

# Independence and Bipolarity in the Structure of Current Affect

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The independence of positive and negative affect has been heralded as a major and counterintuitive finding in the psychology of mood and emotion. Still, other findings support the older view that positive and negative fall at opposite ends of a single bipolar continuum. Independence versus bipolarity can be reconciled by considering (a) the activation dimension of affect, (b) random and systematic measurement error, and (c) how items are selected to achieve an appropriate test of bipolarity. In 3 studies of self-reported current affect, random and systematic error were controlled through multifactor measurement and confirmatory factor analysis. Valence was found to be independent of activation, positive affect the bipolar opposite of negative affect, and deactivation the bipolar opposite of activation. The dimensions underlying D. Watson, L. A. Clark, and A. Tellegen's (1988) Positive and Negative Affect schedule were accounted for by the valence and activation dimensions.

A consensus on a descriptive structure of current affect is at hand—if we can only agree on what the structure is. The psychology of mood, emotion, and affect needs a consensual structure and is tantalizingly close to achieving one. Among the remaining disagreements, the most puzzling and persistent is bipolarity versus independence. Is positive affect the bipolar opposite of, or is it independent of, negative affect? Are happiness and sadness two ends of one continuum, or separate entities, like apples and oranges?

A resolution to this puzzle is needed to answer questions about the number of dimensions of affect, how affect should be measured, and the underlying processes involved. Despite repeated attempts, a solution to this puzzle remains elusive, and a long-simmering debate has recently flared up. Much is at stake in this debate, for important lines of research have arisen on these opposing assumptions. This article offers conceptual and empirical analyses aimed at resolving the dispute.

## Background

Tradition and common sense have assumed bipolarity in affect. Pleasure and pain, happy and sad, tension and relaxation, depression and elation—such pairs seem to express opposites. Bipolarity appears strongly in the semantics of emotion in diverse languages (Russell, 1991; Russell, Lewicka, & Niit, 1989) and in the semantic differential (Osgood, 1969).<sup>1</sup> Research in

diverse areas related to affect often assumes bipolarity. For example, a bipolar positive–negative dimension appears in theories of the appraisal process leading to an emotion (Smith & Ellsworth, 1985), in judgments of the intensity of emotions (Reisenzein, 1994), in the perception of emotion in vocal (Pittam & Scherer, 1993) and facial expression (Kring, Smith, & Neale, 1994), in judgments of economic utility (Fredrickson & Kahneman, 1993), and in attitudes of all kinds (Green, 1988). Experimental studies have favored bipolarity; for example, when contrast effects are experimentally induced in the perception of emotion from facial expression, a relatively neutral face seems happy alongside a sadder face, sad alongside a happier face (Russell & Fehr, 1987). Only a bipolar model can account for such results. Researchers who include affect as a predictor, manipulation check, or dependent variable in their research often assume bipolarity. For example, even when scales that assume independence are used, it is not uncommon to subtract the negative affect score from the positive one (as was done by Lykken & Tellegen, 1996, for example), thereby creating a single score on an implicitly bipolar dimension.

The study of self-reported affect began with the assumption of bipolarity: Wundt (1912/1924) described his introspected affective feelings in terms of bipolar dimensions (Reisenzein, 1992). The introduction of more objective techniques, however, immediately raised the issue of independence. Two pioneers of this area, Nowlis (1965) and Bradburn (1969; Bradburn & Caplovitz, 1965) expected to find bipolarity, but their evidence led them to proclaim that the two ends of anticipated bipolar continua were actually independent. Degree of happiness did not predict degree of sadness, even at the same point in time. Further factor analyses and research on mood scales seemed to confirm independence (Borgatta, 1961; Clyde, 1963; Diener & Emmons, 1984; McNair & Lorr, 1964; Thayer, 1967; Warr, Barter, & Brownridge, 1983; Watson & Tellegen, 1985). Where one bipolar activation–deactivation factor was expected, Thayer

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<sup>1</sup> Interestingly, bipolarity of the semantic differential factors was challenged by Green and Goldfried (1965) but established empirically by Bentler (1969).

(1967) found four independent unipolar dimensions. A large literature is developing in which positive and negative affect are treated as independent (e.g., Cacioppo & Berntson, 1994). A commonly used scale, the Positive And Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), produces largely independent scores for positive and negative affect.

Still, indications of bipolarity persist (Diener & Emmons, 1984; Larsen & Diener, 1992; Lorr & McNair, 1982; Lorr & Wunderlich, 1980; Russell & Mehrabian, 1977; Russell & Steiger, 1982). Meddis (1972) and Russell (1979) reminded us that the observed correlation between obtained scores is not necessarily the same as the true correlation between the underlying variables themselves. The observed covariance is a combination of true covariance between, say, positive and negative affect and the covariance due to the process of measurement. Measurement covariance may obscure bipolarity and bias the results in favor of independence. Some researchers who initially found independent factors have later found that controlling measurement error favors bipolarity (Diener & Emmons, 1984; Lorr & Wunderlich, 1980; Thayer, 1986). Some self-report scales are therefore based on bipolar dimensions (Cuthbert, Bradley, & Lang, 1996; Lang, Greenwald, Bradley, & Hamm, 1993; Lorr & McNair, 1982; Mehrabian & Russell, 1974; Russell, Weiss, & Mendelsohn, 1989). Diener and his colleagues have discussed at length some of the empirical issues associated with finding bipolarity (see Diener & Emmons, 1984; Diener & Iran-Nejad, 1986; Diener, Larsen, Levine, & Emmons, 1985; Diener, Smith, & Fujita, 1995).

The latest round in this dispute began with a masterful analysis by Green, Goldman, and Salovey (1993). Their title is an aphorism for their theme: "Measurement Error Masks Bipolarity in Affect Ratings." The combination of random and systematic errors inherent in the process of measurement can produce the appearance of independence even when the underlying structure is bipolar. In a series of four studies of self-reported affect, Green et al. obtained the often found weak to moderate negative zero-order correlations between their measures of positive and negative affect. They applied confirmatory factor analysis to their multifactor affect scales to estimate both random and systematic sources of error in their data. They could thus estimate correlations not between single measures, but between the latent constructs themselves. The result was the reemergence of bipolarity. In one dramatic example, the correlation between observed scores on happiness and those on sadness was  $-.25$ ; the correlation between their latent scores was estimated to be  $-.84$ .

Green et al. (1993) delivered the *coup de grâce* to all research in which conclusions are based directly on the *observed* correlation between *measures* of affect. Yet the issue of independence versus bipolarity is far from settled. Watson and Clark (1997) and Tellegen, Watson, and Clark (1994) have vigorously defended their claim that positive affect is independent of negative affect, and they have raised a number of challenges to Green et al. (1993). In particular, they have interpreted Green et al. as presupposing a problematic premise: "A strictly bipolar model of positive and negative affect is by implication a strictly *unidimensional* model of positive and negative affect" (emphasis in original, p. 2). However, no conceptual model of affect today is unidimensional (Feldman, 1995; Lang et al., 1993; Larsen &

Diener, 1992; Morris, 1989; Russell, 1997; Thayer, 1989; Watson & Tellegen, 1985).

Tellegen and his colleagues have also argued that when their own scales of positive and negative affect, which they term PA and NA, are used, they are found to be "largely independent" (Watson & Clark, 1992, p. 490; Watson & Tellegen, 1985, p. 233; see also Tellegen, 1985; Watson, 1988; Watson, Clark & Tellegen, 1988), even when random and systematic errors are taken into account (Tellegen et al., 1994; Watson & Clark, 1997). Although powerful, such errors are not powerful enough to account for the near independence of their NA and PA scales. In an empirical analysis using confirmatory factor analysis to control for one such error, acquiescence, the correlation between the latent variables underlying their scales was  $-.43$  (Tellegen et al., 1994). Other recent analyses using confirmatory factor analysis have provided similar estimates for these scales ( $-.44$ , Diener et al., 1995;  $-.58$ , Green et al., 1993).

This article offers a reconciliation of bipolarity and independence in current affect. Comparisons between the full models of affect offered by various researchers (their assumptions, concepts, hypotheses, and methods) are beyond the scope of this article. Instead, we focus on a key question that any model must address: bipolarity versus independence of the descriptive dimensions of affect. Our starting premise was that a broader perspective is required. We argue that the evidence advanced by Green and Tellegen and their colleagues can be united in a single structure, with the remaining differences a matter of naming rather than substance. We replicate and extend the results of Green et al. (1993) and confirm Tellegen et al.'s (1994) point that affect is not unidimensional. We focus attention on certain properties of the two PANAS (Watson et al., 1988) scales, which are often used in studies of the relation between positive and negative affect. Furthermore, we argue, along with Tellegen et al., that measurement errors are not sufficient to solve this puzzling controversy. In the end, we propose a parsimonious structure of affect that we hope will be acceptable to everyone.

### Testing Bipolarity

The bipolar model has not always been specified properly. Bipolarity is a hypothesis embedded in the semantics of affect: Happiness seems the bipolar opposite of sadness in part because the words *happy* and *sad* are antonyms. Any empirical test of bipolarity must begin with a clear specification of the bipolarity hypothesis implied by and consistent with the semantics of affect. We emphasize three points.

First, not every positive affect term is the bipolar opposite of every negative affect term. According to the semantics of affect, *elated* is the bipolar opposite of *depressed*, but not of many other negative terms, such as *jittery* or *tense*. (This is not to say that *elated* is therefore independent of *jittery* or *tense*; terms can bear any degree of relation, not just antonymy, independence, or synonymy.) The methodological consequence is so obvious that it would go without saying, were it not frequently overlooked: In testing bipolarity, the items selected must actually be the hypothesized bipolar semantic opposites.

