Interpersonal perception, personality, and academic achievement: a dyadic approach for the study of undergraduate performance

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Título: Percepción interpersonal, personalidad y rendimiento académico: un enfoque diádico para el estudio del rendimiento de los estudiantes universitarios.
Resumen: El presente trabajo trata sobre la cuantificación de características grupales mediante índices diádicos. Concretamente, el objetivo del presente estudio fue explorar la posible relación entre indicadores diádicos e individuales de percepción interpersonal y personalidad y el rendimiento académico en grupos de trabajo en un contexto académico real. 88 estudiantes universitarios formaron 22 grupos de cuatro personas para llevar a cabo un trabajo de curso. Tras trabajar juntos durante el semestre, los participantes contestaron a un *Cuestionario de Percepción Interpersonal* y al cuestionario de personalidad *NEO-FFI* y el trabajo de curso fue evaluado. Los resultados muestran que algunos índices diádicos de percepción interpersonal están asociados a las puntuaciones obtenidas en el trabajo de curso. Además, se propone un modelo de regresión exponencial que explica el 50.3% de la variabilidad en las notas de los grupos. Los resultados para predecir el rendimiento en grupos encontrados en la literatura científica, siguiendo una perspectiva individual, no son mayores de 18%. Los resultados del presente estudio concuerdan con resultados previos obtenidos en un contexto de laboratorio y dan apoyo a la perspectiva diádica para el estudio de grupos.
Palabras clave: análisis diádico; grupos de trabajo; rendimiento académico; *NEO-FFI*.

Abstract: The present work deals with the quantification of group characteristics by means of dyadic indices. Specifically, the aim of the present study was to explore whether dyadic and individual measures of interpersonal perceptions and personality could be related to academic achievement when dealing with project groups in a real academic setting. 88 undergraduate students formed 22 groups of four people to carry out a course report. After working together throughout the semester, participants filled in an *Interpersonal Perception Questionnaire* and *NEO-FFI* and the course report was assessed. Results showed that some dyadic measurements of interpersonal perceptions are associated to the marks obtained in the course report. Furthermore, an exponential regression function is proposed accounting for 50.3% of group marks variance. The predictive results found in the scientific literature revised, that follows an individualistic approach, are no larger than 18%. The results of the present study concur with previous results obtained in a laboratory context supporting the usefulness of the dyadic approach for the study of groups.
Key words: dyadic analysis; project groups; academic achievement; *NEO-FFI*.

Introduction

The study of academic achievement has traditionally emphasized the role of teachers producing knowledge and its implementation in students' curriculum focussing on variables such as intelligence as a determinant of academic success (Harris, 1940). However, recent research on factors that influence academic success is focused on relatively modifiable predictors such as approaches to learning, personality, attitudes, perceived control, motivation, subjective norms, or intentions (Armitage, 2008; Diseth, 2003; Mas-Tous & Medinas-Amorós, 2007; Wagerman & Funder, 2007). An important promoter of these studies is related to educational organizations' concerns about creating a GPA (Grade Point Average) predictive model and defining colleges' admission criteria. Results have shown successful percentages of academic achievement explained variance using both traditional and new variables (Laidra, Pullmann, & Allik, 2007). These studies have mainly worked with individuals exploring relationships among variables that mediate academic achievement. In terms of Tett and Murphy (2002), this is a *task-level fit* approach since consist in fitting people characteristics to a specific task. The aim of the present study was to explore

the relationship between small academic groups' achievement and interpersonal perceptions and personality traits quantified with dyadic indices, specifically with skew-symmetry (Solanas, Salafranca, Riba, Sierra, & Leiva, 2006) and dissimilarity indices. Following Tett and Murphy's (2002) conceptualization, this is a *group-level fit* approach since the focus is on the matching of a person to his or her co-workers. In fact, previous results showed the usefulness of computing dyadic indices for predictive purposes (Andrés, Salafranca, & Solanas, 2008) when dealing with group performance. Specifically, these traits quantified with dyadic indices accounted for 49.5% of group performance whereas the same traits quantified with indices based on aggregation (as mean or variance) were unrelated to group performance or accounted for a lower percentage of group output. Nevertheless, these results were obtained by means of a laboratory task in a controlled context and need to be explored in a real interaction context. In the present study an academic context was considered to explore the relationship between the above-mentioned traits quantified by means of dyadic indices and group academic achievement.

