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Affect and interpersonal behaviors: Where do the circumplexes meet?

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ABSTRACT

The study reported in this article examined the relationship between affect and interpersonal behaviors by identifying the intersection between Yik's (2009b) Chinese Circumplex Model of Affect (CCMA) and Wiggins' (1995) Interpersonal Circumplex (IPC). Past research on the relationships between circumplexes has relied on zero-order correlations and principal components analysis, but neither method provides a definitive test of the connections between two structural models. In the present study, Michael Browne's CIRCUM-extension procedure was used to locate each circumplex within the other. The results show that the two circumplexes overlap on one axis: 37° within the CCMA (pleasant feelings with medium arousal) and 76° within the IPC, which is close to where extraversion lies.

1. Introduction

Research interest in the ties between dispositions and affect dates back at least to Galen's proposal that temperament consists of emotions, and recent research has provided evidence of a close connection between the two phenomena. The personality factors of extraversion and neuroticism, for example, have been shown to enjoy a robust relationship with emotions (Costa & McCrae, 1980; Lucas & Fujita, 2000; Meyer & Shack, 1989; Yik & Russell, 2001; Yik, Russell, Ahn, Fernández Dols, & Suzuki, 2002).

An interesting question immediately arises: Why are affect and dispositions so closely related? Plutchik (1997) asserted that the two phenomena have a common biological source. Indeed, he speculated that many domains exhibit a circumplex structure because they share such a source. McCrae and Costa (1989), however, developed a more specific proposition: "…affects and interpersonal behaviors have a common cause: the underlying dimension of Extraversion. Structurally, one could say that the dimension of Extraversion is defined by the intersection of the affective plane with the interpersonal plane" (p. 593).

The question that stimulated the current study was how to identify the *intersection* between an interpersonal plane, Wiggins' (1995) Interpersonal Circumplex, and an affective plane, Yik's (2009b) Chinese Circumplex Model of Affect. Both of these models happen to be circumplexes.

1.1. Interpersonal dispositions

Based on the seminal work carried out by Sullivan (1953) and Leary (1957), and the later work of Benjamin (1974), Kiesler (1983), and Lorr and McNair (1963), Wiggins (1979) built a descriptive model, namely, the Interpersonal Circumplex (IPC), as shown in Fig. 1, and developed the accompanying Interpersonal Adjective Scales (IAS) for interpersonal behaviors and dispositions (Wiggins, 1995). Drawing on the universe of interpersonal adjectives contained in Goldberg's (1977) master pool, the IAS subsequently underwent extensive development, with the final model taking the form of a circumplex with eight octants, each coded by a two-letter combination (viz., PA, BC, DE, FG, HI, JK, LM, NO). In this circumplex model, the interpersonal space is defined by two axes, the vertical axis of dominance (dominance versus submission) and the horizontal axis of love (friendly versus hostile), which are related to the metaconcepts of Agency and Communion, respectively, in the social sciences (Wiggins, 1991). The model is arbitrarily carved into eight octants, PA through NO, in a counter-clockwise direction, with each conveying a unique blend of dominance and love in interpersonal relations.

The circumplex structure of the IAS has been tested using different analytic approaches and has received mixed support. Wiggins (1979, 1995), for example, reported a series of principal components analyses whose results revealed the dimensions of dominance and love. Tracey and Schneider (1995) found strong support for the IAS's circumplex structure when they applied circular order analysis to a large dataset. When Gaines et al. (1997) examined the IAS through general structural equation modeling, however, they concluded that it did not conform to an ideal circumplex. Gurtman and Pincus (2000) then reexamined the circumplexity of the IAS by employing both exploratory and confirmatory analyses and concluded that, overall, the IAS attained a good model-data fit.

Nunnally and Bernstein (1994) argued that "validation is an unending process … most psychological measures need to be constantly evaluated and reevaluated to see if they are behaving

