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Construction and Validation of the Circumplex Model of Affect with English and Greek Athletic Samples

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Abstract

The circumplex model of affect holds that most emotions can be arranged in a circular fashion around the perimeter of two independent bipolar dimensions that intersect each other, namely pleasant/unpleasant and arousing/sleepy (Russell, 1980). The authors of the present study attempted to construct the circumplex model using English and Greek athletic samples, examining similarities among and differences between these cultures, and comparing the original circumplex against the models that were constructed. A mixed-model design was employed in which there was a within-subjects factor (three word-sorting tasks) and a between-subjects factor (culture). A purposive athletic sample of 128 volunteers (English, n = 60; 29 women, 31 men; *M*age = 24.5 ± 5.0 years; Greek, n = 68; 23 women, 45 men; *M*age = 23.2 ± 4.2 years) completed three word-sorting tasks. A software package named *Kyklos* was developed to facilitate the circumplex analysis. Findings provided support for the circumplex model among English and Greek athletic populations and more specifically, its pleasantness and arousal dimensions. Some concepts describing an individual's emotional or psychological state may be understood and experienced differently across such diverse cultures.

Keywords: Cross-cultural, multidimensional scaling, unidimensional scaling

Construction and Validation of the Circumplex Model of Affect with English and Greek Athletic Samples

Everyday human interactions are guided by affect and this construct has, accordingly, attracted considerable research attention (e.g. Crispim et al., 2015; Ekkekakis & Petruzzello, 2002; Russell, 1980; Russell, Lewicka, & Niit, 1989; Watson & Tellegen, 1985). Affect and related constructs such as mood and emotion have attracted a great deal of interest from researchers in the sport and exercise domain, given their relevance in the optimisation of pre-competition mindset and enhancement of people's experience of physical activity (see, e.g. Beedie, Terry, & Lane, 2005; Ekkekakis, 2008, 2013).

A number of investigators in psychological research have used dimensional models of affect to support their inquiries, including Russell (1980) who proposed the circumplex model of affect. In the three decades since Russell's landmark study, numerous dimensional models have been developed, with one of the most commonly used being the valence–arousal circumplex model (Larsen & Denier, 1992; Thayer, 1986; Watson & Tellegen, 1985). Valence is the hedonic quality of an affect-related stimulus – that is, the feeling of pleasure/displeasure – while arousal is the level of activation associated with it.

The present study is grounded in the sport context and its main focus is on athletes' placement of emotions in circumplex space and how this might vary across diverse cultures. It is therefore important to establish that emotions are qualitatively different to core affect. According to Russell (2009, p. 259), core affect is a primitive, non-reflective feeling entailing "…a neurophysiological state that underlies simply feeling good or bad, drowsy or energized". Contrastingly, emotion has been defined with reference to feelings that are typically brief, intense, and attributable to a *discernible cause* (Beedie et al., 2005). Although the framework underlying the present investigation is predicated on the two dimensions of the circumplex model that is associated with core affect – valence and arousal – it is the emotions which fill circumplex space that are of primary interest.

The valence–arousal structure of the circumplex model has been investigated and replicated using a range of affective stimuli (e.g. Russell & Pratt, 1980; Russell et al., 1989) and with different cultures (Blas, 2000; Russell et al. 1989; Tsai, Knutson, & Fung, 2006; Yik, Russell, Oceja, & Dols, 2000; Yik & Russell, 2003). It has also been used to classify different biological measures related to emotion (e.g. Neuman & Waldstein, 2001). Given the replicability of the circumplex model, it might be assumed to be a multipurpose model that can be widely applied, representing affective phenomena as combinations of pleasure and arousal dimensions.

On the other hand, according to Russell and Barrett (1999), not all the details pertaining to emotion are able to be captured by the circumplex model. In relation to this, the lexical content of the model is likely to vary in accord with domain-specific and cultural differences (Ekkekakis, 2008). Indeed, Russell (2009) highlighted that there are cultural differences in all known aspects of emotion and that different languages lack a one-to-one correspondence between emotion terms. Nonetheless, Russell went on to assert that "…there are both similarities and differences in emotion concepts across cultures and languages." (p. 1270). Accordingly, the circumplex model is deemed a potentially valuable tool in assessing and evaluating affective states across many domains, cultures, and languages.

Russell's (1980) circumplex model forms the basis of the circumplex theory of emotion. This theory proposed that most emotions (emotional experiences) could be arranged in a circular fashion around the perimeter of two independent bipolar dimensions that intersect each other: namely, pleasant/unpleasant and arousing/sleepy. Although the circumplex model provided evidence that self-reported mood could be characterised by two factors represented by bipolar dimensions, most available data at the time supported that selfrating was characterised by a larger number of factors, usually in the range of 5-11 factors (see Watson & Tellegen, 1985). As a result of this debate, Watson and Tellegen reanalysed all available data and declared the two dimensional structure of affect as “basic”. Based on their evidence, they proposed an alternative version of Russell’s (1980) circumplex model, labelling the two dimensions as positive affect (PA) and negative affect (NA). Although the two models can be perceived to resemble one another and share a number of common features, a close inspection reveals some notable differences.

Watson and Tellegen (1985) emphasised the importance of PA and NA dimensions, whereas Russell (1980) emphasised the pleasantness (pleasure/misery) and activation (arousal/sleepy) dimensions. Further comparison of the two models reveals that Russell placed terms such as sad and depressed in the low PA octant, while Watson and Tellegen moved them by 45° to the unpleasantness octant. Moreover, Watson and Tellegen related sleepy to low PA, while Russell viewed it as a marker of disengagement.

There have been additional models which have included Thayer’s (1986) tense and energetic activation (arousal) dimensions, Larsen and Denier’s (1992) eight-octant circumplex, as well as a revised version of Russell’s (1980) circumplex model by Barrett and Russell (1998). In contrast to Russell, Thayer proposed that the activation dimension consists of two dimensions: namely, energetic arousal and tense arousal. High energetic arousal is associated with feelings such as activation and elation, while the low energetic arousal dimension corresponds with terms such as “sluggish” and “tired”. The tense dimension includes anxiety at the higher end with calmness at the lower end. Furthermore, the energetic and tense dimensions correspond with the PA and NA dimensions of Watson and Tellegen’s (1985) model, respectively.

Having reviewed the literature on the circumplex theory of affect, Larsen and Denier (1992) suggested a new structure for the circumplex model that represented an adaptation of both Russell's (1980) and Watson and Tellegen's (1985) models. Larsen and Denier kept pleasantness and activation as the main dimensions of their model, in accordance with Russell, but renamed the PA and NA dimensions of Watson and Tellegen as activated pleasant affect/unactivated unpleasant affect and activated unpleasant affect/unactivated pleasant affect, respectively. Larsen and Denier's model showed high consistency with that of Watson and Tellegen's. This is unsurprising given that 27 of the terms used can be found in both models. Larsen and Denier placed each of these 27 terms in the same octants as Watson and Tellegen's model, with the exception of "active", which was moved by 45° to the high activation (strong engagement) octant.

Barrett and Russell (1998) proposed an updated and revised circumplex model presenting a blend of earlier versions, in an attempt to reach a consensus on the structure of affect. In the revised version of the circumplex, Barrett and Russell kept the original pleasant/unpleasant dimension of Russell's (1980) circumplex and renamed the arousal/sleepy dimension as activated/deactivated. In addition, following the Watson and Tellegen (1985) format, they renamed the PA and NA dimensions pleasant activated/ unpleasant deactivated and pleasant deactivated/unpleasant activated respectively in partial agreement with Larsen and Denier's (1992) labelling. Moreover, consistent with Watson and Tellegen, they placed terms such as "sluggish" and "tired" as indicators of unpleasant deactivated (low PA) dimension, rather than deactivation (disengagement). On the other hand, in agreement with Russell (1980), but contrary to Watson and Tellegen, sleepy was considered to be a marker of deactivation (disengagement).

The five proposed models described earlier appear to be interchangeable. Indeed, Yik, Russell, and Barrett (1999) provided support for this assertion, finding considerable overlap between the models. Further, using English-speaking samples, Yik and Russell (2003) indicated that they fit to the same two-dimensional bipolar space, using pleasantness and arousal as the main axes. An immediate question therefore arises: Can the circumplex model be generalised to non-English speaking cultures? Although tested and supported in a diverse range of cultures and societies including Estonian, Greek, and Polish, and more recently Italian, Spanish, and Chinese, further investigation needs to be conducted to confirm extant findings, since a consensus on the basic structure of affect has yet to be reached (Blas, 2000; Russell et al., 1989; Yik et al., 2000; Yik & Russell, 2003).