Second, when the topic is positive or negative affect in general, rather than individual items, the positive items must be chosen to represent adequately the range of pleasant affect terms

and the negative items to represent adequately the range of unpleasant affect terms. The logic of sampling prevails: If the items sampled are not representative of the entire domain, then the test of bipolarity can be biased.

Third, by focusing exclusively on the valence (the pleasant or unpleasant quality) of affect, research can miss the overall layout of the forest. There are more semantic components in affect than just valence. It is an empirical finding that both pleasant and unpleasant affect words vary in the level of activation versus deactivation they denote (Averill, 1975; Bush, 1973; Neufeld, 1975, 1976; Russell, 1978; Thayer, 1989; Whissell, 1981).<sup>2</sup> Some pleasant words imply activation (*elated, thrilled*); others imply deactivation (*serene, calm*). Some unpleasant words imply activation (*upset, distressed*); others imply deactivation (*lethargic, depressed*). Similarly, it was an exclusive focus on degrees of activation that led to the initial conclusion of independent unipolar activation factors (Thayer, 1967). Words denoting activation and deactivation also vary in valence. Some activation words are pleasant (*thrilled, excited*), some unpleasant (*tense, jittery*). Some deactivation words are pleasant (*relaxed, calm*), others unpleasant (*down, lethargic*).

In short, a proper test of the bipolarity hypothesis must select items that (a) are hypothesized bipolar opposites, (b) represent the full range of pleasant and unpleasant terms, and (c) take into account activation. The semantic hypothesis portrayed in Figure 1 shows how these three criteria can be met and is the basis of our proposed solution to the controversy over independence and bipolarity. This structure is not new, but captures the main features of Green et al. (1993) and Tellegen et al. (1994), as well as those of Larsen & Diener (1992), Feldman (1995), Lang et al. (1993), Reisenzein (1994), Russell (1980), and Thayer (1989). Indeed, its roots go back to Schlosberg (1952, 1954) and Wundt (1912/1924). It unites the results from those who focus on affect with the results from those who focus on activation.

Figure 1 shows an array of affect-related words, each of which varies both in valence and activation. Positive affect (the right half of the figure) consists of a range of words that vary in level of activation, as does negative affect (the left half). Activation (the top half of the figure) consists of words that vary in valence, as does deactivation (the bottom half). Every affect word has both valence and activation components. Each word has a bipolar opposite 180° away that is opposite on both components. This last point is key in understanding the bipolarity of affect: Opposites are opposite on both valence and activation. Put differently, any straight line placed through the center of Figure 1 marks out bipolar opposites.

Figure 1 is thoroughly bipolar. Yet, Figure 1 is also such that clusters of items can be constructed to bear any correlations whatsoever to each other. Just which clusters are created and what they are named is critical in any test of bipolarity. Figure 1 thus illustrates what can happen when the three criteria listed above are overlooked. Suppose that a researcher creates two scales. The positive scale consists of items that happen to be high in activation as well as pleasantness (with items such as *elated*). Indeed, suppose that the positive scale consists of equal parts pleasantness ( $x$ ) and activation ( $y$ ). The negative scale consists of items that also happen to be high in activation, as well as unpleasantness (with items such as *tense*). Indeed, sup-

pose that the negative scale consists of equal parts unpleasantness ( $-x$ ) and activation ( $y$ ). In terms of semantic components, if  $x$  is pleasantness and  $y$  is activation, then the positive scale =  $x + y$  and the negative scale =  $-x + y$ . Now, when any two variables  $x$  and  $y$  are in standard score form, the following is always true: The correlation of  $x + y$  and  $-x + y$  is exactly zero.

Later, we discuss how Figure 1 can reconcile apparently disparate conclusions and explain the empirical evidence offered by both sides in this debate. But before doing so, we offer evidence that the semantic hypothesis presented in Figure 1 can describe the structure of self-reported actual current affective states. An empirical test is especially important in light of Green et al.'s (1993) dramatic demonstration of the potential distorting effects of errors of measurement.

## Overview

Three studies that followed Green et al.'s (1993) design are reported here. Study 1 was a brief investigation that examined the correlation between separate scales of positive and negative affect; these scales included hypothesized opposites and held activation approximately constant. Preliminary scales for activation and deactivation were also included; these scales too included hypothesized opposites and held valence approximately constant. The results showed two bipolar dimensions of affect: one of valence (pleasant vs. unpleasant) and one of activation (activation vs. deactivation). Valence and activation were approximately independent of one another. Study 2 replicated these results with a larger sample of respondents and an improved set of measures. Study 3 replicated the two-dimensional bipolar structure again and demonstrated the position of Watson and colleagues' (Watson et al., 1988) PANAS scales in the space.

## Study 1

In a preliminary study ( $N = 129$ ), we pilot-tested measures of pleasant, unpleasant, activated, and deactivated affective states that met the three criteria listed above for an adequate test of bipolarity. Scales were developed in two different for-

<sup>2</sup> The activation factor of which we speak appears clearly in semantic studies. Of course, not everyone agrees on the nature of actual physiological activation or the role it plays in affect. For example, Frijda (1988) has suggested that low activation states are not emotions, although they may be moods or states of affect. Similarly, Ortony, Clore, and Collins (1988) have suggested that pure activation states are not emotions, although they may be feeling states. In contrast, Watson & Tellegen (1985) have suggested that low activation states are not affects, even if they are valenced (*depressed, serene*). In the present article, we do not take up the distinctions between emotion, mood, and affect, except to say that we take affect to be a part of mood and emotion. We argue that a consideration of differences in activation (e.g., the difference between *excitement* and *serenity*) does clarify the structure of affect ratings. Such ratings presumably depend on persons' subjective perceptions of their own states of activation and not necessarily on the actual (and perhaps unperceived) peripheral physiological changes occurring (Feldman Barrett, in press; Russell, 1989). Indeed, central mechanisms may mediate both felt activation and peripheral changes, with the latter two having no direct causal connection.

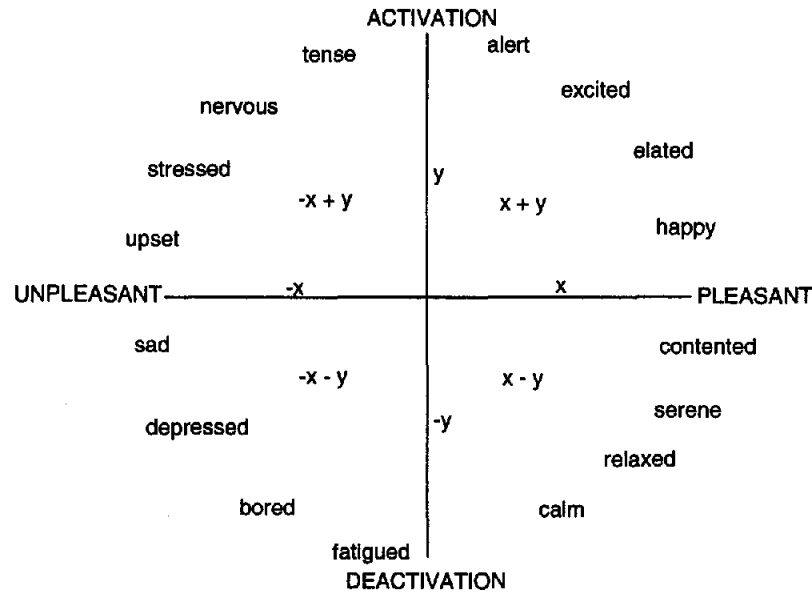


Figure 1. A semantic structure of affect. The letters  $x$  and  $y$  represent semantic components:  $x$  = pleasantness;  $y$  = activation.

mat: (a) an adjective list accompanied by a 5-point Likert-type scale ranging from 1 (*not at all*) to 5 (*extremely*), and (b) a list of statements with which respondents indicated their degree of agreement on a 5-point scale ranging from 1 (*strong disagreement*) to 5 (*strong agreement*). In addition, participants also completed a semantic differential for pleasant-unpleasant states and for aroused-sleepy states (Russell & Mehrabian, 1974). Confirmatory factor analysis was used to construct a structure of affect using these measures. The methods and analyses used were identical to those to be described in Study 2 and therefore are not presented here.<sup>3</sup>

The results of Study 1 can be summarized briefly. As predicted, the analyses indicated large negative correlations between latent pleasant and unpleasant factors ( $-.92$ ) and between latent activation and deactivation factors ( $-.84$ ). In addition, our two-dimensional structure with bipolar pleasantness-unpleasantness and activated-deactivated latent factors fit the data extremely well.

## Study 2

In Study 2, we attempted a replication of our initial findings with a larger sample of participants and with improved measures. As in Study 1, we conducted analyses to investigate (a) whether valence and activation dimensions were each bipolar and (b) whether the data conformed to a two-dimensional structure of affect.

## Method

**Participants.** Participants were 225 undergraduate students in the Department of Psychology at the University of British Columbia. Participants received course credit for their participation in the study.

**Procedure.** Participants completed the battery of measures in large

groups. On the cover sheet of the battery, participants were directed to "stop for a moment and think about how you are feeling." They were asked to use the words and phrases that followed to describe that feeling. They were specifically instructed not to rate how their mood changed as they moved from question to question, but rather to report how they felt at the moment immediately before they began the battery.