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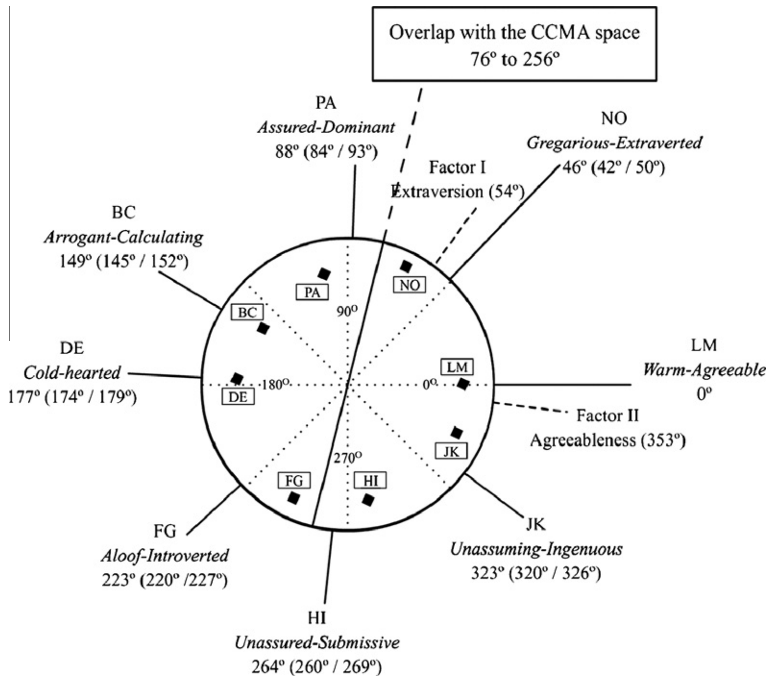

Fig. 1. Wiggins' Interpersonal Circumplex (IPC): the IAS-R octants are located via PCA in the inner part of the circle and via CIRCUM in its circumference. The figures given for CIRCUM are estimates of the polar angles in CIRCUM, with the 95% confidence intervals in parentheses. The dashed lines indicate possible alternative rotations: Factors I and II (empirical values based on a subsample of 386 participants) and the axis of overlap with the CCMA space.

as they should" (p. 84). In view of the mixed findings on the circumplexity of the IAS, the current study was carried out to test the scales' structural adherence to a circumplex model using new data from a large Chinese sample ($N = 655$). The aim was to validate the structure of the IPC, the model on which the IAS is based, employing a variety of tools, including principal components analysis (PCA), Tracey's (1997) RANDALL, and Browne's (1992) CIRCUM.

1.2. Affect

In the past decade, a number of dimensional models have been proposed to characterize the covariations of affective feelings among English speakers. 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 affect. As the names of the principal dimensions of these models suggest, they all seem to capture similar phenomena and are therefore ripe for integration. One hypothesis is that all of these dimensions fit within the same two-dimensional space, with 45° between the major dimensions (Yik, Russell, & Barrett, 1999). The results of a number of studies carried out among speakers of different languages, including Chinese, Japanese, Korean, and Spanish, show that the aforementioned models fit comfortably within a Cartesian space defined by the bipolar axes of pleasure and arousal (Yik, 2007, 2009a; Yik & Russell, 2003; Yik et al., 2002).

Drawing on the dimensional model tradition and supplementing it with emotion terms in common use among Chinese speakers, Yik (2009b) constructed a descriptive model, namely, the Chinese Circumplex Model of Affect (CCMA), as shown in Fig. 2, along with accompanying scales. In this circumplex model, the affective space is arbitrarily carved into 12 segments, 1 o'clock (o'c) through 12 o'c, based on the metaphor of a clock. The horizontal axis, pleasure versus displeasure, is defined by the 3 o'c segment (*carefree and uninhibited, satisfied*) and the 9 o'c segment (*unhappy, downhearted*). The vertical axis, activation versus deactivation, is defined by the 12 o'c segment (*vehement, awed*) and the 6 o'c segment (*still, emotionally detached*). Other segments convey different combinations of pleasure and arousal. The objectives of the study reported herein were to cross-validate the circumplex structure of the CCMA in another sample of participants and to establish the relationship between this newly developed circumplex model and the IPC.

1.3. On relating two circumplexes

A number of researchers have attempted to chart the relationship between two circumplexes, but their units of analysis have been the individual scales that define the circumplexes, rather than the circumplex structures under scrutiny. One approach is to examine the pattern of intercorrelations between the scales of one circumplex and those of another. In this approach, individual correlation coefficients are examined, with conclusions reached on the basis of whether the observed correlations match the expectations of correspondence between the two circumplex structures. A more common approach is to rely on PCA, with conclusions about structural convergence drawn on the basis of a visual inspection of the two-dimensional space in which scales are plotted on the two extracted components. Using this approach, researchers have found the IAS to share a two-factor space with the Inventory of Interpersonal Problems (Alden, Wiggins, & Pincus, 1990), the horizontal axis with the Support Actions Scale Circumplex (Trobst, 2000) and the vertical axis with the Non-Evaluative Personality Circumplex (Saucier, Ostendorf, & Peabody, 2001). In summary, PCA has indicated replicable empirical relationships between the IPC and other circumplexes.

