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EFFECTS OF RESPONSE STYLE ON POLARITY AND VALIDITY OF TWO-DIMENSIONAL MOOD MODELS

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REPORT NO. 85-25

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NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND

89 8 07 148

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS None	
2a. SECURITY CLASSIFICATION AUTHORITY NA		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE NA			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NHRC Report No. 85-25		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Naval Health Research Center	6b. OFFICE SYMBOL (if applicable) Code 40	7a. NAME OF MONITORING ORGANIZATION Commander, Naval Medical Command	
6c. ADDRESS (City, State, and ZIP Code) P. O. Box 85122 San Diego, CA 92138-9174		7b. ADDRESS (City, State, and ZIP Code) Dept of the Navy Washington, DC 20372-5120	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Medical Research & Development Command	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code) NMCNCR Bethesda, MD 20814-5044		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 61152N	PROJECT NO. MR0000.01
11. TITLE (Include Security Classification) (U) EFFECTS OF RESPONSE STYLE ON POLARITY AND VALIDITY OF TWO-DIMENSIONAL MOOD MODELS			
12. PERSONAL AUTHOR(S) Vickers, Ross R. Jr., & Hervig, Linda K.			
13a. TYPE OF REPORT Interim	13b. TIME COVERED FROM TO	14. DATE OF REPORT (Year, Month, Day) 1985 August	15. PAGE COUNT 12
16. SUPPLEMENTARY NOTATION <i>Final Report</i>			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP		
			Mood, Military recruits Emotions, Factor Analysis Attrition, Criterion validity, <i>Report</i>
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Unipolar and bipolar two-dimensional models have been proposed to represent mood. This study showed that a given data set will produce both a unipolar model and a bipolar model when a response-style adjustment is employed. The two models provided mathematically equivalent descriptions of a single-factor space and were equally valid for describing mood differences between successful and unsuccessful military recruits and between recruits in different basic training platoons. Both models discriminated between these groups as well as a six-factor model. The findings confirmed the existence of a reliable two-dimensional representation of self-reported mood but indicated that any choice between unipolar and bipolar models must be based on criteria other than the structure of self-reported mood. Further comparisons to more complex mood models are needed to determine whether two dimensions adequately represent self-reported mood when a wider range of			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Dr. Ross R. Vickers, Jr.		22b. TELEPHONE (Include Area Code) 619/553-8454	22c. OFFICE SYMBOL Code 70

EFFECTS OF RESPONSE STYLE ON POLARITY AND
VALIDITY OF TWO-DIMENSIONAL MOOD MODELS¹

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Summary.—Unipolar and bipolar two-dimensional models have been proposed to represent mood. This study showed that a given data set will produce both a unipolar model and a bipolar model when a response-style adjustment is employed. The two models provided mathematically equivalent descriptions of a single-factor space and were equally valid for describing mood differences between successful and unsuccessful military recruits and between recruits in different basic training platoons. Both models discriminated between these groups as well as a six-factor model. The findings confirmed the existence of a reliable two-dimensional representation of self-reported mood but indicated that any choice between unipolar and bipolar models must be based on criteria other than the structure of self-reported mood. Further comparisons to more complex mood models are needed to determine whether two dimensions adequately represent self-reported mood when a wider range of situational factors and behavioral correlates are considered. If so, a simple, reliable, consensual model for mood would be available to researchers interested in studying mood determinants and effects.

Recent research suggests that two mood dimensions are adequate to replace more complex mood models but competing two-dimensional models have been proposed. One model consists of bipolar dimensions which can be labelled hedonic tone (positive versus negative affect) and psychological arousal (lethargy versus arousal) (Mackay, Cox, Burrows, & Lazzarini, 1978; McCormick, Walkey, & Taylor, 1985; Plutchik, 1980; Russell, 1979, 1980; Thayer, 1978a, 1978b; Whissell, 1981). A second model consists of unipolar dimensions labelled positive mood and negative mood² (Diener & Emmons, 1984; Zevon & Tellegen, 1982). Because no direct empirical comparison of the unipolar and bipolar two-dimensional mood models has been made to provide a basis for choosing between the models, in this study we compared Russell's (1980) version of the bipolar model with the unipolar model emphasizing response-style adjustment as a potentially important determinant of mood polarity and validity.