Team composition measurement

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

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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). Team composition measurement (the configuration of member attributes in a team) has traditionally been carried out by means of central tendency statistics and diversity indexes (Harrison & Klein, 2007). Working with central tendency indices as mean is potentially problematic since aggregation can mask important information, e. g., outliers' effect. 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 this drawback is computing indices based on dispersion as standard deviation or mean Euclidean distance. Although these indices are upper bounded (Harrison & Klein, 2007) they do not allow comparing group characteristics with different metrics or groups of different size (Biemann & Kearney, 2009). Furthermore, in the case of standard deviation squaring the difference between a value and the mean provides a distorted view of the amount of dispersion in a set of values that is not completely eliminated by computing the squared root of the sum of the squares (Roberson, Sturman, & Simons, 2007). Despite these drawbacks, mean and standard deviation are the most frequent indices computed in personality studies and are called Team Personality Elevation (TPE) and Team Personality Diversity (TPD) (Barrick, Stewart, Neubert, & Mount, 1998). A different approach focuses on the highest or lowest score of a 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 main weakness of this method is that outliers can considerably bias group measurements. O'Reilly, Cadwell, and Barnett (1989) proposed the abovementioned mean Euclidean distance for measuring distances in an attribute among individuals in a team. However, it should be noted that its maximum value depends on the number of group members and on the range of attributes measured and thus suitable comparisons and interpretations are not possible. This index has traditionally been computed in demographic studies (Elfenbein & O'Reilly, 2007; Tsui, Egan, & O'Reilly, 1992; Tsui & O'Reilly, 1989).

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 catego-

ries and many researchers deal with quantitative instead of nominal scale measures. Teachman's entropy index, originally proposed by Shannon in 1948, has also been recommended for categorical variables (Harrison & Klein, 2007). However, it shows the same problems as Blau's index and they are further limited when the number of group members is less than the number of categories. The coefficient of variation has also been used as a measure of heterogeneity. 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.

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 (Barrick et al., 1998; Bolin & Neuman, 2006; Neuman, Wagner, & Christiansen, 1999). For instance, a large amount of studies have found associations between personality traits and certain features of performance such as speed, quality, or quantity, but correlation values are not large enough for predictive purposes (Bell, 2007; Hough, 1992). In fact, the highest percentage of explained variance for predicting team output found in the scientific literature was 18% (Neuman et al., 1999). Furthermore, regarding variables that account for academic achievement, in some studies the same variable is positively associated with academic achievement and in other studies this relationship is negative. For instance, Cano-García and Hughes (2000) found that academic achievement was positively related to intellectual style and Grigorenko and Sternberg (1997) found a negative relationship between these variables. Bernardo et al. (2009) found that intellectual styles account for around 10% of the variance of academic achievement. It seems that these studies are focussed on exploring whether the relationship between a predictor variable and academic achievement is positive or negative. These studies are based on individuals' achievement and they cannot take into account how the variable is distributed within a team.

As it has been mentioned before, dyadic indices explained a higher percentage of group performance variance in a laboratory task than traditional indices as mean or variance. Furthermore, in a small university context, skew-symmetry index explained jointly with Social Relations Model indices (Kenny, 1994) the 85% of group performance in an academic task (Sierra, Andrés, Solanas, & Leiva, in press). A small university context is here defined as a university centre where students know each other and create working groups that usually perform together along the degree. The most representative characteristic of this kind of groups is that is not easy to avoid responsibilities since if someone is expelled from the group is unlikely to found another work group for the next semester. In the present study the possible relationships between the dyadic measurements and academic achievement were explored at a large university con-

text. Complementary to a small university context, a large university context is defined here as an overcrowded university centre where students do not know each other and working groups usually disband after finishing a subject. Contrary to working groups in a small university context, avoiding responsibilities towards the team is not so punished and it is likely to find another working group to perform along the degree. This kind of groups are called, in scientific literature, project groups since they carried out defined, specialized, time limited projects, and disbanded after finishing (Sundstrom, McIntyre, Halfhill, & Richards, 2000). In the present study, interpersonal perception and personality were measured in these groups using skew-symmetry and dissimilarity indices. These statistics are briefly presented since they are not yet conventional.

Skew-symmetry and Group personality dissimilarity 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:

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

where k_{ij} and x_{ij} denote, respectively, the elements of the matrices **K** and **X** and Φ ranges from *0* to *.5*. In the context of interpersonal perceptions, if $\Phi = 0$, 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).

Dissimilarity index (λ) of personality is based on the comparison of the scores obtained in a personality questionnaire answered by a group. That is,

$$\lambda = \frac{\sum_{i=1}^{n} \sum_{j=i+1}^{n} |x_i - x_j|}{\delta \quad x_{\max} - x_{\min}}, \qquad 0 \leq \lambda \leq 1$$

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

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 participants of the team. 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 but the proposed index is based on the computation of absolute values differences, instead of squared differences, and it does not give disproportionate weights avoiding the added problem that presents the mean Euclidean distance.

Considering individualistic indices drawbacks, the highest percentage of team performance explained variance found (18%, Neuman et al., 1999), and previous results in the laboratory context following a dyadic approach (49.5%), the present study explores the usefulness of dyadic measurements of interpersonal perceptions and personality for predicting work team performance in a natural context, specifically, in an academic context. The main aim is to explore whether higher percentages of group performance explained variance could be obtained by means of dyadic measurements. Furthermore, recent research oriented to the study of performance in higher education have found percentages of grades explained variance that range between 14% and 23% (Kennett & Keefer, 2006; Kennett & Van Gulick, 2001; Kennett & Reed, 2009). According to these authors, academic resourcefulness directly predicted grades, accounting for 20% of the variance in students' performance. Torenbeeka, Jansen, and Hofman (2010) found that social integration contact (with teachers or with fellow students) was indirectly related to achievement. The exploration of group members' interpersonal perceptions and personality by means of dyadic indices may be useful for understanding variability in group grades in higher education and could contribute to the growing body of knowledge in this field.