Although it could be argued that differences between the proposed models are relatively minor, they may impact upon a model's ability to fit empirical data and be applied in the field. In an attempt to contribute to the validity of the circumplex model and to the process of "dissecting the elephant" as Russell and Barrett (1999) referred to the structure of emotion, the present study will attempt, in part, to revisit the original circumplex model (Russell, 1980). Despite the evidence supporting the validity and explanatory power of the circumplex model, it has not been examined extensively in the domain of sport and exercise, although its use has been widely advocated (e.g. Ekkekakis, 2013; Ekkekakis & Pertuzzello, 2002).

Considering the seminal importance of measurement to any research endeavour and the complexities that are germane to the context of sport and exercise, it is unsurprising that the conceptualisation and measurement of affect has generated much debate in the literature (see, e.g. Beedie et al., 2005; Ekkekakis, 2008, 2013). Although a number of studies have applied circumplex-based measures in the sport and exercise domain (see Ekkekakis, 2013 for review), no study to date has examined the applicability of the circumplex model among athletic populations. This would enable researchers and practitioners to ascertain whether the way in which athletes understand emotions is analogous to the understanding expressed by the general, non-athletic population (e.g. vs. Russell's 1980 data). There are also major cultural differences that have been highlighted between English and Greek populations that centre around the interactional formality of the English vs. the informality of the Greeks (Bousoulenga, 2001) that warrant further investigation with reference to the conceptualisation and measurement of affect.

Purpose and Hypotheses

The purpose of this study was to construct and validate the circumplex model of affect (Russell, 1980) across two samples that were deemed to be culturally diverse (Bousoulenga, 2001). This was accomplished through examination of the results of three word-sorting tasks, conducted by English and Greek athletic samples in their own languages, using both multidimensional and unidimensional scaling techniques. New software was developed to facilitate this process and results derived from the software named *Kyklos* (meaning circle in Greek) will be presented herein. Two hypotheses were tested: H_1 – The original circumplex model of affect (Russell, 1980) would be applicable across culturally diverse athletic samples (English and Greek); and H_2 – The constructed circumplex models for English and Greek athletic samples would exhibit a similar structure.

Method

Participants

Following procurement of institutional ethical approval, a purposive athletic sample of 128 volunteers (English, n = 60; 29 women, 31 men; *M*age = 24.5 $\pm$ 5.0 years; Greek, n = 68; 23 women, 45 men; *M*age = 23.2 years $\pm$ 4.2 years) who were heterogeneous in terms of level of sports participation and involvement completed the study. In the English sample, 47 participants described their ethnicity as White-UK/Irish. The remaining 13 participants had a range of ethnic backgrounds but were British nationals. Of the English sample, 25 participants were participating in sport at recreational level, 21 at club level, 2 at regional level, 4 at national level, and 8 at the international level. Twenty participants in the Greek sample described their ethnicity as Greek and 48 as Cypriot. Thirty-nine of them were participating in sport at recreational level, 11 at club level, 1 at county level, 4 at national level, and 9 at international level.

Experimental tasks

The study entailed three word tasks conducted in the participants' first language, in order to reveal the degree to which the circumplex model of affect was replicable across English and Greek cultures. The methodology adopted by Russell (1980) was followed.

*Category-sort task***.** Twenty-eight stimulus words identified as "words or phrases that people use to describe their moods, feelings, temporary states, affect, or emotions" (Russell, 1980, p. 1164) were presented to participants in alphabetical order. They were asked to place each word into one of the eight categories representing the concepts of affect (arousal, contentment, depression, distress, excitement, pleasure, misery, and sleepiness).

*Circular ordering task***.** Having completed the category-sort task, participants were asked to place the eight categories described above into a circular order, complementing the category-sort task used by Ross (1938). The instructions were as follows: "Your task is to place the words around the edge of a circle in such a way that (1) words opposite each other on the circle describe opposite feelings and (2) words closer together on the circle describe feelings that are more similar" (Russell, 1980, p. 1164).

*Group-sort task***.** The participants were asked to sort the 28 stimulus words presented in the category-sort task into 4, 7, 10, and 13 groups of related words in separate trials in accord with the work of Russell (1980) and Russell et al. (1989). The similarity of each pair of stimuli for a participant was assessed by the number of trials in which the pair was placed in the same group, with the score of each sort weighted by the number of alternatives available in that sort. For example, for a score of 13 to be given, the pair of words should be placed in the same group during the trial in which the participants sort words into 13 groups. The default score was 1 for each pair of words, given that all the words could be assembled in one group. Thus, the minimum similarity would be 1 and the maximum possible similarity score would be 35 (1 + 4 + 7 + 10 + 13 = 35), which would occur if a pair was placed in the same group for all trials. A similarity matrix was formed by taking the mean entry across participants for each cell in the matrix produced.

Translation

A focus group of bilingual experts (both Greek [n = 4] and Cypriot [n = 3]) with a background in sports science was used to translate the 28 stimulus words and the 8 categories representing the concepts of affect into the Greek language using the back-translation approach. Given that this approach yielded words that were considerably similar to Russell et al.'s (1989) original translation for the 28 stimulus words (see Table 1), we adopted their original wording so that this could be further tested and validated. Furthermore, the group of bilingual experts provided the Greek wording for the eight concepts of affect (see Table 2) using the same technique, given that Russell et al. did not report this.

Procedure

A brief written description of the study together with a declaration of informed consent form was given to all participants prior to testing. Once written consent and demographic information were obtained, participants conducted the three tasks described earlier, starting with the category-sort task followed by the circular ordering, and group-sort task respectively. Further debriefing and possible questions that the participants had were answered at the conclusion of data collection by the first author.

Data analysis

The manifold analytical and statistical techniques that were used in the present study are outlined in brief here. Also, we will present *Kyklos*, a software package designed within the present study to facilitate circumplex analysis.

*The Kyklos software for circumplex analysis***.** The Kyklos software was developed using Matlab computer language owing to the lack of software packages that facilitate circumplex analytical methods. It evolved using methods which are described in detail by Ross (1938) and Lingoes (1965, 1973) and employs both multidimensional and unidimensional scaling techniques. Kyklos consists of two components; namely, *scoring* and *analysing* components. The scoring component allows the researcher to input data and create frequency matrices, distance matrices, position matrices, and similarity matrices. The different matrices are then analysed to reveal the appropriate circumplex models.

A flow diagram indicating the functions of the Kyklos software is presented in Figure 1. Data were inputted to create individual matrices for each participant for each test task. Four matrices were created for each individual. An 8 x 28 frequency matrix of the 28 different emotions, and the 8 main categories representing the concepts of affect was created using scores of the category-sort task. Two 8 x 8 matrices, one distance matrix, and one position matrix of the eight main categories of affect resulted from the circular ordering task. Finally, a 28 x 28 similarity matrix of the 28 emotions was created through the similarity test task. The different individual matrices were then combined to form the final matrix of the corresponding task. The final 8 x 8 distance matrix from the circular ordering task and the final 28 x 28 matrix of the similarity test task were analysed using multidimensional scaling techniques, while the final 8 x 28 frequency matrix of the category-sort task and the final 8 x 8 position matrix of the circular ordering task were analysed using unidimensional scaling techniques. The software enables results to be presented graphically (see Results section) and to be saved automatically in Microsoft Excel files.

*Multidimensional scaling***.** The need to investigate relationships between variables (referred to as “objects”) with unknown underlying dimensions to provide researchers with a guiding structure led to the development of the Multidimensional Scaling (MDS) techniques.

MDS has been popular in a range of disciplines that range from social and behavioural sciences to marketing and advertising (Davinson, 1984; Schiffman, Reynolds, & Young, 1981). MDS functions by identifying meaningful underlying dimensions through data visualisation. This enables the researcher to analyse similarity and dissimilarity matrices among the objects under investigation (StatSoft, 2013). Thus, the unified purpose of MDS is to (a) identify the pattern or structure hidden in a matrix of empirical data; (b) present the results in a geometrical model that is accessible to the human eye; and (c) reveal meaningful dimensions that explain the observed similarities or dissimilarities among objects (Shepard, 1972; StatSoft, 2013).

