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Chinese Affect Circumplex: I. Structure of Recalled Momentary Affect

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Abstract

The structure of momentary affect among Cantonese-speaking Chinese was explored by developing questionnaire scales in four response formats. Scales can be scored for dimensions defined by Feldman Barrett and Russell (1998), Thayer (1996), Larsen and Diener (1992), and Watson and Tellegen (1985). In a study of recalled affect ($N = 487$), the newly translated scales were found to support all but Watson and Tellegen's structural model originating from English. Results cross-validated well in a second sample ($N = 402$). Affective dimensions were interrelated as found with English-speaking Canadians and they could be integrated into a two-dimensional bipolar space.

Chinese Affect Circumplex: I. Structure of Recalled Momentary Affect

Affect has been found to be an important factor in the research laboratory, clinic, and workplace. In this study, we ask a fundamental question: How can affect be described and compared across languages? More specifically, we, first, test the generalizability of a two-dimensional descriptive model developed with English-speaking Canadians to two large samples of Cantonese-speaking Chinese. Second, we develop a preliminary version of scales to assess momentary affect among the Chinese.

The study of affect requires a comprehensive descriptive structure of affective feelings. It is also highly desirable to have the whole or part of such a structure be a common framework for describing affect across language and cultural groups. If such a universal structure can be found, it would be a tool for researchers to compare and contrast affective feelings in different groups. In that way, both universal and language-/culture-specific aspects of affect could be delineated. The present study is part of a larger project aimed at just such a descriptive structure.

In the past decade, various dimensional models have been proposed to characterize the covariations of self-reported momentary affective feelings. Major models include Russell's (1980) circumplex, Thayer's (1996) energetic and tense arousal, Larsen and Diener's (1992) eight combinations of pleasantness and activation, and Watson and Tellegen's (1985) positive and negative activation (Watson, Wiese, Vaidya, & Tellegen, 1999). Each has achieved psychometric success and inspired a line of supportive research.

Recently, attempts have been made to integrate these four major models, although exclusively in English-speaking samples. Results have shown that the four models fit comfortably within a two-dimensional affective space, characterized by the

bipolar axes of Pleasure and Arousal. Figure 1 shows an empirical example of that integrated space (Russell, Yik, & Steiger, 2003). On the right hand side are the more pleasant states; on the left hand side the more unpleasant ones. On the upper half are the more activated states; on the lower half the more deactivated ones. Any specific affective state is composed of different blends of the Pleasure and Arousal. The model is thoroughly bipolar in that any state has a bipolar opposite 180° away. It is also a circumplex in that affective dimensions fall in a circular ordering along the perimeter: Affective dimensions can fall at any angle throughout the integrated space of Figure 1. The circumplex nature of affective states has received strong empirical support (Remington, Fabrigar, & Visser, 2000). We do not, however, assume that the structure of Figure 1 captures all of affect. Rather, we propose it as a means of representing affect at the most general level.

One question immediately arises: Is the integrated structure of Figure 1 limited to English-speaking societies where it was developed? Or can it be generalized to those speaking other languages, such as Chinese? Current evidence provides initial support for the circumplex as a tool to organize affect among the Chinese (Russell & Yik, 1996). Russell (1983) reported a study on the similarity ratings of 28 emotion terms among Canadian Chinese. Multidimensional scaling of the ratings resulted in a circumplex model characterized by Pleasure and Arousal. Similar results were found when Hong Kong Chinese were asked to rate the similarities of facial expressions of emotion (Russell, Lewicka, & Nitt, 1989; see also Chan, 1985). In a study on the cognitive mediators of emotion in different languages, including Chinese, Mauro, Sato, & Tucker (1992) found support for the two axes when correlations among affective ratings of remembered episodes were submitted for a multidimensional scaling procedure. Based on commonly used

words for emotion in Chinese, Hamid and Cheng (1996) developed the Positive Affect and Negative Affect scales.

We adopt a new method for gathering data about momentary affect that relied on remembered moments (Yik, Russell, Ahn, Fernández Dols, & Suzuki, 2002). This alternative complements the more typical method in which respondents were asked to report current or online mood. We asked respondents to remember a moment (around breakfast, lunch, or supper time) from the previous day. The sample of moments is thus likely to be more representative of experiences in the external non-laboratory world. Our method's downside is its reliance on memory. To minimize this problem, respondents are asked to select a moment that was well remembered, and mealtimes were used as memoric anchors.

In the present study, scales for all dimensions in the structural models developed by Feldman Barrett and Russell (1998), Thayer (1996), Larsen and Diener (1992), and Watson and Tellegen (1985) were translated into Chinese. The resulting tools should be valuable for pursuing each of the original models. Together, they also allowed us to examine whether they can be integrated in the way indicated in Figure 1. Integration relied on confirmatory factor analysis, a powerful tool that estimates relations among variables relatively free of random and systematic errors inherent in measurement. To take full advantage of confirmatory factor analysis requires that each dimension be measured in several different ways. We therefore developed all scales in at least three different response formats.

