

A Spherical Conceptualization of Personality Traits

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Abstract

This research utilizes the geometric structure of the two-dimensional Interpersonal Circumplex (IPC), and adds the Five-Factor Model (FFM) dimension of conscientiousness to create a three-dimensional spherical model of personality; the interpersonal sphere (IPS). A sample of 250 participants was initially used to select items that conformed to the geometric locations of 26 different characteristics on the IPS. A separate sample of 251 participants confirmed the geometric structure of these characteristic measures using randomization tests. To demonstrate an application of this three-dimensional model, the IPS was employed as a geometric taxonomy to map various personality constructs. The combined sample of 501 participants was used to cartographically locate 164 scales from the NEO Personality Inventory, (NEO-PI-R), the 16 Personality Factor Questionnaire (16PF), the California Psychological Inventory (CPI), the Hogan Personality Inventory (HPI), the Temperament and Character Inventory (TCI), the Multidimensional Personality Questionnaire (MPQ), and the Jackson Personality Inventory (JPI-R) onto the IPS. The spherical conception of traits provided by the three-dimensional IPS is discussed as both an extension of the FFM and the two-dimensional IPC. Copyright © 2006 John Wiley & Sons, Ltd.

Key words: interpersonal; circumplex; sphere; Five-Factor Model

INTRODUCTION

Models of personality both facilitate and limit how we think about and understand others. Many researchers and laypersons alike tend to focus on a single dimension when evaluating others. John may be ‘warm’ while Cathy is ‘cold’. The simplicity of describing people in terms of a single dimension is appealing to us, and seems to occur automatically when we first meet another person. However, it typically does not take long for us to

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recognize that a one-dimensional model of personality does not adequately describe a person. All people who are 'warm' do not necessarily behave in the same manner; a person who is 'warm' and 'conscientious' will probably act quite differently than a person who is 'warm' but 'unconscientious'. In other words, the most effective way to describe an individual is often not with a single dimension of personality, but by considering how multiple personality dimensions 'blend' together within the individual.

A one-dimensional approach to personality examines traits separately from each other. This approach usually involves an in-depth study of a trait and various correlates of this trait. The one-dimensional approach has unquestionably yielded some of the most important and influential findings in personality research (e.g. authoritarianism, self-monitoring, self-esteem, etc.). Even the popular conception of personality, the Five-Factor Model (FFM; Digman, 1990; Goldberg, 1990; McCrae & Costa, 1995), is frequently used in a one-dimensional manner. While the FFM contains five dimensions (extraversion, agreeableness, conscientiousness, neuroticism and openness to experience) of personality, researchers often examine each factor as if it exists in a separate space from the other factors (Ahadi & Diener, 1989). Researchers using this one-dimensional approach will often correlate each of the five factors to some outcome of interest and then independently interpret the resulting coefficients. For example, the current authors have examined the relations between children's personalities (assessed using the FFM) and behaviour. Some findings from these studies indicate that agreeable children tend to express accommodating behaviours when interacting with their parents and are unlikely to engage in potentially health-compromising behaviours when with peers (Markey, Ericksen, Markey, & Tinsley, 2001; Markey, Markey, & Tinsley, 2003; 2004). Such findings provide information about the trait of agreeableness, but say little about how the behaviours related to this trait might be modified by the other traits included in the FFM.

A two-dimensional approach to personality examines two traits simultaneously and provides insight into how two traits 'blend' together within an individual (Trapnell & Wiggins, 1990). This approach realizes that while some traits may be orthogonal to each other when assessed across individuals (e.g. FFM), they are not isolated entities within individuals. This understanding has been an underlying (although sometimes forgotten) theme in the study of personality since Allport (1937) defined personality as '... the dynamic organization *within* the individual of those psychophysical systems that determine his unique adjustments to his environment' (p.48; emphasis added). A child who is agreeable and extraverted will likely exhibit different behaviours (e.g. warm behaviours) than a child who is agreeable and introverted (e.g. submissive behaviours). This view is similar to Goldberg's (1993) horizontal approach to organizing personality constructs, which stresses the importance of locating personality traits in a multi-dimensional space. Arguably, the most popular two-dimensional approach to personality is the Interpersonal Circumplex (IPC; Leary, 1957; See Hofstee, DeRaad, & Goldberg, 1992 for additional two-dimensional models). Figure 1a displays the circular ordering of the eight IPC styles presented by Wiggins, Trapnell, and Phillips (1988). The structure of the IPC implies that interpersonal styles vary along a circular continuum and are oriented by the two primary dimensions of dominance and warmth. In this ordering, interpersonal styles that fall close together are expected to be more positively related than styles that fall further apart, styles at right angles are unrelated and styles at the opposite pole of a diameter are negatively related.

The IPC was first introduced by researchers at the Kaiser Foundation (Freedman, Leary, Ossorio, & Coffey, 1951; LaForge, & Sucek, 1955; Leary, 1957) as a means of examining

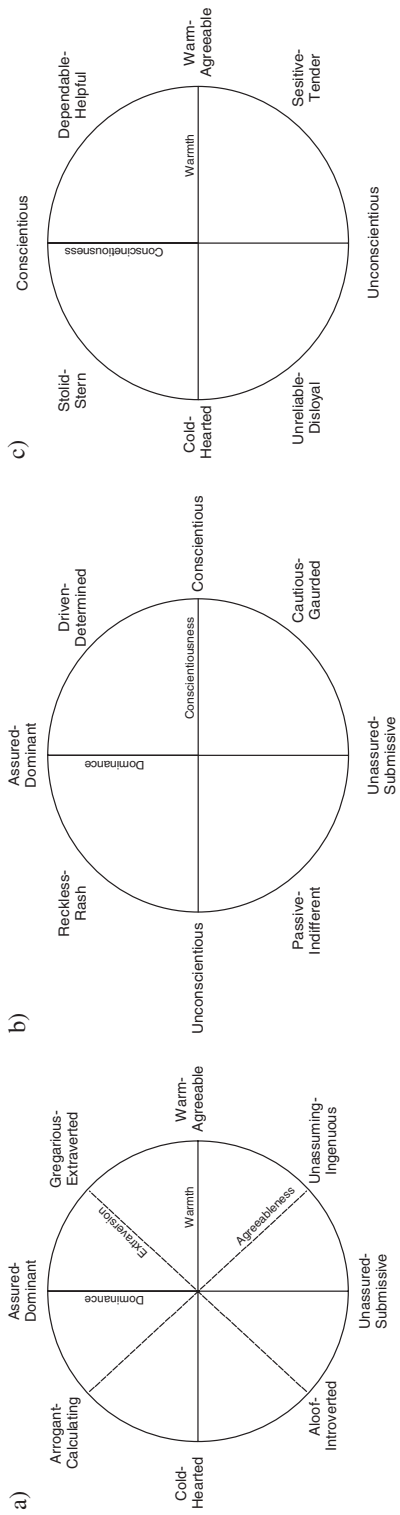


Figure 1. The three circumplex models that comprise the interpersonal sphere. (a) Warmth and Dominance Circumplex (The Interpersonal Circumplex). (b) Conscientiousness and Dominance Circumplex. (c) Warmth and Conscientiousness Circumplex.

basic concepts related to Harry Stack Sullivan's (1953) interpersonal theory. According to interpersonal theory, one's personality is created and maintained through ongoing interpersonal interactions. For Sullivan, to understand people you must have knowledge of the interpersonal styles that they utilize when interacting with others. Not only does the IPC represent a method for classifying these interpersonal styles, but it has been argued that it provides the conceptual foundation of personality assessment within the interpersonal paradigm (Wiggins, 2003).