However, as very broad analytic tools, neither zero-order correlations nor principal component analyses are ideally suited to detailing the relationship between two sets of scales, each defining a different circumplex model. To identify the axis of overlap and the precise location of the intersection between the two circumplexes of interest, namely, the CCMA and the IPC, this study thus employed Michael Browne's CIRCUM-extension procedure (M. Browne, personal communication, June 12, 1999; Browne & Liang,

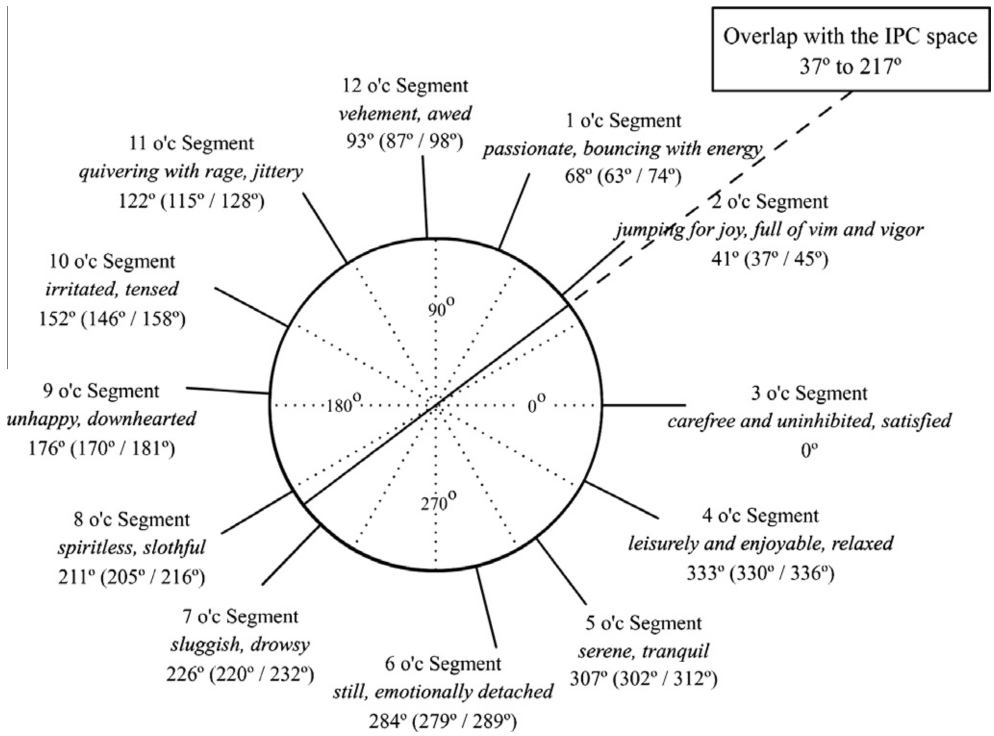

Fig. 2. Yik's Chinese Circumplex Model of Affect (CCMA). The figures given are estimates of the polar angles in CIRCUM, with 95% confidence intervals in parentheses. The dashed line indicates the axis of overlap with the IPC space.

2005) to locate each within the other. With this procedure, rather than examine the correlation between the IAS and an existing affect scale, researchers can estimate the precise location of each IAS scale within the CCMA space – and hence with *all* affect segments simultaneously – even though that location is not currently defined by a measured variable. Rather than assume that one octant of the IAS is correlated with only one of the CCMA segments, such as NO (*gregarious-extraverted*) with the 3 o'c segment, researchers can now remain open to any location within the CCMA space. The CIRCUM-extension procedure also allows researchers to go beyond tests of the significance of zero-order correlations to an estimation of the precise angles of the IAS octants within the CCMA space (in parallel fashion, this study repeated the foregoing sequence of analysis with the CCMA segments placed within the IPC space). This approach has proved useful in revealing the number of axes of overlap and the magnitude and location of the overlap between two circumplexes (Yik & Russell, 2004). In the present study, it was employed to examine the relationship between yet another two circumplex structures in a large sample of Chinese participants.

2. Method

2.1. Participants and procedure

The study participants were 655 undergraduates (312 males, 343 females, M_{age} = 20.1 years, age range: 16–25 years) studying at a university in Hong Kong who received course credit for their participation. They were asked to complete the questionnaires, all of which were in Chinese, in a large lecture theater.