Response style is important in this comparison because it is a component

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²A. Tellegen, The structure of mood states. (Unpublished manuscript, University of Minnesota, Minneapolis, MN, 1980)

of Russell's (1980) bipolar model that is missing from unipolar models. Russell (1980) assumed that responses to mood questionnaires are influenced by "... individual differences in response to the rating format rather than in response to the content of the items" (p. 1172). To correct for this, Russell's (1980) bipolar model incorporates a response-style construct as well as the dimensions of hedonic tone and psychological arousal. This response-style construct is not subject to the criticisms leveled at many suggested response-style variables (Hamilton, 1968), but the mood model that results from incorporating the adjustment is more complex than the competing unipolar model. It remains to be determined whether the increased complexity is justified by gains in the understanding of mood.

One study objective was to test the hypothesis that the same data which produce a unipolar two-dimensional mood structure when raw data are analyzed will produce a bipolar structure when Russell's (1980) response style adjustment is employed. This hypothesis is reasonable because adjusting for extreme response tendencies consistently increases the bipolarity of mood dimensions relative to results obtained with raw data (Lorr, McNair, & Fisher, 1982; Lorr & Shea, 1979; Russell, 1979). However, no study of two-dimensional mood models has directly compared the results derived from a single data set analyzing both raw and adjusted scores to compare the resulting factor structures. This concern was addressed by analyzing raw data and data ipsatized using Russell's (1980) procedure and comparing the resulting mood models.

A second study objective was to evaluate the effect of response-style adjustment on the validity of the resulting mood models. If response style is a reaction to questionnaire format with no other behavioral implications, the response-style adjustment will eliminate a purely methodological source of variance in mood scores which should increase the validity of the resulting mood measures. However, extreme response style may indicate personality differences (Hamilton, 1968) or the presence of mixed emotions (Plutchik, 1980). In these cases, the response-style adjustment could remove variance which has implications for nonquestionnaire behaviors, thereby reducing the validity of the mood measures. These opposed predictions were tested by relating mood measures derived with and without Russell's (1980) response-style adjustment to platoon membership and attrition from military basic training. These potential correlates of mood could be ascertained from data sources other than self report, so any association to mood would not arise because both the mood measure and the external correlate were influenced by response style.

METHOD

Sample

Participants ($n = 341$) were volunteers representing 94.2% of the men in four Marine Corps basic training platoons. The average participant was

Sciences (SPSS, 1983). Principal components analyses were performed on mood data collected on seven days spread over the entire basic training period. Data from different days were analyzed to determine the stability of the factor solutions across different training experiences ranging from initial exposure to training to learning fundamental military skills and on to successful completion of training. Two-factor orthogonal and oblique solutions were determined for both raw data and ipsatized data for each day. Ipsatized data were derived by standardizing each participant's responses relative to his mean and standard deviation for the 32-item set. This procedure paralleled Russell's (1980) analysis and is referred to as "ipsatized data" to emphasize the within-person aspect of the standardization. The correlations between the factors obtained with the oblique rotation averaged $-.39$ for the raw data and $.25$ for the ipsatized data. These correlations did not alter the general factor structure obtained with the orthogonal rotation, so the results from the orthogonal analysis have been used in the remainder of this paper.

The validity comparisons used factor scores computed with the average factor regression coefficients derived from the seven factor analyses.³ This weighted sum was preferred to simple item sums because simple sums have produced highly correlated factors in prior research even when there was reason to believe the mood factors should be independent (Burrows, Cox, & Simpson, 1977).