**Affect measures.** The battery of questionnaires used was identical to that used in Study 1, with the addition of another set of statements presented with a 4-point rating scale ranging from 1 (*describes me not at all*) to 4 (*describes me very well*). The items used, as well as their response formats, are given in the Appendix.

## Results

**Data analyses.** Covariance and correlation matrices for measured variables were submitted to confirmatory factor analyses (CFA) through use of LISREL VIII (Joreskog & Sorbom, 1993). Because both produced nearly identical results, we report the results in correlation metric. Many different indices are available to assess the degree to which a hypothesized model is consistent with observed data. Because most researchers agree that no single measure of fit should be relied on exclusively (Bollen & Long, 1993), we used four measures to assess model fit. First, we used the chi-square statistic. As the most commonly used measure of fit, the chi-square statistic tests the null hypothesis that the specified theoretical model reproduces the covariance matrix of the observed variables. A significant chi-square indicates that the covariance matrix derived from the theoretical model deviates significantly from the observed covariance matrix. The chi-square statistic is dependent on sample size, however, so that it can be significant even for models that fit relatively

<sup>3</sup> A report of this pilot study is available from Lisa Feldman Barrett on request.

well (Bentler, 1990). Second, we used the adjusted goodness of fit index (AGFI), which provides a more direct measure of fit than the chi-square statistic. This index is similar to the adjusted  $R^2$  statistic used in the general linear model (Tanaka, 1993) and typically falls between 0 (indicating complete lack of fit) and 1 (indicating perfect fit). Like the chi-square statistic, the AGFI is not totally free from sample size constraints (Bentler, 1990). Third, we used the comparative fit index (CFI; see Bentler, 1990; Bentler & Bonett, 1980). The CFI is a normed-fit index that evaluates the adequacy of a specified model in relation to a baseline model. The most restricted baseline model (called a null model) is used in the calculation of the CFI; a null model assumes that all observed variables are uncorrelated (i.e., every measure is an indicator for a separate latent variable). As in the AGFI, CFI coefficients range from 0 to 1, with higher values indicating greater fit. The rule of thumb is that a normed-fit index of .90 or greater indicates that the specified theoretical model fits the data well (Bentler & Bonett, 1980). Finally, we also calculated the Root Mean Square Residual, representing the discrepancy between the observed and the hypothesized covariance matrices. Larger numbers indicate more discrepancy and therefore poorer fit.

*Bipolarity of the affect dimensions.* The first set of analyses was designed to evaluate the structure among the four unipolar state scales: Pleasant, Unpleasant, Activated, and Deactivated. The semantic differential measure was not used in this analysis because it is inherently bipolar and we were not able to split it into unipolar scales. The top half of Table 1 gives the correlation matrix for the observed ratings. All scales demonstrated adequate convergent validity (correlations ranged from  $r = .49$  to  $r = .88$ ). The Pleasant and Unpleasant scales had substantial negative correlations (correlations ranging from  $r = -.66$  to  $r = -.86$ ), as did the Activated and Deactivated scales (correlations ranging from  $r = -.33$  to  $r = -.66$ ).

We first tested a model that specified that only random measurement error influenced the observed correlations. Because random error produces correlation coefficients that are biased toward zero, we expected that the correlations between the latent unipolar factors would be more negative than the corresponding observed zero-order correlations shown in the top half of Table 1. We specified a model with four latent factors, each corresponding to one end of a unipolar dimension; the latent factors were scaled by setting their variances to 1. We estimated the correlation between the latent factors to assess bipolarity, and we estimated the random error associated with each of the measured variables. This model fit the data well,  $\chi^2 (48, N = 225) = 142.48, p < .001$ , AGFI = .84, CFI = .96, Root Mean Square Residual = .06. The parameter representing the correlation between the latent factors estimates the true correlation between the factors after controlling for random errors in measurement. As predicted, this analysis yielded a more substantial negative correlation between latent pleasant and unpleasant factors ( $-.93$ ) than those observed between the measured variables (mean correlation =  $-.78$ ). The same was true for the correlation between latent activation and deactivation factors ( $-.79$ ) compared with the correlations between the measured variables (mean correlation =  $-.54$ ). Thus, a CFA of the observed ratings in Table 1 supported the hypothesis that both the Pleasant and

Unpleasant state scales are bipolar in nature, as are the Activated and Deactivated state scales.

Next, we specified an analysis that modeled nonrandom sources of error, in addition to random sources, by correlating the errors between questionnaire scales of similar response format. Systematic measurement error can produce observed correlations that are larger or smaller than the correlations between latent factors (Green et al., 1993). Once again, we estimated a model with four latent factors, each corresponding to one end of a unipolar dimension; the latent factors were scaled by setting their variances to 1. We estimated the correlations between the latent factors to assess bipolarity, and we correlated the errors between measures using the same response format to take account of nonrandom measurement error. This model fit the data well,  $\chi^2 (30, N = 225) = 83.75, p < .001$ , AGFI = .85, CFI = .98, Root Mean Square Residual = .05, and in fact fit the data significantly better than the model that estimated random error only, difference in  $\chi^2 (18, N = 225) = 58.73, p < .001$ . The standardized factor loadings and the interfactor correlations are presented in the left side of Table 2. The parameter representing the correlation between the latent factors estimates the true correlation between the factors after controlling for both random and nonrandom errors in measurement. As predicted, this model yielded a substantial negative correlation between latent pleasant and unpleasant factors ( $-.93$ ), and between latent activation and sleepiness factors ( $-.79$ ). The estimated interfactor correlations did not change when the CFA model took nonrandom sources of error into account (for a discussion of this effect, see Green et al., 1993, p. 1034), although modeling the nonrandom error in the data improved the fit of the model.

*Two-dimensional structure of affect.* Our third analysis was designed to create a measurement model for a two-dimensional affective space. We used the same data as in the preceding analysis to construct three bipolar measures of the pleasantness and activation dimensions, and we included the semantic differential measures in this analysis. The top half of Table 3 presents the correlation matrix for these observed ratings. The Pleasant–Unpleasant measures demonstrated reasonable convergent validity (correlations ranging from  $r = .36$  to  $r = .86$ ), and the Activated–Deactivated measures demonstrated moderate convergent validity (correlations ranging from  $r = .62$  to  $r = .82$ ). Most measures demonstrated good discriminant validity (correlations ranging from  $r = .01$  to  $r = .23$ ).

To model a two-dimensional structure of affect, we specified two latent bipolar factors, Pleasantness–Unpleasantness and Activation–Deactivation. As in the previous analysis, the latent factors were scaled by setting their variances to 1. We estimated the correlation between the latent factors, and we also correlated the errors between measures using the same response format. This model fit the data well,  $\chi^2 (15, N = 225) = 55.17, p < .001$ , AGFI = .87, CFI = .96, Root Mean Square Residual = .04. The standardized factor loadings are presented in the left half of Table 4; all were statistically significant. The interfactor correlation, .21, was statistically significant. Thus, the valence and the activation factors were weakly correlated even after controlling for random and nonrandom errors in measurement.

### Study 3

In Study 3, we first replicated the valence–activation structure of affect that emerged from Studies 1 and 2. Second, we exam-

Table 1  
Zero-Order Correlations for Unipolar Affect Measures

Measure	Pleasant-Unpleasant						Activated-Deactivated						<i>M</i>	<i>SD</i>
	1	2	3	4	5	6	7	8	9	10	11	12		
Study 2														
1. Pleasant statements 1	—												9.55	2.77
2. Pleasant statements 2	.88	—											5.75	1.69
3. Pleasant adjectives	.85	.82	—										8.16	2.85
4. Unpleasant statements 1	-.86	-.84	-.78	—									7.09	3.02
5. Unpleasant statements 2	-.78	-.79	-.72	.83	—								4.45	1.97
6. Unpleasant adjectives	-.77	-.75	-.66	.83	.85	—							6.04	2.98
7. Activated statements 1	.18	.20	.30	-.14	-.11	-.03	—						9.18	2.96
8. Activated statements 2	.20	.23	.29	-.13	-.09	-.01	.82	—					5.97	2.31
9. Activated adjectives	.25	.24	.37	-.21	-.15	-.04	.75	.72	—				6.56	2.27
10. Deactivated statements 1	-.10	-.14	-.24	.17	.11	.05	-.66	-.60	-.55	—			9.88	2.31
11. Deactivated statements 2	-.14	-.20	-.23	.20	.14	.07	-.65	-.66	-.56	.72	—		10.16	2.54
12. Deactivated adjectives	-.19	-.21	-.21	.24	.22	.24	-.40	-.38	-.33	.62	.49	—	5.84	1.68
Study 3														
1. Pleasant statements 1	—												10.09	2.48
2. Pleasant statements 2	.81	—											5.84	1.59
3. Pleasant adjectives	.78	.75	—										8.64	2.69
4. Unpleasant statements 1	-.82	-.80	-.69	—									6.40	2.92
5. Unpleasant statements 2	-.79	-.79	-.70	.86	—								6.03	2.76
6. Unpleasant adjectives	-.72	-.71	-.59	.84	.82	—							5.38	2.68
7. Activated statements 1	.12	.18	.24	-.03	-.07	.00	—						7.80	2.18
8. Activated statements 2	.04	.08	.14	.00	-.01	.04	.67	—					6.06	2.08
9. Activated adjectives	.25	.26	.40	-.16	-.19	-.04	.65	.54	—				6.42	2.18
10. Deactivated statements 1	-.05	-.06	-.16	.06	.05	.03	-.46	-.44	-.41	—			6.76	1.67
11. Deactivated statements 2	.03	-.02	-.04	-.01	.01	-.05	-.46	-.50	-.41	.58	—		9.94	2.55
12. Deactivated adjectives	-.12	-.14	-.22	.08	.14	.14	-.51	-.41	-.48	.59	.56	—	8.67	2.71

Note. Statements 1 = agree-disagree statement scales; Statements 2 = "Describes me" statement scales. Values in italics indicate correlations between unipolar scales of the same factor. Values in boldface indicate correlations between bipolar opposites.