***Multidimensional scaling procedure*.** In the procedures that are germane to MDS, the researcher needs to formulate the problem, state the purpose of the study, and identify the number of variables (objects) under investigation. The testing protocol and procedures are identified, and once data are collected and scored, input matrices (similarity/dissimilarity/distance matrices) are created. Prior to running the statistical analyses of the input matrices, the researcher should identify an appropriate number of dimensions for the software to work on. This is done by use of a scree test (see scree test subsection below) that is very similar to that employed in exploratory factor analysis (Tabachnick & Fidell, 2014).

***Mapping the results and defining the dimensions*.** Kyklos presents the results graphically in two dimensions and saves all the parameters and quantitative results in Microsoft Excel files. The proximity of the variables indicates the relationships and differences among them. Interpretation of the final orientation of the dimensions in the resultant model is challenging as it is based on the final geometrical representation of the results and thus dependent upon the subjective interpretation of the researcher.

*Measure of Goodness-of-fit-Stress***.** To check the reliability of the results, test–retest reliability tests using different forms of matrices can be assessed using Kruskal's Stress Test (Kruskal, 1964a, 1964b). This addresses the goodness of fit of the resultant model. To determine the stress value, a monotone regression of distance upon dissimilarity was performed and the residual variance was normalised to provide an indication of fit. Given that the stress value is a residual sum of squares, it is positive; accordingly the smaller the better (Kruskal, 1964a). The stress value can be expressed as a percentage and the goodness of fit can be determined.

According to Kruskal (1964a), a stress percentage score of 20% represents poor goodness of fit, a score of 5% represents good fit, while 0% implies that there is a perfect monotone relationship between the distances and dissimilarities.

*Scree test***.** The scree test provides the researcher with a means by which to determine the correct number of dimensions to be used in the MDS analysis. The test was first proposed in the context of factor analysis (Cartell, 1966). Kruskal and Wish (1978) discussed the application of the scree test to MDS. The scree test is a graphical method that is used to determine a meaningful number of dimensions. The stress values are plotted against the number of dimensions and the number of dimensions is determined by the point at which the stress values appear to level off to the right of the graph (scree point or "elbow"). According to Kruskal (1964b) "the best fitting configuration in *t*-dimensional space, for a fixed value of *t*, is that configuration which minimizes the stress" (p. 115).

*Unidimensional scaling***.** Unidimensional scaling is a one-dimensional alternative to MDS (Groenen, 2005) that works in a straight line – not in a circle. However, there are a number of statistical problems that are not adequately resolved by linear scales, given that they can be better addressed using circular scales. To address the issue of giving singular linear scales a circular form, Ross (1938) developed a vectorial method for circular statistics.

The vectorial method employed herein provides the researcher with an angular value (θº) indicating the position of the central tendency of the *object* and a scalar value (*r*) that ranges from zero (when all cases are equally distributed) to a maximum number of *N* (when all cases fall at the same point). A measure of the accuracy of the central tendency (Pk_{yklos}) can then be calculated using P = r / N, with 1.0 indicating a complete (100%) consistency and zero indicating indeterminacy.

Discrepancy analysis

The analysis to investigate discrepancies between Russell's (1980) original circumplex model and the constructed circumplex models was conducted using Fisher's Aº (Fisher, Heise, Bohrnstendt, & Lucke, 1985; Wanger, Keiesker, & Schmidt, 1995) and cosine difference (CDIFF; Gurtman, 1992, 1993) techniques. Both Fisher's Aº and CDIFF are measures of the correlation between actual and theoretical angular location of an item on a circular configuration (circumplex) in a two-dimensional space. Fisher's Aº values ranges from 0 to 1; 0 corresponds with maximum possible displacement between two data points (180º), whereas 1 represents perfect alignment (0º displacement). Fisher's Aº is calculated using the formula Aº = 1- θ/180 where θ represents the mean angular displacement between the two data points.

The CDIFF refers to the cosine of the discrepancy between the actual and the theoretical location of an item in a two-dimensional space. It ranges from -1 (maximum displacement, 180 º) to 1 (perfected alignment). For example, if the discrepancy between the actual and the theoretical locations is 0º, CDIFF will be 1 (cos [0] = 1); for discrepancy of 90º, CDIFF equals 0 and for discrepancy of 180º, CDIFF = –1. The average CDIFF is the index of the goodness of fit between actual and theoretical locations (Gurtman, 1992, 1993).

According to Gurtman (1992), the vector length is a determinant of construct similarity. Furthermore, Wiggins and Broughton (1991) indicated that the vector length shows how well variance of an item is captured by the two coordinates of a circular configuration. Vector length calculated using Kyklos software was used in accordance with the sample size to determine a value of central tendency (P_{Kyklos}) for each item under investigation. Moreover, the constructed models were analysed statistically using SPSS v. 13.0 for Windows. Pearson's product correlations were computed to examine possible similarities between the original and constructed models.

Results

Overview

The results are arranged in such a way that a Kyklos-derived visual depiction of the Russell (1980) original circumplex model data pertaining to the eight concepts of affect (Table 2) and data from the English and Greek samples are presented first. This is followed by a visual depiction of the discrepancies between the present English and Greek athletic samples in relation to the 28 stimulus words (Table 1). Thereafter, Russell's original data are reanalysed to reveal the discrepancy between his theoretical (target) and actual angles for the eight concepts of affect. Finally, a series of discrepancy and Kyklos analyses are presented wherein Russell's theoretical and actual data are compared to the data derived from both English and Greek athletic samples, and the English and Greek samples are compared against each other.

Visualisation of the data using Kyklos

Results from the circular ordering task of the eight main concepts of affect (circular ordering task; see Figure 2a) revealed the same trend moving anticlockwise using arousal as a reference point for all three models (original Russell's 1980 model, English model, and Greek model) confirming the main axes of the circumplex model of affect, namely pleasant/unpleasant and arousal/sleepy (see Figure 2b). The two main axes of the circumplex model intersect each other, forming two orthogonal dimensions that divide the model into four quadrants. Moving anticlockwise and starting with the top-right quadrant: Quadrant 1 (arousal–pleasant), Quadrant 2 (pleasant–sleepy), Quadrant 3 (sleepy–unpleasant), and Quadrant 4 (unpleasant–arousal).

Using results from the circular ordering task, Pearson's correlations among each of the three models revealed a strong positive correlation among all models ($r = 0.99$, $p < .001$). Figure 3 presents the English and Greek models that were constructed using results from the category-sort task. Pearson's correlations revealed a strong positive correlation between the two models that were constructed ($r = 0.96$, $p < .001$). Furthermore, in comparing the two constructed models with Russell's (1980) original circumplex model, strong positive correlations were evident with each culture under investigation (English; $r = 0.82$, $p < .001$, Greek; $r = 0.81$, $p < .001$).

Ostensibly, both the English and the Greek constructed models confirmed the original main structure of the circumplex model and, more specifically, its pleasantness and arousal dimensions. In the Greek model, however, feelings such as happy, glad, and pleased were found to be in the first quadrant related to arousal, while in the English model they were found in the second quadrant, which was related more with calmness and sleepiness. On the other hand, when the results of the group-sort task were examined, all three emotions were positioned in the first quadrant for both the English and Greek constructed models. Furthermore, droopy and depressed were found in Quadrant 3 of the English constructed circumplex and distressed in Quadrant 4. Conversely, in the Greek constructed circumplex model, droopy and depressed were found in the fourth quadrant, and distressed in the third. Results of the Greek constructed model are consistent for both category-sort and group-sort tasks, with all relevant emotions found in the expected quadrant.

Discrepancies between Russell's (1980) theoretical and actual angles

Russell (1980) had not calculated the precise angles from his data for the eight concepts of affect (Table 2) but had used theoretical angles in his construction of the original circumplex model. Thus, the data from the original circumplex model were reanalysed using Kyklos with the application of Fisher's Aº and cosine difference (DIFF) techniques. Subsequent inspection of the angles in Russell's data for the eight concepts of affect indicated very close resemblance to the angles predicted in his theoretical model (Table 3). The mean discrepancy between target and actual angles (θº) was 6.29 ± 4.84, average Fisher's Aº was 0.97 ± 0.03, the goodness-of-fit using CDIFF was 0.99 ± 0.01 and the mean central tendency was 0.92 ± 0.03. The angles derived from the Russell data facilitated the subsequent comparison with the data derived from the English and Greek samples.