2.2. Interpersonal Adjective Scales Revised (IAS-R)

All of the instructions and scales were translated into Chinese by two bilinguals using the back-translation procedure. The first bilingual translated the English version into Chinese, and the second, who was blind to the English original, translated the Chinese version back into English. Any discrepancies between the English and Chinese versions were then reviewed by the author, and the translations were revised until considered satisfactory for use in data collection.

The IAS-R (Wiggins, Trapnell, & Phillips, 1988) is a 64-adjective questionnaire designed to measure eight octants, ranging from PA (*assured-dominant*) to NO (*gregarious-extraverted*), with each octant represented by eight adjectives. The participants were asked to rate the self-descriptive accuracy of these adjectives on an 8-point rating scale ranging from 1 (*extremely inaccurate*) to 8 (*extremely accurate*). Each octant score was the average of its eight constituent adjectives. The Cronbach's alphas ranged from .69 to .91, values that are comparable to the reliability estimates for normative samples (Wiggins, 1995; see also Gaines et al., 1997).

2.3. Chinese Circumplex Model of Affect (CCMA) scales

The CCMA scales (Yik, 2009b) comprise 48 adjectives that are designed to measure 12 affect segments, 1–12 o'c, each of which is represented by four adjectives. The participants were asked to describe their feelings in the current moment on a 5-point rating scale ranging from 1 (*not at all*) to 5 (*extremely*). Each segment score was the average of its four constituent adjectives. The Cronbach's alphas ranged from .73 to .89, values that are comparable to the reliability estimates reported in previous studies (Yik, 2009b).

3. Results

3.1. Structure of the Interpersonal Circumplex

3.1.1. Preliminary test

The correlation pattern observed in the current data replicated previous findings that have suggested a circumplex structure (e.g., Wiggins, 1979, 1995). To place the IAS-R into the two-dimensional space, the eight IAS-R scores were ipsatized,[1] intercorrelated, and subjected to PCA, and the resulting two principal components accounted for 64% of the total variance. Inside the circle in Fig. 1 can be seen the coordinates of the eight variables on the first two unrotated principal components. The IAS-R exhibited the predicted circular order, as reported in studies employing normative samples (Wiggins, 1995).

3.1.2. RANDALL

To evaluate the circular model's fit to the data, this study employed Hubert and Arabie's (1987) randomization test, a confirmatory test of the fit of hypothesized order relations to a correlation matrix. Ipsative data were used. It tests the model in which a circumplex of equal distant variables is assumed. For instance, a perfect fit to the IPC would require the correlations of the vectors adjacent on the IPC (e.g., PA–BC) to be greater than those between the interpersonal types one step apart on the circle (e.g., PA–DE), which, in turn, would be greater than those between the interpersonal types opposite to each other (e.g., PA–HI). The extent to which the correlation matrix matched this circular ordering was assessed, with the distribution then compared with that resulting from an examination of the hypothesized order relations in 1000 random permutations of the rows and columns of the sample correlation matrix.

This randomization test provides a Correspondence Index (CI), which is a correlation coefficient that indicates the extent to which the model predictions of the hypothesized order relations are met in the sample data. The CI ranges from 1.00 (every prediction met) to −1.00 (every prediction violated), with 0.00 indicating that an equal number of predictions have been met and violated. Rounds and Tracey (1996) found a benchmark CI value of .70 in their meta-analysis of US samples and measures, and this value is therefore conventionally taken as indicative of a good fit. The test also provides a *p*-value that indicates the proportion of hypothesized predictions met or exceeded in the set of 1000 random permutations of the rows and columns of the sample correlation matrix.

To test the circumplexity of the IAS-R data, a randomization test was applied to the 8×8 matrix using RANDALL (Tracey, 1997). The CI value was estimated to be .98 (of the 288 predictions examined, 285 were confirmed), and the *p*-value was .001 (1/1000). These values are comparable to those reported in research conducted among English-speaking participants (Gurtman & Pincus, 2000; Markey & Markey, 2009; Pincus et al., 2009). Thus, the RANDALL analysis carried out in this study suggested that the circumplex model provides a significant model fit to the data.

3.1.3. CIRCUM

Given the encouraging results obtained in the preceding analysis, Browne's (1992) CIRCUM was then employed as a more rigorous test of the circumplexity of the data. CIRCUM implements Browne's tests of a circular stochastic model of the circumplex and provides maximum likelihood estimates of the model parameters. Ipsative data are inappropriate for CIRCUM analyses, and non-ipsative data were therefore used (M. Browne, personal communication, September 12, 2002). No constraints were placed on the minimum common score correlation. CIRCUM estimates the angle, θ (theta), on the circle for each variable, as well as the 95% confidence interval for that angle. It also provides ζ (zeta), which is a communality index, the square root of the proportion of each variable's variance that is explained by the CIRCUM model. To assess model fit, I relied on the chi-square statistic (χ^2) and the root mean square error of approximation (RMSEA).