The conception of the two-dimensional IPC as a measurement of interpersonal styles has been supported by research examining 'interpersonal complementarity'. The principle of complementarity states that, during social interactions, the interpersonal style of one person tends to elicit or constrain the interpersonal style of the other, and vice versa (Kiesler, 1983). Perhaps the most popular definition of complementarity that utilizes the IPC is Robert Carson's (1969), which states that complementarity occurs when individuals act similarly in regards to warmth (i.e. warmth encourages warmth, and hostility encourages hostility) and in an opposite manner in regards to dominance (i.e. dominance encourages submission, and submission encourages dominance). Past research using the IPC has found that people tend to alter their behaviour in a complementarity manner when interacting with confederates coached to act in a particular style (e.g. Strong et al., 1988; Bluhm, Widiger, & Miele, 1990), with naive opposite sex-strangers (e.g. Markey, Funder, & Ozer, 2003; Sadler & Woody, 2003), and with individuals who are interpersonally important (e.g. friends, romantic partners, etc.; Tracey, Ryan, & Jaschik-Herman, 2001; Yaughn & Nowicki, 1999).

The IPC presented in Figure 1a also implies that the eight interpersonal styles arranged around the circumplex represent different 'blends' of the two-dimensions of dominance and warmth. For example, the characteristic of extraversion is a blend of dominance and warmth; while arrogance is a blend of dominance and hostility (low warmth). By considering these dimensions together, the IPC provides a useful elaboration of two factors of the FFM. Specifically, the two primary dimensions of the IPC represent approximately 45° rotations of the FFM dimensions of extraversion and agreeableness (see Figure 1a; McCrae & Costa, 1989). The FFM and IPC are therefore complementary models of personality; the FFM provides a framework with which to interpret the circumplex and the IPC provides an elaboration of two factors from the FFM (McCrae & Costa, 1989). Research clearly indicates that the two-dimensional IPC has demonstrated its utility both as a model of personality and as a tool for interpersonal researchers (e.g. Bartholomew, 1990; D'Antono, Ditto, Moskowitz, & Rios, 2001; Madison, 1997; Markey, Funder, & Ozer, 2003; Markey, Markey, & Tinsley, 2005; Matano & Locke, 1995; Tracey, Ryan, Jaschik-Herman, 2001; Wiggins & Pincus, 1989). It would therefore be useful to examine whether or not this model could be further expanded to include additional interpersonal content by adding a third dimension to its circular structure.

The interpersonal sphere

Because the IPC contains the two factors of the FFM that are seen as the 'basic coordinates of social life' (Wiggins & Broughton, 1991, p. 362), it supplies interpersonal information related to love and status (Wiggins & Trobst, 1997). However, an examination of only two dimensions provides a still-limited view of the complexity of personality (Costa & McCrae, 1992a). In order to increase the amount of interpersonal information provided by this model it may be useful to add any of the remaining three traits of the FFM (i.e.

conscientiousness, neuroticism, or openness to experience) to the IPC. Past research suggests that conscientiousness in combination with extraversion and agreeableness are the most robust factors of the FFM (Saucier & Goldberg, 2003). Lexical studies have tended to find that this three factor solution (sometimes referred to as the 'Big Three'; Saucier & Goldberg, 2003) is even more robust than the traditional FFM (DeRaad & Szirmak, 1994; DiBlas & Forzi, 1999; Saucier & Goldberg, 2003). Such findings suggest that the IPC, which only contains the factors of agreeableness and extraversion, is missing an important third factor; this factor is conscientiousness.

As with the IPC dimensions of warmth and dominance, during interpersonal interactions the conscientiousness of one's interpersonal style likely elicits or constrains the conscientiousness of others, and vice versa. For example, it seems probable that a person would act differently towards an interaction partner who tended to be conscientious (e.g. is diligent, works hard, etc.) than he or she may behave around a partner who frequently acted in an unconscientious manner (e.g. is lazy, doesn't work hard, etc.). Although the complementarity of conscientiousness has never been directly studied, research examining social compensation suggests that the perceived helpfulness and diligence of an interaction partner affects the amount of effort and thoroughness one expresses in return. Specifically, during dyadic relations, individuals appear to act in a manner opposite to the conscientiousness of their interaction partners (i.e. conscientiousness encourages unconscientiousness and unconscientiousness encourages conscientiousness; Plaks & Higgins, 2000). For example, Williams and Karau (1991) found that when an interaction partner (in reality a confederate) stated 'I don't think I am going to work very hard', participants were likely to work harder in order to compensate for their partners loafing and lack of diligence than if the confederate announced 'I think I'm really going to work hard'. These, and other findings in social cognition (e.g. Kruglanski, 1990; Fiske & Taylor, 1991), suggest that people are 'motivated tacticians' who flexibly allocate the amount of effort they put into a task by withdrawing effort on tasks that their interaction partners will perform and intensifying their effort when the task is unlikely to be completed by others. Such results imply that an individual's level of conscientiousness alters the conscientiousness of his or her interaction partner in predictable ways that would be undetected if only the IPC dimensions of warmth and dominance were assessed.

Conscientiousness is also related to various socially important attributes including reliability, self-discipline and socially prescribed impulse control (Costa & McCrae, 1992a; Hogan & Ones, 1997). Conscientious individuals are commonly perceived by others as being more trusting (Bond & Forgas, 1984), likeable (Cartwright, 1997; Markey & Wells, 2002), and even more attractive (Noor & Evans, 2003) than unconscientious individuals. Thus, although the IPC conveys information to others about one's status or love it does not explain how these qualities might be expressed during interpersonal interactions; conscientiousness is a dimension that may serve as an interpersonal medium that moderates how this information is (or is not) conveyed. For example, the characteristic of 'dominance' on the IPC has been found to manifest itself in interpersonal behaviours that are both functional (e.g. self-confidence, need for achievement) and dysfunctional (e.g. impulsivity; Wiggins & Broughton, 1991). These seemingly contradictory findings may occur because the IPC fails to consider how conscientiousness moderates, or blends with, dominance.

To graphically, display how conscientiousness might moderate the expression of dominance, Figure 1b presents a hypothesized circular ordering of eight interpersonal characteristics that are oriented by the two primary dimensions of conscientiousness and

dominance. This circumplex structure predicts that individuals who are dominant and conscientious will likely express their dominant behaviours in a self-confident and driven manner (i.e. would be driven and determined), whereas persons who are dominant but unconscientious would probably exhibit their dominant behaviours in an impulsive or undisciplined manner (i.e. would be reckless and rash). Similarly, individuals who are submissive and conscientious are predicted to be somewhat cautious and guarded, and persons who are submissive and unconscientious may act in a passive and indifferent manner.

In order to hypothesize how conscientiousness might moderate the expression of the warmth dimension of the IPC, a third circumplex can be constructed using the two primary dimensions of warmth and conscientiousness (see Figure 1c). As indicated by this circumplex, it is predicted that persons who are warm and conscientious will express their warmth towards others by being dependable and helpful. However, individuals who are warm but unconscientious might express their warmth to others by being sensitive and tender rather than dependable. This figure also predicts that individuals who are not very warm (i.e. cold) and are unconscientious will be unreliable and somewhat disloyal towards others, whereas persons who are cold and conscientious can be described as being stolid and stern.

The robustness of conscientiousness as a third factor (e.g. DiBlas & Forzi, 1999; DeRaad & Szirmak, 1994; Saucier & Goldberg, 2003), past research examining the affect of conscientiousness behaviour on interpersonal interactions (e.g. Plaks & Higgins, 2000; Williams & Karau, 1991), and the hypothesized circumplexes presented in Figure 1b and 1c suggest that conscientiousness may have a very important impact on interpersonal interactions. This is not to imply that neuroticism or openness to experience have no affect on the interpersonal behaviours of individuals. However, research suggests that these traits are often related to intrapersonal and affective constructs (e.g. Emmons & Diener, 1986; Gross, Sutton, & Ketelaar, 1998; Larsen & Ketelaar, 1991; Watson & Clark, 1984, 1992; Furnham & Brewin, 1990). For example, when neuroticism is combined with extraversion the resulting circumplex model has been consistently related to affect (as opposed to interpersonal behaviours; Watson & Tellegen, 1985; Saucier, 1992; Gurtman, 1997). The robustness of these findings even led Tellegen (1985) to suggest that when the dimensions of extraversion and neuroticism are combined together to create a circumplex the dimensions should be renamed 'positive emotionality' and 'negative emotionality', respectively. Consistent with this notion that neuroticism is a temperamental trait, recent EEG research has even found that neuroticism is related to brain activity associated with affect (Schmidtke & Heller, 2004). Thus, although the addition of any third factor (e.g. neuroticism) to the IPC would enhance the models explanatory power of interpersonal behaviours, in light of the findings described above, this study will add the dimension of conscientiousness to the IPC.

