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Predicting Team Output Using Indices at Group Level

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The present study explores the usefulness of dyadic quantification of group characteristics to predict team work performance. After reviewing the literature regarding team member characteristics predicting group performance, percentages of explained variance between 3% and 18% were found. These studies have followed an individualistic approach to measure group characteristics (e. g., mean and variance), based on aggregation. The aim of the present work was testing whether by means of dyadic measures group output prediction percentage could be increased. The basis of dyadic measures is data obtained from an interdependent pairs of individuals. Specifically, the present research was intended to develop a new dyadic index to measure personality dissimilarity in groups and to explore whether dyadic measurements allow improving groups' outcome predictions compared to individualistic methods. By means of linear regression, 49.5 % of group performance variance was explained using the skew-symmetry and the proposed dissimilarity index in personality as predictors. These results support the usefulness of the dyadic approach for predicting group outcomes.
Keywords: interpersonal perception, dyadic measurements, team work, skew-symmetry index, dissimilarity in personality.

El presente estudio explora la utilidad de la cuantificación diádica de las características grupales para predecir el rendimiento en equipos de trabajo. Tras revisar la literatura relacionada con el estudio de las características de los miembros de un grupo para predecir el rendimiento grupal, se encontraron porcentajes de varianza explicada de entre el 3% y el 18%. Estos estudios han seguido el denominado enfoque individual, fundamentado en la agregación, para resumir las características de los grupos (e. g., media y varianza). El objetivo del presente estudio es poner a prueba si, mediante medidas diádicas se puede incrementar el porcentaje de predicción del rendimiento grupal. La base de las medidas diádicas son datos obtenidos a partir de pares de individuos interdependientes. Concretamente, en la presente investigación se pretende desarrollar un nuevo índice diádico para medir disimilitud en personalidad en grupos y verificar si las medidas diádicas mejoran la predicción del rendimiento grupal en comparación con las predicciones obtenidas mediante índices basados en la perspectiva individual. Mediante regresión lineal fue explicado el 49.5% de la variabilidad en el rendimiento grupal utilizando como predictoras las medidas tomadas mediante los índices diádicos de antisimetría y disimilitud en personalidad. Estos resultados apoyan la utilidad de la perspectiva diádica para predecir el rendimiento grupal.
Palabras clave: percepción interpersonal, medidas diádicas, trabajo en equipo, índice de antisimetría, disimilitud en personalidad.

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Team composition is the configuration of member attributes in a team (Levine & Moreland, 1990) and is thought to have an influence on team processes and outcomes (Kozlowski & Bell, 2003). Research concerning team composition can be categorized along three dimensions: characteristics of team members (e.g., number of team members, members' abilities, demographics, and personality traits), measurement of these characteristics, and the analytical perspective used to approach team composition (Levine & Moreland, 2006; Moreland & Levine, 1992). The most common analytical perspective considers team composition as a predictor of teamwork processes and outcomes and, therefore, team composition becomes of interest for both researchers and applied psychologists. The present study deals with the measurement of characteristics in work groups. Specifically, it is focused on the indices that have been used and, considering their drawbacks, two dyadic indices are proposed: a dyadic index for quantifying personality dissimilarity in groups and an application of the skew-symmetry index (Solanas, Salafranca, Riba, Sierra, & Leiva, 2006) to interpersonal perceptions in work groups.

Team-level composition variables show a particular problem since individual attributes are by definition at the individual level. On the contrary, the interest in team composition is in the unique combination of individuals who compose a team or how the individual-level variables are combined to reflect team-level properties (Mohammed, Mathieu, & Bartlett, 2002; Peeters, Van Tuijl, Rutte, & Reymen, 2006). It is likely that the relationship between team members' composition attributes and team performance will be moderated by how the construct is operationalized at the team level, with more appropriate team-level operationalizations of the constructs revealing stronger relationships between the team composition attributes and team performance (Arthur, Bell, & Edwards, 2007). Although research has specifically explored how different operationalizations of team composition variables affect team performance, results have been inconsistent across studies even when multiple operationalizations were used, that is, there is a lack of agreement about which is the best index to quantify group characteristics to predict team performance (Barrick, Stewart, Neubert, & Mount, 1998; Bolin & Neuman, 2006; Neuman, Wagner, & Christiansen, 1999). In fact, although a large amount of studies have found associations between personality traits and certain features of performance such as speed, quality, or quantity, correlation values between personality traits and group performance are not large enough for predictive purposes. For instance, results described in Hough's meta-analysis (1992) show percentages of explained variance of overall performance and effectiveness between 3% and 8%. For instance, achievement correlates .19 (3.6% of explained variance) with overall performance, − .19 (3.6% of explained variance) with irresponsible behavior, .27 (7.3% of explained variance) with sales effectiveness, and .21 (4.4% of explained variance) with effort. As for dependability, this correlates − .24 (5.8% of explained variance) with irresponsible behavior and .17 (2.9% of explained variance) with team work. Results in a recent meta-analysis showed similar mean correlations regarding personality variables predicting group performance in laboratory studies (Bell, 2007). The highest percentage of explained variance found among the studies reviewed is 18% and corresponds to agreeableness as a predictor of job performance (Neuman et al., 1999). As mentioned above, these empirical results seem to be insufficient to predict group performance using personality traits. Although there is empirical evidence about personality traits' effect on team performance, laboratory studies that follow the traditional measurement of group characteristics, that is, the individualistic approach, seemed to result in low predictions of team performance in terms of explained variance. Studies based on Social Network Analysis paradigm shown percentages of explained variance between 10% and 30% being more frequent the former results than the latter (Cummings & Cross, 2003; Hollingshead, McGrath, & O'Connor, 1993; Sparrowe, Liden, Wayne, & Kraimer, 2001).

Team Composition Variables Operationalization

The most common approach to specify the appropriate operationalization of team composition variables has been Steiner's typology (Steiner, 1972, cited in Bell, 2007). This strategy combines task type with several indices such as mean, variance, maximum, and minimum. In personality studies, mean and variance have traditionally been computed for operationalizing team composition constructs (Barrick et al., 1998). Specifically, Team Personality Elevation (TPE) and Team Personality Diversity (TPD) are the most common indices to measure team personality composition in relation to team performance (Neuman et al., 1999). TPE is a team's mean level on a particular trait of personality or set of personality traits and TPD corresponds to the variance among team members for a particular personality construct or set of constructs. Teams that are high in terms of TPD are referred to as heterogeneous, whereas teams with low TPD values are described as homogeneous. Peeters et al., (2006) showed how *Big Five's* TPE and TPD (in professional and student samples) affect team performance. For instance, based on their results, neither elevation nor variability in Extraversion influences team performance whereas the more similar team members were in Agreeableness, the better their teams perform. Furthermore, circumplex models of personality have worked with the terms *complementary* and *supplementary* among individuals. The former concept refers to individuals that are dissimilar in an attribute so they complement each other (e.g., dominance-submissiveness) and the latter denotes similarity in a specific trait. Similarity and dissimilarity along personality traits could result in

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different performance increasing individuals' satisfaction or cohesiveness among co-workers (Anderson & Tett, 2006).