Multivariate analyses of variance related the mood measures to platoon membership and attrition status. These analyses were limited to the data collected on the first study day because attrition prior to the second data collection substantially reduced the size of the attrition groups. As a result, data from later days of the study would not have provided stable estimates of the mean values for the attrition groups.

Multivariate analyses of variance and discriminant analyses tested the adequacy of two-dimensional model relative to the six standard scales from the mood questionnaire (Ryman, Biersner, & LaRocco, 1974). The multivariate analyses of variance determined whether scores on the mood scales differed significantly across the attrition groups and platoons. Discriminant analyses then were performed in which the measures from one of the two-dimensional models were entered into the discriminant equation and individual mood scales

³The factor-score coefficients had average interday correlations of $.79$ for positive mood, $.91$ for negative mood, $.59$ for hedonic tone, and $.62$ for psychological arousal. The estimated alpha coefficients for the averaged coefficients ranged $.90$ to $.99$. Comparing these factor-score coefficients to the average coefficients determined from two additional samples of Marines in cold weather training produced an average convergent correlation of $.73$ compared with an average discriminant correlation of $-.20$. These values would probably have been higher if the additional estimates had been based on more than two samples of Marines. The factor-score coefficients are available from the authors.

added to the equation if they were significant predictors. This procedure was equivalent to a stepwise regression with group membership as the criterion and provided an estimate of the additional discriminating power of the specific mood measures after controlling for the general dimensions. A lenient criterion ($p < .10$ by Wilks's lambda) was used to permit the specific moods to enter the discriminant equation to favor the more complex model if there was even slight improvement in prediction. Separate discriminant analyses were performed with the factors from the bipolar and unipolar two-dimensional models as the initial variables in the discriminant function.

RESULTS

Factor Identification

The two-dimensional solutions for the raw and ipsatized data had substantial cross-time consistency. The average of the 21 pairwise correlations for the factor loadings across the seven days was .970 for the first raw-score factor, .978 for the second raw-score factor, .861 for the first ipsatized-score factor, and .904 for the second ipsatized-score factor. The average loadings from the seven analyses are presented in Table 1 as the best estimates of the true factor loadings.

The factors derived from the present data were similar to those reported by other researchers. As expected, the raw data produced essentially unipolar factors (30 of 33 loadings greater than .40 [absolute] were positive) while ipsatized data produced bipolar factors (14 of 30 loadings greater than .40 [absolute] positive). The raw-data factors could be interpreted as positive and negative mood and the ipsatized factors as hedonic tone and psychological arousal.

Coefficients of congruence (Gorsuch, 1974, pp. 253-254) based on the loadings for items common to this study and prior studies confirmed the proposed factor designations, showing clear correspondence between both the unipolar and bipolar factors from this study and the comparable factors previously reported (Table 2). There was a trend toward higher coefficients of congruence when the polarity of the factors from this study matched that of the factors from the comparison study, but this trend did not include the comparison with Tellegen's factors.²

Comparison of the Unipolar and Bipolar Factors

Simple, but highly accurate, equations for expressing the bipolar factor loadings in terms of the raw unipolar factor loadings were obtained by regressing the ipsatized data loadings (labelled y_1 and y_2) onto the corresponding raw data loadings (labelled x_1 and x_2):

$$\begin{aligned} y_1 &= 1.002 * x_1 - .274 & (r &= .974) \\ y_2 &= -0.948 * x_2 + .118 & (r &= -.987) \end{aligned}$$

