating separate weekly scores for positive affect and negative affect. Internal consistency aggregated across-persons, for this measure was .94 for PA and .94 for NA.

Life Events

During the phone interviews, participants were given a modified version of the Inventory of Small Life Events (ISLE) (49). The ISLE provides a frequency count of negative interpersonal events and was validated to be largely statistically independent from confounds such as personality, affective reactions, psychopathology, and physical well-being. Stressful events fell under four domains of spouse, family, friends, and coworkers. The 21 undesirable daily events were summed, forming a weekly stress index.

Pain

Arthritis pain was gathered on 101-point analog scales, which are considered very reliable and valid self-report devices for the measurement of pain (50). The analog endpoints were anchored with the phrases, "*Zero would mean there was no pain*" and "*One-hundred would mean the pain was as bad as it could be.*" Participants separately rated three factors: (a) current pain, (b) worst pain over the past 7 days, and (c) average pain over the past 7 days. The mean of these three scores served as the weekly pain measure. Over the study, the internal consistency of these ratings per week ranged from .92 to .97. and averaged .94.

RESULTS

In all, 423 weekly telephone interviews were conducted. To establish the presence of a stressful week, each participant was first assigned a "baseline" for negative interpersonal events. The baseline was defined as the average number of negative events reported over the first 3 weeks. "Stressful" and "nonstressful" conditions were derived from the negative event baseline. Interview weeks were deemed stressful if the negative events score was greater than three times baseline, and 33 weeks met this criteria. The other 390 weeks were considered nonstressful.

This methodology specifically serves to highlight within-person changes under moderate and high levels of stress, where effects are most evident. Variations of the method have been used successfully to distinguish stress-induced changes in a wide variety of relevant outcomes including mood, mental health measures, symptom reports, and physiological markers of disease activity in chronically ill patients (51,52).

Positive Affect/Negative Affect Correlations

The overall correlation between PA and NA across both conditions ($n = 423$) was modest but significant nonetheless ($r = -.153$, $p = .002$), which is quite typical of the relationship between bivariate affects often reported elsewhere (12). We then investigated correlations within conditions. The 390 nonstressful weeks also showed the usual modest negative correlation between affects ($r = -.115$, $p = .023$). However, results from the 33 stressful weeks were vastly different. During these weeks, PA and NA were inversely correlated to a substantial degree ($r = -.558$, $p = .001$). A dependent sample z test (53) showed that these two correlations were significantly different from one another ($z = 2.82$, $p = .003$).

The large correlation between PA and NA during stressful weeks did not appear to be manufactured through concurrent floor or ceiling effects created by condition assignment. PA mean levels were no different, $t(421) = .860$, *ns*, from nonstressful weeks (mean = 3.04, $SD = .76$) to stressful weeks (mean = 2.92, $SD = .92$). Surprisingly, mean levels of NA also were unchanged, $t(421) = .852$, *ns*, from weeks with relatively fewer negative events (mean = 1.67, $SD = .63$) to more events (mean = 1.76, $SD = .57$). The variance of the scores did not differ substantially either, suggesting these data did not result from range restriction in negative affect during periods where stressful event numbers were not elevated.

Pain

During nonstressful weeks, a small but significant correlation was evident between NA and pain ($r = .262$, $p < .001$), but not between pain and PA ($r = .011$, *ns*). However, very different relationships were demonstrated during stressful weeks. NA and pain became strongly correlated ($r = .628$, $p < .001$), as did pain and PA ($r = -.596$, $p < .001$). Given the apparent collapse of the data space, our interests turned to the question of whether PA and NA retained discriminant features or if the affects functioned as a single redundant variable, in relationship to pain. To test this, we employed a multiple regression where both affects were simultaneously entered in an equation to predict pain, using only data points from the 33 stressful weeks. Results demonstrated that both PA ($B = -8.965$, $SE = 3.975$, $t = -2.255$, $p = .032$) and NA ($B = 17.529$, $SE = 6.462$, $t = 2.713$, $p < .011$) were unique predictors during these times, accounting for 48% of pain variance. Thus, it would seem that functional discriminations could still be made between NA and PA at stress, regardless of the degree of their interrelationship.