However, according to Barrick et al. (1998), the mean score of individual measures is potentially problematic since aggregation can mask important information. Furthermore, computing mean values of a specific trait implies working under the assumption that the amount of the characteristic possessed by each individual increases the collective pool of this characteristic, regardless of how it is distributed within the group (Halfhill, Sundstrom, Lahner, Calderone, & Nielsen, 2005). A possible solution for overcoming central tendency drawbacks is computing indices based on discrepancy as variance. However, this index has several limitations since the upper bound depends on the values on the response scale which limits the comparison between different empirical studies. Furthermore, by squaring the difference between a value and the mean, this index provides a distorted view of the amount of dispersion (Roberson, Sturman, & Simons, 2007). A different approach focuses on the highest or lowest score of a personality trait that a group member obtains in a questionnaire and this value represents the whole group. This approach assumes that a single individual may significantly affect a group.

The abovementioned indices have been applied in group diversity research. Although there have been unclear descriptions about what diversity was along the scientific literature, Harrison and Klein (2007) classified the different ways to understand group differences and proposed a diversity typology: separation, variety, and disparity. Diversity as separation represents the differences among unit members along a single continuous attribute (e.g., perceptions, personality traits, attitudes, beliefs). Minimum separation occurs when all the members of a unit are at the same point along the attribute. Maximum separation corresponds to a situation where members are equally split at opposite points of the continuum. Indices recommended to measure separation are standard deviation and mean Euclidean distance. O'Reilly, Cadwell, and Barnett (1989) proposed the mean Euclidean distance of attribute dissimilarity of an individual team member. This index has traditionally been computed in demographic studies (Elfenbein & O'Reilly, 2007; Tsui, Egan, & O'Reilly, 1992; Tsui & O'Reilly, 1989). It should be noted that the maximum value depends on n (the number of group members) and the range of attributes measured and thus suitable comparisons and interpretations are not possible. Additionally, the mean Euclidean distance requires computing the squared difference for each pair of group members' scale values. Following O'Reilly et al. (1989), the squaring and the square-root operations make the mean Euclidean distance insensitive to the direction of a group member's distance from others in the group, without giving disproportionate weight to greater distances. However, the square-root of the sum of differences squared does not adequately capture the mean Euclidean distance among team members (Biemann & Kearney, 2009). It should be highlighted that insensitivity to the direction of the differences can be achieved by another mathematical function (i.e., absolute value function), not necessarily squaring differences. Particularly challenging is to properly define what disproportionate weights mean, although it is understandable that distance weightings will depend on scale ranges. In addition to the reasons mentioned above, it has been pointed out that the mean Euclidean distance shares a weakness with standard deviation since it cannot be compared across scales with different metrics.

The term variety is applied to member differences on a categorical attribute. Minimum variety occurs when all members belong to the same category and maximum when all members are uniformly distributed along the different categories. Indices recommended to quantify variety are Blau and Teachman (entropy) indices. Blau (1977, cited in Jackson et al., 1991) proposed an index of heterogeneity for categorical variables that varies from 0 (if all group members possess a characteristic) to 1 (if all group members do not possess it). However, the maximum value of this index depends on the number of categories and many researchers deal with quantitative instead of nominal scale measures. Teachman's entropy index (Shannon, 1948) has also been proposed for categorical variables. However, it shows the same problems as Blau's index and is further limited when the number of group members is less than the number of categories.

The disparity concept has been commonly employed in sociological studies (e.g., pay, power, income) to represent the differences in the distribution of a valued resource. Disparity is high when a low percentage of people (e.g., 5%) possess a great amount of a resource and a high percentage (e.g., 95%) owns a little. Indices recommended to quantify disparity are the coefficient of variation and Gini index.

Social psychology research on team performance has also mainly followed an individualistic approach. Social researchers have focused their attention on identifying those attributes or processes that influence team efficiency. This approach does not take into account environmental factors that may mediate social interactions. Conceptually, Tett and Murphy (2002) illustrated this phenomenon, regarding personality studies in work teams, explaining that personality can influence three levels of person-job fit: task level, group level, and organizational level. However, task-level fit (fitting people to a specific job task) has been the most studied level and group-level fit (matching people to their co-workers) has been largely ignored. Furthermore, Tett and Burnett (2003) proposed that certain tasks or situations facilitate specific trait expression highlighting that interaction between contextual factors and trait expression results in different performance. Interpersonal perceptions would be among these contextual

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factors (Kenny, 1994) since people's beliefs about others (i.e., family, friends, and teammates) guide them to explain and predict other people's behavior and determine social interactions. In fact, *Interdependence Theory* states this social phenomenon considering that in the context of a social relationship, the interaction that occurs between persons A and B is a function of both persons' respective tendencies in relation to each other in the particular situation of interdependence (Holmes, 2002). Therefore, the study of interpersonal perceptions in work groups may give significant information regarding group performance (Erber & Fiske, 1984; Neuberg & Fiske, 1987, Smeesters, Wheeler, & Kay, 2009). In the context of social psychology, the study of interpersonal perceptions has been carried out following the Social Relations Model methodology (SRM; Kenny, & La Voie, 1984). This model provides statistical techniques for making decisions regarding dependent data. Among the indices provided by the SRM (Kenny, 1994) two correlational measures of reciprocity can be obtained: generalized and dyadic. Generalized reciprocity is a correlation between an individual's tendency of acting, thinking, or feeling toward the group and group's tendency of acting, thinking, or feeling toward the individual. Dyadic reciprocity is a correlation between the individual relationship effects, which represent the individual's specific tendency to direct an action, thought, or feeling toward another individual (Lashley & Bond, 1997). The main drawback of this method is that it only detects levels of association but not differences in magnitude. Nevertheless, Holmes (2002) and Reis (2007) have pointed out that relationship research should be focussed on the dyadic forces that generate interpersonal behaviour. A possible solution is to apply the skew-symmetry index, Φ, (Solanas et al., 2006) to interpersonal perceptions among group members. This index considers discrepancies between group members and it can be generalized to scores obtained in an assessment questionnaire where group members' perception about the contribution of their partners on a group task is assessed.