Method

Participants

88 undergraduate students of Psychology enrolled in a methodological first course subject accepted to participate in the study, 81% of them were women and 19% were men. The participants formed 22 groups of four people to work together along the semester. The mean and semi-interquartile range of age were 19.7 and 1.5, respectively. Written consent was obtained from participants and who did not want to participate were free to decline.

Instruments

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 dyadic research tradition (Cook, 2005; Kenny, Mannetti, Pierro, Levi, & Kashy, 2002), a task evaluation questionnaire was created (Appendix I). 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 mates performed in the task. It consisted of *7* items scored on a Likert scale related to distribution of time, work method, decision making, information fitting, and communication style. Participants had to rate each other excluding themselves (round robin design), that is, each participant had one questionnaire with all the group member names except theirs and he/she had to give a score on each one of the items of the test. Pooling the four questionnaires, an interpersonal perceptions sociomatrix can be constructed for each item.

Procedure

Students did a work in groups of four people as a part of the subject. The work consisted in carrying out some statistical analyses with a data matrix and answering some questions regarding the results obtained. They had to hand out a written report with their answers at the end of the course. This report was assessed from 0 to .75 as a part of their formative assessment. The mark obtained in this report was taken as an indicator of group achievement. As it was a group work, all group members obtained the same mark. Furthermore, they filled in *NEO-FFI* and *Task Evaluation*

Questionnaire after submitting the written report, that is, after working together along the semester.

Data Analysis

TPE, TPD, and λ indices were computed for each personality trait using the scores obtained in *NEO-FFI*. Φ index was computed for each item of the *Task Evaluation Questionnaire*. An exploratory correlation analysis was conducted in order to evaluate the strength of the relationship between variables measured with individual and dyadic indices and the marks obtained in the group report. Spearman rank's correlation coefficients were computed since the aim was to explore linear or nonlinear monotonic relationships. Due to the results obtained in the correlation analysis and the visual inspection of the scatter plots, a nonlinear monotonic function was proposed as a descriptive model and percentages of explain variance were obtained.

Results

Table 1 shows descriptive statistics for Φ values. Mean and standard deviation values are low, being the maximum value .132 for Φ_1 *(She/He profited the time available to solve the task)* and the minimum 0 for Φ_2 *(She/He participated actively to solve the task, e.g., sharing her/his point of view, debating, and searching for solutions)* and Φ_7 *(She/He took into account their mates proposals)*.

Table 1. Descriptive statistics for Φ, where Φ_i are the asymmetry values of *Task Evaluation Questionnaire* items.

	Mean	SD	Max.	Min.	Range
Φ_1	.028	.031	.132	.003	.129
Φ_2	.034	.033	.113	.000	.113
Φ_3	.033	.030	.104	.004	.100
Φ_4	.037	.032	.099	.004	.095
Φ_5	.024	.021	.082	.003	.079
Φ_6	.035	.027	.090	.004	.086
Φ_7	.017	.015	.047	.000	.047

Table 2 shows descriptive statistics for λ values of personality traits. Neuroticism was the personality trait with the highest λ value, being .49, and the minimum value was .05 for Extroversion.

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	.20	.11	.39	.07	.32
λ_C	.21	.09	.39	.06	.33
λ_E	.22	.09	.39	.05	.34
λ_A	.19	.08	.39	.08	.31
λ_N	.27	.11	.49	.08	.41

Table 3 shows Spearman's rank correlation coefficients between Φ indices and marks obtained in the group task. Φ values of item 3 *(She/He made decisions to reach the best results)* and 5 *(She/He used the information given to solve the task)* showed

significant correlations with marks obtained in the group task. Results regarding personality measures did not show significant correlations.

Table 3. Spearman's Rank correlation coefficients between Φ values and marks obtained in group task where Φ_i are the asymmetry values of task evaluation questionnaire items.

	Φ_1	Φ_2	Φ_3	Φ_4	Φ_5	Φ_6	Φ_7
Φ_1	-						
Φ_2	.776**	-					
Φ_3	.746**	.892**	-				
Φ_4	.742**	.752**	.685**	-			
Φ_5	.608**	.682**	.764**	.751**	-		
Φ_6	.811**	.845**	.884**	.632**	.617**	-	
Φ_7	.546**	.411	.500*	.178	.336	.583**	-
Marks	.260	.354	*.431*	.332	*.564***	.193	.279