TABLE 1
 ORTHOGONAL FACTOR LOADINGS FROM TWO-FACTOR SOLUTION
 FOR RAW SCORE AND IPSATIZED SCORE ANALYSES

Item	Raw Scores		Ipsatized Scores	
	Factor 1	Factor 2	Factor 1	Factor 2
2. Lively	-.182	.783*	-.413*	-.636*
3. Irritated	.640*	-.218	.357	.293
4. Contented	-.102	.497*	-.394	-.316
5. Active	-.110	.747*	-.332	-.623*
6. Restful	-.085	.490*	-.231	-.407*
9. Weary	.492*	-.417*	.103	.606*
11. Calm	-.277	.350	-.445*	-.204
12. Blue	.678*	-.274	.476*	.336
15. Afraid	.560*	-.069	.303	.092
16. Happy	-.269	.708*	-.554*	-.491*
17. Miserable	.712*	-.324	.513*	.406*
18. Alarmed	.511*	.108	.229	-.067
20. Drowsy	.413*	-.361	-.121	.641*
21. Downcast	.678*	-.339	.512*	.372
22. Pleased	-.244	.708*	-.563*	-.479*
23. Satisfied	-.270	.664*	-.573*	-.433*
24. Depressed	.720*	-.303	.553*	.375
25. Energetic	-.099	.807*	-.333	-.675*
26. Cheerful	-.232	.738*	-.541*	-.512*
27. Uneasy	.719*	-.209	.441*	.310
28. Grouchy	.617*	-.183	.323	.263
29. Sluggish	.509*	-.402*	.077	.630*
30. Vigorous	-.010	.679*	-.305	-.538*
31. Alert	-.100	.652*	-.312	-.521*
32. Annoyed	.663*	-.232	.375	.336
33. Sad	.737*	-.238	.569*	.305
34. Hopeless	.685*	-.173	.501*	.163
35. Insecure	.709*	-.128	.485*	.180
36. Jittery	.613*	.015	.313	.062
37. Bored	.449*	-.237	.088	.375
38. Tired	.379	-.454*	-.098	.680*
40. Angry	.656*	-.177	.412*	.207

Note.—Entries are average factor loadings from analysis of seven days' data (see Analysis Procedures).

*Loadings greater than .40 (absolute).

The 95% confidence interval included 1.00 for both regression weights, but both intercepts differed significantly from 0.00 ($t = -12.97$ for Equation 1 and $t = 9.01$ for Equation 2; $p < .0001$ for each).

The generality of this surprisingly simple relationship between the raw and ipsatized factors was tested in data from two additional samples of marines ($n_s = 161$ and 153) who completed the mood questionnaire during a cold-

TABLE 2
COMPARISON WITH FACTOR STRUCTURES FROM OTHER STUDIES

Factor Label	Raw Scores		Ipsatized Scores	
	Factor 1	Factor 2	Factor 1	Factor 2
Arousal*	-.782	.974	-.727	-.996
Stress*	.828	-.819	.969	.878
Positive Mood†	-.494	.836	-.529	-.886
Negative Mood†	.859	-.535	.904	.520
Positive Mood‡	-.607	.973	-.763	-.923
Negative Mood‡	.958	-.575	.870	.628
Positive Mood§	-.442	.970	-.807	-.880
Negative Mood§	.983	-.575	.860	.767

*Based on average of the loadings for the bipolar factors from Mackay, *et al.* (1978) and McCormick, *et al.* (1985) factor analyses of Thayer's (1978a, 1978b) activation checklist. Although the present analyses included 14 items from this research, the coefficients were based on $n = 6$ for Stress and $n = 8$ for Arousal because these studies reported just the loading for the more salient factor for each item.

†Based on the loadings for 13 items from Tellegen's 1980 unipolar factors² as reported by Zevon and Tellegen (1982).

‡Based on loadings for 11 items from Zevon and Tellegen's (1982) unipolar factors.

§Based on loadings for 14 items from Diener and Emmons' (1984) unipolar factors.

weather training course. Results of the factor analyses for the two samples were averaged to approximate the averaging over time in the recruit analyses. Coefficients of congruence based on the resulting factor weights ranged from .918 to .976 (absolute value), so there were clear matches to the recruit factors.