Characteristics of Persons Experiencing Stress

We further focused investigation on those participants who had stressful weeks to see if our effects were specific to a very select subsample. A total of 13 participants registered at least 1 stressful week, and no individual contributed more than 4 stressful weeks. This subsample evidenced no significant mean level differences from the 28 participants who only had nonstressful weeks on several important factors including neuroticism, $t(39) = -.261$, *ns;* average pain, $t(39) = -.347$, *ns;* average NA, $t(39) = .690$, *ns;* or average PA, $t(39) = -1.191$, *ns*, over the course of the study.

We then investigated the possibility that our effects were merely a function of inherently large inverse NA–PA correlations naturally exhibited by the 13 participants who experienced at least 1 stressful week. This subsample did demonstrate higher inverse correlations among the variables of interest compared to the full sample, but in each case those correlations were higher at times of stress than otherwise (see Table 1). To retest the hypothesis that the relationship between affects changed significantly as a function of stress, we conducted a pooled regression analysis[2] (54) for only those weekly data generated by the 13 participants. The sample had 33 weeks considered stressful and 115 considered nonstressful for a total of 148 weeks. We generated n-1 dummy variables to code for subject effects; recoded negative events weekly conditions as nonstressful weeks (code = 0) or stressful weeks (code = 1); and an interaction term was developed by multiplying recoded stress × NA. The pooled regression analysis was conducted on the subsample data to predict PA. Dummy variables were entered first,

[2] The procedure is a pooled time-series analysis (54). The method pools data across participants and observations, allowing analysis of within-subject effects while providing statistical control of between-subjects differences on the dependent variable and control of correlated error terms which arise from repeated measures.

TABLE 1
Correlations for Rheumatoid Arthritis Patients

Measures	Negative Affect	Pain
Positive Affect	−.115	.011
	−.408***	−.421***
	−.558***	−.596***
Negative Affect	—	.262***
	—	.416***
	—	.628***

Note: The top number in each cell represents the correlation derived from nonstressful weeks for the complete sample (390 observations); the middle number is the correlation derived from nonstressful weeks for the 13 participants who experienced a stressful week (115 observations); and the bottom number represents the correlation derived from stressful weeks (33 observations).
*** $p < .001$.

main effects for recoded events and NA were entered second, and the interaction variable was entered last. This analysis removed any between-persons differences on PA, subsequently focusing on the within-person correlation between NA and PA, as moderated by the stressful events condition. After controlling for between-subjects differences and main effects, a one-tailed test of the interaction was significant, $B = -.296$, $SE = .181$, $t(132) = -1.733$, $p = .048$, suggesting that the NA–PA relationship fluctuated with stress levels, becoming more negative, even when analyzing data from the 13 participants by themselves.

SUMMARY

The data suggest PA and NA function as two separate systems during periods when negative interpersonal events numbers are not elevated. These "normal" or "nonstressful" conditions characterize our environments a majority of the time. However, when the environmental context was altered such that participants endured high amounts of negative interpersonal events, PA and NA became more inversely correlated at the within-person level. Additionally, we located substantial between-persons differences on the correlation between affects that were not accounted for by neuroticism, mean levels of either affect, or pain.

Relationships with another affect-laden variable, pain, also differed as a function of stress. During usual conditions, NA and pain were correlated and PA was independent of pain. However, the correlations changed under more stressful circumstances. NA and pain were once again substantially related, but the inverse PA–pain correlation increased under stressful conditions, leading us to believe that these predominantly unrelated systems began to converge.

These methods, measures, and design defended against some of the threats to the validity of our findings. For instance, the ISLE (49) was validated as an events measure largely free from the confounds of personality, psychopathology, and physical disorder often seen in early small events inventories (47). In addition, the variables were assessed prospectively, and the longitudinal nature of the collection procedure therefore limits the chances that participants selectively remembered recent past events, or manufactured memories of remote events, in order to explain their current emotional distress or physical disorder (55).