Table 2  
Standardized Factor Loadings and Interfactor Correlations for Correlated Error Model Using Unipolar Factors

Measure	Study 2 factors				Study 3 factors			
	Pleasant	Unpleasant	Activated	Deactivated	Pleasant	Unpleasant	Activated	Deactivated
Factor loadings								
Pleasant statements 1	.94				.91			
Pleasant statements 2	.92				.90			
Pleasant adjectives	.89				.80			
Unpleasant statements 1		.93				.94		
Unpleasant statements 2		.90				.92		
Unpleasant adjectives		.89				.89		
Activated statements 1			.92				.89	
Activated statements 2			.88				.74	
Activated adjectives			.76				.68	
Deactivated statements 1				.88				.77
Deactivated statements 2				.82				.74
Deactivated adjectives				.69				.76
Interfactor correlations								
Pleasant	—				—			
Unpleasant	-.93	—			-.93	—		
Activated	.27	-.15	—		.24	-.09	—	
Deactivated	-.22	.19	-.79	—	-.11	.07	-.73	—

Note. Statements 1 = agree-disagree statement scales; Statements 2 = "describes me" statement scales.

Table 3  
Zero-Order Correlations for Bipolar Affect Measures

Measure	Pleasant–Unpleasant				Activated–Deactivated				<i>M</i>	<i>SD</i>
	1	2	3	4	5	6	7	8		
Study 2										
Pleasant–Unpleasant										
1. Semantic differential	—								32.90	8.81
2. Statements 1	.56	—							17.28	3.83
3. Statements 2	.86	.60	—						11.29	3.46
4. Adjectives	.45	.43	.36	—					14.98	3.11
Activated–Deactivated										
5. Semantic differential	.19	.09	.18	.11	—				27.06	7.98
6. Statements 1	.16	.02	.16	.03	.74	—			16.76	4.13
7. Statements 2	.18	.01	.18	.02	.82	.78	—		15.81	4.42
8. Adjectives	.23	.10	.23	.03	.69	.67	.62	—	12.16	2.79
Study 3										
Pleasant–Unpleasant										
1. Semantic differential	—								34.15	7.94
2. Statements 1	.79	—							21.69	5.15
3. Statements 2	.81	.90	—						14.78	4.16
4. Adjectives	.83	.89	.88	—					21.26	4.79
Activated–Deactivated										
5. Semantic differential	.05	.02	.05	.05	—				27.72	7.24
6. Statements 1	.14	.08	.11	.14	.61	—			13.05	3.29
7. Statements 2	.06	.00	.04	.03	.64	.72	—		16.10	4.01
8. Adjectives	.23	.18	.21	.26	.65	.74	.64	—	15.74	4.22

Note. Statements 1 = agree–disagree statement scales; Statements 2 = “describes me” statement scales. Values in italics indicate correlations between bipolar scales of the same factor. Values in boldface indicate correlations between scales of the two factors.

ined the dimensions that underlie Watson et al.'s (1988) NA and PA scales. We also incorporated in this analysis what we hypothesized to be the bipolar opposites of the two PANAS dimensions. Using Larsen & Diener's (1992) terminology, we hypothesized that Watson and Tellegen's (1985) PA is equivalent to pleasant activated affect and that its bipolar opposite is unpleasant deactivation; similarly, we reasoned, Watson and Tellegen's NA is equivalent to unpleasant activation and its bipolar opposite is pleasant deactivation. Third, we investigated the joint structure that emerged when all dimensions were modeled simultaneously. Both Russell (e.g., Russell, Lewicka, & Niit, 1989) and Watson and Tellegen (1985), as well as others (Larsen &

Diener, 1992; Reisenzein, 1994), have assumed that one set of dimensions is a 45° rotation of the other, but empirical evidence has raised questions about that idea (Hutchison et al., 1996; Russell, Weiss, & Mendelsohn, 1989). Here we suggest that previous failures to confirm the 45° rotation hypothesis were likely the result of errors of measurement; CFAs have shown that once measurement error is taken into account, the valence and activation dimensions are largely redundant with the dimensions underlying the PANAS scales. Finally, we derived a joint structure of affect with all the unipolar affect scales in the same two-dimensional space. This empirically derived structure conformed closely to the semantic structure hypothesized earlier

Table 4  
Standardized Factor Loadings for Bipolar Factors

Measure	Pleasant–Unpleasant	Aroused–Sleepy	Pleasant–Unpleasant	Aroused–Sleepy
Pleasant–Unpleasant semantic differential	.93		.86	
Pleasant–Unpleasant statements 1	.63		.95	
Pleasant–Unpleasant statements 2	.93		.94	
Pleasant–Unpleasant adjectives	.47		.93	
Activated–Deactivated semantic differential		.90		.75
Activated–Deactivated statements 1		.85		.86
Activated–Deactivated statements 2		.90		.81
Activated–Deactivated adjectives		.74		.83

in Figure 1 and provided the basis upon which we have built our resolution of the various disputes surrounding bipolarity and independence.

### Method

Participants were 316 undergraduate students in the Department of Psychology at the University of British Columbia. Participants received course credit for their participation in the study. The battery of questionnaires included (a) those used in Studies 1 and 2, (b) Watson et al.'s (1988) PA and NA adjective scales, (c) additional statement scales to measure Watson and Tellegen's NA and PA, and (d) statement and adjective scales designed to measure pleasant deactivation and unpleasant deactivation. No measures existed for pleasant deactivation and unpleasant deactivation (Watson & Clark, 1997), and so we constructed several. We constructed the adjective scales in part from the Fatigue and Serene subscales of the Positive and Negative Affect Schedule—Extended Version (PANAS-X; Watson & Clark, 1994). We constructed the statement scales by transforming the adjectives into statements of various sorts, and we also included statement-type items for Watson et al.'s (1988) NA and PA that were used by Green et al. (1993). All items used, as well as their response formats, are given in the Appendix.

### Results

**Valence and activation dimensions.** The first analysis replicated Studies 1 and 2. The bottom half of Table 1 gives the correlation matrix for the unipolar Pleasant, Unpleasant, Activated, and Deactivated state scales. All measures demonstrated strong convergent validity (correlations ranged from  $r = .54$  to  $r = .86$ ). The Pleasant and Unpleasant scales had substantial negative correlations (from  $r = -.59$  to  $r = -.82$ ), as did the Activated and Deactivated scales (from  $r = -.41$  to  $r = -.51$ ).

The CFAs of the unipolar scales verified that both the pleasant–unpleasant and the activated–deactivated dimensions were primarily bipolar in nature. The model estimating both random error and systematic error, specified exactly as in Studies 1 and 2, fit the data well,  $\chi^2(30, N = 316) = 69.60, p < .001$ , AGFI = .91, CFI = .99, Root Mean Square Residual = .05. The standardized factor loadings and the interfactor correlations are presented in the right half of Table 2. As predicted, this analysis yielded a more substantial negative correlation between latent pleasant and unpleasant factors ( $-.93$ ) than those observed between the measured variables (mean correlation =  $-.74$ ). The same was true for the correlation between latent activation and deactivation factors ( $-.73$ ) compared with the correlations between the measured variables (mean correlation =  $-.45$ ).

As in Studies 1 and 2, we next constructed three bipolar measures of the pleasant–unpleasant and activated–deactivated dimensions. The bottom half of Table 3 presents the correlation matrix for these scales. The Pleasant–Unpleasant measures demonstrated good convergent validity (correlations ranging from  $r = .81$  to  $r = .90$ ), as did the Activation–Deactivation measures (correlations ranging from  $r = .61$  to  $r = .74$ ). All measures demonstrated good discriminant validity (correlations ranging from  $r = .00$  to  $r = .26$ ).

As predicted, we replicated the measurement model for the two-dimensional affective space. A model with two correlated bipolar factors, Pleasantness–Unpleasantness and Activation–Deactivation, and with correlated errors fit the data well,  $\chi^2(15, N = 316) = 57.34, p < .001$ , AGFI = .90, CFI = .98,

Root Mean Square Residual = .05. The standardized factor loadings are presented in the right half of Table 4; all were statistically significant. The interfactor correlation was .14. Thus, the valence and the activation factors were weakly correlated even after controlling for random and nonrandom errors in measurement.

**Dimensions underlying Watson et al.'s (1988) NA and PA scales.** The next set of analyses was designed to explore the structure underlying Watson et al.'s (1988) PANAS scales and what we hypothesized to be their bipolar opposites. Table 5 gives the observed correlations for these scales. All scales demonstrated adequate convergent validity (correlations ranging from  $r = .63$  to  $r = .85$ ). Watson et al.'s (1988) PA (Pleasant Activation) and the Unpleasant Deactivation scales had substantial negative correlations (ranging from  $r = -.32$  to  $r = -.68$ ), as did their NA (Unpleasant Activation) and the Pleasant Deactivation scales (from  $r = -.50$  to  $r = -.76$ ).