By adding the third dimensions of conscientiousness to the IPC, the resulting model demonstrates that interpersonal characteristics can be arranged on a sphere (see Figure 2). This spherical structure implies that interpersonal characteristics vary along a spherical continuum and can be oriented by the primary dimensions of dominance, warmth and conscientiousness. As with the IPC, characteristics that fall close together on the Interpersonal Sphere (IPS) are expected to be more positively related than characteristics that fall further apart, behaviours at right angles are unrelated, and behaviours at the opposite pole are negatively related. While there are actually an infinite number of different characteristics that can be yielded from different 'blends' of these three

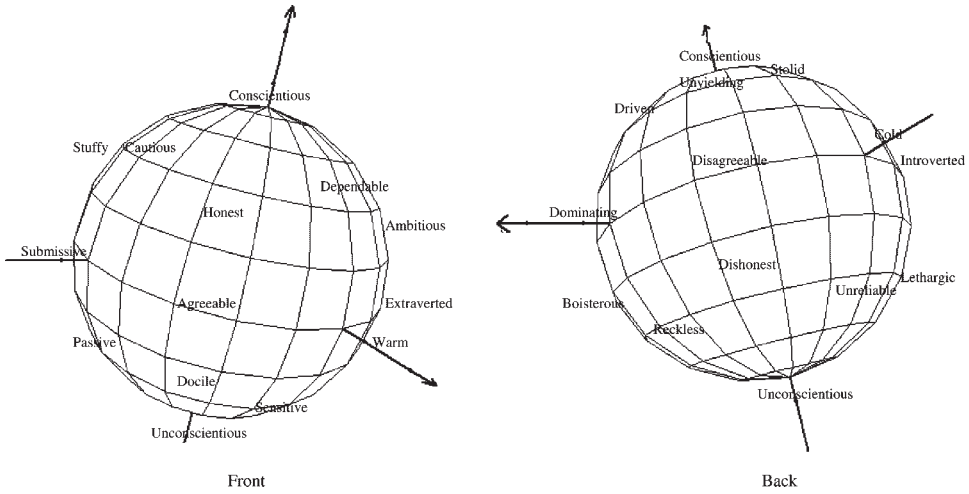


Figure 2. The Interpersonal Sphere.

dimensions, Figure 2 presents 26 different characteristics. Eighteen of these characteristics were derived from the three circumplex models presented in Figure 1 and eight characteristics were created in order to represent locales on the IPS when warmth, dominance and conscientiousness are equally blended together (e.g. ‘Honest’, ‘Stuffy’, etc.). The 26 characteristics of the IPS are also presented in Table 1, along with their theoretical weights on each dimension. These weights represent hypothetical correlations between each characteristic and the dimensions of warmth, dominance and conscientiousness.

Each of the characteristics presented in Table 1 and Figure 2 can be cartographically located on the IPS by their longitude and latitude coordinates. Using the traditional IPC as the defining location of longitude, a characteristic’s location can range from 0° to 359.9° (see Figure 3). To calculate its longitudinal angle, a characteristic’s warmth and dominance weights can be applied to the formula:

$$\Lambda = \arctangent(D_{Weight}/W_{Weight})$$

Where:

Λ is the longitudinal angle of a characteristic

D_{Weight} is the characteristic’s weighted relation to dominance

W_{Weight} is the characteristic’s weighted relation to warmth

In a similar manner, a characteristic’s latitude location can be calculated along the dimension of conscientiousness (see Figure 3):

$$\Phi = \arctangent(C_{Weight}/[(D_{Weight}^2 + W_{Weight}^2)^{1/2}])$$

Where:

Φ is the latitudinal angle of a characteristic

C_{Weight} is the characteristic’s weighted relation to conscientiousness

D_{Weight} is the characteristic’s weighted relation to dominance

W_{Weight} is the characteristic’s weighted relation to warmth

Table 1. Theoretical locations of the 26 IPS characteristics and example items used to measure each characteristic

	Warm	Dominating	Conscientious	Longitude	Latitude	Example Item
1. Warm	1.00	0.00	0.00	0	0	Get along well with others.
2. Cold	-1.00	0.00	0.00	180	0	Want to be left alone.
3. Dominating	0.00	1.00	0.00	90	0	Do most of the talking.
4. Submissive	0.00	-1.00	0.00	270	0	Seldom took my own horn.
5. Conscientious	0.00	0.00	1.00	0	90	Do things in a logical order.
6. Unconscientious	0.00	0.00	-1.00	0	-90	Leave my work undone.
7. Ambitious	0.577	0.577	0.577	45	35	Take the initiative.
8. Boisterous	0.577	0.577	-0.577	45	-35	Let myself go.
9. Honest	0.577	-0.577	0.577	315	35	Try to follow the rules.
10. Docile	0.577	-0.577	-0.577	315	-35	Tolerate a lot from others.
11. Unyielding	-0.577	0.577	0.577	135	35	Give in to no one.
12. Dishonest	-0.577	0.577	-0.577	135	-35	Don't care about rules.
13. Stuffy	-0.577	-0.577	0.577	225	35	Seldom joke around.
14. Lethargic	-0.577	-0.577	-0.577	225	-35	Excel in nothing at all.
15. Extraverted	0.707	0.707	0.00	45	0	Start conversations.
16. Introverted	-0.707	-0.707	0.00	225	0	Don't talk a lot.
17. Disagreeable	-0.707	0.707	0.00	135	0	Snap at people.
18. Agreeable	0.707	-0.707	0.00	315	0	Think of others first.
19. Driven	0.00	0.707	0.707	90	45	Seek to be the best.
20. Passive	0.00	-0.707	-0.707	270	-45	Let things proceed at their own pace.
21. Reckless	0.00	0.707	-0.707	90	-45	Rush into things.
22. Cautious	0.00	-0.707	0.707	270	45	Take precautions.
23. Dependable	0.707	0.00	0.707	0	45	Seldom forget appointments.
24. Unreliable	-0.707	0.00	-0.707	180	-45	Break my promises.
25. Sensitive	0.707	0.00	-0.707	0	-45	Laugh and cry at the same time.
26. Stolid	-0.707	0.00	0.707	180	45	Don't fall for sob-stories.

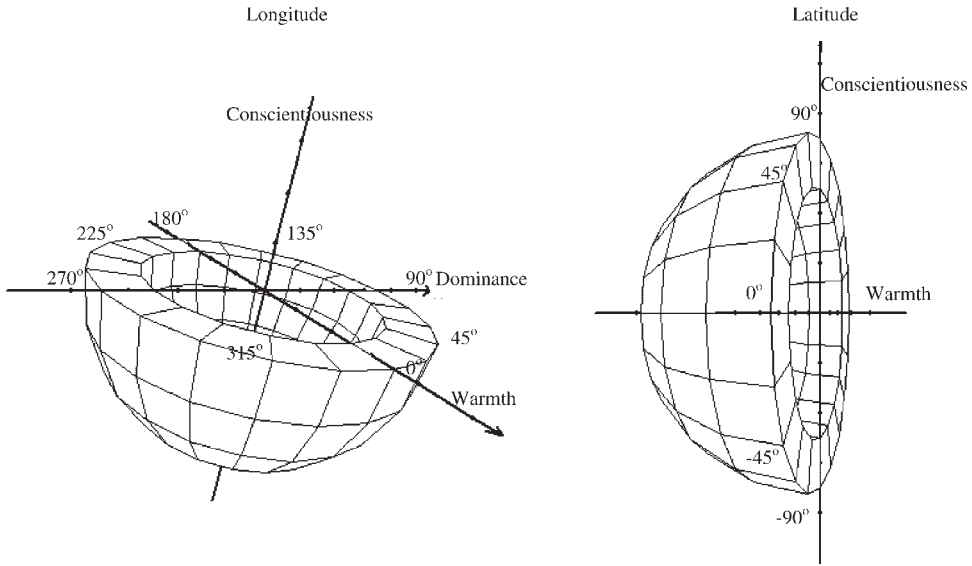


Figure 3. Longitude and Latitude Locations on the Interpersonal Sphere.