We began by translating various affect scales from English into Chinese. Data from two samples ($N_s = 487; 402$) of Chinese respondents were gathered to examine two issues: (a) The psychometric properties of the translated affect scales,

especially their bipolarity; (b) the relations among these scales, especially their circumplex ordering.

Method

Respondents and Procedure

Sample One consists of 487 undergraduates (164 men, 323 women) from the Chinese University of Hong Kong and City University of Hong Kong. Their mean age was 19.74 (s.d. = 2.04). Their participation was either voluntary or in exchange for course credit. Test administration took place during class time or in a laboratory.

Sample Two consists of 402 undergraduates (200 men, 202 women) from the University of Hong Kong. Their mean age was 20.24 (s.d. = 1.47). Respondents took part in the study in exchange for HK\$60 (US\$8). Test administration took place in a laboratory. Respondents first completed the battery of affect questionnaires under the title “Remembered Moments Questionnaire” and then a set of personality questionnaires (not reported here). All questionnaires were in Chinese.

Affect Questionnaires

Translation. All instructions and scales were translated into Chinese by two bilinguals. A back-translation procedure was adopted. First, one bilingual translated the English version (Yik, Russell, & Feldman Barrett, 1999) into Chinese. Second, another bilingual, who was blind to the English original, translated the Chinese version back into English. Discrepancies between the English and Chinese versions were reviewed by the authors. Translations were revised until satisfactory before we used them in the data collection.

Instructions. The front page of the battery provided general instructions. For Sample One, there were six versions of the questionnaire, each with a different anchoring time. The six anchoring times were “before breakfast,” “after breakfast,”

“before lunch,” “after lunch,” “before dinner,” and “after dinner.” Respondents were randomly assigned to one of the six. For instance, the instructions for one version were as follows:

“... we need to ask you to remember a particular moment. Please think back to yesterday. Specifically, recall the time just before breakfast. (If you didn't have breakfast yesterday, simply recall that approximate time of day.)

“It is important that you remember a specific moment accurately. So, please search your memory and try to recall where you were, what you were doing at that time, who you were with, and what you were thinking.

“Now select a particular moment that is especially clear in your memory. (If you really have no recollection of the time just before breakfast, please search your memory for the closest time that you do recall accurately.)”

In the other five versions, italicized words were replaced. The instructions then emphasized that all subsequent questionnaires were to be answered with respect to that selected moment of the day before. For Sample Two, the instructions were identical to those used in Sample One, except that only three anchoring times (after breakfast, after lunch, and after dinner”) were used. On average, completion took approximately 25 minutes.

Formats. Respondents then received a battery of four questionnaires, each in a different format, in the following order: (a) Semantic differential scales (SEM); (b) Adjective format (ADJ), which was an adjective list accompanied by a five-point Likert scale ranging from 1 “not at all” to 5 “extremely”; (c) “Agree-Disagree” format (AGREE), which was a list of statements with which respondents were asked to indicate their degree of agreement, ranging from 1 “strongly disagree” to 5 “strongly agree”, and (d) “Describes Me” format (DESCRIBE), which was a list of statements, for each of which respondents were asked to indicate how well it described their feelings, ranging from 1 “not at all” to 4 “very well”.

The SEM format consisted of bipolar measures of pleasure and arousal translated directly from Mehrabian and Russell (1974). The remaining three questionnaires were unipolar in format and each questionnaire included translated items from (a) Feldman Barrett and Russell's (1998) Current Mood Questionnaire (CMQ) assessing Pleasant, Unpleasant, Activated, and Deactivated affect; (b) Larsen and Diener's (1992) Activated Unpleasant, Unactivated Unpleasant, Activated Pleasant, and Unactivated Pleasant affect; (c) Thayer's (1996) Energy, Tiredness, Tension, and Calmness; and (d) Watson, Clark, and Tellegen's (1988) Positive Activation and Negative Activation.

Data Analysis

Revising the scales. Pleasant, Unpleasant, Activated, and Deactivated – these four constructs are the cornerstones of the two-dimensional space proposed in the present study. Because it was the first time these scales were adopted to Chinese, we used the data from Sample One to examine the correlations among the 14 scales (3 unipolar formats x 4 constructs; plus the 2 semantic differential scales) before proceeding to further analyses. The purpose was to make sure that these scales align with each other as expected – the Pleasant and Unpleasant scales should yield high correlations with other items related to Pleasure but low correlations with items related to Arousal; the Activated and Deactivated scales should yield high correlations with items related to Arousal but low correlations with items related to Pleasure.