We tested a model that specified that both random and systematic measurement error influenced the observed correlations. The model had four latent factors, each corresponding to one end of a unipolar dimension (Watson et al.'s PA, Unpleasant Deactivation, Watson et al.'s NA, and Pleasant Deactivation scales); the latent factors were scaled by setting their variances to 1. We estimated the correlation between the latent factors to assess bipolarity, and we estimated the degree of random and nonrandom error associated with each of the measured variables. This model fit the data moderately well,  $\chi^2(30, N = 316) = 177.38, p < .001$ , AGFI = .78, CFI = .96, Root Mean Square Residual = .08. The standardized factor loadings and the interfactor correlations are given in Table 6. The parameter representing the correlation between the latent factors estimates the true correlation between the factors after controlling for random and nonrandom errors in measurement. This analysis yielded a negative correlation between the latent factors representing Watson and Tellegen's PA and Unpleasant Deactivation ( $-.71$ ) and between the latent factors representing their NA and Pleasant Deactivation ( $-.81$ ).

Next, we created a measurement model for a two-dimensional space containing all the dimensions in the last analysis. We used the same data discussed in the previous paragraph to construct three measures for each of the two bipolar dimensions. Table 7 gives the correlation matrix for these observed scores. The bipolar Watson and Tellegen NA–Pleasant Deactivation measures demonstrated strong convergent validity (correlations ranging from  $r = .79$  to  $r = .88$ ), as did the bipolar Watson and Tellegen PA–Unpleasant Deactivation measures (correlations ranging from  $r = .75$  to  $r = .88$ ). The measures demonstrated moderate discriminant validity (correlations ranging from  $r = -.08$  to  $r = -.59$ ).

We then specified a CFA with two latent bipolar factors, which, using Larsen & Diener's (1992) terminology, we called Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation; the bipolar versions of the state scales were used in this analysis. As in previous analyses, the latent factors were scaled by setting their variances to 1. We estimated the correlation between the latent factors, and we also correlated the errors between measures using the same response scale. Following the findings from Green et al. (1993), we expected that the correlation between the latent Unpleasant Activa-



Table 5

*Zero-Order Correlations for Unipolar Unpleasant Activation, Pleasant Deactivation, Pleasant Activation, and Unpleasant Deactivation*

Measure	Pleasant Activation–Unpleasant Deactivation						Unpleasant Activation–Pleasant Deactivation						M	SD
	1	2	3	4	5	6	7	8	9	10	11	12		
1. Pleasant Activation S1	—												24.19	5.12
2. Pleasant Activation S2	.81	—											18.06	4.88
3. Pleasant Activation Adj.	.64	.73	—										22.79	6.46
4. Unpleasant Deactivation S1	-.68	-.60	-.43	—									16.45	4.92
5. Unpleasant Deactivation S2	-.62	-.57	-.44	.85	—								11.22	3.47
6. Unpleasant Deactivation Adj.	-.49	-.48	-.32	.75	.76	—							13.16	4.58
7. Unpleasant Activation S1	-.52	-.33	-.14	.51	.40	.30	—						16.32	5.77
8. Unpleasant Activation S2	-.44	-.26	-.14	.43	.37	.25	.85	—					15.49	5.81
9. Unpleasant Activation Adj.	-.32	-.12	.09	.34	.22	.21	.75	.75	—				15.75	6.38
10. Pleasant Deactivation S1	.51	.30	.17	-.40	-.31	-.24	-.62	-.56	-.50	—			14.45	3.49
11. Pleasant Deactivation S2	.58	.41	.21	-.45	-.33	-.27	-.76	-.70	-.65	.76	—		16.50	4.43
12. Pleasant Deactivation Adj.	.36	.18	.12	-.25	-.13	-.05	-.61	-.55	-.60	.65	.73	—	12.63	3.43

*Note.* S1 = agree–disagree statement scales; S2 = “Describes me” statement scales; Adj. = adjective scales. Values in italics indicate correlations between unipolar scales of the same factor. Values in boldface indicate correlations between bipolar opposites.

tion–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors would be more negative than the corresponding observed zero-order correlations presented in Table 7. This model fit the data moderately well,  $\chi^2(5, N = 316) = 121.13$ ,  $p < .001$ , AGFI = .52, CFI = .94, Root Mean Square Residual = .08. The standardized factor loadings are presented in Table 8; all were statistically significant. The estimated interfactor correlation was a statistically significant  $-.48$ . (The average zero-order correlation was  $-.36$ .) These results repli-

cated Green et al. (1993) and Tellegen et al.’s (1994) finding that the dimensions underlying the PANAS scales are moderately negatively correlated when random and nonrandom errors in measurement are controlled.

*A joint structure of affect.* Finally, we examined the relationship between the valence–activation structure and the Unpleasant Activation–Pleasant Deactivation/Pleasant Activation–Unpleasant Deactivation structure developed so far. Our basic hypothesis was that these are actually one and the same structure,

Table 6

*Standardized Factor Loadings and Interfactor Correlations for Correlated Error Model Using Unipolar Unpleasant Activation, Pleasant Deactivation, Pleasant Activation, and Unpleasant Deactivation Factors*

Measure	Pleasant Activation	Unpleasant Deactivation	Unpleasant Activation	Pleasant Deactivation
Pleasant Activation S1	.88			
Pleasant Activation S2	.91			
Pleasant Activation Adj.	.73			
Unpleasant Deactivation S1		.91		
Unpleasant Deactivation S2		.93		
Unpleasant Deactivation Adj.		.80		
Unpleasant Activation S1			.90	
Unpleasant Activation S2			.91	
Unpleasant Activation Adj.			.76	
Pleasant Deactivation S1				.72
Pleasant Deactivation S2				.97
Pleasant Deactivation Adj.				.76
Interfactor correlations				
Pleasant Activation	—			
Unpleasant Deactivation	-.71	—		
Unpleasant Activation	-.42	.45	—	
Pleasant Deactivation	.50	-.41	-.81	—

*Note.* S1 = agree–disagree statement scales; S2 = “Describes me” statement scales; Adj. = adjective scales.

Table 7  
Zero-Order Correlations for Bipolar Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation Measures

Measure	Pleasant Activation– Unpleasant Deactivation			Unpleasant Activation– Pleasant Deactivation			<i>M</i>	<i>SD</i>
	1	2	3	4	5	6		
Pleasant Activation–Unpleasant Deactivation								
1. Statements 1	—						43.64	9.25
2. Statements 2	.88	—					31.81	7.46
3. Adjectives	.75	.84	—				45.63	9.02
Unpleasant Activation–Pleasant Deactivation								
4. Statements 1	–.59	–.42	–.28	—			32.75	8.41
5. Statements 2	–.55	–.39	–.26	.88	—		28.92	9.50
6. Adjectives	–.39	–.20	–.08	.79	.81	—	27.10	8.87

Note. Statements 1 = agree–disagree statement scales; Statements 2 = “Describes me” statement scales. Values in italics indicate correlations between bipolar scales of the same factor. Values in boldface indicate correlations between scales of the two factors.

although rotated from one another. Rather than producing a four-dimensional structure, we predicted a two-dimensional structure that would contain all the factors included in this study. Specifically, we used SEM to demonstrate that the dimensions underlying Watson et al.’s (1988) NA and PA scales and their bipolar opposites (i.e., the Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation dimensions) could be empirically described as combinations of the valence and activation dimensions.

First, we constructed a structural model to evaluate how well the Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation dimensions as we constructed them could be accounted for by the valence and activation dimensions. Given that there was no item overlap in the measures as we constructed them, the relationships between the dimensions were entirely an empirical matter; one structure

could be independent of the other, completely redundant with the other, or something in between. This analysis consisted of four bipolar latent factors, one corresponding to each dimension (i.e., valence, activation, Unpleasant Activation–Pleasant Deactivation, and Pleasant Activation–Unpleasant Deactivation). Bipolar versions of all scales were used in this analysis. The valence and activation factors were considered exogenous and were scaled by setting their variances to 1. Their latent correlation was estimated. The Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors were considered endogenous and were scaled by setting their corresponding “Agree–Disagree” statement scale loadings to 1. The following parameters were estimated: (a) the relationships between the valence and activation factors and the correlation between the Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors, (b) the correlation between the Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors, and (c) the degree of variance in the latent Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors accounted for by the valence and activation dimensions.<sup>4</sup> Both random and nonrandom sources of error were estimated; we correlated the errors between exogenous measures using the same response scale to take account of nonrandom measurement error, and did the same for endogenous measures.