Discrepancies between Russell's (1980) model and the constructed models

Results using Fisher's Aº, CDIFF techniques, and central tendency (P_{Kyklos}) revealed a strong agreement for both the theoretical target angles and the original circumplex model of affect with the constructed English model (Tables 4 and 5). The mean discrepancy between theoretical target angles and actual angles (θº) was 5.76 ± 5.52, average Fisher's Aº was 0.97 ± 0.03), the goodness-of-fit using CDIFF was 0.99 ± 0.01) and the mean central tendency was 0.92 ± 0.03). Similarly, when comparing the original circumplex model with the constructed English model (Table 5), the mean discrepancy was 3.46 ± 3.50, average Fisher's Aº was 0.98 ± 0.02, the goodness of fit using CDIFF was 0.995 ± 0.01, and the mean central tendency was 0.92 ± 0.03.

Results from the Greek constructed model showed strong resemblance for most of the eight categories representing the concepts with both the theoretical and original circumplex angles. However, a poor goodness of fit was observed for depression (Aº = 0.60, CDIFF = 0.31) and distress (Aº = 0.60, CDIFF = 0.32) when compared with the theoretical target angles (Table 6) leading to a decreased central tendency for misery ($P_{Kyklos} = 0.7$). The overall mean discrepancy between the original model and the Greek constructed model angles (θ^{o}) was 21.89 $\pm$ 31.32, average Fisher's A^{o} was 0.88 $\pm$ 0.17, the goodness of fit using CDIFF was 0.82 $\pm$ 0.31, and the mean central tendency was 0.86 $\pm$ 0.10.

This finding was repeated between the original circumplex model and the Greek constructed model (Table 7), but a stronger goodness of fit was observed with depression (A^{o} = 0.69, CDIFF = 0.55) and distress (A^{o} = 0.63, CDIFF = 0.40). Kyklos central tendency of misery remained the same ($P_{Kyklos} = 0.7$). Overall, the mean discrepancy between the original model and the Greek constructed model angles (θ^{o}) was 17.86 $\pm$ 27.23, average Fisher's A^{o} was 0.90 $\pm$ 0.15, the goodness of fit using CDIFF was 0.87 $\pm$ 0.24, and the mean central tendency was 0.86 $\pm$ 0.10, showing strong similarity between models.

Discrepancies between English and Greek constructed models

When comparing the results of the English constructed model with the equivalent Greek one, it can be seen that the arousal/sleepiness dimension was invariant (A^{o} = 1.00, CDIFF = 1.00). The pleasure/misery dimension was also invariant with average Fisher's A^{o} = 0.99 and CDIFF = 0.99. Nonetheless, a weak goodness of fit was observed for depression (A^{o} = 0.63, CDIFF = 0.40) and distress (A^{o} = 0.63, CDIFF = 0.41) when comparing the two constructed models (Table 8). The overall mean discrepancy between the two models' angles (θ^{o}) was 19.67 $\pm$ 29.14, average Fisher's A^{o} was 0.89 $\pm$ 0.16, and the goodness-of-fit using CDIFF was 0.85 $\pm$ 0.27.

Discussion

The present study sought to examine the applicability of the circumplex model of affect (Russell, 1980) among sportspeople from two diverse cultures. Results confirmed the two-dimensional nature of the circumplex model using a heterogeneous athletic sample and supported its applicability among both English and Greek cultures, thus H_1 was supported.

This is a valuable contribution to the literature, given the call for culturally specific and domain-specific measures (Ekkekakis, 2013). Furthermore, the applicability of the model to populations and cultures not typically used in studies investigating the structure of affect, such as the ones examined in the present study, add to the corpus of evidence supporting the validity of the model (Blas, 2000; Russell & Pratt, 1980; Yik et al., 2000; Yik et al., 2003).

Although three tasks were administered, different scaling techniques yielded a remarkably similar picture across the English and Greek constructed models (category-sort task: $r = 0.96$, $p < .001$; circular ordering task: $r = 0.99$, $p < .001$), as well as with the original circumplex model (category-sort task: English, $r = 0.82$, $p < .001$; Greek, $r = 0.81$, $p < .001$; circular ordering task: English, $r = 0.99$, $p < .001$; Greek, $r = 0.99$; $p < .001$). Both multidimensional and unidimensional scaling techniques yielded two-dimensional circular models, similar to the original circumplex model, with the main axes being pleasure/misery and arousal/sleepiness. All emotion concepts were found to fall in a circular order around the perimeter of the space, with the majority of the emotions placed in the equivalent quadrant of the resultant circumplex models. In accordance with these findings, H_2, stating that the constructed circumplex model would exhibit a similar structure across English and Greek athletic samples, was accepted.

Despite the overall consistency of results across the two cultures, some aspects of the circumplex model did vary. With reference to the results of the category-sort task and the group-sort task of the English constructed model, minor differences were evident in the positioning of emotions such as glad, happy, and pleased in their corresponding circumplex quadrant. For the category-sort task, the aforementioned emotions were placed in the first quadrant of the circumplex, related to arousal, whereas in the case of the of the group-sort task, they were located in the second quadrant, showing a tendency towards sleepiness. In the case of the Greek constructed model, all three emotions were found in the first quadrant across both tasks in accordance with the original circumplex model. A plausible explanation for this is that English people are generally characterised as being more conservative when compared with Greeks in terms how they express their feelings and emotions. As observed by Bousoulenga (2001, p. 5) in a cross-cultural investigation of the English and Greek populations, "...the major interactional difference between the Greek and English culture is that a preference for formality and distance has been observed in English, whereas in Greek a tendency for intimacy and informality seems to be manifested."

Another notable finding from the category-sort and the group-sort tasks is that feelings of droopy and depression were found in Quadrant 3 of the English constructed model, while distressed was placed in Quadrant 4. The converse was observed in the Greek constructed model with droopy and depressed placed in the Quadrant 4 and distressed in Quadrant 3. These findings were in line with the findings presented in the discrepancy tables (Tables 5–7) where depression and distress show weak goodness of fit values in the Greek constructed model when compared with the theoretical target angles (depression, $A^{o} = 0.60$, CDIFF = 0.31; distress, $A^{o} = 0.60$, CDIFF = 0.32), original Russell's circumplex model (depression, $A^{o} = 0.68$, CDIFF = 0.55; distress, $A^{o} = 0.63$, CDIFF = 0.40), and English constructed model (depression, $A^{o} = 0.63$, CDIFF = 0.40; distress, $A^{o} = 0.63$, CDIFF = 0.41). Thus, the overall mean goodness of fit between the two constructed models was limited to average Fisher's A^{o} of 0.89 ± 0.16, and goodness-of-fit using CDIFF of 0.85 ± 0.27.

When depression and distress were excluded from the analysis, the mean discrepancy between the two constructed models is reduced to $4.13^{o} \pm 5.43$, while Fisher's A^{o} value was raised to 0.97 ± 0.03, and the goodness of fit using CDIFF to 0.99 ± 0.01. This could also have resulted in the lower central tendency of misery ($P_{kyklos} = .70$) when compared with the remaining seven categories representing the concepts of affect. Conversely, results of the circular ordering task indicated that the positions of distress and depression matched those in the original corresponding quadrants. It should be noted, however, that in the circular ordering task, the first author's backward translation was used, while for the category-sort and the group-sort tasks the original Russell et al. (1989) translation was used to describe distress and depression. Accordingly, emotions of depression and distress should be included in the Greek constructed model using the new translation presented here (Table 2), in order to avoid lexical confusion given that the boundaries of emotional lexicon could limit the ability of the model to predict and assess emotional experience and expression (Larsen & Diener, 1992; Russell, 2009). Alternatively, they could be replaced and tested using other translations such as "συντετριμμένος" (syntetrimenos) or "δυσφορών" (dysforon) for distress and "μελαγχολικός" (melagholikos)/θλιμμένος (thlimenos) for depression (see Table 1).