However, substantial questions and concerns remain. Primary among these reservations is the knowledge that our method of determining within-person changes in stress failed to locate a significantly stressful week for every individual, and thus, the data may be confined to those persons who report significant increases in stressful events. Other questions and concerns include the magnitude of the within-person changes on the relationship between affects, the portability of the results across different chronic pain populations, and especially the absence of an analysis of the proposed cognitive mechanisms. With these limitations in mind, we set out to test our hypotheses in another chronic pain group and address the question of cognitive features associated with the differing relationship between positive and negative affect.

STUDY 2

Lacking in Study 1 was an independent assessment of our putative mechanism, information processing, specifically the degree of cognitive simplicity/complexity. We assume that life events, if frequent enough, cause a reduction in information processing down to a focused, simplified system to better deal with the stress itself. Affective simplification co-occurs in this circumstance to facilitate the process. Although Linville (37,56) and Paulhus and Lim (39) have provided experimental evidence for this simplification process, no study to date has reported the degree of affective independence/dependence in relation to the degree of information processing simplicity. Therefore, we addressed the between-persons hypothesis using a standardized measure of cognitive simplicity, the Response to Lack of Structure (RLS) subscale from the Personal Need for Structure (PNS) scale (57).

The PNS is a two-factor measure of individual differences in the way people cognitively organize social and nonsocial information. Those who score higher tend to process information in a less complex manner. That is, they form far-reaching mental categories and are less apt to recognize or make distinctions in the environment or in their adaptive responses. In effect, these persons tend to overgeneralize their world. For two reasons, the RLS subscale was considered an excellent measure of the pheneomenon under investigation. First, the RLS variable mapped on well to our inerests. It specifically addresses the extent to which people respond to lack of structure in their everyday lives. Thus, RLS assesses individuals' average responses to environmental changes, which are key components to our definition of stress. Second, during validation studies, the RLS subscale has demonstrated reasonably good concurrent validity, showing significant correlations with several factors, including neuroticism ($r = .32$), anxiety ($r = .30$), and an intolerance for ambiguity factor ($r = .36$) (57).

METHOD AND MEASURES

Participants

Study 2 participants were 112 female chronic pain patients who reported having received a physician's diagnosis of fibromyalgia (FM). They were recruited through various community advertisements throughout the local metropolitan area. FM is a pain disorder of unknown etiology and nondescript pathology. However, the population is an excellent comparison to Study 1, in that both groups were in considerable chronic pain (58).

The FM participant's average age was 56.0 years ($SD = 10.4$). The average time since diagnosis was 11.8 years ($SD = 10.1$). A total of 78 women (71%) were married at the time of the study. Overall, these FM participants were well-educated. Approximately 21% completed a high school education and another 70% completed at least a portion of college, business, or trade school. Each participant responded to a one-time questionnaire to measure demographics, levels of cognitive simplicity, positive affect, negative affect, and pain.

Cognitive Simplicity

The RLS subscale of the PNS scale was used as the measure of cognitive simplicity (57). Participants utilized a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*) in response to each of seven items which described personal responses to lack of environmental structure. Some sample items are, "I hate to change my plans at the last minute" and "I don't like situations that are uncertain." The average score across items served as the measure of cognitive simplicity, with greater scores corresponding to greater simplicity. Internal consistency was adequate at .78.

Affect

As in Study 1, the PANAS (12) was used to measure affective states and the same method was used to calculate separate scores for PA and NA. Internal consistency for PA was .86 and .91 for NA.

Pain

Participants responded to the Medical Outcome Survey Short Form (SF-36) (59), and the one item which asked, "How much bodily pain have you felt during the past four weeks?" was extracted for our purposes. The scale ranged from 1 (*none*) to 6 (*very severe*).