**Correlation in significant at .01. *Correlation in significant at .05.

Visual inspection of Figure 1 suggests that a monotonic nonlinear model could represent the relationship of these pairs of variables. Furthermore, visual inspection of these graphics suggests that an exponential function could be a suitable solution to obtain data fitting. However, Figure 1 shows that groups 3, 19, and 21 are out of this monotonic nonlinear tendency and therefore the regression model has been computed with and without these groups in order to explore the change in the percentage of explained variance. That is, although these groups could not be considered outliers, they may affect parameter estimating and model fitting (increasing the sum of squares of the residual) due to their distance to the regression curve. Whether these groups affect the model, the percentage of explained variance would change obtaining a lower value.
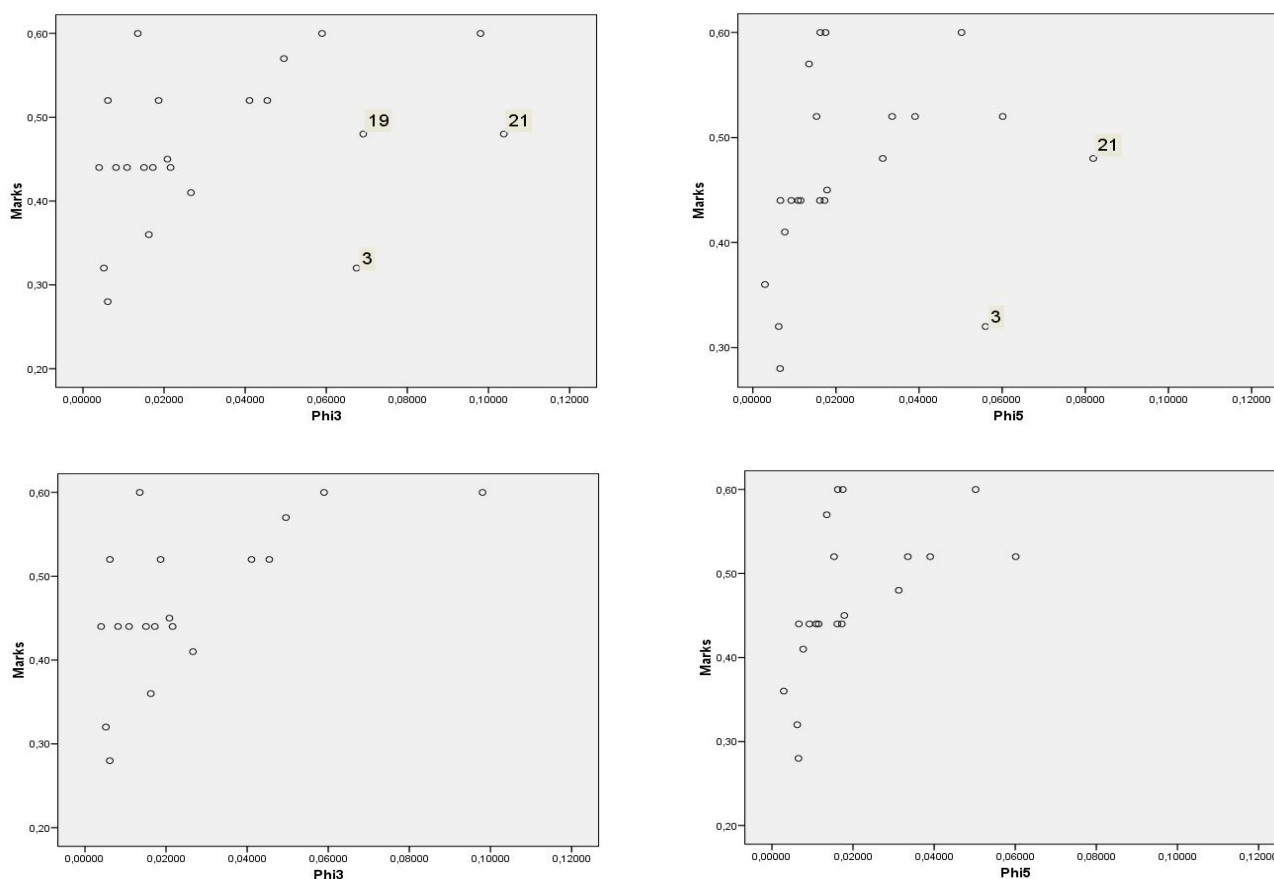

Figure 1. *Upper panel*: bivariate distribution of Φ values of item 3 (left), *She/He made decisions to reach the best results* and 5 (right), *She/He used the information given to solve the task,* and marks obtained in the group task for 22 groups. *Lower panel*: bivariate distribution of Φ values of item 3 (left), *She/He made decisions to reach the best results* and 5 (right), *She/He used the information given to solve the task,* and marks obtained in the group task for 19 groups and 20 groups, respectively. Numbers inside the graphics (3, 19, and 21) are groups that are excluded for regression fitting.

The exponential function is as follows:

$$M = .75 - \alpha\, e^{-\beta \phi_i}$$

where M represents group marks in the written report, .75 represents an asymptotic value (since it is the maximum value of the dependent variable), α is a value for which .75 − α corresponds to the intercept, β is a scale parameter on Φ_i (skew-symmetry values of an specific item) and thus governs the rate of change. Initial parameter values were specified to start the iteration process to estimate parameters and convergence criteria were established at 10^{-8}. The method used

to parameter estimation was Levenberg-Marquardt. There is general agreement that, in practice, Levenberg-Marquardt algorithms have been proved to be general-purpose algorithms for least-squares problems and generally are robust and work well (Seber & Wild, 1989).