Another controversial result concerns the adjective "droopy". Droopy was positioned in Quadrant 3 of the English constructed model, while in the Greek model, it emerged in Quadrant 4. The different placement of droopy is probably not caused by any differences in the translation but by the fact that in the Greek language, "droopy" does not exist as an emotion. The direct translation of droopy in Greek is the one used by Russell et al. (1989) and literally means "hanged". It can therefore only be used in a metaphorical sense to describe an individual's emotional state and not as a direct descriptor of an emotion in the Greek language. This is probably the reason for which "droopy" in the Greek constructed model was placed between the emotions depressed and frustrated; such emotions might well be indicative of the mental state of someone about to be hanged. To avoid any possible confusion in the future, it is recommended that droopy be excluded from the Greek circumplex model of affect, as its meaning is ambiguous and thus not interpretable in a consistent manner. Alternatively, it could be replaced and tested using other translations such as πεσμένος (pesmenos; see Table 1).

If items such as “droopy” or “distressed” are not located in a position that is consistent with their hypothesised location in circumplex space (i.e., in accord with Russell, 1980), the problem may not be theoretical in nature. Rather the specific items chosen to represent parts of the model may be at fault or, as in the present case, the meaning conveyed by the items in colloquial language limits their applicability (Ekkekakis, 2008; Russell, 2009). Moreover, in line with Ekkekakis’ (2008) argument “...even if such lexical equivalents did exist, they need not be parts of the working vocabularies of a given set of respondents.” (p. 146). Thus, although it would be somewhat convenient for measurement purposes, there is neither a theoretical nor mathematical reason that, for the circumplex model to be valid across cultures or domains, there must be items in all of its regions (Ekkekakis, 2013).

In relation to this, the back-translation technique is not always a reliable method by which to translate psychometric instruments (Douglas & Craig, 2007). Therefore, a psychological measure, whether in the form of a model or questionnaire, needs first to be tested and validated before being used in research and applied contexts with a variety of cultural groups (see e.g., Tsai et al., 2006). Furthermore, psychological terms pertaining to emotions should be evaluated and accepted by local psychologists who use such terms in their native tongue (see e.g. Efklides, Kantas, Leondari, & The Standing Committee on Terminology of the Hellenic Psychological Society, 2003).

This process facilitates the avoidance of inaccurate results that are caused by linguistic and cultural differences (see Russell, 2009). One extension of the present line of research that might shed further light on the subject matter would be to have Greek participants (both athletic and non-athletic samples) self-generate concepts of affect. Such an approach would likely yield terms that are more person-relevant and task-specific (i.e., relevant to the sporting domain), and would circumvent the acknowledged limitations of the back-translation technique (Douglas & Craig, 2007). Another extension would be to assess how diametrically opposed emotions in the circumplex model (e.g. contentment and anger) are experienced in tandem (i.e. "mixed feelings") and whether such clusters of emotions hold across diverse cultures.

Perspectives

Findings of the present study provided support for the circumplex model of affect and, more specifically, for its arousal and pleasantness dimensions in both English and Greek athletic samples. It was also evident that some concepts describing the emotional states of an individual may be understood and experienced differently in diverse cultures; this is an important consideration for psychologists. Consequently, a psychological measure should first be validated in its target population before being used for research or applied purposes in the sporting domain. Moreover, as had been stressed recently by Ekkekakis (2013), those who wish to use a domain-specific measure should bear into consideration that validation entails a joint responsibility between the test developer and the test user. Thus, given the contribution to model validation made by the present study, it is imperative for users (i.e., practitioners working with athletic samples) to contribute to the validation process through application of the redeveloped model.

Accordingly, the use of the circumplex model would be a valuable and user-friendly evaluation tool for sport researchers and practitioners in terms of monitoring athletes' affective states in response to training and competition (Ekkekakis & Pertuzzello, 2002; Van Landuyt, Ekkekakis, Hall, & Pertuzzello, 2000). The model might also be useful in monitoring the NA associated with overtraining and could therefore be used as a diagnostic tool to assist athletes in regulating their training intensities and modalities. The authors recommend that the circumplex model be tested with a range of physiological outcome measures (e.g., heart rate, electrocardiograph, heart rate variability) as part of the ongoing process of establishing construct validity.

A recent trend in the emotion literature has entailed the assessment of neurophysiological correlates of emotion with reference to the circumplex model of affect (see, e.g. Colibazzi et al., 2010; Kassam, Markey, Cherkassky, Loewenstein, & Just, 2013). This line of work could be extended to athletes, as it has considerable scope in terms of optimizing and regulating their pre-performance emotional states. Specifically, assessments of in vivo emotional states using the circumplex model can be used to subsequently induce comparable emotional states in a functional magnetic resonance imaging (*f*MRI) scanner. This can be achieved using a mock pre-event warm-up routine that may include music, task-relevant images (presented and imagined), and evocative sentences (see, e.g. Colibazzi et al., 2010). The neurophysiological correlates of the emotions can be examined in the scanner and lead practitioners towards interventions that that will serve to stimulate specific regions of the brain that are implicated in an athlete's optimal constellation of emotions.

References

Barrett, L. F., & Russell, J. A. (1998). Independence and bipolarity in the structure of current affect. *Journal of Personality and Social Psychology, 74,* 967–984.

Beedie, C. J., Terry, P. C., & Lane, A. M. (2005). Distinctions between emotion and mood. *Cognition and Emotion, 19,* 847–878.

Blas, L. D. (2000). A validation study of interpersonal circumplex scales in the Italian language. *European Journal of Psychological Assessment, 16,* 177–189.

Bousoulenga, A. (2001, October). *Politeness phenomena in Greek and English: A cross-cultural comparison*. Paper presented at the International Conference entitled "Speakers of Smaller Languages in the Big World", New Bulgarian University, Sofia. Paper retrieved from http://www.rhodes.aegean.gr/ltee/papers/paper_docs/bousoulegka/Sofia%20Bulgaria.doc

Cartell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1,* 140–161.

Colibazzi, T., Posner, J., Wang, Z., Gorman, D., Gerber, A., Yu, S. ...Peterson, B. S. (2010). Neural systems subserving valence and arousal during the experience of induced emotions. *Emotion, 10,* 377–389.

Crispim, A. C., Cruz, R. M., Baasch, D., Amorim, L., Trevisan, R. L., & Da Silva, M. A. (2015). Measurement of affect: From theoretical and instrumental perspectives. *Psychology Research, 5,* 96–107.

Davison, M. L. (1983). *Multidimensional scaling*. New York, NY: Wiley.

Douglas, S. P., & Craig, C. S. (2007). Collaborative and iterative translation: An alternative approach to back translation. *Journal of International Marketing, 15,* 30–43.

Efklides, A., Kantas, A., Leondari, A., & The Standing Committee on Terminology of the Hellenic Psychological Society (2003). Γλωσσάρι [Glossary]. *Psychology, 10,* 183–225.

Ekkekakis, P. (2008). Affect circumplex redux: the discussion on its utility as a measurement framework in exercise psychology continues. *International Review of Sport and Exercise Psychology, 1,* 139–159.

Ekkekakis, P. (2013). *The measurement of affect, mood and emotion: A guide for health-behavioral research*. Cambridge, UK: Cambridge University Press.

Ekkekakis, P., & Pertuzzello, S. J. (2002). Analysis of the affect measurement conundrum in exercise psychology: IV. A conceptual case of affect circumplex. *Psychology of Sport and Exercise, 3, 35–63.*

Fisher, G. A., Heise, D. R., Bohrnstedt, G. W., & Lucke, J. F. (1985). Evidence for extending the circumplex model of personality trait language to self-reported mood. *Journal of Personality and Social Psychology, 49,* 233–242.

Gurtman, M. B. (1992). Construct validity of interpersonal personality measures: The interpersonal circumplex as nomological net. *Journal of Personality and Social Psychology, 63,* 105–118.

Gurtman, M. B. (1993). Constructing personality tests to meet a structural criterion: Application of the interpersonal circumplex. *Journal of Personality, 61,* 237–263.

Kassam, K. S., Markey, A. R., Cherkassky, V. L., Loewenstein, G., & Just, M. A. (2013). Identifying emotions on the basis of neural activation. *PLoS ONE, 8,* e66032. doi:10.1371/journal.pone.006603

Kruskal, J. B. (1964a). Multidimensional scaling by optimizing goodness of fit to nonmetric hypothesis. *Psychometrika, 29,* 1–27.

Kruskal, J. B. (1964b). Nonmetric multidimensional scaling: A numerical method. *Psychometrika, 29,* 115–129.