Any revision procedure can be accused of capitalizing on chance. We therefore took steps to minimize this possibility: No items were allowed to switch from one scale to another and therefore items could be dropped (but not added) in the revision procedure. With these criteria in mind, we found that all the pleasant

and unpleasant items were adequate, but that some revisions were helpful in the activated and deactivated scales, from which a total of seven items were dropped from further analyses.

To maintain the similarity between the Chinese and English versions of scales developed by other authors, we used a more conservative procedure in their revision. Reliability estimates for scales defining Thayer's (1996), Larsen and Diener's (1992), and Watson and Tellegen's (1985) constructs were examined. The purpose was to make sure that the scales were internally consistent (with a minimum alpha of .60) and that each item was reasonable indicator of the intended construct (with a minimum factor loading of .70). All scales passed both criteria and these scales were therefore left intact in subsequent analyses.¹

Ipsatization. Affective scales are often contaminated by the presence of a general factor (Bentler, 1969). With data from Sample One, we conducted an exploratory factor analysis with the 12 x 12 correlation matrix for the CMQ scales. There were three factors with eigenvalues greater than 1.00 (5.16, 2.66, and 1.24) and which accounted for 75.5% of the total variance. In the unrotated solution, Factor 1 was interpretable as "Pleasant versus Unpleasant," and Factor 2 as "Activated versus Deactivated." Factor 3 was a general factor with positive loadings from all 12 scales. The interpretation of a general factor depends on the content of measures included (Wiggins, Steiger, & Gaelick, 1981). Because of the heterogeneity of the content (including semantic opposites such as "happy" and "sad"), we interpreted it as an acquiescence response style, the tendency to endorse an item regardless of its content.

Our next step was to reduce the "general factor" by ipsatizing the data by scales. Ipsatization removes individual differences in grand mean and variance. So

for instance, to ipsatize the unipolar Pleasant ADJ score, we deduct an individual's grand mean of all affect ADJ scales from that individual's Pleasant ADJ score; this difference is divided by the standard deviation of the affect ADJ scores for the same individual. Ipsatization for this purpose requires that the scales be heterogeneous in content, ideally including opposite content. (For example, if the adjective scale of "Pleasant" is in the pool, then its theoretical semantic opposite, the adjective scale of "Unpleasant," would have to be there as well.) This consideration led us to use 12 rather than the full 14 scales in each response format. (Watson and Tellegen's PA and NA scales were excluded because they lacked semantic opposites.) We ipsatized our data across the 12 scales (four each from CMQ, Thayer, and Larsen and Diener) within each response format. In total, we created 36 ipsative scores, 12 within each response format.

With the ipsative data from Sample One, we re-computed a 12 x 12 correlation matrix for the CMQ scales and submitted it to an exploratory factor analysis. There were now 2 factors with eigenvalues greater than 1.00: 4.98, 2.85. The third factor had an eigenvalue of .92 and was no longer a general factor, having positive loadings from 6 scales and negative loadings from another 6. Indeed, it was difficult to interpret. We repeated this analysis with data from Sample Two and no general factor appeared with ipsatized data. Where possible, subsequent analyses are based on ipsative data.

Results

The results are presented in three sections. We examine, first, the assumption of bipolarity of affective dimensions; second, the psychometric properties of four structural models of affect; and, third, the integration hypothesis illustrated in Figure 1.

Test for Bipolarity

Russell and Carroll (1999) noted a contradiction in previous analyses of bipolarity, which had required unipolar response formats and a correlation of -1 . These two requirements cannot be met simultaneously. Even when random and non-random error has been completely eliminated, to achieve a correlation of -1 requires a strictly bipolar response format, and yet bipolar response formats are (rightly) deemed illegitimate and not used. Unipolar formats were used, but the more strictly unipolar the format, the farther from -1 is the expected correlation between bipolar opposites. Further, ostensibly unipolar formats, such as those used in three out of four of our questionnaires, vary in just how strict they are. Russell and Carroll argued that the type of format we used is ambiguous, explicitly unipolar but implicitly bipolar, because some but not all respondents interpret it as bipolar.

The implication of Russell and Carroll's (1999) analysis is that testing bipolarity is not as straightforward as once thought. One cannot simply calculate a correlation and require that it be close to -1 . Testing bipolarity requires a number of additional assumptions, such as that the latent bipolar dimension is normally distributed. With these assumptions, and for the types of unipolar format used here, we suggest two indications of bipolarity:

1. The correlation fall within the range of $-.47$ to -1.00 . The closer to -1 , of course, the more confident one is of bipolarity. By correlation, here we refer to the correlation estimated by a structural equation modeling procedure that takes into account both random and non-random error.
2. When the correlation is within this range but far from -1.00 , then this might be due to respondents interpreting the response format as unipolar – an interpretation that would pull the correlation away from -1.00 . One sign that

respondents are indeed interpreting the format as unipolar is that there is a positive skew in the data. Thus, at least one of the variates, and possibly both, show a positive skew (when they are scored, as is done traditionally and as was done here, with the lowest score corresponding to neutral and the highest score to a high degree of the named variable, such as sadness). The more positive skew seen in the two variables, the lower in magnitude is the correlation between them.