As it is shown in Table 4, *Φ* values of item 3 account for 14.6% of group marks variance considering all of the groups. However, when model fitting is carried out excluding the groups 3, 19, and 21, the percentage of explained variance increased up to 43.1%. That is, *Φ* values of item 3 account for 43.1% of the variance of group marks. Table 3 shows that the relationship between *Φ* values of item 3 and group marks is positive, which means that as asymmetry in

interpersonal perceptions increases, group marks increase too. Similarly, *Φ* values of item 5 account for 8% of group marks variance before excluding groups 3 and 21. *Φ₅* accounts for a higher percentage of explained variance, 36.5%, when these groups are excluded from the regression analysis. These results are shown in Table 5. Table 3 shows that the relationship between *Φ* values of item 5 and group marks is positive, which also means that as asymmetry in interpersonal perceptions increases, group marks increase too. Thus, as larger the asymmetry as regards making decisions to reach the best results and using the information given to solve the task is, better results in the group task are obtained.

Table 4. Nonlinear regression analysis regressing marks obtained in the group task on *Φ₃* values considering 22 groups (left) and nonlinear regression analysis regressing marks obtained in the group task on *Φ₃* values considering 19 groups, that is, excluding groups 3, 19, and 21 (right).

Regression for all groups n = 22					Regression excluding group 3, 19, and 21 n = 19				
Regressor	Parameter Estimation		SE	R²	Regressor	Parameter Estimation		SE	R²
Φ₃	a	.329	.030		*Φ₃*	a	.362	.031	
	b	1.445	2.54			b	11.075	3.727	
				.146					.431

Table 5. Nonlinear regression analysis regressing marks obtained in the group task on *Φ₅* values considering 22 groups (left) and nonlinear regression analysis regressing marks obtained in the group task on *Φ₅* values considering 20 groups, that is, excluding groups 3 and 21 (right).

Regression for all groups n = 22					Regression excluding group 3 and 21 n = 20				
Regressor	Parameter Estimation		SE	R²	Regressor	Parameter Estimation		SE	R²
Φ₅	a	.321	.032		*Φ₅*	a	.371	.035	
	b	4.895	3.688			b	15.784	5.353	
				.080					.365

Φ₃ and *Φ₅* are associated with group marks. Furthermore, Table 3 shows that the Spearman's rank correlation value between *Φ₃* and *Φ₅* is .76 (p < .01). Hence, a model in which *Φ₃* and *Φ₅* were jointly entered as independent variables was analyzed. The equation is as follows:

$$M = .75 - \alpha e^{-\beta_3 \phi_3 + \beta_5 \phi_5}$$

The additive model using *Φ₃* and *Φ₅* as regressors accounts for 50.3% of group marks variance excluding groups 3, 19, and 21 (b₃ = 7.637, SE= 4.321 and b₅ =9.518, SE= 6.364). It seems that as asymmetry in both regressors increases, group marks increase too. The small increase in the percentage of explained variance (from 43.1% to 50.3%) is due to *Φ₃* and *Φ₅* are related among them.

Discussion

Overall, regarding the aim of the present study some considerations should be made. First, it seems that in a large university context only two measures of skew-symmetry were related to the marks obtained in a group task (*Φ* values of item 3, *She/He made decisions to reach the best results,* and *Φ* val-

ues of item 5, *She/He used the information given to solve the task*). Using separately these skew-symmetry values, an exponential function is proposed to model the relationship between these dyadic measures and the results obtained in a group task (marks in the written report) obtaining percentages of explained variance between 36.5 % and 43.1% when using *Φ* values of item 5 and *Φ* values of item 3, respectively. A model using both predictors has been proposed too accounting for 50.3% of group marks variance. These percentages are higher than the percentages found in the scientific literature regarding group performance prediction (that range between 3.6% and 18%, see Hough's meta-analysis, 1992 and Bell's meta-analysis, 2007). These results partially support the main aim of the study since none of the personality measures (TPD, TPE, or λ) was related to group marks. Although the percentages of explained variance obtained in the present study are lower than the ones obtained in a laboratory context (Andrés et al., 2008), they are still higher than the ones found in the scientific literature. In fact, the percentages found in the scientific literature would be the lowest, followed by the results of the present study and the highest would be the results obtained in the laboratory context. It seems that the percentage of group performance explained variance increase as measurements go from

an individualistic to a dyadic approach. Furthermore, as it has been mentioned above, recent results regarding percentages of grades explained variance in higher education context range between 14% and 23%. Taking into account these data, the present findings could be a contribution to the growing body of knowledge on higher education processes since they help to explain a high percentage of academic achievement.

The results of the present study have both theoretical and practical implications. On one hand, considering that the study of groups in academic context is largely ignored, the present results contribute to the understanding of small groups achievement when dealing with course projects. Interaction among group members generates asymmetrical interpersonal perceptions that seem to have an influence on final group marks. On the other hand, these relational variables could be useful for monitoring group academic development in order to prevent from undesirable effects of asymmetrical workload. Furthermore, detection of asymmetry in interpersonal perception about team mates collaboration in course works could be beneficial for both teachers and students. Teachers could mentor work groups and detect problems of coordination, such as unfair distribution of workload among group members. Students could realize whether they have similar perceptions regarding how different group members are contributing to the shared work.