Kruskal, J. B., & Wish, M. (1978). *Multidimensional scaling*. Beverly Hills, CA: Sage.

Larsen, R. J., & Danier, E. (1992). Promises and problems with the circumplex model of emotion. In M. S. Clark (Ed.), *Emotion* (pp. 25–59). Beverly Hills, CA: Sage.

Lingoes, J. C. (1965). An IBM-7090 program for Guttman-Lingoes smallest space analysis. *Behavioral Science, 10,* 183–184.

Lingoes, J. C. (1973). *Guttman-Lingoes nonmetric program series*. Ann Arbor, MI: Mathesis.

Neuman, S. A., & Waldstein, S. R. (2001). Similar patterns of cardiovascular response during emotional activation as a function of affective valence and arousal and gender. *Journal of Psychosomatic Research, 50,* 245–253.

Ross, R. T. (1938). A statistic for circular scales. *The Journal of Educational Psychology, 29,* 384–389.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*, 1161–1178.

Russell, J. A. (2009). Emotion, core affect, and psychological construction. *Cognition and Emotion*, *23*, 1259–1283.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*, 805–819.

Russell, J. A., Lewicka, M., & Niit, T. (1989). A cross-cultural study of a circumplex model of affect. *Journal of Personality and Social Psychology, 57,* 848–856.

Russell, J. A., & Pratt, G. (1980). A description of affective quality attributed to environments. *Journal of Personality and Social Psychology, 38,* 311–322.

Schiffman, S. S., Reynolds, M. L., & Young, F. W. (1981). *Introduction to multidimensional scaling. Theory, methods, and applications*. London, UK: Academic Press.

Shepard, R. N. (1972). The purpose of multidimensional scaling. In R. N. Shepard, A. K. Romney & S. B. Nerlove (Eds.), *Multidimensional scaling. Theory and applications in the behavioral sciences* (pp. 1–20). New York, NY: Seminar Press.

StatSoft, Inc. (2013). *Electronic statistics textbook.* Tulsa, OK: StatSoft. Retrieved April 14, 2014, from http://www.statsoft.com/textbook/

Tabachnick, B. G., & Fidell, L. S. (2014). *Using multivariate statistics* (6th ed.). Boston, MA: Allyn and Bacon.

Thayer, R. E. (1986). Activation-deactivation check list: Current overview and structural analysis. *Psychological Reports, 58,* 607–614.

Tsai, J. L., Knutson, B., Fung, H. H. (2006). Cultural variation in affect valuation. Journal of *Personality and Social Psychology, 90,* 288–307.

Van Landuyt, L. M., Ekkekakis, P., Hall, E. E., & Pruzzello, S. J. (2000). Throwing the mountains into the lakes: On the perils of nomothetic conceptions of the exercise-affect relationship. *Journal of Sport & Exercise Psychology, 22,* 208–234.

Wanger, C. C., Kiesler, D. J., & Schmidt, J. A. (1995). Assessing the interpersonal transaction cycle: Convergence of action and reaction interpersonal circumplex measures. *Journal of Personality and Social Psychology, 69,* 938–949.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98,* 219–235.

Wiggins, J. S., & Broughton, R. (1991). A geometric taxonomy of personality scales. *European Journal of Personality, 5,* 343–365.

Yik, M. S. M., Russell, J. A., Oceja, L. V., & Dols, J. M. F. (2000). Momentary affect in Spanish: Scales, structure, and relationship to personality. *European Journal of Psychological Assessment, 16,* 160–176.

Yik, M. S. M., Russell, J. A., & Barret, L. F. (1999). Structure of self-reported current affect: Integration and Beyond. *Journal of Personality and Social Psychology, 77,* 600–619.

Yik, M. S. M., Russell, J. A., & Steiger, J. H. (2003). A 12-point circumplex model of affect. In M. S. M. Yik & J. A. Russell (Eds.), *Chinese affect circumplex: I. Structure of recalled momentary affect*: *Asian Journal of Social Psychology, 6,* 185–200.

Table 1.

Russell et al.’s (1989) Translation of the 28 stimulus words presented to participants in the category-sort and groups-sort tasks

English	Greek	Greek Phonetics
Afraid	Φοβισμένος	Fovesmenos
Alarmed	Ταραγμένος	Taraymenos
Angry	Θυμωμένος	Theemomenos
Annoyed	Ενοχλημένος	Enochleemenos
Aroused	Εξεγερμένος	Ekseyeermenos
Astonished	Έκπληκτος	Ekpleektos
At ease	Χαλαρός	Halaros
Bored	Βαριεστημένος	Vareestemenos
Calm	Ήσυχος	Eeseehos
Content	Γαληνεμένος	Yaleenemenos
Delighted	Περιχαρής	Pereeharees
Depressed	Καταπιεσμένος	Katapiesmenos
Distressed	Στενοχωρημένος	Stenohoreemenos
Droopy	Κρεμασμένος	Kremasmenos
Excited	Γεμάτος ενέργεια	Yematos Eneryeea
Frustrated	Εκνευρισμένος	Eknevreesmenos
Glad	Χαρούμενος	Haroumenos
Gloomy	Κατηφής	Kateefees
Happy	Ευτυχισμένος	Evteeheesmenos
Miserable	Δυσαρεστημένος	Theesaresteemenos
Pleased	Ευχαριστημένος	Evhareesteemenos
Relaxed	Αναπαυμένος	Anapvmenos
Sad	Λυπημένος	Leepeemenos
Satisfied	Ικανοποιημένος	Eekanopieemenos
Sleepy	Νυσταγμένος	Neestaymenos
Serene	Ήρεμος	Eeremos
Tense	Τεταμένος	Tetamenos
Tired	Κουρασμένος	Kourasmenos

Note: A Greek expert in sport and exercise psychology suggested the following suitable alternatives: Διεγερμένος (Diegermenos) for Aroused, Μελαγχολικός (Melagholikos)/Θλιμμένος (Thlimenos) for Depressed, Συντετριμμένος (Syntetrimenos)/Σε δυσφορία (Se dysphoria)/Δυσφορών (Dysforon) for Distressed and Πεσμένος (Pesmenos) for Droopy.

Table 2.

Translation of the eight categories representing the eight concepts of affect.

English	Greek	Greek Phonetics
Arousal	Εξέγερση	Ekseeyerse
Contentment	Γαλήνη	Yaleenee
Depression	Κατάπτωση	Kataptose
Distress	Άγχος	Enthouseeasmos
Excitement	Ενθουσιασμός	Aychos
Pleasure	Ευχαρίστηση	Echareestese
Misery	Αθλιότητα	Athlioteta
Sleepiness	Νύστα	Neesta

Note: Using the Greek glossary of psychology (Efklides et al., 2003), a Greek expert in sport and exercise psychology suggested Διέγερση (Diegersi) as a possible alternative to arousal.

Table 3.

Target and actual Angles, discrepancy, fisher's A°, CDIFF, and central tendency (P_{Kyklos}) for the eight categories representing the concepts of affect in Russell's (1980) circumplex model

Emotion	Target angle (θ°)	Actual angle (θ °)	Discrepancy (θ °)	A°	CDIFF	P_{Kyklos}
Arousal	0	0	0	1.000	1.000	0.88
Excitement	45	41.42	-3.58	0.980	0.998	0.94
Pleasure	90	96.84	6.84	0.962	0.993	0.89
Contentment	135	126.04	-8.96	0.950	0.988	0.88
Sleepiness	180	178.12	-1.88	0.990	0.999	0.97
Depression	225	240.36	15.36	0.915	0.964	0.93
Misery	270	261.26	-8.74	0.951	0.988	0.92
Distress	315	310.07	-4.93	0.973	0.996	0.92

Table 4.

Target and actual angles, discrepancy, Fisher's (Aº), CDIFF, and central tendency (P_{Kyklos}) for the eight categories representing the concepts of affect in the english constructed circumplex model

Emotion	Target angle (θ º)	Actual angle (θ º)	Discrepancy (θ º)	Aº	CDIFF	P_{Kyklos}
Arousal	0	0	0	1.000	1.000	0.88
Excitement	45	44.28	-0.72	0.996	1.000	0.94
Pleasure	90	104.19	14.19	0.921	0.969	0.89
Contentment	135	127.29	-7.71	0.957	0.991	0.88
Sleepiness	180	180	0	1.000	1.000	0.97
Depression	225	230.40	5.40	0.970	0.996	0.93
Misery	270	257.42	-12.58	0.930	0.976	0.92
Distress	315	309.52	-5.48	0.970	0.995	0.92

Table 5.