These two criteria are to some extent overlapping, and must be considered tentative. Still, for the kinds of response formats in common use, such rules of thumb may be the best we can do for now.

The six pairs of hypothesized bipolar opposites (two each from Feldman Barrett and Russell; Thayer; and Larsen and Diener) were subjected to a test of bipolarity. Relevant statistics for both samples are given in Table 1. For instance, consider Pleasant and its hypothesized bipolar opposite, Unpleasant in Sample One. Pleasant showed negative skew in all three formats, but Unpleasant showed positive skew much greater in magnitude than the negative skew of Pleasant. The correlation between Pleasant and Unpleasant was estimated to be $-.89$ (by a confirmatory factor analysis) and fell within the predicted range. Indeed, it was substantial in magnitude. Therefore, Pleasant and Unpleasant are clearly consistent with a bipolar model. The remaining five pairs passed the test of bipolarity as well; skew tended to be positive; where negative, it was lower in magnitude than the positive skew of the other variates; and the estimated latent correlations fell within the range of $-.78$ to $-.93$. Similar results were found in Sample Two. Estimated latent correlations fell between $-.60$ and $-.94$.

Individual Measurement Models

In this section, we examine the ability of the various affect scales to assess the original four structures from which the scales were developed. We used confirmatory factor analysis, with each latent construct indicated by three scales with different response formats. For all confirmatory factor models, we estimated: (a) factor loading between each manifest variable and its intended latent construct, (b) error term associated with each manifest variable, and (c) correlations between latent constructs.

Table 2 gives indices of fit for all the models in both samples. For each hypothesized model, we estimated a corresponding comparison model where the correlations among all latent constructs were fixed to .00. This comparison model thus posits orthogonal unipolar factors. In both samples and for all analyses, the comparison model fit poorly, noticeably worse than the hypothesized model. Other than Watson and Tellegen's (1985) model yielding an RMSEA of .17 in Sample One, all other models achieved an RMSEA between .09 and .12. These values of RMSEA were considered too close to one another to favor one model here over another. In addition, all were considered adequate to proceed, even though they were borderline by a conventional standard (e.g., Browne & Cudeck, 1992). We believe there might be two reasons accounting for the borderline values of RMSEA. First, as stated by Steiger (1998), when the variables are highly correlated, as they are in the present study, the weighting function tends to produce higher discrepancy function values than when the correlations are low -- yielding high RMSEA. Second, all of the models here were tested with preliminary translations. None had the advantage of being honed through repeated item selection. For these reasons, we believe that all scales used here are adequate to proceed with further analyses and, ultimately, further development.

Specific parameters for the measurement models for CMQ are given in Table 3. As expected, factor loadings were substantial and statistically significant indicating that the manifest variables are reasonable indicators of their intended latent constructs. The latent constructs were related in the way expected. In both samples, Pleasant was related highly and negatively with Unpleasant ($-.89$; $-.94$); Activated related highly and negatively with Deactivated ($-.78$; $-.62$). The remaining off-diagonal coefficients were moderate or small, ranging from $-.42$ to $.07$ in Sample One and $-.39$ to $.21$ in Sample Two. ²

The Full Two-Dimensional Affective Space

Our principal hypothesis was that all structures would be mappable onto one common integrated space. In the following, we adopted two ways to test this hypothesis.

Structural equation models. One way to demonstrate the convergence of constructs of different origins was to use the two axes of pleasure and arousal as exogenous variables to predict (account for the reliable variance in) all other affect constructs, treated as endogenous variables.

To specify the exogenous side, we began with a multi-sample (Samples One and Two) confirmatory factor model (which we call Model 1) with two latent constructs, corresponding to the bipolar axes of Pleasure and Arousal. In each sample, each latent construct was indicated by the bipolar versions of its three scales with different response formats. The semantic differential scale of pleasure was specified to load only on the pleasure construct; the semantic differential scale of arousal to load only on the arousal construct. Loadings for other manifest affect scales were estimated. The latent correlation between the two axes was fixed to $.00$. Parameter estimates for both samples were constrained to be equal. Model 1 fit the

data well: $\chi^2(48, N=487, 402) = 230.67$, RMSEA = .09, APCI = .93 (90% CI = .91 / .94). Results from the multi-sample analysis provided the best available estimates to define the axes of the space of Figure 1.

In the following structural equations, we estimated (a) factor loading between each manifest variable and its endogenous construct, (b) regression weights of the endogenous construct on the exogenous constructs, (c) percentage of variance explained by the exogenous constructs for each endogenous construct. With data from each sample, we conducted a separate analysis for each of 10 affect constructs (four from Thayer, four from Larsen and Diener, and two from Watson and Tellegen). Results are summarized in Table 4.