Therefore a latitudinal angle can range between 90° (high conscientiousness) and -90° (low conscientiousness), with 0° indicating no relationship to conscientiousness. Table 1 also displays the theoretical longitude and latitude location of each characteristic.

The IPS maps an array of interpersonal characteristics that are ordered in a spherical space around the three dimensions of warmth, dominance and conscientiousness. By building upon the traditional IPC with the addition of a third factor from the FFM, the spherical model presented in this paper is an extension of both the FFM and the IPC. The remainder of this paper will first discuss a methodological technique for assessing the IPS (Study 1). This will demonstrate how and if the spherical structure presented in Figure 2 can be geometrically and statistically modelled using empirical data. The breadth of the IPS will then be examined by cartographically locating over 100 personality constructs in its three-dimensional space (Study 2).

STUDY 1

Assessing the interpersonal sphere

The largest challenge in creating a measure of the IPS is finding or creating enough items to measure the 26 different characteristics of the sphere and confirming that these items adhere to the three-dimensional structure presented in Figure 2. Such a task would have been extremely difficult, if not impossible, prior to 1999 when Goldberg (1999) created the International Personality Item Pool (IPIP). The IPIP is an extensive collection of 1956 items available to the public at the IPIP web site (<http://ipip.ori.org>). The IPIP items have been used to create a multitude of personality measures, due in part to the generous nature of Goldberg and his collaborators at the Oregon Research Institute in their sharing of

resources and data. In order to select which items best represent the various characteristics of the sphere, the current study employed data supplied by this group.

METHOD

Participants and procedure

Participants used in the current study were 501 adults recruited from mailing lists of local homeowners in the Eugene Oregon area. Participants from the Eugene-Springfield Community Sample were extremely heterogeneous in age (ranging from 22 to 90). For further information about this sample see Goldberg (1999).

After agreeing to complete various questionnaires via mail, participants were administered the IPIP items in three separate questionnaires over a three-year period of time. In the current study, these data were split into two samples; Sample 1 ($n = 250$) was used to initially select appropriate items to measure the IPS and Sample 2 ($n = 251$) was used to confirm the structure of the selected items to the three-dimensional model.

RESULTS AND DISCUSSION

Assessment of the interpersonal sphere characteristics

In order to measure the IPS, four items from the IPIP were used to represent each of the 26 characteristics contained in this model, for a total of 104 items. Items were first selected from the IPIP that conceptually represented the main dimensions of the IPS (warmth, dominance and conscientiousness). The selected items were subjected to a principal components analysis using Sample 1 and three orthogonal components were extracted. The four items that loaded highest and lowest on the resulting components were selected and averaged in order to create measures for the characteristics of warmth, cold-heartedness, dominance, submissiveness, conscientiousness and unconscientiousness. Next, to select items that represented the characteristic of 'ambition' (high dominance, high warmth and high conscientiousness) candidate items were first selected that conceptually represented this characteristic. These items were then submitted to a principal components analysis with the previously selected mean characteristic measures, and three components were extracted and rotated to match the theoretical location of the three dimensions. This was done by using the six mean characteristic measures of these dimensions as markers and then rotating the components until maximum concordance with the markers' theoretical positions (see Table 1) was achieved. Four items were then selected that loaded highly on these three components. The remaining characteristic scales were created in the same manner using four basic steps: (1) items were selected that conceptually represented the characteristic, (2) these items were submitted to a principal components analysis containing the previously selected mean characteristic scales, (3) three components were extracted and rotated for maximum concordance with the theoretical positions of the previously selected mean characteristic scales, (4) the four items that best conformed to the characteristic's theoretical location on the IPS were selected. Using the above methodology a total of 26, four-item characteristic scales were created (see Table 1 for examples of selected items).

Reliability of the interpersonal sphere characteristic and dimensional scales

Because four items were selected to measure each characteristic, it was expected that the reliability of any single characteristic would be modest. As anticipated, the average four-item composite reliability of the characteristics in Sample 1 was 0.54 and in Sample 2 it was 0.51. However, since the IPS suggests that these characteristics are ordered in a spherical manner, the characteristics' scales can all be used in concert with each other to compute dimensional scores for warmth, dominance and conscientiousness. This is advantageous because it increases the overall reliability of these dimensional scores. Dimensional scores can be computed using the geometric formulas:

$$\text{Warmth} = \sum Z_i W_{i \text{ weight}}$$

$$\text{Dominance} = \sum Z_i D_{i \text{ weight}}$$

$$\text{Conscientiousness} = \sum Z_i C_{i \text{ weight}}$$

Where:

Z_i is the individual's standardized score on the i th characteristic

W_{weight} is the characteristic's weighted relation to warmth

D_{weight} is the characteristic's weighted relation to dominance

C_{weight} is the characteristic's weighted relation to conscientiousness

The reliability of these dimensional scores is easily calculated by methods traditionally used to compute reliabilities of weighted sums (Nunnally & Bernstein, 1994; Equation 7-17). As expected, the reliabilities for the dimensional scores of warmth, dominance and conscientiousness were reasonably high for both sample 1 (0.87, 0.88 and 0.88, respectively) and sample 2 (0.88, 0.87 and 0.86, respectively). Additionally, the spherical structure presented in Figure 2 suggests that the dimensional scores of warmth, dominance and conscientiousness should be orthogonal to each other. Consistent with this notion, the average interscale correlations for Sample 1 (average $|r| = 0.05$) and 2 (average $|r| = 0.05$) were very low.

Confirmation of the geometric structure of the three circumplex models

Before the spherical structure of 26 characteristic scales could be examined it was first important to determine if the characteristics used to create the three circumplex models presented in Figure 1 conformed to a circular structure. A circumplex structure implies that the magnitude of correlations between various characteristics of a circumplex can be predicted based on the angular distance between the characteristics. Specifically, the predicted correlation between two characteristic scales can be obtained by taking the cosine of their angular separation (Gurtman, 1992). The correlations of characteristics closer on the circle are therefore predicted to be greater than those more distal. The correlations for the characteristic scales separated by 45° in Figure 1 should be greater than the correlations for the characteristics separated by 90° ; the correlations for the characteristics separated by 90° should be greater than the characteristics separated by 135° ; and the correlations for the characteristics separated by 135° should be greater than the correlations for the characteristics separated by 180° . The circular structure also suggests that the correlations of characteristics separated by 45° will be greater than those separated by 135° and those

separated by 180° ; and the correlations of the characteristics separated by 90° will be greater than the octants separated by 180° . Taken together, the circular structures presented in Figure 1 generate a total of 288 order predictions for each circumplex model.

To evaluate the fit of the three circumplex models to the obtained correlation matrices of Sample 1 and 2, correspondence indices were computed (Hubert & Arabie, 1987). A correspondence index (CI) serves as a measure of fit of a correlation matrix with the order predictions and is computed by comparing an obtained correlation matrix with the 288 order predictions (Hubert & Arabie, 1987). The CI is a correlation coefficient (Somnders's D; Sommers, 1962) that can range from +1 (perfect fit) to -1 (no predictions were met), with a CI of 0.0 indicating the number of predictions met is equal to the number of predictions violated. To evaluate the significance of the fit of a circumplex model to the obtained correlation matrices, the confirmation or violation of the 288 order predictions for that circumplex model is examined with a randomization test of hypothesized order relations (Hubert & Arabie, 1987; Rounds, Tracey, & Hubert, 1992). This test yields an exact probability of obtaining the predicted order among the correlations in the observed data matrix under the null hypothesis that the characteristic scales are relabelled at random; no assumptions about the independence of the order predictions are made. In a correlation matrix with eight variables, there are a total of $8!$ (40 320) possible random matrices that can be used to create a comparison distribution for evaluating the fit of the original matrix.