Another contribution of the present research is the nonlinear function proposed for modeling the relationship between dyadic measurements of interpersonal perceptions and academic group achievement. Ayán, García, and Howard (2008) have pointed out that linear regression is not always the most appropriate model for predicting students' achievement in higher education since logistic regression may lead to higher predictive results. Furthermore, Horwitz and Horwitz (2007) suggested that an important line of research in team diversity field regarding their effects on team performance lies in exploring the possible nonlinear relationship between diversity and similarity in teamwork since there is tendency of viewing this constructs as mutually exclusive. There is an increasing interest in the study of the potential curvilinear relationship between diversity/similarity and team performance. In fact, the inverted U model and the upright U model have been proposed to investigate the effects of team diversity on teamwork. Jetten, Spears, and Manstead (1998) supported the inverted U model arguing that a balance between team members differences and similarities maximizes the organizational output. In contrast, Earley and Mosakosky (2000) defended the upright U model suggesting that giving sufficient time, both similar and dissimilar teams are likely to be more effective than moderately heterogeneous teams. In previous studies, linear models have been proposed to describe the relationship between values obtained by means of dyadic indices and group output (Andrés et al., 2008; Sierra et al., in press). However, in the present study visual inspection suggested that a nonlinear model could be more suitable in a large university context. That is, when asymmetry is close to 0 group participants perceive the contribution of their mates to the global task as symmetrical. In this situation, team members are likely working together and they reach a specific mark. However, as asymmetry is closer to .5 and group members perceive their mates' contribution more and more asymmetrical, a team member could lead the group task to obtain the best results working alone. In this situation, the group is likely not working together and some members are avoiding responsibilities. Perhaps, in this scenario, avoiding responsibilities is shown by asymmetry values. In this context, the relationship between asymmetry in interpersonal perceptions and final group performance is not linear. In fact, these results concur with other studies on intrateam coordination field. This construct focuses on task coordination within the team, that is, teams have high intrateam coordination when they are interdependent and members depend on each other for information, materials, and reciprocal inputs. This kind of teams encourage team members to work together closely and develop shared expectations and norms for appropriate behavior. High intrateam coordination creates high interdependence among team members and some research studies have shown that interdependence among team members can exhibit a curvilinear relationship with collective performance (e. g., Saavedra, Earley, & Van Dyne, 1993; Stewart & Barrick, 2000; Wageman, 1995). High and low levels of interdependence correspond with higher performance than moderate levels of interdependence and, therefore, performance varies nonlinearly with these forms of interdependence (Stewart, 2006). The results of the present study concur with Horwitz and Horwitz's (2007) suggestion of studying nonlinear relationships between team diversity and team performance, although the relationship between dyadic measures of interpersonal perceptions and group performance did not fit a specific U shape model.

Although the present study was not aimed to propose conceptual or theoretical background about group dynamics, some considerations about the meaning of the items entered in the regression model should be made. Relational variables, as interpersonal perceptions, seem to have an influence on group academic achievement. Specifically, items included in the model (item 3, *She/He made decisions to reach the best results* and item 5, *She/He used the information given to solve the task*) seem to reflect some leadership characteristics. Schmuck & Schmuck's definition of leadership in classrooms stated that "leadership consist of actions by group members that aid in setting group goals, moving the group towards its goals, improving the quality of the interactions among the members, building the cohesiveness of the group, or making individual competencies available to the group" (Schmuck & Schmuck, 1975, pp. 27). Items that entered in the regression analysis show a close relationship to this definition of leadership. However, leadership was not quantified by *NEO-FFI* and, perhaps, this is the reason for explaining that any personality trait significant correlated with marks obtained in a real academic task neither when

TPE, TPD, nor dissimilarity index for personality were computed. In fact, a practical interpretation of these results could fit with Tett and Guterman's concept of situation trait relevance (2000). This concept deals with the opportunity for trait expression, that is, "the behavioral expression of a trait requires arousal of that trait by trait-relevant situational cues" (Tett & Guterman, 2000, pp. 398). Perhaps this academic situation has not provided cues for Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism expression.

Regarding the limitations of this study some aspects should be considered for future studies. The first one deals with the low values obtained with skew-symmetry index. The skew-symmetry index was developed for frequency measures and the Task Evaluation Questionnaire was measured in a Likert scale. The results of the present study 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 one is related to *NEO-FFI* choice for measuring personality traits. Perhaps, another questionnaire that considers other personality traits would be more suitable in a real context where maybe other traits as leadership, would be a key aspect in this interaction setting. Another important aspect that should be considered for future research deals with sample size. Although significant relations were found and an exponential model has been proposed, sample size should be increased to obtain more precise parameter estimation. Sample size also limits the strength of the conclusions regarding the statistical techniques applied to obtain percentages of explained variance.