The replicability of the initial regression findings was demonstrated by repeating the regression analyses with the following results:

$$y_1 = .991 * x_1 - .518 \quad (r = .947)$$

$$y_2 = -.938 * x_2 + .128 \quad (r = -.980)$$

The 95% confidence interval for the regression weights included 1.00, but the intercepts differed significantly from 0.00 ($t = -9.27$, $p < .0001$ for y_1 and $t = 4.18$, $p < .0003$, for y_2). Direct cross-validation of the initial regression equations would produce correlation coefficients identical to those obtained in the regression analyses (Hays, 1963, pp. 667-671), so it is noteworthy that the cross-validation coefficients would be extremely close to the initial correlation values.

Predictive Validity Comparison

Attrition outcome.—Attrition from training was related to the raw data factors (Hotelling's $T^2 = 5.32$, $p < .001$; canonical $r = .248$) and the ipsatized-data factors (Hotelling's $T^2 = 5.95$, $p < .001$; canonical $r = .261$). Given the direction of scoring for the factors, the differences were consistent with previous findings that recruits who subsequently fail to complete basic training initially have more negative moods (Table 3). The canonical cor-

TABLE 3
COMPARISON OF GRADUATES AND ATTRITES ON MOOD DIMENSIONS

Factors	Graduate	Medical Attrite	Behavioral Attrite	F	p
Raw Score Factors					
Factor 1	-0.07	0.45	0.78	8.73	.001
Factor 2	0.03	-0.28	-0.49	3.24	.04
Ipsatized Factors					
Factor 1	-0.07	0.52	0.80	11.65	.001
Factor 2	-0.04	0.28	0.41	3.11	.04

Note.—Sample sizes were Graduate = 296, Medical Attrite = 19, and Behavioral Attrite = 15. N was 330 because attrition status was indeterminate for 10 participants and 1 participant did not complete the mood questionnaire.

relation coefficients for the group differences were of comparable magnitude, indicating that the two models were about equally effective in discriminating between the groups.

Platoon membership.—Even though the four platoons studied were not selected to represent extremes of stress or leadership style, these platoons differed significantly for raw scores (Hotelling's $T^2 = 4.40$, $p < .001$, canonical $r = .269$) and ipsatized scores (Hotelling's $T^2 = 4.03$, $p < .001$; canonical $r = .257$). Again, the magnitudes of the canonical correlations and the group differences obtained with the alternative models were comparable (Table 4).

Comparison to specific mood measures.—Additional analyses compared the two-dimensional mood models to a six-dimensional alternative including scales for happiness, activity, depression, fear (or anxiety), anger, and fatigue (Ryman, *et al.*, 1974). Initial multivariate analyses of variance showed significant differences for these six scales between attrition groups (Hotelling's $T^2 = 2.38$, $p < .005$; canonical $r = .280$) and between platoons (Hotelling's $T^2 = 2.36$, $p < .001$; canonical $r = .304$). Each individual mood scale differed significantly across the attrition groups ($p < .05$ to $p < .001$) and the platoons ($p < .008$ to $p < .001$).

TABLE 4
COMPARISON OF PLATOONS ON MOOD DIMENSIONS

Factors	Platoon				F	p
	I	II	III	IV		
Raw Score Factors						
Factor 1	-.16	-.05	-.06	.28	3.58	.01
Factor 2	.24	.09	.00	-.35	6.23	.001
Ipsatized Factors						
Factor 1	-.16	-.08	-.05	.31	5.28	.001
Factor 2	-.21	-.06	.00	.29	5.52	.001

Note.—Sample size was I = 86, II = 85, III = 87, IV = 82.

Stepwise discriminant analyses then were performed with the mood measures from one of the two-dimensional models entered as predictors in the first step. The individual mood scales from Ryman, *et al.* (1974) then were entered stepwise using a $p < .10$ criterion. None of the specific mood scales even approached significance for comparison with the attrition group ($p > .26$ for the raw scores; $p > .20$ for the ipsatized scores). Depression entered the predictive equation for the platoon comparison ($p < .04$ for the raw data; $p < .06$ for the ipsatized data).