Apart from the mean Euclidean distance, all the abovementioned indices follow an individualistic approach since the primary measures used for computing them are individual scores which are aggregated to obtain the indices themselves. Considering the most frequently used indices abovementioned, their limitations, and the results regarding team performance prediction, the aim of the present study is to propose dyadic indices to measure group characteristics. That is, to measure group' characteristics from an interdependent approach instead of a cumulative amount of characteristics. In the present study, traditional (TPE and TPD) and dyadic indices are applied to explore the percentage of group outcome prediction. Specifically, skew-symmetry index is applied to quantify interpersonal perceptions and a new index is proposed to quantify group personality dissimilarity. In the next section these indices are briefly introduced, since these measures are not yet conventional.

Group personality dissimilarity and Skew-symmetry indices

We propose a group personality dissimilarity index (λ), based on the comparison of the scores obtained in a personality questionnaire answered by a group (see Appendix I for further details). That is,

$$\lambda = \frac{\sum_{i=1}^{n}\sum_{j=i+1}^{n}\left|x_i - x_j\right|}{\delta\left(x_{\max} - x_{\min}\right)}, \qquad 0 \le \lambda \le 1$$

$$\delta = \begin{cases} \dfrac{n^2}{4} & \text{if } n \text{ is even.} \\ \dfrac{n^2-1}{4} & \text{if } n \text{ is odd.} \end{cases}$$

where x_i and x_j represent the score obtained in a personality factor by participant i and the participant j, x_{max} and x_{min} are the maximum and minimum scores of the personality scale, and n is the number of group participants. The index ranges from 0, for groups with identical scores in the personality scale measured, to 1, for groups with the maximum differences on the personality scale. This index is lower and upper bounded for any personality scale range and for any value of n. Therefore, it allows proper comparisons and interpretations. Comparing this index, in terms of computation, with those presented in the introduction, the most similar index is the mean Euclidean distance. However, computing absolute values differences, instead of squared differences, does not give disproportionate weights avoiding the added problem that presents the mean Euclidean distance. Following Harrison and Klein's typology (2007), the dissimilarity index is a measure of diversity in terms of separation, that is, a horizontal distance along a single continuum representing dissimilarity in a particular attribute. The computation of the dissimilarity index will be illustrated using fictitious Neuroticism data, measured using the *NEO-FFI* personality questionnaire (Costa & McRae, 2002), from four groups of four people. We will show the computation only in group *A*. Dissimilarity values will be compared with Neuroticism means in order to illustrate λ properties. Group *A* obtained 40, 41, 3, and 5 scores, group *B*, 22, 20, 21, and 23, group *C*, 2, 3, 4, and 1, and group *D*, 45, 46, 47, and 48. The personality scale ranges from 0 to 48, corresponding to x_{min} and x_{max}, respectively. Since four people compose each group, we use the even expression of δ and the computation is as follows:

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Group A (40, 41, 3, 5)

$$\lambda = \frac{|40-41|+|40-3|+|40-5|+|41-3|+|41-5|+|3-5|}{\frac{4^2}{4}(48-0)} = .78$$

$$\bar{X} = 22.25$$

Group B (22,20,21,23)

$\lambda = .05$

$\bar{X} = 21.5$

Group C (2, 3, 4, 1)

$\lambda = .05$

$\bar{X} = 2.5$

Group D (45, 46, 47, 48)

$\lambda = .05$

$\bar{X} = 46.5$

In this example, λ value equals .78 for group *A* and .05 for groups *B*, *C*, and *D*. The information reported by λ is that team members of *A* are quite dissimilar in terms of Neuroticism and members of *B*, *C*, and *D* are very similar regarding this trait. However, means reflect quite similar values for groups *A* and *B* and quite different results comparing *B*, *C*, and *D*. Considering all the information, mean and λ values, the conclusion will be that members of *B*, *C*, and *D* are quite similar (λ = .05) although scores are low for group C (= 2.5), medium for group B (= 21.5), and large for group *D* (= 46.5) in terms of Neuroticism. Hence, the proposed dissimilarity index is not affected by changes in location, that is, remains constant although mean values are quite different for groups B, C, and D. Finally, members of group *A* are rather different in this personality trait and mean does not reflect it since its mean value is close to that of group B. Note that the computation of the index is not more complex than the computation of other traditional indices.

The skew-symmetry index, Φ, is based on the decomposition of a sociomatrix **X**, where rows and columns refer to the actors making up the pairs, into its symmetrical and skew-symmetrical parts (Solanas et al., 2006). That is,

$$\mathbf{X} = \frac{\mathbf{X}+\mathbf{X}'}{2} + \frac{\mathbf{X}-\mathbf{X}'}{2} = \mathbf{S}+\mathbf{K}$$

where **S** is a symmetric matrix and **K** is a skew-symmetric matrix, respectively. The previous mathematical expression enables us to decompose the sum of squares into two parts, one due to symmetry and the other representing skew-symmetry. Given that **S** and **K** are orthogonal matrices, the cross-products are equal to 0 or, equally, tr(**SK**) = 0. Φ is computed by taking into account the ratio between the sum of squared values due to skew-symmetry and the total sum of squared values. The computation is as follows:

$$\Phi = \frac{tr(\mathbf{K'K})}{tr(\mathbf{X'X})} = \frac{\sum_{i=1}^{n}\sum_{\substack{j=1\\ j\neq i}}^{n} k_{ij}^2}{\sum_{i=1}^{n}\sum_{\substack{j=1\\ j\neq i}}^{n} x_{ij}^2}, \quad tr(\mathbf{X'X}) > 0; \quad 0 \le \Phi \le .5$$

where k_{ij} and x_{ij} denote, respectively, the elements of the matrices **K** and **X** and Φ ranges from *0* to *.5*. If Φ = 0, interpersonal perceptions are symmetric. If Φ value is close to *.5*, interpersonal perceptions show an appreciable asymmetry (for more details see Solanas et al., 2006). The computation of the skew-symmetry index will be illustrated with a fictitious interpersonal perception sociomatrix, **X**, obtained from a round robin questionnaire administered to a four-people group. Participants rated each other (from *1*, never, to *6*, always) on the item *"She/He fulfils the deadlines for finishing her/his work"*. **X** represents a sociomatrix in which rows and columns correspond to participants as actors and partners, respectively. The skew-symmetry index can be obtained by means of the following calculations:

$$\mathbf{X} = \begin{pmatrix} 0 & 6 & 5 & 4 \\ 3 & 0 & 5 & 2 \\ 1 & 3 & 0 & 5 \\ 2 & 6 & 3 & 0 \end{pmatrix}$$

$$\mathbf{K} = \frac{\mathbf{X}-\mathbf{X}'}{2} = \left(\frac{\begin{pmatrix} 0 & 6 & 5 & 4 \\ 3 & 0 & 5 & 2 \\ 1 & 3 & 0 & 5 \\ 2 & 6 & 3 & 0 \end{pmatrix} - \begin{pmatrix} 0 & 3 & 1 & 2 \\ 6 & 0 & 3 & 6 \\ 5 & 5 & 0 & 3 \\ 4 & 2 & 5 & 0 \end{pmatrix}}{2} \right) = \begin{pmatrix} 0 & 1.5 & 2 & 1 \\ -1.5 & 0 & 1 & -2 \\ -2 & -1 & 0 & 1 \\ -1 & 2 & -1 & 0 \end{pmatrix}$$

$$\Phi = \frac{\sum_{i=1}^{n}\sum_{\substack{j=1\\ j\neq i}}^{n} k_{ij}^2}{\sum_{i=1}^{n}\sum_{\substack{j=1\\ j\neq i}}^{n} x_{ij}^2} = \frac{2.25+4+1+2.25+1+4+4+1+1+1+4+1}{36+25+16+9+25+4+1+9+25+4+36+9} = \frac{26.5}{199} = 0.133$$

In this fictitious example, Φ is close to zero, but it cannot be assessed without making comparisons with another group or by considering a substantive criterion. Statistical significance of Φ can be obtained by means of SAS and R programs (Leiva, Solanas, & Salafranca, 2008).

Considering the drawbacks of the techniques that follow an individualistic approach, the SRM weaknesses, and the highest percentage of explained variance found (18%) for predicting team performance (Neuman et al., 1999), the present study is intended to test the following hypotheses:

Hypothesis 1: Compared with TPE and TPD, dyadic dissimilarity measures of group personality will present a stronger relationship with group outcomes.

Hypothesis 2: dyadic measures of interpersonal perceptions about group members participation will predict group outcomes.

Hypothesis 3: dyadic measures of interpersonal perceptions and dissimilarity measures of group personality considered together will account for a larger percentage of explained variance of group outcome than considering these variables separately.

Following Sundstrom, McIntyre, Halfhill, and Richards (2000), groups that participated in this study could be labelled as project groups since they carried out defined,

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specialized, time limited projects, and disbanded after finishing, that is, they carried out a specific agreement task, during limited time, and disbanded after finishing.

Method

Participants

64 under-graduate Psychology students, 25% men and 75% women, formed 16 groups of 4 people. The median and semi-interquartile range of age were 20 and 2, respectively. All the participants were members of the same university and received 30 USD for their collaboration.

Instruments

Foundation Task

The *Foundation Task* (Watson, 1987) is a problem solving task where participants have to integrate information to reach a solution to a problem taking the role of a person who has inherited an amount of money and allocating part or the whole amount of this money to some proposals according to personal values. This task was chosen due to Deutsch's research in 1951 (cited in Morris, 1966) where he found that groups were more active when discussing human problems, for which there is no single correct answer, than when solving a mathematical problem, for which there are unique answers. Considering that groups have not met before, the resolution of the *Foundation Task* provided participants with a pre-task situation that allowed them to start interacting with each other. Furthermore, interaction was enhanced requiring a report from each group summarizing the conclusions reached. Although this task has been traditionally used to study group decision strategies, in the present research the Foundation Task's final aim was to help participants to get accustomed to the methodology of the task: taking group decisions and allowing them to show each other their contribution as a group member. Since the present study is related to groups, only section III of the Foundation Task was applied. The main characteristic of this part is that it is a group activity where participants have to behave as a group to allocate an amount of money to some fictitious projects.

Dilemmas dossier

The *dilemmas dossier* consisted of 20 discussion texts concerning social issues in which participants had to reach agreements to decide how to solve a problem. For each one, three solutions were proposed. Two of them were opposite (e.g., solution 1 proposes "A" and solution 2 proposes "no A"). The third one was "we do not agree" and it was the same in all dilemmas. The third option was included in order to prevent groups collapse in a dilemma and provide them a solution to step to the next dilemma. In this task, the objective was to reach as many agreements as they could. An example of the dilemmas task is presented bellow and the dossier is available on request,

"Ramón Sampedro's case caused an enormous uproar in our country. After spending years completely motionless on the bed and fight legally to apply active euthanasia, he got someone to provide the means to help him die. He decided that his death was videotaped as an example of his fight for euthanasia.

Under Spanish law was not clear whether this fact should be considered as active euthanasia or assisted suicide, but there was the fact that both acts are punished in our country. For this reason, there was a legal investigation to find the person who had helped him. After a while, they stopped the investigation since there was no evidence to implicate anyone. Spanish public opinion followed the case through the media, which were settled controversy among supporters of the action of Sampedro and among its critics, who claimed that it was a homicide, although the victim consented.

If you had been a relative or a close friend of Ramón Sampedro, and he had asked you repeatedly to help him die, what would you have done?

- *We would have helped him …*
- *We would not have helped him …*
- *No agreement…"*

NEO-FFI

NEO-FFI is a reduced form of *NEO PI-R* questionnaire. It has 60 items and is based on the S form of the original *NEO PI-R* questionnaire. It consists of 5 scales of 12 items each that measure The Big Five factors of personality *Openness, Conscientiousness, Extraversion, Agreeableness,* and *Neuroticism* (Costa & McRae, 2002).

Task Evaluation Questionnaire

Following the methodology of other authors of this research tradition (Cook, 2005; Kenny, Mannetti, Pierro, Levi, & Kashy, 2002), a task evaluation questionnaire was created (Appendix II). The main objective of the questionnaire was to obtain information about how participants perceived each other in relation to how they contributed to solve the task, in other words, how their teammates performed in the task. It consisted of 7 items scored on a six-point Likert scale related to distribution of time, work method, decision making, information fitting, and communication style. These aspects are commonly measured in employee behaviour research (Williams & Anderson, 1991). Participants had to rate each other excluding themselves (round robin), that is, each participant had one questionnaire with all group member names except their own and he/she had to give a score on each one of the items of

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the test. Pooling the four questionnaires, an interpersonal perceptions sociomatrix could be constructed for each item.