Randomization tests were computed to examine the 288 predicted order relations for each of the three circumplex models. As shown in Table 2, for both Sample 1 and Sample 2 all the randomization tests were significant, and none of the random matrices fit the predicted order relations better than the original matrices. Additionally, the obtained CIs indicated that the characteristics scales used for the warmth-dominance circumplex (CIs = 0.99 and 0.97), the conscientiousness-dominance circumplex (CIs = 0.97 and 0.95), and the warmth-conscientiousness circumplex (CIs = 0.93 and 0.83) consistently fit a circular structure.

Confirmation of the geometric structure of the interpersonal sphere characteristics

Analyses were next conducted to determine whether or not the 26 characteristic scales conformed to the spherical structure implied by the IPS. Similar to the previous circumplex analyses, the spherical structure of the 26 characteristic scales was assessed by examining the angular separation between each of these characteristics. Figure 2 predicts

Table 2. Randomization Tests of the Circular Order Relations for Three Circumplex Models Comprising the Interpersonal Sphere

	Predictions Made	Predictions Met	Correspondence Index	<i>p</i>
Warmth and Dominance				
Sample 1	288	285	0.99	< 0.001
Sample 2	288	287	0.97	< 0.001
Conscientiousness and Dominance				
Sample 1	288	284	0.97	< 0.001
Sample 2				
Warmth and Conscientiousness				
Sample 1	288	276	0.93	< 0.001
Sample 2	288	261	0.83	< 0.001

that characteristics that are more proximal on the sphere will have smaller angular separations than those characteristics more distal. The predicted angular separation between two characteristics on the sphere can be calculated by using each characteristic's longitude and latitude location in the formula:

$$\cos(\theta) = [\cos(\Lambda)\cos(\lambda) + \sin(\Lambda)\sin(\lambda)]\cos(\emptyset)\cos(\Phi) + \sin(\emptyset)\sin(\Phi)$$

Where:

- θ is the angular distance between characteristics a and b
- Λ and Φ are the longitude and latitude of characteristic a
- λ and \emptyset are the longitude and latitude of characteristic b

For example, by applying the above formula to the theoretical longitude and latitude locations of 'boisterous' ($\Lambda = 45^\circ$, $\Phi = -35^\circ$) and 'extraverted' ($\lambda = 45^\circ$, $\emptyset = 0^\circ$) it can be determined that these two characteristics are theoretically separated by 35° . In a similar manner, the above formula can be applied to all possible pairings of characteristics to yield a total of 325 different predictions pertaining to the angular separations of all the characteristics. Table 3 displays the predicted angular separations between all of the 26 characteristics. As evident from this table, it is predicted that some pairs of characteristics will have greater angular separations than other pairs of characteristics. For example, the angular separation of 'warm' and 'cold' is predicted to be greater than the separation of 'warm' and 'introverted', which is greater than the separation of 'warm' and 'unyielding', which is greater than the separation of 'warm' and 'driven', and so forth.

Next, to determine the actual angular separations between each characteristic, Pearson correlations were calculated between all possible pairings of characteristics and were converted to angles by taking the arccosine of each coefficient. The arccosine uses the correlation coefficient to calculate the angular separation between two variables when they are projected as vectors in Euclidean space (Gurtman, 1992). This procedure is equivalent to what was done in the earlier analysis when the circumplex structure was examined by converting the angular separations of characteristics to correlations. The resulting coefficients are bound between 180° (i.e. $r = -1.00$) and 0° (i.e. $r = 1.00$). The angles presented in Table 4 represent the observed angular separations for all pairs of characteristics from both Sample 1 and Sample 2. Again, note that in this table the observed angular separations of some pairs of characteristics were greater than the observed angular separations of other pairs of scales. For example, in Sample 1, the angular separation of 'warm' and 'cold' was greater than the separation of 'warm' and 'introverted', which was greater than separation of 'warm' and 'unyielding', which was greater than the separation of 'warm' and 'driven'.

To evaluate the similarity between the predicted geometric patterns of characters presented in Table 3 and the observed geometric patterns of characters presented in Table 4, an *r*-alerting coefficient was computed (Rosnow, Rosenthal, & Rubin, 2000; Westen & Rosenthal, 2003). Like the CI used in the earlier circumplex analyses, an *r*-alerting coefficient is a correlation that quantifies the predictability of the observed angular separations by correlating each pair's predicted angular separation with its observed angular separation. An *r*-alerting value can range from +1 (the observed angular separations were perfectly predicted by the theoretical angular separations) to -1 (the observed angular separations occurred in a manner opposite to the theoretical angular separations). Although the *r*-alerting and CI would produce similar results, the *r*-alerting was used in the current

Table 3. Predicted angular separations of the Interpersonal Sphere characteristics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
1. Warm	—																										
2. Cold	180	—																									
3. Dominating	90	90	—																								
4. Submissive	90	90	180	—																							
5. Conscientious	90	90	90	90	—																						
6. Unconscientious	90	90	90	90	180	—																					
7. Ambitious	55	125	55	125	55	125	—																				
8. Boisterous	55	125	55	125	125	55	71	—																			
9. Honest	55	125	125	55	55	125	71	109	—																		
10. Docile	55	125	125	55	125	55	109	71	71	—																	
11. Unyielding	125	55	55	125	55	125	71	109	109	180	—																
12. Dishonest	125	55	55	125	125	55	109	71	180	109	71	—															
13. Stuffy	125	55	125	55	55	125	109	180	71	109	71	109	—														
14. Lethargic	125	55	125	55	125	55	180	109	109	71	109	71	71	—													
15. Extraverted	45	135	45	135	90	90	35	35	90	90	90	90	145	145	—												
16. Introverted	135	45	135	45	90	90	145	145	90	90	90	90	35	35	180	—											
17. Disagreeable	135	45	45	135	90	90	90	90	145	145	35	35	90	90	90	90	—										
18. Agreeable	45	135	135	45	90	90	90	90	35	35	145	145	90	90	90	180	—										
19. Driven	90	90	45	135	45	135	35	90	90	145	35	90	90	145	60	120	60	120	—								
20. Passive	90	90	135	45	135	45	90	35	145	90	90	35	145	90	35	120	60	120	60	180	—						
21. Reckless	90	90	45	135	135	45	90	35	145	90	90	35	145	90	60	120	60	120	60	90	90	180	—				
22. Cautious	90	90	135	45	45	135	90	145	35	90	90	145	35	90	120	60	120	60	60	90	90	180	—				
23. Dependable	45	135	90	90	45	135	35	90	35	90	90	145	90	145	60	120	60	120	60	60	120	60	60	120	60	120	60
24. Unreliable	135	45	90	90	135	45	145	90	145	90	90	35	90	35	120	60	120	60	60	60	120	180	—				
25. Sensitive	45	135	90	90	135	45	90	35	90	35	145	90	145	90	60	120	60	120	60	60	120	60	60	120	90	90	—
26. Stolid	135	45	90	90	45	135	90	145	90	145	35	90	35	90	120	60	120	60	60	60	120	60	60	120	90	180	—