In both samples, hypothesized models fit the data well with a mean RMSEA of .08. Affect constructs were substantially explained by the two bipolar axes of the integrated space. The mean variance explained was 75% for Sample One (range = 48% to 88%) and 76% for Sample Two (range = 49% to 91%). The pattern of relations between the exogenous variables and the endogenous variable was approximately as expected in Figure 1. Consistent with results obtained in English, the four structures can be comfortably integrated into a two-dimensional space.

CIRCUM analyses. Another way to demonstrate the convergence of the constructs across different models was to portray the full representation of all constructs simultaneously within a circumplex. To do so, we used a structural equation modeling program (CIRCUM) developed by Browne (1992). This program provides fit indices and angular position for each input variable. Ipsative data are likely inappropriate for CIRCUM analyses and we therefore used the non-ipsative versions of the scales (M. Browne, personal communication, September 12, 2002).

This analysis used the unipolar affect scales (the semantic differential scales were not used.) First, a score was created for each of the 14 unipolar constructs by summing the z-scores of its three scales with different response formats. A 14 x 14 correlation matrix was then computed with the resulting sums and was submitted to the maximum likelihood estimation using CIRCUM. Pleasant was designated as the reference variable (its location was fixed at 0°.) The locations of other variables were then estimated relative to Pleasant. The communality estimates of all variables were free to vary. No constraints were put on the minimum common score correlation.

With data from Sample One, the analysis converged on a solution in 23 iterations. Three free parameters were specified in the correlation function equation; additional free parameters did not improve the model fit. The final model had a total of 44 free parameters and 61 degrees of freedom. The data fit the model only moderately well: $\chi^2(61, N=487) = 498.81$, RMSEA = .12. Similar results were obtained with data from Sample Two: $\chi^2(61, N=402) = 400.06$, RMSEA = .12. The resulting angular estimate for each angle was extremely similar between the two samples (rank-order correlation = 1).

Figure 2 displays the results of Sample One. The four cornerstone variables (Pleasant, Unpleasant, Activated, and Deactivated) were located close to the predicted values: With Pleasant fixed at 0°, Activated was 85° away, Unpleasant was 167° away, and Deactivated was 277° away. Hypothesized bipolar opposites were located close to the predicted values: Pleasant was 167° from its bipolar opposite, Unpleasant. Activated was 192° from its bipolar opposite, Deactivated. Constructs developed by various investigators again fell remarkably close to that predicted in Figure 1.

Nevertheless, the circumplex model fit the data only moderately well. The circumplex too is but an approximation. One explanation for the modest level of fit is that CIRCUM is not able to estimate systematic error in the present data sets. Present and past findings show that affect scales can include substantial amounts of systematic as well as random error (Green, Goldman, & Salovey, 1993). Removing the systematic errors may be necessary to pinpoint the underlying structure. Another (complementary) possibility is that additional substantive dimensions account for some of the variance in the original affect scales. Still another possibility currently being explored in our laboratory is non-linear relation between manifest and latent variables (Carroll, Russell, & Reynolds, 1999).

Discussion

A research program on affect requires extensive development of the conceptual models and measuring instruments for the concepts in those models. We took the expedient of borrowing models and instruments already developed for English-speaking people. We then validated them in two large independent Chinese samples. Beginning with scales fresh from translation (or, in the case of Activated and Deactivated, revised minimally) meant that none of them had the advantage of being refined through iterative item selection as had been done in English. Of course, all the scales and structures that we used in this article must be subjected to further psychometric development with other independent samples. Still, this method gave our study of Chinese affect a headstart.

Despite this lack of prior scale development, the present findings lend support to the viability of the structural model in Figures 1 and 2 as an integration of various dimensional models for momentary affect in Chinese. To compare the Chinese results (Figure 2) with those in English (Figure 1), one can simply superimpose the

two figures on top of each other. It becomes immediately obvious how similar the empirical placements of the affect variables are. Indeed, the rank order of the 14 variables is identical in English and Chinese (rank order correlation = 1.00). Further, the locations of the variables agree very well with the original authors' conceptualizations: For instance, Thayer (1996) defined his Energy scale as pleasant activation and it indeed fell in the pleasant activated quadrant in Figure 2. Watson and Tellegen (1985) defined their variables as forms of positive and negative activation and they indeed fell close to the horizontal axis of pleasure but both were shifted towards the high arousal side.

Of the various scales examined here, the Activated and Deactivated scales proved to be the most problematic. Of the six, five were revised by dropping items. Further research needs to be directed to adding new items and perhaps constructing new scales. Nevertheless, other analyses demonstrated that, despite the psychometric weaknesses in the available scales, a clear bipolar arousal axis was evident in exploratory factor analysis, confirmatory factor analysis, and CIRCUM. In addition, that bipolar dimension accounted for a substantial amount of the variance in all affect constructs proposed by Thayer (1996), Watson and Tellegen (1985), and Larsen and Diener (1992).