Procedure

During the first month of the course, students were invited to participate in the study using a specific research board in where they are used to register to participate in the experiments and studies offered in the faculty. They registered and enrolled in groups of four people to carry out several activities in a laboratory. Once the groups were in the laboratory, participants were informed about the main purposes of the research and they signed the consent form. The session lasted two hours and it was divided into two parts. During the first part, they had to solve the *Foundation Task* and fill in the *NEO-FFI* personality questionnaire. They had 45 minutes for reasoning how to solve the *Foundation Task,* interacting with each other, and writing one page reporting their conclusions. After this activity, they were given the *NEO-FFI*; they had 15 minutes to answer this questionnaire. They had a break of ten minutes before the second part started. In this second part, they were given the dilemmas dossier and they had 45 minutes to reach as many agreements as they could. When time was up, they had 15 minutes for filling in the task evaluation questionnaire where they could score their teammates' performance on the second part of the task.

Data analysis

TPE, *TPD*, and dissimilarity indices of each personality factor were computed for all the groups using the scores of the *NEO-FFI* questionnaire. The skew-symmetry index was calculated for each item using the rates on the task evaluation questionnaire. The number of agreements obtained in the dilemmas dossier was taken as a measure of group outcome. A correlational analysis was performed to obtain the degree of association between the *TPE*, *TPD*, dissimilarity, skew-symmetry values, and the number of agreements in order to explore whether measures of interpersonal perceptions and personality were related to group outcome. As a result of this analysis, several linear regression analyses were carried out in order to test the three hypotheses of the present study: to test the first hypothesis, two regression analyses were carried out to show the contribution of personality indices to predict group outcome; the second hypothesis was tested conducting a regression analysis using Φ values to show the contribution of these values to the explanation of group performance variability; the third hypothesis was tested considering personality measures and Φ values that appeared as significant for testing hypotheses 1 and 2. The number of agreements obtained in the second part of the session (dilemmas task) was used as dependent variable in all analyses. A summary of the procedure and data analyses is shown in Figure 1.

PROCEDURE			DATA ANALYSIS
Explanation of the study and consent form signature			
START	*Foundation Task* *45 minutes*	*Indices computed*: - *Aim*: warm-up task.	
	NEO-FFI *15 minutes*	*Indices computed*: *TPD*, *TPE*, and dissimilarity index (λ) for each personality trait. *Aim*: obtain personality measurements by means of individual indices and the new dyadic index proposed.	Measurements for testing hypotheses 1 and 3. *TPD* and λ were introduced in the regression analyses as independent variables.
	BREAK *10 minutes*	*Aim*: avoid tiredness.	
	DILEMMAS DOSSIER *45 minutes*	*Measures*: number of agreements obtained as a group. *Aim*: obtain a quantification of team outcome.	The number of agreements was taken as an indicator of group performance and was introduced as dependent variable in the regression analyses for testing hypotheses 1, 2, and 3.
END	*TASK EVALUATION QUESTIONNAIRE* *15 minutes*	*Indices computed*: Skew-symmetry indices for each item (Φ_i) *Aim*: quantify interpersonal perceptions of team members by means of a dyadic index.	Measurements for testing hypotheses 2 and 3. Φ_i values were introduced as independent variables in the regression analyses.

Figure 1. Procedure and data analyses summary.

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Results

Table 1 shows the descriptive statistics for Φ values. In general, means and standard deviation values are low, being the maximum value .184 for Φ_5 (*She/He used the information given to solve the task*) and the minimum 0 for Φ_7 (*She/He took into account their teammates proposals*).

Table 2 shows descriptive statistics for the dissimilarity index of personality for each factor measured by the *NEO-FFI* questionnaire. In general, means and standard deviations were similar in all personality traits. Note that, if the random personality variables in the population are characterized by high density central areas, e. g., normal distribution, the obtained mean values are expected. Neuroticism was the personality factor for which the index of dissimilarity showed its maximum value, being .55, and the minimum value was .05 for Openness, Conscientiousness, and Extroversion.

Table 3 shows Pearson's correlation coefficients between Φ values of task evaluation questionnaire and group output, that is, the number of agreements reached in the dilemmas task. Φ values of item 1 "*She/He profited the time available to solve the task"* showed significant correlation with group output. Φ values of items 3, 4, and 5, that also correlated with near the same strength that Φ_1, fail to reach statistical significance. Table 3 also shows correlation coefficients among Φ values that seem to be high correlated among them.

Table 1
Descriptive statistics for Φ, where Φ_i are the skew-symmetry values of task evaluation questionnaire items

	Mean	*SD*	*Max.*	*Min.*	*Range*
Φ_1	.012	.013	.049	.001	.048
Φ_2	.014	.010	.033	.001	.032
Φ_3	.022	.021	.084	.003	.081
Φ_4	.014	.011	.037	.001	.036
Φ_5	.037	.044	.184	.004	.180
Φ_6	.017	.017	.075	.003	.072
Φ_7	.020	.015	.049	0	.049

Table 2
Descriptive statistics for dissimilarity index of personality, where λ_O, λ_C, λ_E, λ_A, and λ_N represent dissimilarity values of Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism, respectively

	Mean	*SD*	*Max.*	*Min.*	*Range*
λ_O	.21	.09	.34	.05	.29
λ_C	.28	.14	.51	.05	.46
λ_E	.27	.10	.46	.05	.41
λ_A	.21	.10	.42	.08	.34
λ_N	.31	.14	.55	.07	.48

Table 3
Pearson's correlations between Φ values and group output (agreements reached in the dilemmas task) where Φ_i are the skew-symmetry values of task evaluation questionnaire items

	Group output	Φ_1	Φ_2	Φ_3	Φ_4	Φ_5	Φ_6
Φ_1	−.56*						
Φ_2	−.22	.26					
Φ_3	−.49	.73**	.59*				
Φ_4	−.46	.39	.54*	.77**			
Φ_5	−.46	.78**	.42	.89**	.75**		
Φ_6	.01	−.05	.66**	.42	.54*	.29	
Φ_7	−.38	.23	.44	.46	.41	.48	.30