The 8×8 correlation matrix was submitted to CIRCUM. In this analysis, LM was designated as the reference variable (and its location was fixed at 0°), relative to which the locations of the other variables were estimated. The communality estimates were constrained to be equal. Three free parameters were specified in the correlation function equation, and additional free parameters failed to improve the model fit. The fit indexes were χ^2 (17, $N = 655$) = 227.56, RMSEA = .14 (90% confidence interval = .12/.15), and the community index was .92. Compared with the RANDALL analysis, the CIRCUM analysis provides less support to the model-data fit.

The placement of the eight variables in the CIRCUM analysis is shown in the outer circle of Fig. 1. With LM fixed at 0°, PA was 88° away, DE 177° away, and HI 264° away. These CIRCUM results place the IAS-R reassuringly close to their placement in previously reported tests of circumplexity (Gurtman & Pincus, 2000; Markey & Markey, 2009; Wiggins, 1979), including the PCA results reported in this section. The rank order of the eight variables as one moves about the perimeter of the space was identical in both the PCA and the CIRCUM analysis.

3.2. Structure of the Chinese Circumplex Model of Affect

To test the circumplexity of the CCMA scales, the 12×12 correlation matrix was first submitted to RANDALL. The CI value was estimated to be .90 (of the 1800 predictions examined, 1707 were confirmed), and the *p*-value was .001 (1/1000), thus indicating a significant model-data fit.

The matrix was then submitted to CIRCUM. The 3 o'c segment was designated as the reference variable, relative to which the locations of the remaining CCMA variables were estimated. The communality estimates were left free to vary. Three free parameters were specified in the correlation function equation, and additional free parameters failed to improve the model fit. The fit indexes were χ^2 (40, $N = 655$) = 231.23, RMSEA = .08 (90% confidence interval = .07/.10), and the community indexes ranged from .78 to .95.

Fig. 2 illustrates the CIRCUM results. With the 3 o'c segment fixed at 0°, the 12 o'c segment was 93° away, the 9 o'c segment 176° away, and the 6 o'c segment 284° away. The hypothesized polar opposites were located close to the predicted values. The 3 o'c segment was 176° away from its bipolar opposite, the 9 o'c segment, and the 12 o'c segment was 191° away from its bipolar opposite, the 6 o'c segment. These results are comparable to those of previous studies carried out to test the circumplexity of the CCMA scales (Yik, 2009b; Yik & Russell, 2003).

3.3. Intersection between the two circumplexes

The central question of this study was how the CCMA and the IPC are related. To answer it, the zero-order correlations among the 20 variables were first examined. NO (*gregarious-extraverted*) was maximally correlated with the 3 o'c segment (*carefree and enjoyable, relaxed*), but was also significantly correlated with the other segments. Similarly, FG (*aloof-introverted*) was maximally correlated with the 9 o'c segment (*unhappy, downhearted*) and also

[1] Ipsatization removes individual differences in grand means and variances, and is thus recommended for assessing the circumplexity of data (Acton & Revelle, 2004; Yik & Russell, 2003). To ipsatize the PA octant, a person's grand mean for all eight octants was deducted from his or her PA score, with the difference divided by the standard deviation of his or her eight octants. Each IAS-R score was ipsatized by the eight octants.

Table 1
Empirical locations of the IAS-R octants in the CCMA space via the CIRCUM-extension procedure.

IAS-R octant (hypothesized angle)	Descriptive statistics[a]				Estimates when placed within the CCMA space[b]		
	α	Mean	SD	Skew	ζ_+	θ_+	VAF (%)
LM (0°)	0.82	5.72	0.81	−0.06	0.14	303°	91
NO (45°)	0.85	5.44	0.98	−0.37	0.30	21°	80
PA (90°)	0.79	4.77	0.95	−0.14	0.23	49°	85
BC (135°)	0.91	3.11	1.21	0.60	0.14	127°	00
DE (180°)	0.82	3.07	0.99	0.46	0.15	156°	32
FG (225°)	0.86	3.80	1.22	0.19	0.29	204°	94
HI (270°)	0.83	4.58	1.05	0.01	0.26	234°	98
JK (315°)	0.69	5.19	0.86	−0.12	0.14	284°	64