RESULTS

Positive Affect/Negative Affect Correlations

The FM sample's (n = 112) overall correlation between PA and NA ($r = -.208$, $p = .027$) fell within the expected range for the instrument (12). As for the RA patients, we then investigated whether the PA–NA relationship varied, in this case at the between-persons level by cognitive simplicity. To address the question, we performed a median split on cognitive simplicity (median = 3.86, SD = .92), forming one group who scored low on the variable (n = 53) and another group who scored high (n = 59). The low simplicity group demonstrated a nonsignificant PA–NA correlation (r = .012, *ns*). On the other hand, the correlation in the high simplicity group was negative and significant ($r = -.316$, $p = .015$). A Fisher's z' test (60) showed the correlations to be different from one another ($z = 1.758$, $p = .038$), suggesting the internal relationship between affects indeed was partly a function of cognitive simplicity, as predicted.

Pain

Overall, the magnitude and direction of the PA–pain and NA–pain correlations were similar to previous studies in that NA correlated with pain ($r = .413$, $p < .001$). PA also predicted pain ($r = -.186$, $p = .049$), even though the effect size was rather small.

Given the differing internal correlation between affects demonstrated by different groups, we once again reasoned that pain–affect relations would be a function of cognitive structure. As can be seen in Table 2, a significant correlation existed between NA and pain, but not between PA and pain, for the low simplicity group. However, these relationships were different for the high simplicity participants. PA and NA each were significant pain predictors for these persons. The PA–pain correlation differed between the low and high simplicity groups ($z = 1.763$, $p = .039$) as predicted, but the NA–pain correlation did not (z = .838, *ns*). A multiple regression analysis was run on the high simplicity group alone to see if, like Study 1, the affects possessed discriminant capacities to predict pain when controlling for the other affect. One-tailed tests demonstrated that NA ($B = .414$, $SE = .124$, $t = 3.333$, $p < .001$) and PA ($B = -.245$, $SE = .146$, $t = -1.678$, $p = .049$) each functioned as unique predictors, accounting for 26% of total pain variance.

TABLE 2

Correlations for Low and High Cognitive Simplicity Conditions

Measures	Negative Affect	Pain
	Low Cognitive Simplicity (n = 53)	
Positive Affect	.012	.004
Negative Affect	—	.336*
	High Cognitive Simplicity (n = 59)	
Positive Affect	−.316*	−.332**
Negative Affect	—	.469***

* $p < .05$.
** $p < .01$.
*** $p < .001$.

TABLE 3

Hierarchical Regression Predicting Negative Affect

(Step) Predictor	R^2 Change	B	SE	t	p
(1) Positive Affect	.076	−.207	.102	−2.028	.045
Simplicity Condition		.293	.147	1.997	.048
(2) Interaction	.033	−.392	.193	−2.027	.045

Characteristics of Low and High Simplicity Groups

We checked mean differences between groups since they might not have been entirely equivalent on specific variables of interest. NA was higher in the high-simplicity group, $t(110) = 2.233$, $p = .028$, but no group differences were found for PA, $t(110) = -1.507$, *ns*, or pain, $t(110) = .175$, *ns*. To examine whether mean differences based on group assignment were responsible for the results, we conducted a multiple regression analysis to predict NA, which was the one variable whose mean level was different from low to high simplicity. An interaction variable was created by multiplying PA × Simplicity condition (low = 0 and high = 1). Main effects were entered first and the mean NA difference between groups was controlled with the cognitive simplicity condition predictor. After controlling for main effects, there was an interaction in the predicted direction. As can be derived from Table 3, the inverse relationship between NA and PA was greater for those persons with higher scores on cognitive simplicity.

SUMMARY

In sum, the Study 2 results complemented those from Study 1. A measure of cognitive simplicity was administered to the Study 2 sample and provided a between-persons test of the hypothesized mechanisms. A greater inverse NA–PA correlation was found in a subgroup of FM patients who scored higher on cognitive simplicity. This subgroup also showed different pain predictor patterns, as both PA and NA were discriminant predictors for those participants, unlike the low-simplicity group where only NA was significantly related to the symptom criterion.