The specified model fit the data moderately well,  $\chi^2$  (64,  $N$  = 316) = 430.15,  $p$  < .001, AGFI = .74, CFI = .93, Root Mean Square Residual = .08. The standardized parameter estimates are given in Table 9. All factor loadings were large and significant. The estimated correlation between the latent valence

Table 8  
Standardized Factor Loadings for Bipolar Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation Factors

Measure	Pleasant Activation– Unpleasant Deactivation	Unpleasant Activation– Pleasant Deactivation
Pleasant Activation–Unpleasant Deactivation		
Statements 1	.90	
Statements 2	.96	
Adjectives	.82	
Unpleasant Activation–Pleasant Deactivation		
Statements 1		.88
Statements 2		.94
Adjectives		.81

<sup>4</sup> All gamma parameters were estimated. The correlation between latent endogenous factors was assessed by estimating the effect of each factor on the other and constraining the beta parameters to be equal.

and activation factors was .13, *ns*. The correlation between latent Unpleasant Activation and Pleasant Activation factors in this model was negative (−.24) and statistically significant; this parameter estimates the true correlation between the factors after controlling for random and systematic errors in measurement, and after the influence of valence and activation has been accounted for. The zero-order correlation between the latent Unpleasant Activation and Pleasant Activation factors was −.46. Our principal hypothesis was supported in this analysis: All paths from the valence and activation factors to the Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation factors were large and statistically significant. Together, the valence and activation factors accounted for 81% of the variance in the latent Pleasant Activation–Unpleasant Deactivation factor and 90% of the variance in the latent Unpleasant Activation–Pleasant Deactivation factor. Thus, the latent bipolar Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation dimensions can be almost completely described as combinations of valence and activation dimensions.<sup>5</sup>

The next analysis demonstrated that all unipolar scales can be configured in a two-dimensional valence–activation space. The outer circle of Figure 2 shows how, theoretically, Unpleasant

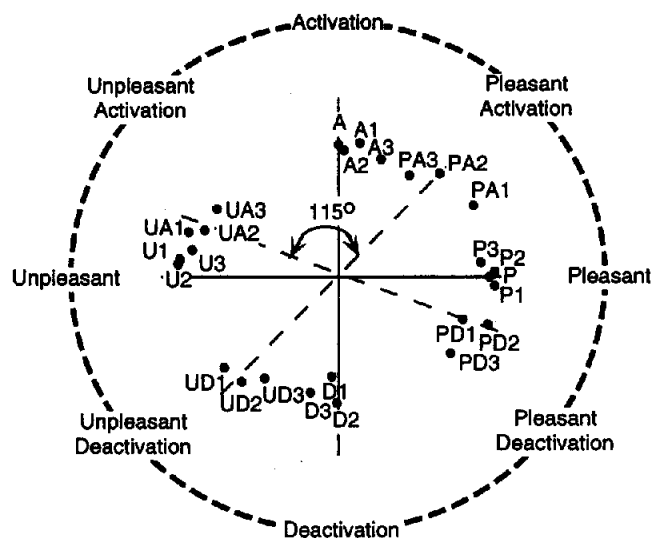


Figure 2. Empirical placement of 24 unipolar scales within the structure of affect (Study 3). 1 = Agree–disagree statement scales; 2 = “Describes me” statement scales; 3 = adjective scales; P = pleasant; PA = Pleasant Activated; A = Activated; UA = Unpleasant Activated; U = Unpleasant; UD = Unpleasant Deactivated; D = Deactivated; PD = Pleasant Deactivated. Outer circle is hypothetical placement of the dimensions.

Table 9

*Structural Model Configuring Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation Scales in a Two-Dimensional Valence and Activation Space*

Measure	Valence	Activation	PA/UD	UA/PD
<b>Valence indicators</b>				
Semantic Differential	.86			
Statements 1	.94			
Statements 2	.96			
Adjectives	.92			
<b>Activation indicators</b>				
Semantic Differential		.77		
Statements 1		.84		
Statements 2		.84		
Adjectives		.82		
<b>PA/UD indicators</b>				
Statements 1			.90	
Statements 2			.96	
Adjectives			.85	
<b>UA/PD indicators</b>				
Statements 1				.90
Statements 2				.95
Adjectives				.83
<b>Regression parameters</b>				
Valence			.34 (.57)	−.79 (−.92)
Activation			.69 (.62)	.45 (.30)
<b>Interfactor correlations</b>				
Valence	—			
Activation	.13	—		
PA/UD	.65	.69	—	
UA/PD	−.89	.18	−.46	—

Note. Regression parameters = gamma parameter estimates; standardized regression estimates are presented in parentheses. PA/UD = Pleasant Activation–Unpleasant Deactivation; UA/PD = Unpleasant Activation–Pleasant Deactivation; Statements 1 = agree–disagree statement scales; Statements 2 = “Describes me” statement scales.

Activation (Watson et al.’s NA), Pleasant Deactivation, Pleasant Activation (Watson et al.’s PA), and Unpleasant Deactivation should be related to valence and activation dimensions. We constructed a confirmatory factor analysis to represent this structure. This analysis consisted of two latent factors, one corresponding to the bipolar valence dimension, the other corresponding to the bipolar activation dimension; each latent factor was scaled by setting the corresponding semantic differential scale loading to 1.0. All unipolar scales (Pleasant, Unpleasant, Activated, Deactivated, Unpleasant Activated, Pleasant Deactivated, Pleasant Activated, and Unpleasant Deactivated) were free to load on each dimension. We estimated the random and nonrandom errors associated with each of the measured variables. This model fit the data moderately well,  $\chi^2$  (190,  $N = 316$ ) = 1219.17,  $p < .001$ , AGFI = .58, CFI = .88, Root Mean Square Residual = .05. All pleasantness and unpleasantness scales loaded significantly on the valence factor; none loaded significantly on the activation factor except the agree–disagree unpleasant statement scale (loading = .14). All activation and

<sup>5</sup> Because Pleasant Activated–Unpleasant Deactivated and Unpleasant Activated–Pleasant Deactivated factors were correlated, some of the variance in each latent factor was accounted for by the other. When models were run separately for each factor, valence and activation accounted for 80% of the variance in the Pleasant Activated–Unpleasant Deactivated factor and 88% of the variance in the latent Unpleasant Activated–Pleasant Deactivated factor. In addition, we also conducted similar analyses using the bipolar versions of the valence and activation scales, but unipolar versions of the unpleasant activated and pleasant activated scales. The results were highly similar to those already presented.

deactivation scales loaded on the activation factor, and three of the six had small (below .30) but significant loadings on the valence factor. As predicted, all Unpleasant Activated, Pleasant Deactivated, Pleasant Activated, and Unpleasant Deactivated scales had large, significant loadings on both valence and activation factors. The inner part of Figure 2 presents a plot of the factor loadings.

As is evident, the empirical findings in Figure 2 are similar to the theoretical ones proposed in the outer circle of Figure 2. The Pleasant Activation and Unpleasant Deactivation measures configure approximately 45° between the valence and activation factors, as predicted. The Unpleasant Activation and Pleasant Deactivation measures, however, align more closely to the valence dimension than predicted. The observed angle between Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation dimensions is approximately 115° (equivalent to  $r = -.42$ ), rather than the predicted 90° (equivalent to  $r = 0$ ).

To improve the fit of the model, we conducted a hierarchical CFA whereby Pleasantness, Unpleasantness, Activation, Deactivation, Unpleasant Activation, Pleasant Deactivation, Pleasant Activation, and Unpleasant Deactivation were treated as first-order latent factors indicated by their respective unipolar scales. Valence and activation latent factors were treated as second-order factors that represented the covariances among the first-order factors.<sup>6</sup> We also estimated the random and nonrandom errors associated with each of the measured variables. This model fit the data well,  $\chi^2(156, N = 316) = 707.68, p < .001$ , AGFI = .71, CFI = .93, Root Mean Square Residual = .10. The results were practically identical to those presented above.

### Toward a Consensual Structure of Affect: Reconciling Opposing Claims of Bipolarity and Independence

Figure 1 shows a schematic structure of affect as the Cartesian space formed from the valence and activation dimensions, and Figure 2 demonstrates the empirical reality of that space. In three studies, we demonstrated that—when random and systematic measurement errors are taken into account—the two principal axes are each unequivocally bipolar and almost fully independent of the other. We also demonstrated that other affective descriptors can be defined as combinations of the valence and activation dimensions.

Although some regions of Figure 1 seem more affective than others (just as some colors seem more colorful than others), a person's current affective state can fall at any point in this space, and therefore no region of the space can be omitted. Any affect term implies both valence and activation. Therefore, the study of valence alone may seem to yield two valence dimensions (e.g., Watson, Clark, & Tellegen, 1988), just as the study of activation alone may seem to yield two activation dimensions (e.g., Thayer, 1986). Yet our findings clearly demonstrate that when the entire affective space is sampled, the result is not four dimensions, but two. Every term in Figure 1 has simultaneously both a valence component and an activation component. The upshot is that the entire space can be thought of as degrees of pleasantness or unpleasantness and as degrees of activation or deactivation.

This two-dimensional structure is a descriptive map of the

affective domain. On its own, it is not a model of affect. We anchored our two-dimensional map by using valence and activation dimensions. This map per se does not imply that valence and activation cause other affective states, or even that valence and activation are more basic than other potential rotations of the axes. In fact, when the paths are reversed in the analysis examining the relationship between the valence/activation structure and the Unpleasant Activation–Pleasant Deactivation/Pleasant Activation–Unpleasant Deactivation structure (with Unpleasant Activation–Pleasant Deactivation and Pleasant Activation–Unpleasant Deactivation explaining the variance in valence and activation), the results are highly similar to those already presented. The model fit the data well, with Unpleasant Activation–Pleasant Deactivation/Pleasant Activation–Unpleasant Deactivation accounting for 87% of the variance in the valence factor and 82% of the variance in the activation factor. Typically, the choice between competing models is made not on statistical grounds, but rather on the basis of a range of empirical and conceptual considerations. Both Larsen and Diener (1992) and Reisenzein (1994) have provided conceptual arguments for the primacy of the valence and activation dimensions.

As a descriptive map, this two-dimensional structure is a common denominator of, and therefore consistent with, various models of affect (Feldman, 1995; Larsen & Diener, 1992; Russell, 1980; Thayer, 1989; Watson & Tellegen, 1985). It is also consistent with the circumplex in which descriptors do not cluster at the axes, but are spread more or less continuously around the periphery (Russell, 1980). The structure of Figure 2 offers a principled basis for a simple, empirically grounded solution to the various (apparently) conflicting claims that have arisen in the debate between Green et al. (1993) and Tellegen et al. (1994). We now turn to that solution.