To sum up, the present study shows that the quantification of asymmetry of interpersonal perceptions in academic work teams measured by means of a dyadic index accounts for group academic achievement. Although further research should be carried out to explore the nonlinear process underlying group performance, this study adds to the growing body of knowledge regarding group measurement and performance. In fact, the application of Φ index to quantify interpersonal perceptions to academic work groups could help both students and teachers along the learning process since these measurements could be applied to quantify peer evaluations. In fact, peer evaluation makes teacher and students conscientious about how the team performs on a task in order to evaluate their perceptions about mates' contribution and, if it is necessary, intercede to guide the learning process. This kind of evaluation is increasingly being applied to make organizational decisions and to provide team members with performance feedback (Greguras, Robie, & Born, 2001). Therefore, a dyadic index that quantifies asymmetry of team members' perception about performance can help to quantify accurately peer evaluation in academic or organizational settings. Finally, although the present study mainly addresses methodological issues concerning individual and dyadic measures in group research, some applied consequences have also been highlighted to monitor undergraduate students' activities in small groups. Methodological and applied aspects of the present study could be of interest for researches interested in measurement of students' traits and for higher education professionals.

References

Andrés, A., Salafranca, Ll., & Solanas, A. (2008, July). *Social reciprocity and group performance.* Poster session presented at the III European Congress of Methodology, Oviedo, Spain.

Ayán, M., García, M., & Howard, V. (2008). Prediction of university students' academic achievement by linear and logistic models. *The Spanish Journal of Psychology, 11,* 275-288.

Armitage, C. J. (2008). Cognitive and effective predictors of academic achievement in schoolchildren. *British Journal of Psychology, 99,* 57-74.

Arthur, W., Jr., Bell, S. T., & Edwards, B. D. (2007). A longitudinal examination of the comparative criterion-related validity of additive and referent-shift consensus operationalizations of team efficacy. *Organizational Research Methods, 10,* 35-58.

Barrick, M. R., Stewart, G. L., Neubert, M. J., & Mount, M. K. (1998). Relating member ability and personality to work-team processes and team effectiveness. *Journal of Applied Psychology, 83,* 377-391.

Bell, S. T. (2007). Deep-level composition variables as predictors of team performance: A meta-analysis. *Journal of Applied Psychology, 92,* 595-615.

Bernardo, A. B., Núñez, J. C., González-Pienda, J. A., Rosário, P., Alvarez, L., González-Castro, P., et al. (2009). Intellectual styles and academic achievement: A developmental perspective. *Psicothema, 21,* 555-561.

Biemann, T., & Kearney, E. (2009). Size does matter: How varying group sizes in a sample affect the most common measures of group diversity. *Academy of Management Proceedings,* 1-6.

Bolin, A. U., & Neuman, G. A. (2006). Personality, process, and performance in interactive brainstorming groups. *Journal of Business & Psychology, 20,* 565-585.

Cano-García, F., & Hughes, E. H. (2000). Learning and thinking styles: An analysis of their interrelationship and influence on academic achievement. *Educational Psychology, 20,* 413-430.

Cook, W. L. (2005). The SRM approach to family assessment: An introduction and case example. *European Journal of Psychological Assessment, 21,* 216-225.

Costa, P. T., Jr., & McRae, R. R. (2002). *Manual NEO PI-R.* Madrid: Tea Ediciones.

Diseth, Á. (2003). Personality and approaches to learning as predictors of academic achievement. *European Journal of Personality, 17,* 143-155.

Early, P. C., & Mosakowski, E. (2000). Creating hybrid team cultures: An empirical test of transactional team functioning. *Academy of Management Journal, 43,* 26-49.

Elfenbein, H. A., & O'Reilly, C. A., III. (2007). Fitting in: The effects of relational demography and person-culture fit on group process and performance. *Group & Organization Management, 32,* 109-142.

Greguras, G. J., Robie, C., & Born, M. P. (2001) Applying the social relations model to self and peer evaluations. *Journal of Management Development, 20,* 508-524

Grigorenko, E. L., & Sternberg, R. J. (1997). Styles of thinking, abilities, and academic performance. *Exceptional Children, 63,* 295-312.

Harris, D. (1940). Factors affecting college grades: A review of the literature, 1930-1937. *Psychological Bulletin, 37*, 125-166.

Harrison, D. A., & Klein, K. J. (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations. *Academy of Management Review, 32*, 1199-1228.

Halfhill, T., Sundstrom, E., Lahner, J., Calderone, W., & Nielsen, T. M. (2005). Group personality composition and group effectiveness: An integrative review of empirical research. *Small Group Research, 36,* 83-105.

Horwitz, S. K., & Horwitz, I. B. (2007). The effects of team diversity on team outcomes: A meta-analytic review of team demography. *Journal of Management, 33*, 987-1015.

Hough, L. M. (1992). The 'big five' personality variables-construct confusion: Description versus prediction. *Human Performance, 5*, 139-154.

Jackson, S. E., Brett, J. F., Sessa, V. I., Cooper, D. M., Julin, J.A., & Peyronnin, K. (1991). Some differences make a difference: Individual dissimilarity and group heterogeneity as correlates of recruitment, promotions, and turnover. *Journal of Applied Psychology, 76,* 675-689.