Study 2 provided a test of between-persons effects only and the data were encouraging. Our median split created two subgroups whose NA mean levels were different between simplicity conditions. However, relationships between NA, PA, and pain were also statistically different between groups. We interpret this as further evidence that our effects were not mere artifacts of our methods or measures, but reflections of an actual process occurring between the affects and a relevant criterion as a function of our proposed mechanism.

DISCUSSION

The overall PA–NA relations in Study 1 and Study 2 established that the affects were well-represented as bivariate factors, on the average. Altogether, pain was correlated with negative affect as expected in both studies and PA was not related to either factor (26). However, these variable configurations were partially dependent on the level of stressful life events and an information processing disposition. The affects correlated inversely when stress was elevated, and for a group of persons scoring higher on cognitive simplicity. For these conditions, NA maintained or increased its correlation with the pain criterion and PA became a discriminant pain predictor, independent of NA's influence.

Our putative mechanism, cognitive simplicity, was investigated in Study 2 as a between-persons moderator of NA–PA and affects–pain correlations, and the hypotheses were again supported. For those FM patients scoring lower on the simplicity measure, affects were bivariate and only NA predicted pain. PA was not related to any variables of interest. Higher simplicity participants, on the other hand, maintained a greater negative relation between affects, and both NA and PA were discriminant pain predictors. These data suggest that information processing may indeed be the important factor in the understanding of differentiated versus undifferentiated affect and its impact on a relevant criterion. Substantial between-persons effects were also noted in Study 1, where those persons who experienced a stressful week demonstrated much greater inverse correlations between the affects than those persons who never experienced stress over the course of the study. These effects were not accounted for by differences between groups on measures of personality or pain.

Results from the two studies supported our primary hypothesis that the relation between NA and PA is not static. Instead, the correlation contains a significant plastic element that may operate according to stressful life events and certain cognitive dispositions associated with information processing. We therefore offer a new topic for debate on the relationship between PA and NA: Under what conditions, for whom, and to what degree are PA and NA correlated? Our studies demonstrated that stressful events and cognitive dispositions play a role in this arena. Additional study into other potential moderators would appear to be fruitful for a number of disciplines, including the investigation of stress, health, cognition, and personality.

These inquiries are meaningful, partly because therapeutic implications arise from the model we have sketched. Cognitive–behavioral (CB) therapies, for example, view affective experience as the outcome of an interplay between a number of related cognitive processes including appraisals of harm, threat, or challenge in response to environmental events; attributions concerning the cause of positive and negative life experiences; perceptions of control; and a sense of efficacy to cope successfully with social demands. Therapeutic gains made as part of CB-based pain reduction programs can theoretically be accomplished by identifying and reducing maladaptive ways of thinking about or coping with the environment so as to reduce mean levels of NA, thereby reducing the experience of pain (45).

Our data, however, suggest another complementary explanation for these effects. Interventions may be effective pain reduction procedures due to their effects on the relation between cognitive factors and affective processes, as well as their ability to reduce NA. In effect, these therapies may serve to "unlink" central neurosystems responsible for cognitive processing of environmental, affective, and somatic stimuli by encouraging more differentiated appraisals and responses. Indeed, at least three clinical studies which provided CB treatments to arthritis patients demonstrated pain reduction that could not be fully attributed to mean level decreases in negative affect (61–63). Our theoretical and empirical foundations state that a more complex or differentiated cognitive milieu may also be responsible for affective and symptom changes, in addition to therapeutic effects seen as decreases in negative affect mean levels. Evidence of these mechanisms at work await further research.

Although our data provide support for our model, additional studies are still needed to firmly establish its plausibility and ultimate utility. Study 1 results were consistent with the idea that within-person increases in stressful events are related to changes in affect dynamics. Substantial between-persons effects were also noted but were not accounted for by the available measures. Study 2, on the other hand, was solely a between-persons analysis focusing on affect relationships as a function of cognitive simplicity. For future studies, it would be appropriate to investigate whether within-person changes in state cognitive processing account for the stress-related alterations in the relationship between PA and NA observed here.