Note. IAS-R = Interpersonal Adjective Scales Revised; CCMA = Chinese Circumplex Model of Affect.
[a] α = Cronbach's alpha. Possible mean scores range from 1 to 9 for each octant.
[b] Zetaplus (ζ_+) is a communality index, the square root of the proportion of variance of each octant explained by the CIRCUM model for the CCMA structure. Thetaplus (θ_+) estimates the angle within the CCMA structure for each IAS-R octant. Variance accounted for (VAF) is the amount of variance explained when a series of correlations between each IAS-R octant and the 12 CCMA segments is fitted to a predefined cosine function.

significantly correlated with the other segments. It thus became clear that the zero-order correlations were unhelpful in charting the intersection between these two circumplexes.

Accordingly, the 20 variables were ipsatized, intercorrelated, and subjected to PCA. Two components that accounted for 43% of the total variance were extracted, and the 20 variables were then plotted on the extracted components. In the components plot, the CCMA segments were scattered along the circumference. Whereas four IAS-R octants (viz., PA, NO, FG, and HI) fell close to the affect segments, the remaining four fell close to the axes of the integrated space. Again, the components plot was deemed unhelpful in charting the precise relationship between the CCMA and the IPC. Where then do these two circumplexes intersect?

To identify the intersection plane between their structures, the CIRCUM-extension procedure (M. Browne, personal communication, June 12, 1999; Browne & Liang, 2005) was next employed to place the IAS-R octants, one by one, into the CCMA space. This procedure provides the zetaplus (ζ_+), a maximum likelihood estimate of the magnitude of the relationship between an external variable (an IAS-R octant) and the base circumplex (CCMA space), and, separately, the thetaplus (θ_+), an estimate of where within the circumplex that external variable falls. Finally, it provides the variance accounted for (VAF), an estimate of the amount of variance explained when a series of correlations between an external variable and the variables of a base circumplex is fitted to a predefined cosine function.

The CIRCUM-extension results are presented in the last three columns of Table 1. To determine the number of axes of overlap, Yik and Russell's (2004) procedure of plotting the ζ_+ for each IAS-R octant against its location in the IPC space was followed. The resulting plot resembled those for *one* dimension of overlap between the IPC and the CCMA – with two humps – as illustrated by Yik and Russell (2004). Two clusters of adjacent octants with non-negligible values of ζ_+ (.23–.30) were identified, and the magnitude of the relationship was found to be modest (mean ζ_+ = .27). One cluster consisted of PA–NO, and the other of HI–FG. The angle within the CCMA space at which the two circumplexes overlap was then estimated. PA and NO had a θ_+ of 49° and 21°, respectively. As the mean was 35°, it was estimated that the IPC space intersects the CCMA space at 35°. HI and FG had a θ_+ of 234° and 204°, respectively. The mean was 219°, and thus it was estimated that the IPC space intersects the CCMA space at 219°. This result was comforting, because the difference between 35° and 219° is 184°, which is close to the anticipated 180°. For simplicity, it was assumed that the axis of overlap is straight and passes through the center of the space (i.e., that the two points of overlap differ by 180°), an assumption which suggests that the axis of overlap lies approximately at 37–217° in the CCMA space, as illustrated in Fig. 2.[2]

A separate question is where within the IPC space its axis of overlap with the CCMA space lies. To answer it, parallel analysis was carried out by placing the CCMA segments, one by one, into the IPC space. The results are presented in the last three columns of Table 2. Again, two clusters surfaced. The first consisted of 12–2 o'c, with the ζ_+ ranging from .22 to .23 and the θ_+ from 67° to 119° (mean = 96°), and the other of 7–9 o'c, with the ζ_+ ranging from .25 to .30 and the θ_+ ranging from 229° to 241° (mean = 236°). Hence, the magnitude of the relationship was found to be modest (mean ζ_+ = .25). For simplicity, it was assumed that the axis of overlap is straight, an assumption (see Footnote 2) which suggests that the axis of overlap lies approximately at 76–256° in the IPC space, as illustrated in Fig. 1.