* Significant at .05 ** Significant at .01

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In order to test hypothesis 1, the correlation analysis carried out to explore the possible relationship between *TPE*, *TPD*, λ of personality factors and group output, showed significant correlation values for *TPD* and λ in Neuroticism ($r_{TPD_N,\ number\ of\ agreements} = -.52$, $p < .05$, $r_{\lambda_N,\ number\ of\ agreements} = -.55$, $p < .05$, respectively). Regarding TPE measures, any of them showed significant correlations and, therefore, TPE values were not considered in the regression analyses carried out to explore the usefulness of these values for predicting group output. As it is shown in Table 4, *TPD* and λ correlated significantly ($r = .97$, $p < .01$) among them which is an indicator that both indices are measuring the same dimension. A test to determine the significance of the difference between $r_{TPD_N,\ number\ of\ agreements}$ and $r_{\lambda_N,\ number\ of\ agreements}$ considering $r_{TPD_N,\ \lambda_N}$ was carried out (Cohen & Cohen, 1975) but the difference was not significant ($t = -.623$, $p = .272$).

Concerning the prediction of group output by means of aggregated measures or dissimilarity index of personality, two separate linear regression analyses were carried out using *TPD* and λ in Neuroticism as a predictors. Conducting separate regression analyses allows exploring the percentage of explained variance that each of these indices accounts for since they were highly correlated among them. λ in Neuroticism accounts for 30.8% and *TPD* of Neuroticism accounts for 26.9% of group output variance. Regression coefficients and confidence intervals are shown in Table 5.

In order to test hypothesis 2, regarding the prediction of group output by means of Φ values of interpersonal perceptions, a linear regression analysis was carried out using Φ values of item 1 as independent variable and group output as dependent variable. Φ_1 accounted for 31.4% ($b = -152.61$, $t = -2.53$, $p < .05$) of group output variance. Confidence interval for the unstandardized regression coefficient ranges from −281.96 to −23.26.

In order to test hypothesis 3, a multiple regression analysis was carried out following the stepwise method. This procedure was chosen due to the significant results obtained regarding personality measurements in the exploratory correlational analysis, that is, *TPD* and λ in Neuroticism correlated $r = .97$ among them. For this regression analysis, Φ values of item 1 of the task evaluation questionnaire, *TPD* in Neuroticism, and λ values in

Table 4

Pearson's correlations between TPD and λ values and group output (agreements reached in the dilemmas task) where TPD_O, TPD_C, TPD_E, TPD_A, TPD_N and λ_O, λ_C, λ_E, λ_A, λ_N represent variance and dissimilarity values of Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism, respectively

	Group output	TPD_O	TPD_C	TPD_E	TPD_A	TPD_N	λ_O	λ_C	λ_E	λ_A
TPD_O	.39									
TPD_C	−.01	.15								
TPD_E	−.38	−.43	.11							
TPD_A	−.28	−.49	−.04	−.28						
TPD_N	−.52*	−.05	.29	.12	.09					
λ_O	.42	.98**	.18	−.36	−.56*	−.04				
λ_C	.06	.16	.97**	.14	−.18	.26	.19			
λ_E	−.29	−.49	.01	.97**	−.24	.03	−.41	.05		
λ_A	−.22	−.47	−.02	−.29	.97**	.12	−.51*	−.16	−.26	
λ_N	−.55*	−.03	.31	.20	.01	.97**	−.02	.28	.08	.05

* Significant at .05 ** Significant at .01

Table 5

Separate regression analyses concerning the prediction of group output by means of aggregated measures (TPD_N) and dissimilarity values of personality (λ_N) of Neuroticism

Model	Unstandardized coefficients		*t*	95% Confidence interval	
	b	*SE*		lower limit	upper limit
Intercept	11.12	1.87	5.95**	7.11	15.12
λ_N	−13.91	5.57	−2.50*	−25.85	−1.96
Intercept	9.25	1.32	7.03**	6.24	12.07
TPD_N	−.03	.014	−2.27*	−.061	−.002

* Significant at .05 ** Significant at .01

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Table 6
Regression analysis for testing hypothesis 3 using asymmetry values of item 1 (Φ_1) and dissimilarity values (λ_N) of Neuroticism as predictors of group output

Model	Unstandardized coefficients		*t*	95% Confidence interval	
	b	*SE*		lower limit	upper limit
Intercept	11.63	1.67	6.95**	8.02	15.25
Φ_1	−121.84	55.54	−2.19*	−241.83	−1.84
λ_N	−11.04	5.11	−2.16*	−22.07	−.001

* Significant at .05 ** Significant at .01

Neuroticism were introduced as predictors of group output, that is, the number of agreement reached in the dilemmas task. A model with Φ values of item 1 and λ in Neuroticism values explain together 49.5% of group outcome variance. Φ values of item 1 accounted for 31.4% of group outcome variance and including λ in Neuroticism this percentage increases 18.1%. *TPD* in Neuroticism was excluded of the model since it does not account for more variance percentage than λ index. Furthermore, as it is shown in Table 6 the sign of regression coefficients showed a negative relationship between predictors and dependent variable. That is, as asymmetry in interpersonal perceptions regarding profiting the time available to solve the task and dissimilarity in Neuroticism increase, the number of agreements reached in the dilemmas task decreases.