Experimental manipulations of stress would also prove quite useful in establishing such effects on information and affective processing, as well as how such processing alterations impact physical states. Administering these manipulations to all sample members would address the question of whether within-person changes hold for every individual under the same stress condition. Further, the use of an experimental stressor provides greater assurance that the findings are not the result of a subtle bias in self-report, since the stress week and levels of PA and NA are all based on self-reports in the present study. Finally, we encourage clinical studies to test the hypothesis that persons with less differentiated affects experience greater pain and more psychological distress than those with more bivariate positive and negative affect. Stable differences on the NA–PA correlation might account for between-persons differences in the experience of chronic pain, after accounting for the effects of traditional measures of personality.

In sum, our model suggests that the person's information processing demands (e.g. stressful events and information processing dispositions) should not be ignored when assessing affective states and correlates. The very phenomenon under investigation may differ in its form, dynamics, and function when the individual is under stress or when that individual processes information in a less differentiated fashion. If this new model holds, many standard measures relevant to stress, coping, adaptation, and health will need to be recast, and theories which seek to explain the interrelationships between stress, personality, and health may need to be refined to account for variability in the structure of affect over time and between persons.

REFERENCES

(1) Cacioppo JT, Berntson GG: Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin.* 1994, *115:*401–423.

(2) Cacioppo JT, Gardner WL, Berntson GG: Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. *Personality and Social Psychology Review.* 1997, *1:*3–25.

(3) Diener E, Emmons RA: The independence of positive and negative affect. *Journal of Personality and Social Psychology.* 1984, *47:*1105–1117.

(4) Green DP, Goldman SL, Salovey P: Measurement error masks bipolarity in affect ratings. *Journal of Personality and Social Psychology.* 1993, *64:*1029–1041.

(5) Watson D, Clark LA: Affects separable and inseparable: On the hierarchical arrangement of the negative affects. *Journal of Personality and Social Psychology.* 1992, *62:*489–505.

(6) Watson D, Tellegen A: Toward a consensual structure of mood. *Psychological Bulletin.* 1985, *98:*219–235.

(7) Russell JA, Carroll JM: The phoenix of bipolarity: Reply to Watson and Tellegen. *Psychological Bulletin.* 1999, *125:*611–617.

(8) Russell JA, Carroll JM: On the bipolarity of positive and negative affect. *Psychological Bulletin.* 1999, *125:*3–30.

(9) Watson D, Tellegen A: Issues in the dimensional structure of affect–effects of descriptors, measurement error, and response formats: Comment of Russell and Carroll. *Psychological Bulletin.* 1999, *125:*601–610.

(10) Diener E, Larson RJ, Levine S, Emmons RA: Intensity and frequency: Dimensions underlying positive and negative affect. *Journal of Personality and Social Psychology.* 1985, *47:*1105–1117.

(11) Lawton MP: The varieties of well-being. *Experimental Aging Research.* 1983, *9:*65–72.

(12) Watson D, Clark LA, Tellegen A: Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology.* 1988, *54:*1063–1070.

(13) Zevon MA, Tellegen A: The structure of mood change: An idiographic/nomothetic analysis. *Journal of Personality and Social Psychology.* 1982, *43:*111–122.

(14) Zautra AJ, Burleson MH, Smith CA, et al: Arthritis and the quality-of-life experience: An examination of positive and negative affect in rheumatoid arthritis patients. *Health Psychology.* 1995, *14:*399–408.

(15) Benin MH, Stock WA, Okun MA: Positive and negative affect: A maximum likelihood approach. *Social Indicators Research.* 1988, *20:*165–175.

(16) Davidson RJ: Affect, repression, and cerebral asymmetry. In Temoshok L, Van Dyke C, Zegans LS (eds), *Emotions in Health and Illness: Theoretical and Research Foundations.* New York: Grove & Stratton, 1983, 123–135.

(17) Davidson RJ: Emotion and affective style: Hemispheric substrates. *Psychological Science.* 1992, *6:*239–253.

(18) Lee GP, Loring DW, Dahl JL, Meador KJ: Hemispheric specialization for emotional expression. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology.* 1993, *6:*143–148.