Table 4. Observed angular separations of the Interpersonal Sphere characteristics in Sample 1 and Sample 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Warm	—	123	94	88	80	96	77	78	77	75	100	106	100	107	69	108	106	67	87	81	91	90	80	103	77	106
2. Cold	124	—	87	91	94	79	103	102	106	111	78	75	73	71	112	69	73	115	71	93	84	88	108	69	104	71
3. Dominating	91	90	—	126	94	81	85	71	105	99	74	69	102	88	75	117	63	98	79	99	69	108	101	81	81	97
4. Submissive	91	83	132	—	86	94	102	104	73	79	97	100	72	82	110	59	109	82	100	74	104	74	88	95	95	81
5. Conscientious	87	86	90	83	—	120	74	96	75	92	80	101	81	109	91	84	92	81	72	97	106	72	75	108	103	76
6. Unconscientious	97	81	89	94	119	—	99	77	107	90	90	74	102	78	95	89	81	96	97	85	69	106	110	69	81	96
7. Ambitious	74	100	84	95	72	104	—	74	86	88	82	89	104	122	71	107	89	87	59	98	85	94	78	109	91	85
8. Boisterous	81	103	74	106	96	84	75	—	98	84	91	83	119	105	70	110	82	85	83	86	61	105	88	92	69	97
9. Honest	75	96	102	73	72	103	82	102	—	77	102	112	83	97	92	82	114	67	87	81	105	73	76	106	92	90
10. Docile	66	102	102	78	94	87	90	82	81	—	109	101	95	82	86	90	106	69	88	68	87	90	87	97	69	104
11. Unyielding	103	69	73	100	77	102	78	86	91	109	—	77	82	95	88	91	67	105	76	107	86	95	93	85	99	76
12. Dishonest	107	75	76	104	100	72	98	81	119	96	79	—	92	82	92	92	66	103	87	92	74	98	109	73	88	91
13. Stuffy	102	70	102	72	82	94	103	111	78	92	81	92	—	77	105	67	95	89	95	83	105	73	93	84	102	78
14. Lethargic	99	75	93	80	99	78	118	96	93	85	94	79	81	—	108	76	84	95	110	77	87	96	107	66	82	96
15. Extraverted	67	117	68	115	92	90	78	66	91	83	89	89	107	100	—	128	91	79	78	95	80	97	85	99	80	100
16. Introverted	107	68	118	55	82	87	100	109	86	85	92	88	65	77	125	—	96	93	95	80	97	81	95	81	102	74
17. Disagreeable	105	73	64	107	95	84	92	85	100	109	68	74	92	81	88	96	—	116	82	104	74	98	104	78	91	85
18. Agreeable	52	111	106	74	80	95	80	85	72	58	101	107	94	92	83	89	118	—	88	79	89	82	74	103	73	103
19. Driven	89	85	72	102	72	104	61	82	89	98	69	91	94	105	83	96	79	89	—	105	86	90	85	99	95	75
20. Passive	85	92	99	77	95	85	101	91	89	75	102	91	83	78	100	77	104	79	99	—	87	91	95	82	80	99
21. Reckless	91	83	74	105	99	80	82	65	107	89	77	66	101	81	84	96	76	95	84	92	—	113	99	79	75	98
22. Cautious	92	83	102	77	72	101	90	98	78	86	90	97	76	93	97	77	96	81	88	86	106	—	77	103	107	76
23. Dependable	79	96	89	87	72	106	80	92	74	81	90	110	92	102	86	95	97	72	85	92	100	81	—	116	98	87
24. Unreliable	103	75	87	90	103	68	97	87	101	96	86	69	82	71	94	82	78	100	100	91	67	101	107	—	83	92
25. Sensitive	78	105	86	100	100	85	92	73	96	71	98	89	100	85	83	98	93	81	94	82	79	108	95	94	—	115
26. Stolid	108	64	97	82	78	95	84	99	81	104	70	91	75	93	100	77	86	99	80	97	91	78	87	88	110	—

Note: Values above the diagonal are the angular separations from Sample 1 and values below the diagonal are the angular separations from Sample 2.

analyses because it would be extremely computationally intensive to compute a randomization test for a CI with 26 scales (over 45 000 order predictions would need to be computed for *each* random sample).

The resulting *r*-alerting ($r_{alerting} = 0.93$) for Sample 1 demonstrated that the patterns of angular separations presented in Tables 3 and 4 were extremely similar. Since the dependency assumption is violated in the above analyses, a *p*-value can not be computed in the traditional manner. However, as with the earlier circumplex analyses, randomization tests (which make no assumptions about independence) were conducted. These tests yield an exact probability of obtaining the *r*-alerting value of 0.93 under the null hypothesis that the 325 different theoretical predictions are randomly paired with the 325 observed angular separations. In a data set with 325 pairs, there are a total of 325 possible random resamplings; in the current analysis a subset of 500 000 random pairings were utilized to create the sampling distribution. An exact probability value associated with the initial *r*-alerting value of 0.93 can be computed by dividing the number of times an *r*-alerting from the sampling distribution exceeded the initial *r*-alerting value by 500 000. For Sample 1, the randomization test was significant ($p < 0.00001$) with none of the random pairings resulting in a greater *r*-alerting than the found *r*-alerting between the predicted angular separations in Table 3 and the empirical angular separations in Table 4.

A replication of the above analysis using Sample 2 produced similar results. The *r*-alerting ($r_{alerting} = 0.91$) for Sample 2 demonstrated that the patterns of angular separations presented in Tables 3 and 4 were extremely similar. The randomization test using 500 000 random resamplings was also significant ($p < 0.00001$) with none of the random pairings yielding a greater *r*-alerting than 0.91. The randomization test and corresponding *r*-alerting values obtained from both samples confirmed that the 26 characteristic scales occurred in the spherical manner predicted by Table 1 and Figure 2.

STUDY 2

Relating the interpersonal sphere to other aspects of personality

In order to examine how different aspects of personality relate to the IPS, the IPS was next used to cartographically locate various personality constructs. Fortunately, the Eugene-Springfield Community data set used in this study contains a plethora of different personality assessments that can be used for this purpose. Since it is believed that the FFM dimensions of extraversion, agreeableness, and conscientiousness share the same Euclidian space as the IPS, the relationship between the IPS and the NEO Personality Inventory's (NEO-PI-R; Costa & McCrae, 1992b) assessment of these dimensions (and their related facets) was of particular interest. Additional inventories selected to be mapped onto the IPS were the 16 Personality Factor Questionnaire (16PF; Conn & Rieke, 1994), the California Psychological Inventory (CPI; Gough, 1996), the Hogan Personality Inventory (HPI; Hogan & Hogan, 1995), the Temperament and Character Inventory (TCI; Cloninger, Przybeck, Svrakic, & Wetzel, 1994), the Multi-Dimensional Personality Questionnaire (MPQ; Tellegan, in press), and Jackson's Personality Inventory (JPI-R; Jackson, 1994). These seven well-established inventories and their corresponding 164 scales were selected because they provide a multitude of interpersonal measures that are likely to represent many different areas of the sphere.

METHOD

Participants and procedure

Participants used in the current study were the same 501 adults used in the earlier analyses. In addition to completing the IPIP items that were used to determine their dimensional scores on the IPS, these participants also completed the personality measures listed above. Of the 501 participants, complete data were available for 423 participants.

RESULTS AND DISCUSSION

In order to map personality constructs onto the IPS, Pearson correlations were first computed to determine the relations of each construct to the IPS dimension scores of warmth, dominance and conscientiousness. By using the resulting correlation coefficients as weights, it is possible to determine a construct's longitude and latitude location using the formulas discussed earlier. Additionally, a measure of each personality construct's vector length (VL) can be computed with the formula:

$$\text{Vector Length} = [(r_w^2) + (r_d^2) + (r_c^2)]^{1/2}$$

Where:

r_w = The correlation between the personality construct and the warmth dimension

r_d = The correlation between the personality construct and the dominance dimension

r_c = The correlation between the personality construct and the conscientiousness dimension

For example, by applying the previously discussed formulas to the correlations found between the 'Liveliness' scale of the 16PF and the IPS dimensional scores (warmth $r=0.34$, dominance $r=0.45$, conscientiousness $r=-0.24$) the VL of 'Liveliness' (VL=0.61) and its longitude and latitude locations ($\Lambda=53^\circ$, $\Phi=-23^\circ$) can be computed. The VL is an indication of how far the personality construct falls from the centre of the circle. Because the dimensional scores are theoretically orthogonal, the VL can also be interpreted as a multiple R . Personality constructs with large VLs are more strongly related to the interpersonal sphere than constructs with low VLs.