The present study adopted an "imposed-etic" approach (Berry, 1969; Church & Katigbak, 1989), in which translations of scales originating from the West were administered to Hong Kong Chinese respondents. This approach assumes similarities across cultures (without testing the assumption) and can be blind to indigenous constructs or processes. Given the richness of the emotion lexicon of Chinese (Russell & Yik, 1996), the possibility remains that additional affect dimensions or even different structural models would emerge with more indigenous

items. The current study represents a first step along this line of research and further efforts should be directed to examine the structure of affect among Chinese using other approaches (see also Berry, 2000; Triandis, 2000).

In the current study, affect was studied at a broad general level high in the affect hierarchy, and further studies are much needed to examine more specific affective dimensions at a lower level in a hierarchy where we believe an emic approach will find its place and thus supplementing the imposed-etic approach (Yik & Bond, 1993). We suspect that cultural differences will be more obvious the lower one goes in that hierarchy. In other words, the similarity between English- and Chinese- speaking respondents found here involves only the most general level of affect. We believe that general part is fundamental, capturing universal affective processes (Russell, 2003). The similarity of the structures obtained here with their original English counterparts is a genuine empirical finding. Chinese respondents using Chinese words report variations in their momentary affect described by the hypothesized space of Figure 1.

Some other affective processes are also likely to be universal, but there will also be important cultural differences as well (see Bond, 1993; Russell & Yik, 1996). Indeed, the present samples cannot even be assumed to represent all Chinese societies. Apart from the usual question on the representativeness of student samples, we readily concede that there may be cultural differences among various Chinese samples. Smith and Bond (1994) documented such differences, for example, when Hong Kong Chinese were compared to mainland or Taiwanese Chinese.

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Footnotes

¹The affect scales are available from the first author upon request.

²Individual measurement models are available from the first author upon request.

Table 1

Statistics for a Test of Bipolarity with Affect Scales

Format	Variable	Skew	Hypothesized Opposite	Skew	Φ
Sample One (N = 487)					
<u>Horizontal Axis: Pleasant versus Unpleasant</u>					
ADJ	Pleasant	-.26	Unpleasant	.79	
AGREE	Pleasant	-.40	Unpleasant	.62	
DESCRIBE	Pleasant	-.33	Unpleasant	.49	-.89
<u>Vertical Axis: Activated versus Deactivated</u>					
ADJ	Activated	-.25	Deactivated	-.05	
AGREE	Activated	.14	Deactivated	.01	
DESCRIBE	Activated	.66	Deactivated	.16	-.78
<u>Thayer's Energy versus Tiredness</u>					
ADJ	Energy	.02	Tiredness	.23	
AGREE	Energy	.07	Tiredness	.09	
DESCRIBE	Energy	.24	Tiredness	.12	-.85
<u>Thayer's Tension versus Calmness</u>					
ADJ	Tension	.81	Calmness	-.24	
AGREE	Tension	.42	Calmness	-.03	
DESCRIBE	Tension	.33	Calmness	-.07	-.83
<u>Larsen and Diener's Activated Pleasant versus Unactivated Unpleasant</u>					
ADJ	Activated Pleasant	-.11	Unactivated Unpleasant	.37	
AGREE	Activated Pleasant	-.16	Unactivated Unpleasant	.21	
DESCRIBE	Activated Pleasant	.21	Unactivated Unpleasant	.16	-.85
<u>Larsen and Diener's Activated Unpleasant versus Unactivated Pleasant</u>					
ADJ	Activated Unpleasant	.72	Unactivated Pleasant	-.40	
AGREE	Activated Unpleasant	.18	Unactivated Pleasant	-.14	
DESCRIBE	Activated Unpleasant	.44	Unactivated Pleasant	-.21	-.93

Table continues

Format	Variable	Skew	Hypothesized Opposite	Skew	Φ
Sample Two (N = 402)					
<u>Horizontal Axis: Pleasant versus Unpleasant</u>					
ADJ	Pleasant	-.40	Unpleasant	.91	
AGREE	Pleasant	-.44	Unpleasant	.61	
DESCRIBE	Pleasant	-.48	Unpleasant	.43	-.94
<u>Vertical Axis: Activated versus Deactivated</u>					
ADJ	Activated	-.43	Deactivated	.15	
AGREE	Activated	.13	Deactivated	.20	
DESCRIBE	Activated	.48	Deactivated	.11	-.60
<u>Thayer's Energy versus Tiredness</u>					
ADJ	Energy	-.17	Tiredness	.28	
AGREE	Energy	-.19	Tiredness	.37	
DESCRIBE	Energy	-.01	Tiredness	.19	-.85
<u>Thayer's Tension versus Calmness</u>					
ADJ	Tension	.76	Calmness	-.31	
AGREE	Tension	.40	Calmness	.11	
DESCRIBE	Tension	.35	Calmness	-.18	-.84
<u>Larsen and Diener's Activated Pleasant versus Unactivated Unpleasant</u>					
ADJ	Activated Pleasant	-.24	Unactivated Unpleasant	.58	
AGREE	Activated Pleasant	-.29	Unactivated Unpleasant	.36	
DESCRIBE	Activated Pleasant	-.03	Unactivated Unpleasant	.29	-.85
<u>Larsen and Diener's Activated Unpleasant versus Unactivated Pleasant</u>					
ADJ	Activated Unpleasant	.73	Unactivated Pleasant	-.39	
AGREE	Activated Unpleasant	.12	Unactivated Pleasant	-.20	
DESCRIBE	Activated Unpleasant	.38	Unactivated Pleasant	-.19	-.91