(19) George MS, Ketter TA, Parekh PI, et al: Brain activity during transient sadness and happiness in healthy women. *American Journal of Psychiatry.* 1995, *152:*341–351.

(20) Lane RD, Reiman EM, Ahern GL, Schwartz GE, Davidson RJ: Neuroanatomical correlations of happiness, sadness, and disgust. *The American Journal of Psychiatry.* 1997, *154:*926–933.

(21) Costa Jr. PT, McCrae RR: Influence of extroversion and neuroticism on subjective well-being: Happy and unhappy people. *Journal of Personality and Social Psychology.* 1980, *38:*668–678.

(22) Clark DA, Beck AT, Stewart BL: Cognitive specificity and positive–negative affectivity: Complementary or contradictory views on anxiety and depression? *Journal of Abnormal Psychology.* 1990, *99:*148–155.

(23) Watson D, Clark LA, Carey G: Positive and negative affectivity and their relation to anxiety and depressive disorders. *Journal of Abnormal Psychology.* 1988, *97:*346–353.

(24) Isen AM, Daubman KA, Nowicki GP: Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology.* 1987, *52:*1122–1131.

(25) Goldstein MD, Strube MJ: Independence revisited: The relation between positive and negative affect in a naturalistic setting. *Personality and Social Psychology Bulletin.* 1994, *20:*57–64.

(26) Watson D: Intraindividual and interindividual analyses of positive and negative affect: Their relation to health complaints, perceived stress, and daily activities. *Journal of Personality and Social Psychology.* 1988, *54:*1020–1030.

(27) Watson D, Pennebaker JW: Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review.* 1989, *96:*234–254.

(28) Suh E, Diener E, Fujita F: Events and subjective well-being: Only recent events matter. *Journal of Personality and Social Psychology.* 1996, *70:*1091–1102.

(29) Diener E, Iran-Nejad A: The relationship in experience between various types of affect. *Journal of Personality and Social Psychology.* 1986, *50:*1031–1038.

(30) Cohen S, Williamson GM: Stress and infectious disease in humans. *Psychological Bulletin.* 1991, *109:*5–24.

(31) Taylor SE: Asymmetrical effects of positive and negative events: The mobilization–minimization hypothesis. *Psychological Bulletin.* 1991, *110:*67–85.

(32) Moss MS, Lawton MP, Glicksman A: The role of pain in the last year of life of older persons. *Journal of Gerontology: Psychological Sciences.* 1991, *46:*51–57.

(33) Nelson G: Women's life strains, social support, coping, and positive and negative affect: Cross-sectional and longitudinal tests of the two-factor theory of well-being. *Journal of Community Psychology.* 1990, *18:*239–263.

(34) Zautra AJ, Reich JW: Life events and perceptions of life quality: Developments in a two-factor approach. *Journal of Community Psychology.* 1983, *11:*121–132.

(35) Zautra AJ, Potter PT, Reich JW: The independence of affects is context-dependent: An integrative model of the relationship between positive and negative affect. In Schaie KS, Lawton MP (eds), *The Annual Review of Gerontology and Geriatrics* (Vol. 17). New York: Springer Publishing, 1997, 75–102.

(36) Sackheim HA, Weber SL: Functional brain asymmetry in the regulation of emotion: Implication for bodily manifestations of stress. In Goldberger L, Breznitz S (eds), *Handbook of Stress: Theoretical and Clinical Aspects.* New York: Free Press, 1982, 183–199.

(37) Linville PW: Self-complexity and affective extremity: Don't put all of your eggs in one cognitive basket. *Social Cognition.* 1985, *3:*94–120.

(38) Easterbrook JA: The effect of emotion on cue utilization and the organization of behavior. *Psychological Review.* 1959, *66:*183–201.

(39) Paulhus DL, Lim TK: Arousal and evaluative extremity in social judgments: A dynamic complexity model. *European Journal of Social Psychology.* 1994, *24:*89–99.

(40) Schroeder DH, Driver MJ, Streufert S: *Human Information Processing.* New York: Holt, Rinehart, and Winston, Inc., 1967.