DISCUSSION

The study findings produced straightforward conclusions regarding the three issues noted in the introduction. Response-style adjustment produced bipolar mood dimensions from data that otherwise produced unipolar dimensions. However, the bipolar loadings were simple linear functions of the unipolar loadings. The form of the linear functions indicated that the two solutions identified the same factor space, except for differences in the choice of origin for the reference axes. The multiple correlations for these linear functions were nearly 1.00. In the technical terminology of linear algebra, these facts mean that the unipolar and bipolar models represent alternative reference bases both of which span a single-factor space and provide mathematically equivalent descriptions of that factor space (Lipschutz, 1968). From an applied perspective, these assertions mean that the two solutions are mathematically interchangeable.

The validity tests for the two models provided further evidence of their equivalence. Unipolar and bipolar dimensions were equally effective in discriminating between recruits who succeeded in basic training and those who failed and between the average recruit in different platoons. This finding would be expected given the mathematical equivalence of the two models. Changing the origin for a dimension is equivalent to adding or subtracting a constant to each score on that dimension. Such changes will not affect the variance computations central to procedures such as regression or analysis of variance (Hays, 1963). The equivalent results obtained with the two models, therefore, provided further evidence that the unipolar and bipolar dimensions described the same factor space.

The two-dimensional model adequately represented mood compared to the six-dimensional model. The latter model produced slightly stronger canonical correlations than the two-dimensional model, but the difference was trivial given the four additional degrees of freedom required to achieve the improvement. In addition, no single mood improved the between-group discrimination for both attrition status and platoon membership after taking the two general dimensions into account.

The over-all findings from this study extended prior support for the two-

dimensional model in two ways. First, Watson and Tellegen (1985) have shown that mood instruments generally produce similar two-dimensional measures of mood whether unipolar or bipolar dimensions are extracted. If attention is directed solely to this aspect of mood research, the difference between the models lies solely in the choice of the origin for the reference axes used to describe locations in the factor space. This choice will not affect the findings in research studies relating self-reports of mood to other constructs, and so will not modify the phenomena that must be explained by mood theories. However, a critical distinction must be made between assigning numbers to characterize emotional states, i.e., a measurement model, and interpreting those numbers. Although bipolar and unipolar measurement models apparently will produce comparable research results, one conceptual model may prove superior to the other as a basis for interpreting and understanding those results and for making predictions about further phenomena. Second, Russell and Steiger (1982) have shown that two dimensions predict scores on scales measuring specific moods at levels that approximate the internal consistency of the specific moods. This finding showed that two dimensions adequately described differences in mood relative to internal measurement standards. This study extended the comparison to show that two dimensions adequately represented mood relative to selected external validity criteria.

The evidence for the two-dimensional mood model now includes demonstrations that the model is robust relative to variations in item content, populations studied, and analysis procedures chosen to describe the factor space. It is reasonable to conclude that a reliable two-dimensional structure for mood has been established. The evidence to date also indicates that the two-dimensional model adequately represents mood, but further studies of external validity criteria are needed. The present findings involved two general criteria. Attrition can result from many different affective and behavioral problems and platoon membership may be a proxy variable for a wide range of specific differences in social environment. General mood dimensions may provide more parsimonious models to explain such general criteria but still be inadequate representations of mood when more detailed assessments of behavioral problems or situational factors are undertaken. In general, the appropriate level of abstraction for mood measures may be determined by the level of abstraction of the criterion. This dictum applies to other psychological research (Anastasi, 1985), and it may generalize to mood. An alternative possibility is that the two-dimensional model will prove adequate over a wide range of cognitive and behavioral criteria with appropriate consideration of interactions between the dimensions (Russell & Steiger, 1982). Further study is needed to determine which alternative actually applies. Confirmation of the adequacy of the two-dimensional model would provide researchers interested in the determinants

and effects of mood with a simple, comprehensive, consensual basis for measuring mood.

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Accepted August 5, 1987.