Note. Φ indicates the latent correlation between the hypothesized opposites in a confirmatory factor analysis, each variable indicated by three scales with different response formats. All Φ coefficients are significant at .001 level.

Table 2

Indices of Fit for Measurement Models

Model	χ^2	df	RMSEA (90% CI)	APGI (90% CI)	CFI
Sample One (N =487)					
<u>CMQ Constructs</u>					
Model with Correlated Constructs	289.70	48	.10 (.08 / .11)	.89 (.87 / .91)	.94
Model with Correlations between Constructs fixed to zero	1207.59	54	.17 (.16 / .18)	.70 (.67 / .73)	.70
<u>Thayer's Constructs</u>					
Model with Correlated Constructs	420.34	48	.12 (.11 / .13)	.84 (.81 / .86)	.93
Model with Correlations between Constructs fixed to zero	1635.03	54	.21 (.20 / .22)	.60 (.57 / .63)	.70
<u>Larsen & Diener's Constructs</u>					
Model with Correlated Constructs	400.74	48	.12 (.11 / .14)	.82 (.80 / .85)	.94
Model with Correlations between Constructs fixed to zero	1984.28	54	.25 (.24 / .26)	.49 (.47 / .52)	.66
<u>Watson & Tellegen's Constructs</u>					
Model with Correlated Constructs	78.27	5	.17 (.14 / .20)	.81 (.73 / .88)	.98
Model with Correlations between Constructs fixed to zero	268.97	6	.27 (.24 / .30)	.57 (.48 / .65)	.91
Sample Two (N =402)					
<u>CMQ Constructs</u>					
Model with Correlated Constructs	214.82	48	.09 (.08 / .10)	.91 (.88 / .93)	.93
Model with Correlations between Constructs fixed to zero	856.12	54	.16 (.14 / .17)	.74 (.71 / .77)	.66
<u>Thayer's Constructs</u>					
Model with Correlated Constructs	299.04	48	.11 (.10 / .12)	.86 (.83 / .89)	.92
Model with Correlations between Constructs fixed to zero	1157.80	54	.20 (.19 / .21)	.63 (.60 / .66)	.64
<u>Larsen & Diener's Constructs</u>					
Model with Correlated Constructs	244.25	48	.11 (.09 / .12)	.87 (.84 / .90)	.94
Model with Correlations between Constructs fixed to zero	1230.67	54	.23 (.22 / .24)	.54 (.51 / .57)	.65

Model	χ^2	df	RMSEA (90% CI)	APGI (90% CI)	CFI
<u>Watson & Tellegen's Constructs</u>					
Model with Correlated Constructs	24.39	5	.10 (.06 / .14)	.93 (.86 / .97)	.99
Model with Correlations between Constructs fixed to zero	144.53	6	.22 (.19 / .26)	.69 (.60 / .77)	.93

Note. RMSEA = Root Mean Square Error of Approximation; APGI = Adjusted Population Gamma Index; CFI = Comparative Fit Index. Ipsative scores were used in all models, except that for Watson & Tellegen.

Table 3

Measurement Models for CMQ Scales: Confirmatory Factor Analysis

Construct	Format	Pleasant	Unpleasant	Activated	Deactivated
Standardized Factor Loading					
Pleasant	ADJ	.89*			
		(.88*)			
Pleasant	AGREE	.93*			
		(.92*)			
Pleasant	DESCRIBE	.90*			
		(.92*)			
Unpleasant	ADJ		.90*		
			(.91*)		
Unpleasant	AGREE		.88*		
			(.94*)		
Unpleasant	DESCRIBE		.85*		
			(.89*)		
Activated	ADJ			.55*	
				(.46*)	
Activated	AGREE			.68*	
				(.78*)	
Activated	DESCRIBE			.40*	
				(.45*)	
Deactivated	ADJ				.68*
					(.79*)
Deactivated	AGREE				.75*
					(.81*)
Deactivated	DESCRIBE				.76*
					(.76*)

Construct	Format	Pleasant	Unpleasant	Activated	Deactivated
Interfactor Correlation					
Pleasant		---			
		(---)			
Unpleasant		-.89*	---		
		(-.94*)	(---)		
Activated		-.25*	-.09	---	
		(.21*)	(-.16)	(---)	
Deactivated		.07	-.42*	-.78*	---
		(.04)	(-.39*)	(-.62*)	(---)

Note. Figures without parentheses are estimates for Sample One ($N = 487$); Figures with parentheses are estimates for Sample Two ($N = 402$).