Russell’s (1980) circumplex model vs. English constructed circumplex model: actual angles, discrepancy, Fisher’s (Aº), CDIFF, and central tendency (P_{Kyklos}) for the eight categories representing the concepts of affect

Emotion	Russell’s (1980) angle (θ º)	Actual angle (θ º)	Discrepancy (θ º)	Aº	CDIFF	P_{Kyklos}
Arousal	0	0	0	1	1	0.88
Excitement	41.42	44.28	2.86	0.984	0.999	0.94
Pleasure	96.84	104.19	7.35	0.959	0.992	0.89
Contentment	126.04	127.29	1.25	0.993	1.000	0.88
Sleepiness	178.12	180	1.88	0.990	0.999	0.97
Depression	240.36	230.40	-9.96	0.945	0.985	0.93
Misery	261.26	257.42	-3.84	0.979	0.998	0.92
Distress	310.07	309.52	-0.55	0.997	1.000	0.92

Table 6.

Target and actual angles, discrepancy, Fisher's (Aº), CDIFF, and central tendency (P_{Kyklos}) for the eight categories representing the concepts of affect in the Greek constructed circumplex model

Emotion	Target angle (θ º)	Actual angle (θ º)	Discrepancy (θ º)	Aº	CDIFF	P_{Kyklos}
Arousal	0	0	0	1	1	0.95
Excitement	45	41.75	-3.25	0.982	0.998	0.92
Pleasure	90	89.73	-0.27	0.999	1.000	0.93
Contentment	135	121.94	-13.06	0.927	0.974	0.91
Sleepiness	180	180	0	1	1	0.95
Depression	225	297.10	72.10	0.599	0.307	0.74
Misery	270	254.96	-15.04	0.916	0.966	0.70
Distress	315	243.63	-71.37	0.604	0.319	0.77

Table 7.

Russell's (1980) circumplex model vs. Greek constructed circumplex model: actual angles, discrepancy, Fisher's (Aº), CDIFF, and central tendency (P_{Kyklos}) for the eight categories representing the concepts of affect

Emotion	Russell's (1980) angle (θº)	Actual angle (θº)	Discrepancy (θº)	Aº	CDIFF	P_{Kyklos}
Arousal	0	0	0	1	1	0.95
Excitement	41.42	41.75	0.33	0.998	1.000	0.92
Pleasure	96.84	89.73	-7.11	0.961	0.992	0.93
Contentment	126.04	121.94	-4.1	0.977	0.997	0.91
Sleepiness	178.12	180	1.88	0.990	0.999	0.95
Depression	240.36	297.10	56.74	0.685	0.548	0.74
Misery	261.26	254.96	-6.3	0.965	0.994	0.70
Distress	310.07	243.63	-66.44	0.631	0.400	0.77

Table 8.

English and Greek constructed model angles, discrepancy, Fisher's (Aº), CDIFF for the eight categories representing the concepts of affect

Emotion	English angle (θº)	Greek angle (θº)	Discrepancy (θº)	Aº	CDIFF
Arousal	0	0	0	1	1
Excitement	44.28	41.75	-2.53	0.986	0.999
Pleasure	104.19	89.73	-14.46	0.920	0.968
Contentment	127.29	121.94	-5.35	0.970	0.996
Sleepiness	180	180	0	1	1
Depression	230.40	297.10	66.70	0.629	0.396
Misery	257.42	254.96	-2.46	0.986	0.999
Distress	309.52	243.63	-65.89	0.634	0.408

Figure Captions

Figure 1. Flow diagram representing the *Kyklos* software for circumplex analysis.

Figure 2. (a) Circular ordering task results of the eight main concepts of affect.

Figure 2. (b) The main axes of the circumplex model of affect: pleasant/unpleasant and arousal/sleepy.

Figure 3. Category-sort task results for the English and Greek constructed models.

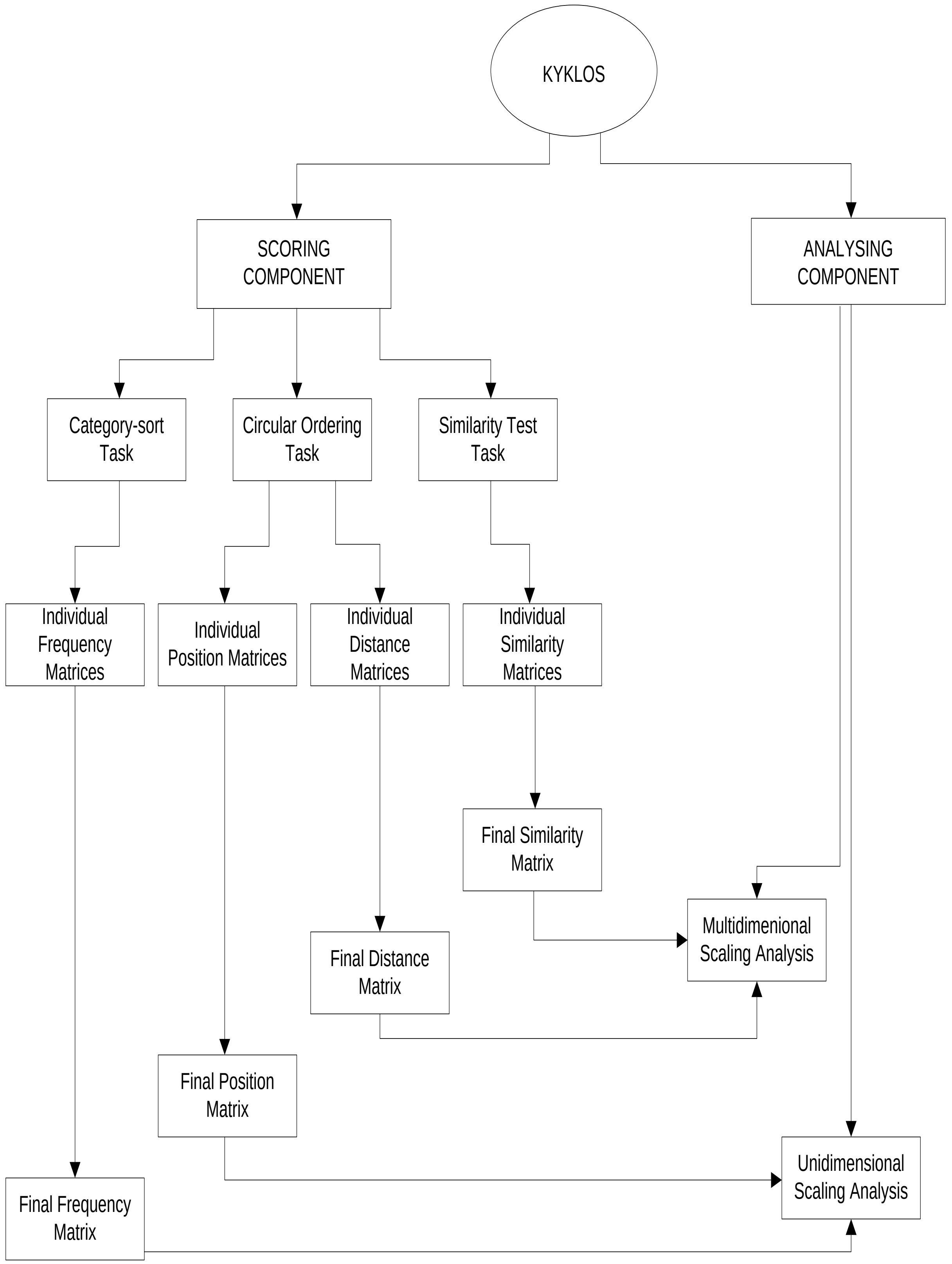

KYKLOS
SCORING COMPONENT
ANALYSING COMPONENT
Category-sort Task
Circular Ordering Task
Similarity Test Task
Individual Frequency Matrices
Individual Position Matrices
Individual Distance Matrices
Individual Similarity Matrices
Final Similarity Matrix
Multidimenional Scaling Analysis
Final Distance Matrix
Final Position Matrix
Unidimensional Scaling Analysis
Final Frequency Matrix

Figure 1.