Since VL is an indication of how strongly a construct is related to the IPS, Table 5 displays the constructs that had VLs greater than 0.30. Additionally, this table presents each construct's longitude (Λ) and latitude (Φ) location, organizing scores according to the nearest IPS characteristic. These characteristics are convenient to use as markers of various locations on the IPS. Personality constructs located near characteristic markers that are close together on the IPS (see Figure 2) are more similar to each other in interpersonal content than constructs that are near characteristics' markers that fall further apart on the IPS.

The geometric structure of the IPS provides a means for cartographically locating various personality constructs in a spherical pattern around the dimensions of warmth, dominance and conscientiousness. It is possible to examine constructs located at any point on the sphere and then circumnavigate away from that point to gain insight into how the

Table 5. Cartographic location of various personality characteristics on the Interpersonal Sphere

Characteristic Location	Λ	Φ	VL	Characteristic Location	Λ	Φ	VL
<u>Warm</u>				<u>Ambitious</u>			
RD2: Friendliness (T)	21	-7	0.74	E Facet:	65	20	0.73
E Facet: Warmth (N)	15	-8	0.73	Assertiveness (N)			
Likeability (HPI)	357	-8	0.67	Dominance (C)	58	27	0.69
A Facet: Altruism (N)	343	5	0.63	Ambition (H)	51	31	0.65
Likeability HCI:	21	-5	0.59	C Facet:	55	62	0.59
Likes People (H)				Achievement-Striving (N)			
C1: Tolerance (T)	338	-13	0.58	S3: Resourcefulness (T)	39	32	0.59
C2: Empathy (T)	354	-5	0.58	E Facet: Activity (N)	61	21	0.58
Warmth (16)	16	-19	0.58	Ambition HIC:	48	20	0.54
Social Closeness (M)	19	-4	0.57	No Social Anxiety (H)			
C3: Trust (T)	351	3	0.56	P3: Achievement-	58	52	0.53
A Facet: Trust (N)	357	0	0.52	Striving (T)			
S1: Satisfaction (T)	13	10	0.47	Independence (C)	65	33	0.51
Well-Being (M)	21	7	0.47	P4: Industriousness (T)	48	60	0.48
Tolerance (C)	350	-10	0.43	Ambition HIC:	57	45	0.47
Likeability HCI:	3	-8	0.43	Competitive (H)			
Caring (H)				Energy Level (J)	57	42	0.46
Adjustment HIC:	9	-7	0.42	Ambition HIC:	55	37	0.42
Trusting (H)				Self-Confidence (H)			
<u>Cold</u>				<u>Boisterous</u>			
Vigilance (16)	180	9	0.43	Liveliness (16)	53	-23	0.61
HA1: Neuroticism (T)	198	-12	0.37	Flexibility (C)	42	-59	0.57
Self-Reliance (16)	192	19	0.36	Openness to Change (16)	48	-22	0.46
<u>Dominating</u>				ST1: Imagination (T)	53	-32	0.38
Social Potency (M)	71	14	0.73	Absorption (M)	29	-42	0.34
Dominance (16)	88	22	0.61	Complexity (J)	63	-29	0.33
Sociability HCI:	80	-10	0.56	Sociability HCI:	51	-18	0.31
Exhibitionistic (H)				Likes Crowds (H)			
NS4: Rebelliousness (T)	106	-19	0.45	<u>Honest</u>			
Risk Taking (J)	99	-9	0.44	C Facet: Dutifulness (N)	315	62	0.58
E Facet: Excitement	83	-13	0.39	Good Impression (C)	321	36	0.52
Seeking (N)				Socialization (C)	318	36	0.45
<u>Submissive</u>				Responsibility (C)	337	22	0.42
HA2: Harm	252	-12	0.38	C5: Morality (T)	340	25	0.40
Avoidance (T)				Adjustment (H)	341	21	0.38
<u>Conscientiousness</u>				Prudence HCI:	311	19	0.36
Conscientiousness (N)	351	87	0.75	Avoids Trouble (H)			
C Facet:	1	71	0.61	Prudence HIC: Moralistic (H)	302	46	0.30
Self-Discipline (N)				<u>Docile</u>			
C Facet: Order (N)	297	86	0.58	RD1: Sentimentality (T)	340	-24	0.52
Perfectionism (16)	264	83	0.58	A Facet:	329	-30	0.50
Organization (J)	99	88	0.55	Tender mindedness (N)			
Prudence HCI:	305	71	0.41	Likeability HIC:	329	-27	0.45
Mastery (H)				No Hostility (H)			
				Adjustment HIC:	323	-19	0.40
				Empathy (H)			
				Femininity (C)	311	-40	0.40
				<u>Unyielding</u>			
				Tension (16)	157	17	0.47
				<u>Stuffy</u>			
				Privateness (16)	216	22	0.61
				<u>Lethargic</u>			
				HA4: Low Self-Efficacy (T)	234	-32	0.40

Continues

Table 5. Continued

Characteristic Location	Λ	Φ	VL	Characteristic Location	Λ	Φ	VL
<u>Extraverted</u>				<u>Disagreeable</u>			
Extraversion (N)	44	1	0.82	Aggression (M)	132	9	0.45
Social Confidence (J)	54	10	0.74	<u>Driven</u>			
Sociability (C)	43	4	0.71	Ambition HIC:	71	26	0.58
Social Boldness (16)	50	3	0.68	Leadership (H)			
E Facet: Positive Emotions (N)	28	-10	0.67	Achievement (M)	61	60	0.34
Self-Acceptance (C)	57	12	0.67	<u>Passive</u>			
Sociability (H)	63	-8	0.66	A Facet: Modesty (N)	274	-22	0.53
Social Presence (C)	43	-8	0.64	<u>Reckless</u>			
Capacity for Status (C)	44	1	0.57	RD3: Self-Disclosure (T)	30	-17	0.65
E Facet: Gregariousness (N)	31	-6	0.55	NS2: Recklessness (T)	80	-52	0.48
Intellectance HCI:	56	10	0.54	Abstractiveness (16)	101	-53	0.47
Generates Ideas (H)				NS3: Extravagance (T)	66	-50	0.45
Sociability HCI:	65	-4	0.50	<u>Cautious</u>			
Entertaining (H)				C Facet: Deliberation (N)	278	63	0.59
NS1: Variety Seeking (T)	50	-11	0.49	Self-Control (C)	288	27	0.58
Sociability HCI:	50	-1	0.46	Control (M)	272	63	0.57
Likes Parties (H)				Prudence HCI:	269	36	0.53
Innovation (J)	59	5	0.46	Impulse Control (H)			
Sociability (J)	24	-10	0.46	Rule-Conscientiousness (16)	290	48	0.47
Sociability HCI:	61	-10	0.39	Traditional Values (J)	264	41	0.40
Experience Seeking (H)				Adjustment HIC:	286	42	0.31
Breadth of Interest (J)	34	-8	0.38	Calmness (H)			
Intellectance (H)	64	14	0.34	Prudence HCI:	252	62	0.30
Intellectual Efficiency (C)	27	15	0.32	Not Spontaneous (H)			
Achievement via Independence (C)	28	16	0.32	<u>Dependable</u>			
Social Astuteness (J)	66	1	0.30	C Facet: Competence (N)	24	60	0.62
<u>Introverted</u>				S5: Impulse Control (T)	344	49	0.59
HA3: Social Discomfort (T)	224	-10	0.61	S2: Optimism (T)	15	32	0.49
<u>Agreeable</u>				P1: Initiative (T)	19	42	0.46
Agreeable (N)	312	8	0.72	P2: Competence (T)	29	60	0.44
A Facet: Compliance (N)	306	0	0.61	Emotional Stability (16)	10	34	0.43
C4: Compassion (T)	329	-9	0.55	Well-Being (C)	355	33	0.41
A Facet: Straight Forwardness (N)	302	8	0.50	Traditionalism (M)	349	48	0.40
Likeability HCI: Easy to Live With (H)	335	-1	0.45	Adjustment HIC: No Guilt (H)	3	36	0.36
Prudence HCI: Virtuous (H)	317	7	0.41	Achievement via Conformance (C)	351	52	0.35
RD4: Dependence	321	1	0.41	<u>Unreliable</u>			
Adjustment HCI: Even Tempered (H)	325	16	0.39	Stress Reaction (M)	195	-28	0.33
Likeability HCI: Sensitive (H)	333	-8	0.37	<u>Sensitive</u>			
S4: Self-Acceptance (T)	319	-16	0.36	Empathy (J)	0	-27	0.49
ST5: Femininity (T)	336	-11	0.35	Tolerance (J)	9	-25	0.46
				ST2: Romanticism (T)	16	-29	0.44
				Sensitivity (16)	351	-41	0.42