One apparent dispute concerns the *power of measurement errors*. Measurement errors exist, and our results confirm that they bias the observed results toward independence and away from bipolarity. Green et al. (1993) put the case for the influence of measurement error very effectively, and our data are consistent with their conclusion. Measurement error, however, is insufficient to tell the whole story in this dispute. Control of measurement error yields strong bipolarity when the original variables consist of hypothesized semantic opposites (e.g., *happy–sad* in the Green et al. study; *pleasant–unpleasant*, *aroused–sleepy*, *elated–depressed*, and *upset–calm* in ours). It does not follow, however, that control of measurement error necessarily produces bipolarity in sets of items that are not semantic opposites. (Specifically, the constructs underlying Watson et al.'s, 1988, PANAS scales are not bipolar opposites of one another because their PA items are not the semantic opposites of their NA items; we return to this issue shortly.)

<sup>6</sup> The higher order factor model was modeled after those presented by Marsh (1985). All latent factors were modeled as endogenous, and the loadings of the first-order factors on the second-order factors were represented in the beta matrix. The first-order latent pleasantness factor was designated as the reference indicator for the second-order valence factor, and the first-order activation factor was designated as the reference indicator for the second-order activation factor (i.e., their loadings were fixed at 1.0). The variances of the higher order factors were estimated through use of the psi matrix.

A second apparent dispute concerns the number of dimensions. The question of bipolarity versus independence is inevitably entangled with the question of the number of dimensions required to describe affect. Our analysis supports Tellegen et al. (1994) on this matter: Affect requires at least two dimensions. In the end, however, the dispute itself is a pseudoissue. A careful reading of Green et al.'s (1993) article shows that they used the terms *one-factor* and *two-factor* about their models in a very limited sense to refer to the number of latent variables required to describe their particular data sets; they were not speaking to the broader issue of the total number of dimensions required to describe the entire structure of affect. For example, determining whether extraversion is the bipolar opposite of introversion does not suffice to determine the total number of dimensions required to describe the domain of personality. In the end, both Green et al. and Tellegen et al. should be able to agree on a two-dimensional structure like that seen in Figure 2. Differences between them as to the number of dimensions of affect are only apparent.

The third apparent dispute concerns independence. Once a two- (or more) dimensional structure is agreed upon, then the following statement is a mathematical necessity: Pairs of orthogonal (independent) dimensions can be mathematically defined—indeed, an uncountable number of such pairs. For any dimension placed at any angle in Figure 2, another dimension exists 90° away that is independent. There can be no dispute on this point. On the other hand, what, if anything, such orthogonal dimensions represent is another matter.

The fourth apparent dispute concerns bipolarity. The mathematical truism of the last paragraph in no way contradicts an empirical conclusion: The full space everywhere shows bipolarity. Every vector from the center of Figure 1 has a vector 180° away that can be at least approximately labeled with English words—and those words are semantic opposites. Again, the difference between Green et al. (1993) and Tellegen et al. (1994) resolves to a pseudoissue. Green et al. have argued strongly for bipolarity, and Watson and Tellegen (1985) have acknowledged that each unipolar vector has its bipolar opposite. Our results confirm and extend the importance of bipolarity in structure of affect. Indeed, nothing could be more bipolar than Figure 1.

Fifth, with these thoughts in mind, we can now clarify Tellegen et al.'s (1994) claim that "Positive and Negative Affect remain largely independent" (p. 13). We can account for the evidence they have offered to demonstrate that, even when random and systematic errors are controlled, the correlation between their NA and PA scales is not as highly negative as between positive and negative affect scales more generally. The key is to realize that Watson, Clark, and Tellegen used the phrases *Positive Affect* and *Negative Affect* in a highly specific way (Watson & Tellegen, 1985, p. 233). Perhaps for this reason, they (and we) put the initial letters in the upper case. As Watson, Clark, and Tellegen defined the phrase, *Positive Affect* is not the set of all positive affect states but is a specific subset, namely, those states that are both pleasant and activated. Their *Negative Affect* is not the set of all negative affect states but a specific subset, namely, those states that are both unpleasant and activated.

These conceptual definitions (Watson & Tellegen, 1985) are reflected in their operational definition. Watson and Tellegen's

PA scale consists of a set of 10 terms (*active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, and strong*), each of which is high in both pleasantness and activation. Their PA omits positive affect words (e.g., *happy, contented, serene*) that are pleasant but low or neutral in activation. Their NA scale consists of a set of 10 terms (*afraid, ashamed, distressed, guilty, hostile, irritable, jittery, nervous, scared, and upset*), each of which is both unpleasant and high (or neutral) in activation. Their NA omits negative affect words (e.g., *sad, depressed*) that are unpleasant but low in activation. Our semantic analysis, illustrated with Figure 1, had anticipated that when one variable was created that combined pleasantness with activation ( $x + y$ ) and a second variable was created that combined unpleasantness with activation ( $-x + y$ ), those two variables would be correlated near zero, even when valence and activation were both bipolar. This is indeed what we found.

All researchers who have used the PANAS scales have borrowed Watson et al.'s (1988) operational definitions, but we wonder whether all such researchers have realized that they were simultaneously borrowing very specialized theoretical definitions. Because researchers may find independence of these scales to be counterintuitive, we suspect that most researchers have assumed that PA is equivalent to positive affect in general and that NA is equivalent to negative affect in general. This is a mistake.

Figure 2 shows how, empirically, Watson et al.'s (1988) PA and NA fall into our two-dimensional space. Their PA is not the same as positive affect, which is the entire right half of the diagram. Our horizontal axis bisects this half of the diagram as a point of central tendency. In contrast, because of its high degree of activation, their PA is rotated about 45° upward from the horizontal axis. Similarly, their NA is not the same as negative affect, which is the entire left half of the diagram. Because of its degree of activation, their NA is rotated about 20° upward from the horizontal axis.

Although 20° or 45° may seem too small to quibble about, when combined the consequences of these two rotations are surprisingly large. Because both have been rotated upward, they are a total of  $20^\circ + 45^\circ = 65^\circ$  closer to each other than are the general dimensions of positive and negative. Because of this rotation, PA and NA are 115° rather than 180° apart. The correlation between two vectors is the cosine of the angle between them. The cosine of 180° is  $-1.00$ , but the cosine of 115° is  $-.42$ . Because of the rotation, PA is not the bipolar opposite of NA, nor of negative affect in general (the left half of Figure 2). NA is not the bipolar opposite of PA, nor of positive affect in general (the right half of Figure 2). Watson et al.'s (1988) PA and NA do have bipolar opposites: Opposite PA (*active, excited*) is a cluster of unpleasant, low-activation items (*tired, sluggish, dulled, and bored*). Opposite NA (*jittery, nervous*) is a cluster of pleasant low-activation items (*calm, relaxed, at rest, serene, and at ease*). A careful reading of Tellegen et al. (1994), Watson and Clark (1997), Watson and Tellegen (1985), and Zevon and Tellegen (1982) shows that they too have acknowledged that their PA and NA have just the bipolar opposites we specify.

### What's in a Name?

Researchers can label dimensions and scales in any way they choose, but some labels are more helpful than others. Names

do count. Labeling different phenomena with the same name can hide differences or create the illusion of conflicting findings. Labeling the same phenomena with different names can hide similarities. It is necessary to sort out which findings are really the same finding under different names, and which are conflicting but unnoticed because differently named.

Part of the confusion arises from Tellegen's decision, no doubt made long ago, to label two particular dimensions with the seemingly very general and nominally opposite terms PA and NA. We are not alone in this concern. Carver (1996), Morris (1989), Thayer (1989), and Larsen and Diener (1992) have also noted problems with these labels. Watson and Tellegen have of course explained their use of the terms (e.g., Tellegen, 1985; Watson & Tellegen, 1985; Zevon & Tellegen, 1982), but when the literal meaning of a term must be denied in explaining its meaning, it may be time for a new term. Tellegen and his colleagues could bring much clarity to this area of research, especially to all the research they have inspired, by renaming PA something like "Surgency" or "Pleasant and Activated Affect" and renaming NA something like "Upset" or "Distress" or "Unpleasant Activated Affect." Renaming the dimensions would not diminish the conceptual importance of these two variables or alter the psychometric properties of the PANAS, but it would help readers understand the place of PA and NA and their bipolar opposites in relation to positive and negative affect more generally. With new names, the mystery of their near independence would disappear.

Names are arbitrary, but what mischief can they create! To give the reader a hint of just how confusing matters could be,

we created a counterfactual story and a figure to illustrate it (Figure 3). Imagine an aging team (Group 1) of researchers. Inspired by writings of Freud, Hull, and maybe even Buddhist scholars, they reason that positive affect is really a freedom from tension; it is tranquility and relaxation. Its ultimate form is serenity. They therefore create a scale of "Positive Affect" with *contented*, *relaxed*, *calm* and close synonyms as its items.

At the same time, a team of younger researchers (Group 2), reared on a diet of Yuppie television, reasons that the worst conceivable state of human misery is boredom, ennui, fatigue, and lethargy. Its ultimate form is depression. They therefore create a scale of "Negative Affect" with *boredom*, *ennui*, *fatigue*, *lethargy*, and *depression* as its items.