(41) Fernandez E, Turk DC: Sensory and affective components of pain: Separation and synthesis. *Psychological Bulletin.* 1992, *112:*205–212.

(42) Hadler NM: Knee pain is the malady—Not osteoarthritis. *Annals of Internal Medicine.* 1992, *116:*598–599.

(43) Melzack R, Casey KL: Sensory, motivational, and central control determinants of pain: A new conceptual model. In Kenshall D (ed), *The Skin Senses.* Springfield, IL: Thomas Publishing, 1968, 423–443.

(44) Potter PT, Zautra AJ: Stressful life events' effects on rheumatoid arthritis disease activity. *Journal of Consulting and Clinical Psychology.* 1997, *65:*319–323.

(45) Smith TW, Christensen AJ: Positive and negative affect in rheumatoid arthritis: Increased specificity in the assessment of emotional adjustment. *Annals of Behavioral Medicine.* 1996, *18:*75–78.

(46) Bolger N, Zuckerman A: A framework for studying personality in the stress process. *Journal of Personality and Social Psychology.* 1995, *57:*808–818.

(47) Dohrenwend BS, Dohrenwend BP, Dodson M, Shrout PE: Symptoms, hassles, social supports, and life events: Problems of confounded measures. *Journal of Abnormal Psychology.* 1984, *93:*222–230.

(48) Eysenck HJ: A short questionnaire for the measurement of two dimensions of personality. *Journal of Abnormal Psychology.* 1958, *42:*14–17.

(49) Zautra AJ, Guarnaccia CA, Dohrenwend BP: Measuring small life events. *American Journal of Community Psychology.* 1986, *14:*629–655.

(50) Price DD: *Psychological and Neural Mechanisms of Pain.* New York: Raven Press, 1988.

(51) Zautra AJ, Hoffman J, Potter PT, et al: Examination of changes in interpersonal stress as a factor in disease exacerbations among women with rheumatoid arthritis. *Annals of Behavioral Medicine.* 1997, *19:*279-286.

(52) Zautra AJ, Hoffman J, Yocum D, et al: An examination of individual differences in the relationship between interpersonal stress and disease activity among women with rheumatoid arthritis. *Arthritis Care and Research.* 1998, *11:*271–279.

(53) Steiger JH: Tests for comparing elements of a correlation matrix. *Psychological Bulletin.* 1980, *87:*245–251.

(54) Ward MM, Leigh JP: Pooled time series analysis in longitudinal studies. *Journal of Clinical Epidemiology.* 1993, *46:*645–659.

(55) Brown GW, Harris TO: *Life Events and Illness.* New York: Guilford Press, 1989.

(56) Linville PW: Self-complexity as a cognitive buffer against stress-related illness and depression. *Journal of Personality and Social Psychology.* 1987, *52:*663–676.

(57) Neuberg SL, Newsom JT: Personal need for structure: Individual differences in the desire for simple structure. *Journal of Personality and Social Psychology.* 1993, *65:*113–131.

(58) Leavitt F, Katz RS, Golden HE, Glickman PB, Layfer LF: Comparison of pain properties in fibromyalgia patients and rheumatoid arthritis patients. *Arthritis and Rheumatism.* 1986, *29:*775–781.

(59) McHorney CA, Ware JE, Lu JFR, Sherbourne CD: The MOS 36-item short-form health survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. *Medical Care.* 1994, *32:*40–66.

(60) Cohen J, Cohen P: *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

(61) Bradley LA, Young LD, Anderson KO, et al: Effects of psychological therapy on pain behavior of rheumatoid arthritis patients. *Arthritis and Rheumatism.* 1987, *30:*1105–1114.

(62) O'Leary A, Shor S, Lorig K, Holman HR: A cognitive–behavioral treatment for rheumatoid arthritis patients. *Health Psychology.* 1988, *7:*527–544.

(63) Parker JC, Smarr KL, Buckelew SP, et al: Effects of stress management on clinical outcomes in rheumatoid arthritis. *Arthritis and Rheumatism.* 1995, *38:*1807–1818.