4. Discussion

Inspired by McCrae and Costa's (1989) proposed intersection between affect and interpersonal behaviors, this study sought to identify that intersection via Yik's (2009b) CCMA and Wiggins' (1995) IPC. Where do these two circumplexes overlap? It was found that a 37–217° axis runs through the affective space, and that this axis is characterized by pleasant feelings with moderate arousal in one direction (*jumping for joy, full of vim and vigor*) and unpleasant feelings with a moderately low degree of arousal in the other (*spiritless, slothful*). It is along this axis that interpersonal dispositions are most strongly related to affect. A 76–256° axis was found to run through the IPC space. The vector at 76° lies between PA (*assured-dominant*) and NO (*gregarious-extraverted*), and describes a person who is extraverted, outgoing, self-confident, and self-assured. That at 256° lies between HI (*unassured-submissive*) and FG (*aloof-introverted*), and describes a person who is introverted, timid, bashful, and meek. It is along this axis that affect is most closely related to interpersonal dispositions. These findings provide additional support for McCrae and Costa's (1989) argument that extraversion constitutes the binding force between affect and interpersonal behaviors.

The circumplex model provides a good approximation to the correlational structure among items pertinent to interpersonal dispositions and that among those pertinent to affect. Nonetheless, the circumplex fit raises several issues, as follows.

[2] The assumption that the axis of overlap is a straight line allowed the use of both empirical values (35° and 219°) in estimating the angular positions of that axis. The first estimate was 35°. The second was computed by subtracting 180° from 219°, thus resulting in 39°. The average of 35° and 39° produced the final estimate of 37°, with 217° simply 180° away.

Table 2
Empirical locations of the CCMA segments in the IPC space via the CIRCUM-extension procedure.

CCMA segment (hypothesized angle)	Descriptive statistics[a]				Estimates when placed within the IPC space[b]		
	α	Mean	SD	Skew	ζ_+	θ_+	VAF (%)
3 o'c (0°)	0.85	2.12	0.92	0.72	0.21	47°	94
2 o'c (30°)	0.89	1.78	0.85	1.02	0.22	67°	93
1 o'c (60°)	0.83	1.72	0.78	1.09	0.23	102°	87
12 o'c (90°)	0.80	1.55	0.69	1.45	0.23	119°	96
11 o'c (120°)	0.77	1.43	0.65	2.03	0.21	160°	95
10 o'c (150°)	0.83	2.24	1.05	0.67	0.20	207°	91
9 o'c (180°)	0.88	2.27	1.00	0.64	0.29	229°	93
8 o'c (210°)	0.84	2.73	1.06	0.11	0.30	240°	94
7 o'c (240°)	0.83	2.67	1.06	0.20	0.25	241°	93
6 o'c (270°)	0.73	2.62	0.86	0.10	0.16	267°	49
5 o'c (300°)	0.89	2.70	1.04	0.18	0.10	295°	00
4 o'c (330°)	0.86	2.52	1.00	0.30	0.10	36°	44

Note. CCMA = Chinese Circumplex Model of Affect; IPC = Interpersonal Circumplex.
[a] α = Cronbach's alpha. Possible mean scores range from 1 to 5 for each affect segment.
[b] Zetaplus (ζ_+) is a communality index, the square root of the proportion of variance of each affect segment explained by the CIRCUM model for the IPC structure. Thetaplus (θ_+) estimates the angle within the IPC structure for each affect segment. Variance accounted for (VAF) is the amount of variance explained when a series of correlations between each affect segment and the eight IAS-R octants is fitted to a predefined cosine function.

4.1. Rotation

Following Leary's (1957) theory (see also Foa & Foa, 1974), Wiggins (1979), in the IPC, emphasized the dimension of dominance, which falls on the PA vector, and the dimension of love, which falls on the LM vector. Dominance and love thus provide a specific rotation of the two-dimensional space. In alternative rotations, dominance falls between PA and NO in the model proposed by Strong et al. (1988) and between PA and BC in the model proposed by Myllyniemi (1997). If a circumplex fits the data, then presumably the space can be rotated in any number of ways; that is, different rotations would leave the circumplex structure intact. Indeed, the question of the optimal rotation may not be resolvable through psychometric means alone. Attempts have thus been made to resolve the issue using complementarity.

Complementarity refers to the extent to which the behaviors of individuals in a dyadic relationship fit with each other in prescribed ways to ensure the continuity of the relationship (e.g., Carson, 1969). In any dyadic relationship, the behavior of one party invites reciprocal behavior from the other. Carson (1969) defined complementarity in the circumplex model as similarity on the love dimension and reciprocity on the power dimension. For instance, affectionate dominant behavior is complemented by affectionate submissive behavior. Although Carson's definition of complementarity has been widely adopted, its operationalization varies depending on the preferred rotation of axes in the circumplex, as the specific locations of the axes have a significant bearing on the definition. For instance, BC (*arrogant-calculating*) is complemented by FG (*aloof-introverted*) in Leary's (1957) orientation and by DE (*cold-hearted*) and HI (*unassured-submissive*) in those of Strong et al. (1988) and Myllyniemi (1997), respectively.