Discussion

Overall, regarding the main objective of this study, dyadic indices (Φ and λ) seem to improve the percentage of variance explained for predicting group output, reaching 49.5% of variability explained using these dyadic measures. After computing individualistic and dyadic statistics (*TPE, TPD*, and λ) for each personality factor and introducing them in the regression analyses, conclusions concerning hypothesis 1 are three. First, central tendency indices (*TPE*) were not related to group outcome in a laboratory context. Second, *TPD* in Neuroticism accounted for a significant percentage of explained variance and λ index accounted for larger percentage of explained variance. Furthermore, the correlation between *TPD* and λ index shows that both indices are measuring the same dimension but the latter is upper and lower bounded and allows comparing groups of different size and variables with different metrics. However, the percentages of explained variance obtained by means of *TPD* (26.9%) and λ (30.8%) in the present study should be considered as they were equal since the result of a test to determine whether TPD_N correlates with group output to a significantly greater degree than λ_N was not significant. Third, it seems that the proposed dyadic index for personality traits based on comparisons between team members' scores allows obtaining significant percentages of group outcome prediction and is a proper way for transforming individual measurements into a group composition variable avoiding the drawbacks of central tendency statistics (Neuman et al., 1999). Additionally, concurring with Harrison and Klein (2007), the choice of a diversity index should be driven by the theoretical specification of diversity type. Once the specification is done, some indices could be applied to gather information about groups. The choice should be conditioned on the purpose of the study, that is, if the aim of the study is to compare groups of different size or characteristics with different metrics, the proposed dissimilarity index should be computed. Nevertheless, if the research is not intended to carry out comparisons among groups other indices could be used, e. g., *TPD*. Although it was not implicit in hypothesis 1, our results concur with Tett and Burnett's (2003) interactionist model combining the Big Five and the extant situational models for the social level since Neuroticism is the most representative trait for cooperative/participative work teams. Furthermore, circumplex models of personality state that in some cases similarity is desirable in interpersonal relations and sometimes dissimilar personality fulfills mutual needs. Both similarity a dissimilarity conditions have found support regarding increasing individuals' satisfaction and cohesion which are positively related to team performance (Dryer & Horowitz, 1997; Dyce & O'Connor, 1992; Morse & Cadwell, 1979; Mullen & Cooper, 1994). The results of the present study show that as dissimilarity values in Neuroticism increase, group output decrease. Therefore, groups more similar in Neuroticism performed better in this task than groups more dissimilar in this particular personality trait. This is a key point of the meaning of dissimilarity since groups high in Neuroticism perform similarly to groups low in this trait. That is, the focus is on *being similar* independently of the specific point of the scale (low, medium, high). This idea concurs with circumplex models of personality that concentrate their efforts in the study of the combination of personality traits among team participants.

Regarding the second hypothesis of this study, the dyadic measure of interpersonal perceptions seems a useful predictor of group outcome since a large percentage of explained variance was obtained in comparison with results found in the literature revised. Using Φ values of item 1 *"She/He profited the time available to solve the task"*, 31.4% of

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group outcome variance was explained. The results of the present study show that a dyadic approach to the study of group performance seems to improve results for predicting team performance in a laboratory context. Furthermore, it seems that interpersonal perceptions quantified by means of Φ index have an influence on group outcome. In this specific context, as asymmetry in interpersonal perception increases, group output decreases. These results support Kenny's proposal about interpersonal perceptions (1994). This kind of social perception guide people to explain and predict other people's behavior and determine social interactions. The present results show that interpersonal perceptions seem to have an influence on final group output. As it has been abovementioned, some studies have found support to outcome dependency on impression formation (Neuberg & Fiske, 1987) and expectations about others (Erber & Fiske, 1984). More recently, Smeesters, Wheeler, and Kay (2009), have demonstrated how several factors, e. g., highly other-focus, determine when interpersonal mechanisms are more likely to drive behavior. Similarly, recent evidence suggests that people infer others' goals from behaviors without conscious intent (Hassin, Aarts, & Ferguson, 2005). The results of the present study seem to add to the growing body of knowledge regarding interpersonal processes for understanding work teams.

Concerning the third hypothesis, our results suggest that taking into account both measures of group characteristics, dissimilarity in personality traits and asymmetry of interpersonal perceptions about group performance, the percentage of team output explained variance is higher than considering these variables separately. A model for predicting team performance would be defined by using the information reported by λ and Φ dyadic indices. In the present study, the percentage of explained variance increases when both variables were considered together reaching 49.5%. It seems that interpersonal perceptions regarding profiting the time available to solve the task results in a different amount of output. Furthermore, Neuroticism also influences the final group output. Among the core facets of Neuroticism are anxiety and vulnerability that are related to coping with stressing situations which are usually time limited. Therefore, independent variables introduced in the regression model, λ in Neuroticism and Φ of profiting time available to solve the task, seem to be conceptually related. In fact, the task that groups have to accomplish was time limited and the aim was reaching as many agreements as they could and, therefore, it seems reasonable that *similarity* in Neuroticism and *symmetric* perceptions about profiting time available to solve the task could predict together 49.5% of group output. These results concur with Hong's (1999) study that examined the relationship between test anxiety, perceived test difficulty, and test performance founding that worrying had a strong inverse relationship with performance. The results of the present research contribute to Tett and Burnet's (2003) personality interactionist model of job performance since give some evidence regarding the interaction of task type, personality traits, the kind of work group, situational, and contextual factors that influence team outcomes.

It has been highlighted that social processes and measurements, e.g., group performance, are seldom predicted with significant accuracy and that it may be due to the use of unsuitable indices (Baker & Salas, 1992). According to Bell (2007), it seems that the composition variable and team performance relationships are moderated by the operationalization of the composition variable to the team level. Group indices should consider more information than aggregation of measures in order to report more representative information of groups. Specifically, the need of indices founded on dissimilarities has been suggested to study group performance (Cooke, Salas, Cannon-Bowers, & Stout, 2000). The proposed index for measuring personality dissimilarity was developed taking into consideration this suggestion. In fact, the index is a dissimilarity measure since the larger the dyadic discrepancy between team members is, the larger the dyadic dissimilarity is. The product-moment correlation coefficient is often obtained to quantify similarity of personality attributes on pairs of individuals, although it should be noted that this statistic is invariant for changes in location if a constant is added to each value of a variable in the pair. The result will be the same if each value of a variable in the pair is multiplied by a constant. Interestingly, if a constant is added to all values of a variable, the discrepancy in personality will clearly increase. Hence, an additional improvement of the proposed index consists in founding people similarity on personality measurements on the discrepancy between pairs of values. In fact, this comparative advantage is common to other indices of personality heterogeneity, as the mean Euclidean distance, although the main drawback of the latter is that does not allow comparing variables with different metrics. This problem is solved by using the proposed index for measuring personality dissimilarity. In addition, the present study has empirically verified that the proposed index correlates with the TPD, therefore, it is a new measurement in accordance with the common quantifications for studying personality in groups.