Magically, neither team of researchers is aware of the current literature on affect, and yet they both publish reports of their research. Now enters a curious graduate student who does read the literature and who takes on the long-simmering controversy between bipolarity and independence. She tries the empirical approach. The student finds that the "Positive Affect" scale from Group 1 is correlated around zero with the "Negative Affect" scale from Group 2. Independence again. Student continues. In her next study, she includes Watson et al.'s (1988) "Positive Affect" and "Negative Affect" scales. Here her results are startling (and are shown in Figure 3). First, bipolarity reemerges. Group 1's "Positive Affect" is the bipolar opposite of Watson et al.'s "Negative Affect." Similarly, Group 2's "Negative Affect" is the bipolar opposite of Watson et al.'s "Positive Affect." But her other finding is a breathtaking breakthrough: Independence also reemerges, more independence than

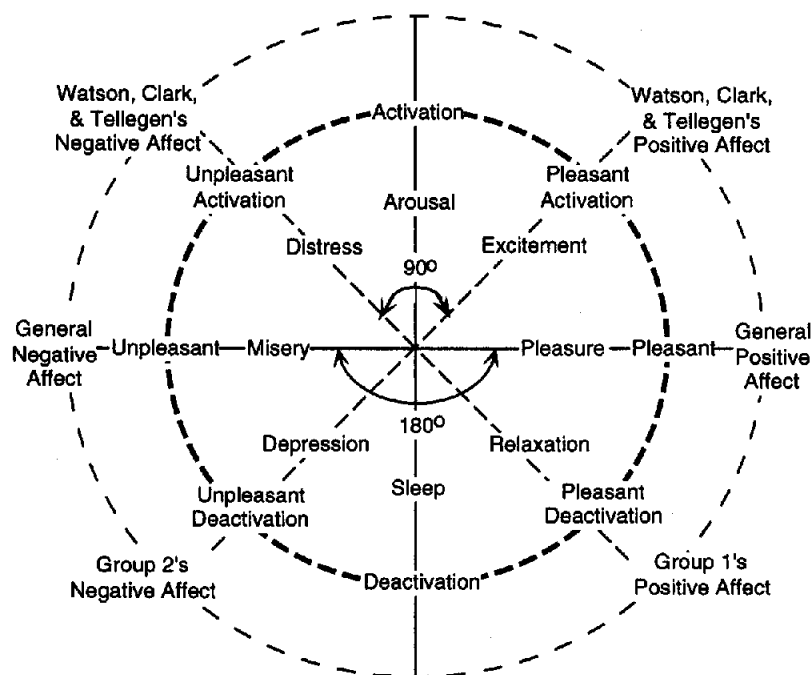


Figure 3. Various sets of names for the two-dimensional structure of affect. The inner circle shows names used by Russell (1980). The middle circle shows names suggested by Larsen and Diener (1992). The outer circle shows names used by Watson and Tellegen (1985) and by us to illustrate various properties of the structure.

she had dreamed. Group 1's "Positive Affect" is independent of Watson et al.'s "Positive Affect!" And Group 2's "Negative Affect" is independent of Watson et al.'s "Negative Affect!"

Is this science fiction? Of course, but nothing about affect prevented this scenario from actually occurring. According to our current knowledge of affect, the student's results would come out approximately as stated above. Figure 3 shows how naming has the potential to create such paradoxical results.

### Conclusion

The properties of affect can be described in paradoxical ways: Positive is independent of negative; affect is both unipolar and bipolar; Positive Affect is not positive affect; Negative Affect is not negative affect. In the space of Figures 1, 2, and 3, bipolarity is everywhere and independence is everywhere. Paradox can emphasize properties that might otherwise be overlooked.

Nevertheless, clarity requires that we resolve the paradoxes. A consensual resolution to the paradox of bipolarity and independence may be closer than is suggested by the dispute between Green and Tellegen and their colleagues. Our analysis suggests that both are right, although both may have to alter their manner of speaking. If so, that would be a small price to pay for a clear and consensual structure of affect. We do not have to choose between one bipolar dimension and two independent ones. The structure of affect can have two dimensions, each bipolar, each independent of the other. Once the situation is clearly described, the paradoxes dissolve. The controversial issues are empty—by which we mean that their resolution is a matter of naming rather than discovering new facts.

Of course, even if consensus were achieved on the issues we describe, it would be but a step in the dialectic that is science. Further issues abound. Figures 1 and 2 use a particular rotation of the axes that was helpful to our exposition, but perhaps other rotations would be more helpful for other purposes; Watson and Tellegen (1985), Thayer (1986), and Reisenzein (1994) have discussed this issue. Mathematically, the space can be defined perfectly well by any two nonredundant dimensions. Therefore, for the purposes of this article, we need offer no position on this matter. The natures of valence and of activation must also be clarified. Still another question concerns the natures of dimensions beyond these first two. The first two dimensions typically account for a large proportion—but not all—of the variance in affect ratings. Furthermore, Watson and Tellegen (1985) and others have embedded their descriptive structures within theories that differ in many ways. We would not want to be misunderstood as comparing or evaluating those broader theories. Our focus here has been the descriptive structure of affect.

Psychology seems closer than ever to a consensus on a first approximation of affective space: a two-dimensional space (which therefore necessarily shows independence), every dimension of which is bipolar. Still, even if it were achieved, such a consensus would be only a base of operations for the further exploration of affect and its role in psychological affairs. And, of course, consensus is not necessarily truth.

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## Appendix

### Items Used to Measure Affect in Studies 2 and 3

#### Adjectives With Unipolar 5-Point Likert-Type Scale

(1 = not at all, 2 = a little, 3 = moderately, 4 = quite a bit, 5 = extremely)

<u>Pleasant</u>	<u>Unpleasant</u>	<u>Activated</u>	<u>Deactivated</u>
happy	miserable	aroused	sleepy
pleased	troubled	alert	still
content	unhappy	hyperactivated	quiet
<u>Unpleasant Activated</u> (PANAS NA scale)	<u>Pleasant Deactivated</u>	<u>Pleasant Activated</u> (PANAS PA scale)	<u>Unpleasant Deactivated</u>
distressed	relaxed	interested	tired
upset	at rest	excited	sluggish
guilty	serene	strong	droopy
scared	calm	enthusiastic	dull
hostile	at ease	proud	drowsy
irritable		inspired	bored
ashamed		determined	
nervous		attentive	
jittery		active	
afraid			

#### Statements 1, With “Agree–Disagree” Response Options (5 points)

(1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

<u>Pleasant</u>	<u>Unpleasant</u>
I am happy.	I am unhappy.
I am satisfied.	I'm dissatisfied.
I feel content.	I'm miserable.
<u>Activated</u>	<u>Deactivated</u>
I'm filled with energy.	My body feels still.
My body feels activated.	I am feeling quiet.
I'm feeling stirred up.	
<u>Unpleasant Activated</u>	<u>Pleasant Deactivated</u>
For some reason, I've been feeling sort of nervous.	I'm feeling pleasantly well-rested.
I feel on edge.	I feel calm, cool, and collected.
I feel worried.	I'm too relaxed to worry about anything.
I'm feeling pretty angry at the moment.	I'm feeling untroubled and comfortable.
I'm bothered by something.	I am feeling “unruffled.”
Right now, life feels like one big struggle.	
I am full of guilt and remorse.	
<u>Pleasant Activated</u>	<u>Unpleasant Deactivated</u>
I feel interested in what I am doing at the moment.	I'm having some trouble paying attention.
I feel pretty enthusiastic about my life right now.	I feel tired.
I'm feeling inspired.	Things feel pretty dull right now.
Right now, life feels terrific.	Right now, everything feels dull and boring.
I'm feeling energetic and positive.	I'm feeling sluggish and dragged out.
I feel determined.	I'm exhausted.
I feel very focused and on task.	
I'm feeling lively and cheerful.	

(Appendix continues)

## Appendix (continued)

Statements 2, With "Describes Me" Response Options (4 points)  
(1 = *not at all*, 2 = *not very well*, 3 = *somewhat*, 4 = *very well*)

Pleasant

My mood is positive.  
Overall, I am satisfied.

Unpleasant

My mood is not good.  
I am feeling troubled.  
I feel unhappy.

Activated

I'm full of energy and tension.<sup>a</sup>  
I'm keyed up.  
I am stirred up.

Deactivated

I'm feeling placid, low in energy.  
My internal engine is running slow and smoothly.  
My body is in a quiet, still state.  
My mind and body are resting, near sleep.

Unpleasant Activated

I feel guilty about something that I have said or done.  
I feel irritated by something.  
I feel rather distressed.  
I feel ashamed of myself.  
For some reason, I feel scared and afraid.  
I feel angry.  
I feel jittery.  
At this moment, I feel nervous.  
I feel disturbed and upset.

Pleasant Deactivated

I feel comfortable and content.  
Right now, I am at ease with things.  
I feel pleasantly at rest.  
I feel at ease.  
I feel peaceful.  
I feel calm and relaxed.

Pleasant Activated

Right now, I am sharp and attentive.  
I feel proud of myself.  
I feel ecstatic.  
I feel very inspired.  
I feel enthusiastic.  
I feel set and determined about something right now.  
I feel powerful and strong.  
I feel alive and active.

Unpleasant Deactivated

I have little interest in things around me.  
I feel exhausted.  
Things are dull and boring.  
I feel sluggish and slow.  
I feel droopy and drowsy.

## Semantic Differential Items

Pleasant–Unpleasant Affect

Unhappy–Happy  
Pleased–Annoyed  
Dissatisfied–Satisfied  
Contented–Melancholic  
Despairing–Hopeful  
Relaxed–Bored

Activated–Deactivated Affect

Relaxed–Stimulated  
Excited–Calm  
Sluggish–Frenzied  
Jittery–Dull  
Sleepy–Wide Awake  
Aroused–Unaroused

Note. PA = positive affect; NA = negative affect.

<sup>a</sup> Because of a typo, this item appeared as "I am full of energy" in Study 3.

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