Note: N=NEO Personality Inventory (NEO-PI-R); 16=16 Personality Factors Questionnaire (16PF); C=California Psychological Inventory (CPI); H=Hogan Personality Inventory (HPI); T=Temperament and Character Inventory (TCI); M=Multi-Dimensional Personality Questionnaire (MPQ); J=Jackson Personality Inventory (JPI-R).

different dimensions of the IPS become emphasized in various constructs. For example, beginning at $270^\circ \Lambda$ and $45^\circ \Phi$ (a point on the sphere that represents an equal blending of submission and conscientiousness) there are many personality characteristics associated with prudence and a concern for rules (e.g. Deliberation, Self-Control, Control, Prudence, Impulse control, Not spontaneous, Rule-Conscientiousness, Traditional Values, etc.). Moving in a southwest direction to $315^\circ \Lambda$ and $35^\circ \Phi$ (a point that represents an equal blend of warmth, submission and conscientiousness) the personality constructs start to reflect a concern for others and tend to be related to issues of morality and responsibility (e.g. Morality, Moralistic, Dutifulness, Responsibility, etc.). Continuing on this journey in a southwest direction to $0^\circ \Lambda$ and $0^\circ \Phi$ (a point that represents warmth) the personality constructs located here tend to emphasize warmth, trust, and friendliness (e.g. Warmth, Social Closeness, Trust, Friendliness, Likeability, Likes People, etc.). Southwest from this point at $45^\circ \Lambda$ and $-35^\circ \Phi$ (a point that represents warmth, dominance and unconscientiousness) constructs start to reflect gregariousness and spontaneity (e.g. Likes crowds, Liveliness, Flexibility, Openness to Change, etc.). Concluding this journey at $90^\circ \Lambda$ and $-45^\circ \Phi$ (a point that represent dominance and unconscientiousness), we find ourselves on the opposite side of the sphere from where we started, and find that the constructs located here reflect a general lack of control and recklessness (e.g. Self-Disclosure, Recklessness, Extravagance, etc.).

The above analyses also indicated that the NEO-PI-R dimensions of extraversion, agreeableness, and conscientiousness were located in their predicted positions. Consistent with McCrae and Costa's (1989) findings that extraversion and agreeableness represent 45° rotations of the primary IPC dimensions of dominance and warmth, extraversion was located at $44^\circ \Lambda$ and $1^\circ \Phi$, and agreeableness was found to be located at $312^\circ \Lambda$ and $8^\circ \Phi$. As expected, conscientiousness was found to be located almost at the exact top of the sphere at $87^\circ \Phi$. The NEO-PI-R scales of extraversion, agreeableness, and conscientiousness, were also found to have extremely high VLs (0.82, 0.72 and 0.75, respectively) suggesting their close correspondence to the IPS.

Results also suggest that many of the personality constructs examined in this study were better represented by the three-dimensional IPS than either a one-dimensional view of the FFM dimensions of agreeableness, extraversion, and conscientiousness, or the two-dimensional view of the IPC. As seen in Table 5, 69% of the constructs with VL greater than 0.30 were not well represented by the characteristics which correspond to a one-dimensional approach using the FFM dimensions of agreeableness (the characteristics of agreeable and disagreeable), extraversion (the characteristics of extraversion and introversion) and conscientiousness (the characteristics of conscientiousness and unconscientiousness). In other words, 69% of the characteristics on the sphere needed to be represented using at least two of the FFM dimensions (e.g. the 16PF scale of Dominance was best represented as a blend of low agreeableness and high extraversion). Similarly, 61% of the constructs in this table were also not characterized well using the characteristics that comprise the two-dimensional IPC (the characteristics of warm, cold, dominating, submissive, extraverted, introverted, agreeable and disagreeable). By considering the three dimensions of warmth, dominance and conscientiousness in a spherical model, a more accurate mapping of various personality constructs was achieved than when the FFM traits of agreeableness, extraversion and conscientiousness were examined separately or when the two-dimensional IPC was employed.

GENERAL DISCUSSION

A one-dimensional view of personality occurs when traits are examined separately from each other; how the expression of one trait might be moderated by the existence of another trait is not considered. This approach has yielded many interesting findings in past research (e.g. authoritarianism, self-monitoring, self-esteem, etc.), yet leaves many questions unanswered. Can a one-dimensional view of traits (even five traits) adequately describe a person? Most personality psychologists would probably agree that a one-dimensional examination of five traits cannot completely explain the complexity of personality. By moving to a two-dimensional or a three-dimensional view of personality, the interrelations amongst traits become evident; dimensions of personality interact with each other to produce a multitude of different characteristics. The IPC presented in Figure 1a suggests that eight characteristics are produced by the blending of two-dimensions. By adding a third-dimension to this model, the IPS increases the number of characteristics to 26.

In this manner, a multi-dimensional view of personality recognizes that what truly makes an individual different and unique is not a high or low rating on a single trait, but their unique 'blend' of traits. Such a view of personality is somewhat analogous to the elements included in chemistry's periodic table. As with dimensions of personality, these 118 elements do not always exist in a vacuum, rather they combine together to create millions of unique compounds (e.g. H₂O, NH₃, CO₂, etc.). However, unlike the elements of chemistry that are clearly defined, which dimensions of personality should be considered basic is somewhat subjective. In the current study, dominance, warmth and conscientiousness were used as the defining dimensions of the IPS primarily due to historical reasons. If the dimensions were rotated to reflect three factors of the FFM (extraversion, agreeableness and conscientiousness) nothing would be gained (or lost) in terms of the amount of variance explained. In this sense, the spherical model presented in this article is a complement to both the FFM and IPC—the FFM and IPC provide the location of both the IPS's equator and its Greenwich, England (i.e. its prime meridian).

Although the IPS contains the constructs of extraversion, agreeableness and conscientiousness—traits that have been found to be the most robust dimensions of the FFM (DeRaad & Szirmak, 1994; DiBlas & Forzi, 1999; Saucier & Goldberg, 2003) and appear to affect interpersonal interactions (Markey, Funder, & Ozer, 2003; Plaks & Higgins, 2000; Williams & Karau, 1991)—the dimensions of neuroticism and openness to experience are also important elements of personality. Conceptually these dimensions of personality are absent from the IPS, but could be added as extra dimensions. While many people have difficulty visualizing beyond three dimensions, mathematically there is no reason additional dimensions cannot be geometrically modelled. For example, the shape of a torus (a geometric object that looks like a doughnut) might be helpful for examining four-dimensions of personality. It is hoped that future research will build upon the three-dimensional IPS in order to create more complex geometric models of personality. Such models have the potential to further demonstrate how a limited number of dimensions can be combined to produce a multitude of unique personality characteristics.

By considering a spherical model of personality, researchers can begin to move beyond flat conceptualizations of personality, and can better understand the complexity of personality traits. For example, using the geometric formulas and methodology presented in this article it is possible for interested researchers to construct spherical models using any three dimensions of personality (e.g. Eysenck's (1991) Extraversion-Neuroticism-Psychoticism model). An examination of multiple personality traits, and the interactions

amongst these traits, has the potential to provide rich insight into the unique patterns of thoughts, beliefs, and behaviours that define us as individuals. It is hoped that the IPS will help researchers to better conceptualize personality and assess it in a manner not commonly considered in the past.

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