Regarding the main limitations of the present study, several aspects should be considered for future research. The first one deals with the low values obtained by means of the skew-symmetry index. The skew-symmetry index was developed for frequency matrices and the Task Evaluation Questionnaire was measured in a Likert scale, ranging from 1 to 6. Results of the present research suggest that a specific index for quantifying variables measured in a Likert scale should be developed since it would allow obtaining more adequate interpersonal perception measurements. The second drawback deals with sample size. This problem is reflected, for instance, in the correlation

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between Φ_5 and the number of agreements reached in the dilemmas task, which correlate nearly with the same strength as Φ_1 with agreements reached in the dilemmas task, but fail to reach statistical significance. These results suggest that more Φ values would appear as significant if sample size is increased. Sample size problem is also shown by the range of regression coefficients' confidence intervals; increasing sample size, parameter estimation would be more accurate. Sample size also limits the strength of the conclusions regarding the techniques applied to test the hypotheses of the present study. However, following Cohen (1988), post hoc power tests were carried out for product moment *r* of hypotheses 1 and 2 and for the multiple regression analysis for testing hypothesis 3. Results for the product moment *r* (hypotheses 1 and 2) for $r_{\lambda_N,\ number\ of\ agreements} = -.55$, $r_{TPD_N,\ number\ of\ agreements} = -.52$, and $r_{\Phi_1,\ number\ of\ agreements} = -.56$ showed power values between .53 and .73 (for $\alpha = .05$ and $n = 16$). Results for multiple regression showed that with an $R^2 = .49$, $n = 16$, and, two independent variables, for $\alpha = .05$, the power of the F test ranges between .88 and .92. Another limitation of the present research is related to ecological validity since the study has been carried out under a quite controlled situation in a laboratory context with undergraduate students. This context limits the scope of the results which should be interpreted in a preliminary way. In this sense, although social dilemma games have been widely applied in social psychology research (e. g., Hertel & Fiedler, 1994; Kay & Ross, 2003; Utz, Ouwerkerk, & Van Lange, 2004) to study cooperative decision-making behavior, choosing an unique criterion of group output (the number of agreements reached in the dilemmas task) limits the scope of the present results. In future studies, both qualitative and quantitative criteria should be taken to represent group output.

The proposed index for measuring dissimilarity in personality should be developed in future research in several features. Firstly, the index must be defined in a general form, that is, it should be conjointly applied for an arbitrary number of personality scales and thus enabling researchers to estimate specific personality scales contributions. Secondly, dyadic and individual effects should be extracted to suitably analyse data at all levels. Moreover, the analytical procedure for extracting dyadic and individual contributions to dissimilarity is not feasible for the mean Euclidean distance. Thirdly, statistical decision methods are necessary at all analysis levels to make proper conclusions, that is, statistical procedures should be developed in order to test hypothesis regarding dissimilarity in personality.

Finally, the present study shows that the quantification of group characteristics by means of dyadic methods results in a larger percentage of group performance prediction. Furthermore, a dissimilarity index for quantifying personality in groups is proposed. Future research should focus on applied contexts and larger samples to confirm that the dyadic approach is useful outside the laboratory. Moreover, other kind of groups (e. g., action teams, service teams) should be considered in future research in order to explore the usefulness of these dyadic indices with not decision making teams. The improvement in group performance degree of prediction should be replicated in natural settings since the obtained results cannot be directly generalized to uncontrolled environments. In fact, although the study was designed to resemble a natural interaction framework as much as possible, the participants were volunteers and the assessment procedure departed from realistic situations in work teams. Hence, further research is needed to test the hypotheses of the present study in natural settings.

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APPENDIX I

Dissimilarity in personality index

Suppose that n individuals have been measured on a psychological characteristic (e.g., Openness to experience) and consider that the psychological scale takes values between x_{min} and x_{max}, respectively, corresponding to scale's minimum and maximum values. Hence, the scores for the n individuals can be represented by the vector (x_1, x_2, …, x_n), where x_i denotes the attribute score for the ith individual. The degree of global discrepancy among individuals' scores in the psychological scale can be obtained as follows:

$$y = \sum_{i=1}^{n} \sum_{j=i+1}^{n} \left| x_i - x_j \right|$$

Note that the expression equals zero if all measurements are identical and takes larger values as the discrepancy among scores increases. That is, the expression is lower-bounded since it is equal to zero if all values are the same. On the contrary, it is not upper-bounded, as the maximum value depends on the number of individuals and scale's minimum and maximum values. Therefore, a potentially useful index founded on the previous mathematical expression should be developed in such a way that both its minimum and maximum values are known. Hence, it is necessary to determine the maximum value for y in order to obtain a standardized index of dissimilarity in personality. Firstly, suppose that n is even. For n = 2, it should be noted that the maximum value for y is obtained when the scores are at the minimum and maximum values of the psychological scales, that is, x_{min} and x_{max}. If n = 4, the maximum value for y is reached when half of scores are at the minimum value of the scale and the remaining ones at its maximum. This result can be generalized for increasing even values of n. The greatest difference between scores (i.e., $|x_{max} - x_{min}|$) will take place when half of the scores ($n/2$) are x_{min} and the other half ($n/2$) are x_{max}. In such a case there would be $n/2$ x $n/2 = n^2/4$ comparisons that would lead to the greatest dissimilarity possible. Therefore, the maximum value for y is as follows:

$$\frac{n^2}{4}\left(x_{\max} - x_{\min}\right)$$

Secondly, suppose that n is odd. We know from the previous result that $(n - 1)/2$ scores must be equal to x_{min} and $(n - 1)/2$ must equal x_{max} for y be maximum. Thus, we only need to determine the value of the remaining score for obtaining the maximum value of y. It should be noted that this value can be located at any admissible point of the scale and the value of y will remain unchanged, considering that moving that value farther from x_{min} would make it more similar to x_{max} and vice versa. Hence, we can suppose that $(n - 1)/2$ and $(n + 1)/2$ scores are respectively at the minimum and the maximum of the scale to obtain the maximum value of y. Therefore, the maximum value for y is as follows:

$$\frac{n^2}{4}\left(x_{\max} - x_{\min}\right)$$

Now the index of dissimilarity in personality can be written as follows:

$$\lambda = \frac{\sum_{i=1}^{n} \sum_{j=i+1}^{n} \left| x_i - x_j \right|}{\delta\left(x_{\max} - x_{\min}\right)}, 0 \le \lambda \le 1$$

$$\delta = \begin{cases} \dfrac{n^2}{4} & \text{if } n \text{ is even} \\ \dfrac{n^2 - 1}{4} & \text{if } n \text{ is odd} \end{cases}$$

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APPENDIX II

Task Evaluation Questionnaire

ITEM	Partner 1	Partner 2	Partner 3	Partner 4
1. She/He profited the time available to solve the task.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
2. She/He participated actively to solve the task (e.g., sharing her/his point of view, debating, and searching for solutions).	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
3. She/He made decisions to reach the best results.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
4. She/He explained clearly her/his ideas.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
5. She/He used the information given to solve the task.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
6. Her/His dialogue was useful for solving the task.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
7. She/He took into account their teammates proposals.	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

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