* $p \leq .01$.

Table 4

Affect Constructs Explained by the Pleasant versus Unpleasant and Activated versus Deactivated Axes

Construct	Indices of Fit				Regression Weights		
	χ^2	RMSEA (90% CI)	AGFI (90% CI)	CFI	Pleasant versus Unpleasant	Activated versus Deactivated	Variance Explained (SE)
Sample One (n=487)							
<u>Thayer</u>							
Energy	254.47	.08 (.07/.09)	.92 (.91/.94)	.95	.73	.44	72.70 (2.90)
Tiredness	179.06	.06 (.05/.08)	.95 (.94/.97)	.97	-.58	-.38	47.80 (4.00)
Tension	315.69	.10 (.09/.11)	.90 (.88/.92)	.94	-.84	.33	80.50 (2.30)
Calmness	235.14	.08 (.07/.09)	.93 (.91/.95)	.95	.55	-.73	84.20 (3.90)
<u>Larsen & Diener</u>							
Activated Pleasant	269.55	.09 (.08/.10)	.92 (.90/.94)	.95	.88	.33	88.50 (2.00)
Unactivated Unpleasant	228.66	.08 (.07/.09)	.93 (.91/.95)	.96	-.73	-.28	60.60 (3.30)
Activated Unpleasant	266.97	.09 (.08/.10)	.92 (.90/.94)	.95	-.89	.29	88.00 (2.00)
Unactivated Pleasant	230.49	.08 (.07/.09)	.93 (.91/.95)	.96	.79	-.45	82.80 (2.60)
<u>Watson & Tellegen</u>							
Positive Affect	291.04	.09 (.08/.10)	.91 (.89/.92)	.95	.76	.33	68.40 (2.90)
Negative Affect	276.16	.09 (.08/.10)	.92 (.90/.93)	.96	-.86	.19	76.60 (2.20)

Construct	Indices of Fit				Regression Weights		
	χ^2	RMSEA (90% CI)	AGFI (90% CI)	CFI	Pleasant versus Unpleasant	Activated versus Deactivated	Variance Explained (SE)
Sample Two ($n=402$)							
<u>Thayer</u>							
Energy	219.97	.09 (.07/.10)	.92 (.90/.94)	.94	.75	.43	74.40 (3.30)
Tiredness	163.82	.07 (.05/.08)	.95 (.93/.97)	.95	-.57	-.40	48.60 (4.60)
Tension	190.57	.07 (.06/.09)	.94 (.92/.95)	.95	-.89	.29	87.40 (2.30)
Calmness	212.47	.08 (.07/.09)	.93 (.91/.95)	.93	.60	-.67	80.90 (4.90)
<u>Larsen & Diener</u>							
Activated Pleasant	215.20	.08 (.07/.10)	.92 (.90/.94)	.94	.89	.30	88.60 (2.30)
Unactivated Unpleasant	214.11	.08 (.07/.10)	.92 (.90/.94)	.94	-.77	-.33	70.20 (3.60)
Activated Unpleasant	178.96	.07 (.06/.08)	.94 (.92/.96)	.96	-.91	.28	90.70 (2.20)
Unactivated Pleasant	194.24	.08 (.07/.09)	.93 (.91/.95)	.95	.79	-.41	78.90 (3.20)
<u>Watson & Tellegen</u>							
Positive Affect	223.08	.08 (.07/.10)	.92 (.90/.94)	.94	.76	.28	65.60 (3.30)
Negative Affect	217.54	.08 (.07/.10)	.92 (.90/.94)	.95	-.87	.17	78.10 (2.40)

Note. df for $\chi^2 = 58$. All regression coefficients are significant at .001 level. RMSEA = Root Mean Square Error of Approximation; APGI =

Adjusted Population Gamma Index; CFI = Comparative Fit Index.

Figure Captions

Figure 1. A Circumplex Model of Affect. 14 unipolar affect constructs empirically placed in an integrated two-dimensional space via CIRCUM (Browne, 1992). Results are obtained from a study of 535 English-speaking Canadians. Adopted from Russell, Yik, and Steiger (2003).

Figure 2. Chinese Scales of Momentary Affect (Sample One; $N=535$). A circumplex representation of 14 unipolar affect constructs via CIRCUM (Browne, 1992). Communality was left free to vary. Figures given are estimates of polar angles with the 95% confidence intervals in parentheses.

Figure 1

Figure 2