Jetten, J., Spears, R., & Manstead, A. S. (1998). Defining dimensions of distinctiveness: Group variability makes a difference to differentiation. *Journal of Personality and Social Psychology, 74,* 1481-1492.

Kennett, D.J., & Keefer, K. (2006). Impact of learned resourcefulness and theories of intelligence on academic achievement of university students: An integrated approach. *Educational Psychology, 26*, 441–457.

Kennett, D. J., & Reed, M. J (2009). Factors influencing academic success and retention following a 1st-year post-secondary success course, *Educational Research and Evaluation, 15,*153-166.

Kennett, D.J., & Van Gulick, C. (2001). Dealing with academic success and failure: The

association between learned resourcefulness, explanatory style, reported grades and sharing experiences with academic self-control. In D.J. Kennett & A.M. Young (Eds.), *Notes on applied statistical methods in psychology integrating STATISTICA software (pp.325–354).* Peterborough, Canada: Trent University Press.

Kenny, D. A. (1994). *Interpersonal perception. A social relations analysis.* New York: The Guilford Press.

Kenny, D. A., Mannetti, L., Pierro, A., Livi, S., & Kashy, D. A. (2002). The statistical analysis of data from small groups. *Journal of Personality and Social Psychology, 83*, 126-137.

Laidra, K., Pullmann, H., & Allik, J. (2007). Personality and intelligence as predictors of academic achievement: A cross-sectional study from elementary to secondary school. *Personality and Individual Differences, 42*, 441-451.

Mas-Tous, C., & Medinas-Amorós, M. (2007). Motivaciones para el estudio en universitarios. *Anales de Psicología, 23,* 17-24.

Mohammed, S., Mathieu, J. E., & Bartlett, A. L. (2002). Technical-administrative task performance, leadership task performance, and contextual performance: Considering the influence of team- and task-related composition variables. *Journal of Organizational Behavior, 23*, 795-814.

Neuman, G. A., Wagner, S. H., & Christiansen, N. D. (1999). The relationship between work-team personality composition and the job performance of teams. *Group Organization Management, 24,* 28-45.

O'Reilly, C. A., III, Cadwell, D. F., & Barnett, W. P. (1989). Work group demography, social integration, and turnover. *Administrative Science Quarterly, 34,* 21-37.

Peeters, M. A. G., Van Tuijl, H. F. J. M., Rutte, C. G., & Reymen, I. M. M. J. (2006). Personality and team performance: A meta-analysis. *European Journal of Personality, 20*, 377-396.

Roberson, Q. M., Sturman, M. C., & Simons, T. L. (2007). Does the measure of dispersion matter in multilevel research? A comparison of the relative performance of dispersion indexes. *Organizational Research Methods, 10,* 564-588.

Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. *Journal of Applied Psychology, 78,* 61-72.

Schmuck, R. A., & Schmuck, P. A. (1975). *Group processes in the classroom. (2nd ed).* Oxford England: Wm. C. Brown.

Seber, G. A. F., & Wild, C. J. (1989). *Nonlinear regression.* New York: John Willey & Sons.

Sierra, V., Andrés, A., Solanas, A., & Leiva, D. (in press). Agreement in interpersonal perceptions as a predictor of group performance. *Psicothema.*

Solanas, A., Salafranca, Ll., Riba, C., Sierra, V., & Leiva, D. (2006). Quantifying social asymmetric structures. *Behavior Research Methods, 38*, 390-399.

Stewart, G. L. (2006). A meta-analytic review of relationships between team design features and team performance. *Journal of Management, 32*, 29-55.

Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of Management Journal, 43*, 135-148.

Sundstrom, E., McIntyre, M., Halfhill, T., & Richards, H. (2000). Work groups: From the Hawthorne studies to work teams of the 1990s and beyond. *Group Dynamics: Theory, Research, and Practice*, 4, 44-67.

Tett, R. P., & Guterman, H. (2000). Situation trait relevance, trait expression, and cross-situational consistency: Testing a principle of trait activation. *Journal of Research in Personality, 34*, 397-423.

Tett, R. P., & Murphy, P. J. (2002). Personality and situations in coworker preference: Similarity and complementary in worker compatibility. *Journal of Business and Psychology, 17,* 223-241.

Torenbeeka, M., Jansen, E. & Hofman, A. (2010). The effect of the fit between secondary and university education on first-year student achievement. *Studies in Higher Education, 35,* 659-675.

Tsui, A. S., Egan, T. D., & O'Reilly, C. A., III. (1992). Being different: Relational demography and organizational attachment. *Administrative Science Quarterly*, 37, 549-579.

Tsui, A. S., & O'Reilly, C. A., III. (1989). Beyond simple demographic effects: The importance of relational demography in superior-subordinate dyads. *Academy of Management Journal, 32*, 402-423.

Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly, 40,* 145-180.

Wagerman, S. A., & Funder, D. C. (2007). Acquaintance reports of personality and academic achievement: A case for conscientiousness. *Journal of Research in Personality, 41,* 221-229.

Appendix I. 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 mates 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