In testing the relative utility of the various definitions of complementarity, each based on a preferred rotation of axes, Tracey, Ryan, and Jaschik-Herman (2001) concluded that the optimal orientation of axes lies between PA (*assured-dominant*) and NO (*gregarious-extraverted*) in the IPC, results supporting Strong et al.'s (1988) orientation and reminiscent of the intersection axis reported in the present study (see also McCrae & Costa, 1989). Taken together, these results are in contrast to previous findings supporting the orientations proposed by Leary (1957) and Wiggins (1979), such as those reported by Markey, Funder, and Ozer (2003) and Orford (1986). Nonetheless, rotation is ultimately a question of the interpretation of the space, and any interpretation is conceptual in nature, involving a network of assumptions and empirical results that extend far beyond correlational structures. The present study thus provides an additional set of data to further fuel the debate surrounding the preferred orientation of the IPC.

4.2. Model fit

In line with common practice, multiple analytic approaches and indexes were employed to evaluate model fit in this study. Each index is associated with underlying statistical assumptions, and each has strengths and weaknesses. Hypothesized models should not be accepted or rejected on the basis of fixed cutoff points (see Hopwood & Donnellan, 2010), nor seen as strictly true or false. Rather, they should be viewed as candidates in furthering our understanding of the underlying structures.

The RMSEA values obtained in the present study are commonly thought of as marginal: .08 and .14. One possible reason for the high RMSEA values is that CIRCUM does not take into account the systematic errors introduced by the specific method of measurement (Green, Goldman, & Salovey, 1993). Another is that substantive dimensions other than the principal axes account for some of the variance in the scales (see Mauro, Sato, & Tucker, 1992; Yik, Russell, & Steiger, submitted for publication). In certain extreme cases in which variables are highly correlated, RMSEA values can become large even when the model reproduces the correlation matrix well (see Browne, MacCallum, Kim, Andersen, & Glaser, 2002; Steiger, 2000).

Consistent with the recent literature attesting to the structural validity of the circumplex models, the results of the current study indicate differences in the conclusions reached by structural tests across analytical methods (see Darcy & Tracey, 2007; Gupta, Tracey, & Gore, 2008; Pincus et al., 2009). More specifically, the results of the randomization test are supportive of the circumplex structure, whereas those of structural equation modeling are less so. CIRCUM, with its parametric assumptions, is more rigorous than RANDALL, although the two tests are hierarchically related. The question that remains is how to reconcile the discrepancies between the two tests in testing the circumplex structures in this study.

CIRCUM compares a model's fit to the "perfect fit," and therefore the question it asks is whether the model fits the data perfectly. The test it employs focuses on determining whether the unexplained variance is different from zero (i.e., a perfect fit). If there is a substantial amount of unexplained variance, then it concludes that there is a lack of fit. RANDALL, in contrast, compares a model's fit to the fit attainable by chance. Thus, the question it asks is whether the fit is better than that which would be obtained if the data were purely random. The test it employs focuses on determining whether the model fit is better than chance, not on whether all of the variance can be accounted for. Taken together, the fit obtained via CIRCUM and that obtained via RANDALL constitute the anchoring poles of a fit continuum (see Darcy & Tracey, 2007). Because the IAS-R data in the current study did not yield a perfect fit to a circumplex model in CIRCUM, it was deemed important to assess the relative fit. To do so, a randomization test (viz., RANDALL) was carried out, and, in this test, the IAS-R achieved an excellent fit (similar findings were obtained for the CCMA data). Thus, the conclusion that the circumplex model fits the present data better than chance appears to be a justifiable one, even though there is variance yet to be explained.

5. Conclusion

This study's innovative application of the CIRCUM-extension procedure in placing the IPC within the CCMA space (and vice versa) is admittedly preliminary, but it will certainly prove useful in propelling methodological advancement in the construction of a nomological net among the circumplex models employed in the field of psychology. Not only does this method reveal the axis of overlap, but it also estimates the magnitude and (precise) vector of overlap between circumplexes, even when that particular vector is not measured by a scale. Its usefulness is not limited to the two domains examined herein, namely, interpersonal behaviors and affect, and future research should be directed at developing a more mathematically sophisticated and general procedure for relating the other circumplex structures in psychology.

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