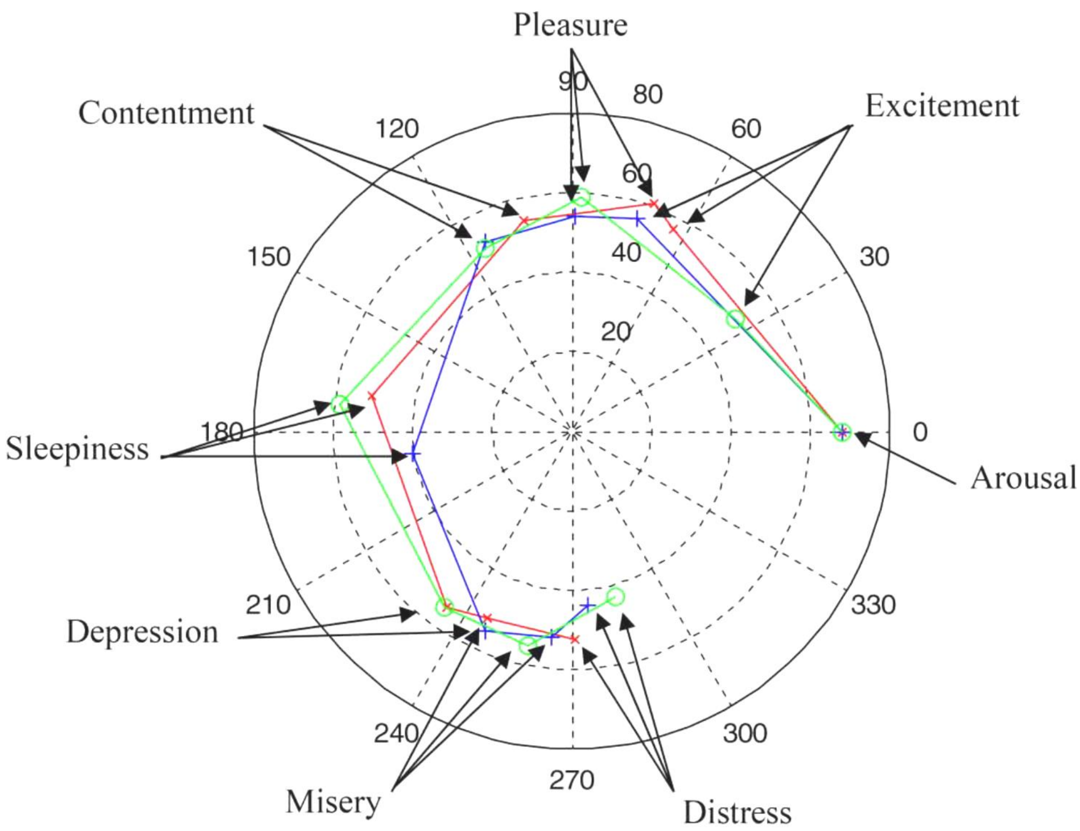
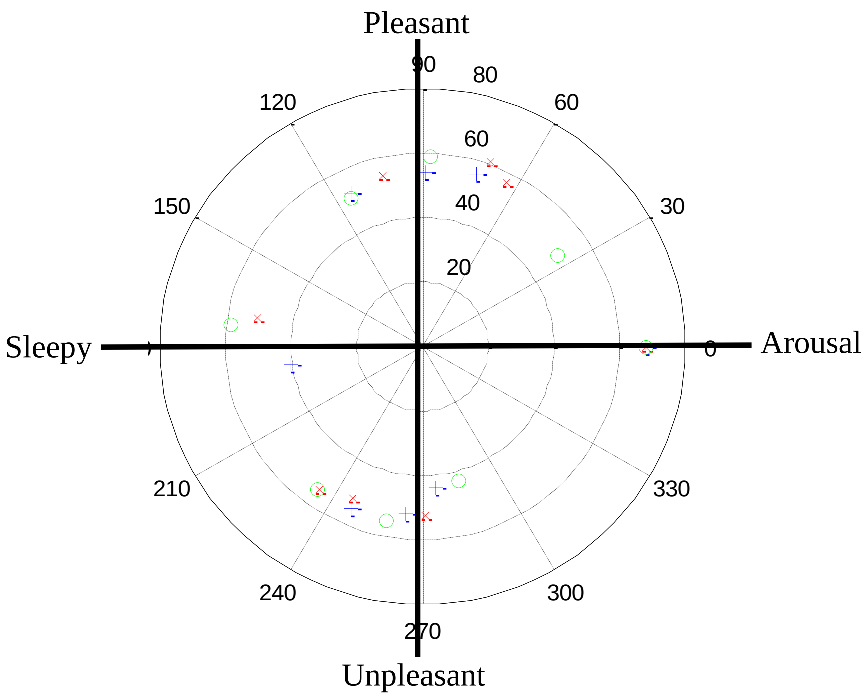
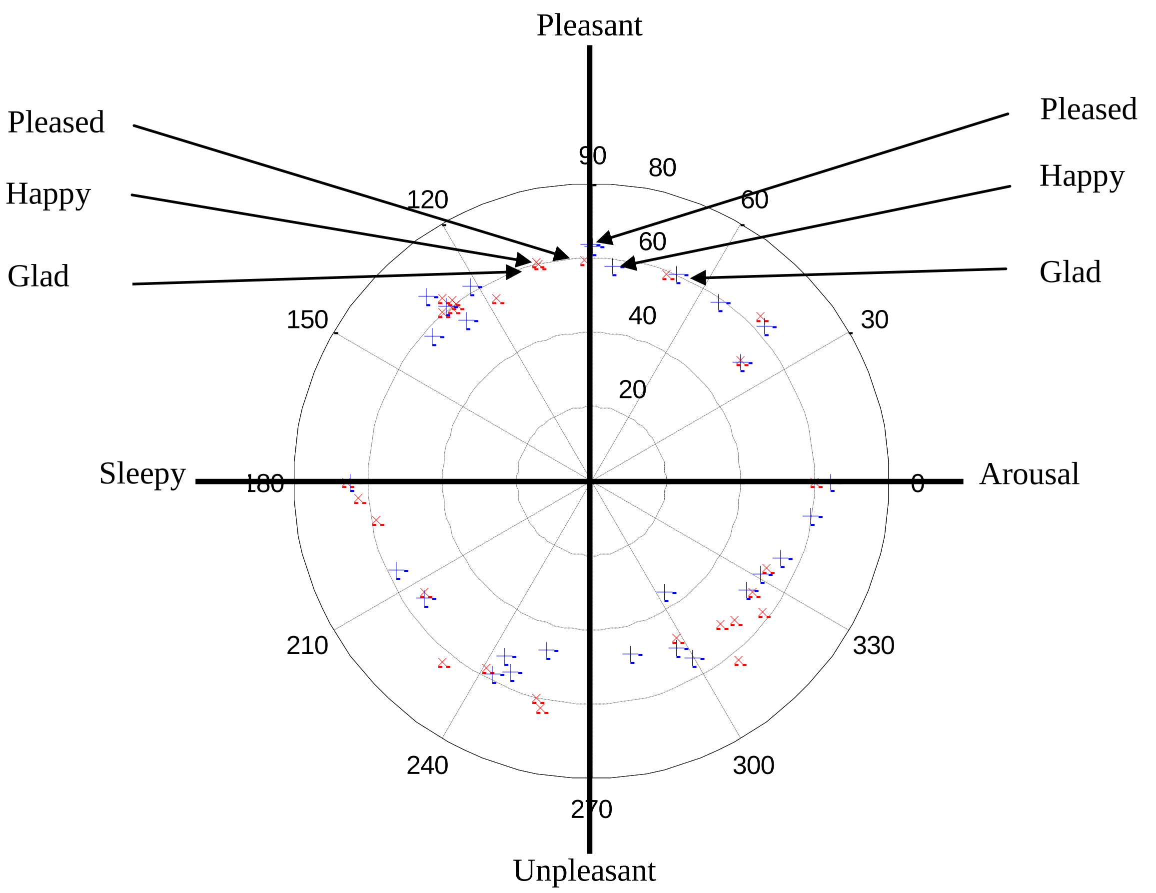


Figure 2a.



○ Russell’s 1980 model, × English constructed model, + Greek constructed model

Figure 2b.



× English constructed model, + Greek constructed model

Figure 3.