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AN EXPERIMENTAL STUDY OF COOPERATION IN A NATURAL SETTING

UN ESTUDIO EXPERIMENTAL DE LA CONDUCTA DE COOPERACIÓN EN UNA SITUACIÓN NATURAL

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ABSTRACT

During the last several decades research in social behavior has allowed to differentiate at least two different types of interactions: cooperation and competition. Specifically, several attempts have been made to predict and explain cooperative behavior. Typically, it has been studied using artificial situations (e.g. Azrin & Lindsley, 1956; Cohen & Lindsley, 1964; Lindsley, 1966; Mithaug & Burgess, 1967, 1968; Schmitt, 1987; Schmitt & Marwell, 1968; Shimoff & Matthews, 1975), being the most typical matrix games like the Prisoner's Dilemma, but recent studies have incorporated more naturalistic situations. Following the research initiated by Ribes-Iñesta (Ribes-Iñesta, 2001; Ribes-Iñesta & Rangel, 2002) we show how a computerized puzzle-solving task can be used to improve our knowledge of dyadic interactions, as minimal settings representative of social behavior. In three studies, the candidates for a job position could cooperate or not cooperate with another candidate by helping with the other's puzzles. Results show that the behaviors could be classified in three groups: non-cooperation, graded cooperation, and systematic cooperation. These behavioral tendencies were highly consistent throughout the

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task and reasonably stable after a one-year interval. Their distribution is not independent of gender; females show a higher frequency of non-cooperative behavior than of systematic cooperation, whereas males show the reverse. These results are in accordance with recent reports in the literature (e.g. Kurzban & Houser, 2001). As previous studies, we demonstrate that the tendency to cooperate is influenced by the cooperative tendency of the others.

Key words: social behavior, cooperation, dyadic interaction, prisoner's dilemma

RESUMEN

La investigación realizada en el ámbito del estudio de la conducta social ha permitido diferenciar, cuando menos, dos tipos diferentes de interacción, a saber, conducta cooperativa vs. competitiva. Más específicamente, un buen número de estudios se han centrado en el estudio de los factores que permiten predecir y explicar la conducta de cooperación. Habitualmente estos estudios se han servido del uso de situaciones de experimentación artificiales (e.g. Azrin & Lindsey, 1956; Cohen & Lindsey, 1964; Lindsey, 1966; Mithaug & Burgess, 1967, 1968; Schmitt, 1987; Schmitt & Marwell, 1968; Shimoff & Matthews, 1975), como por ejemplo el dilema del prisionero. Sin embargo, estudios más recientes han hecho uso de situaciones con mayor validez ecológica. A partir de lo estudios descritos por Ribes-Iñesta (Ribes-Iñesta, 2001; Ribes-Iñesta & Rangel, 2002), se desarrolló una tarea por computadora (rompecabezas) para el estudio de interacciones sociales diádicas. Se presentan tres estudios en los que una muestra de candidatos a un puesto de trabajo podían elegir entre cooperar o no hacerlo con su compañero en la tarea de resolución del rompecabezas. Los resultados muestran que es posible clasificar a los participantes en tres grupos: no cooperadores, cooperadores graduales y cooperadores sistemáticos. Estos patrones de interacción fueron altamente consistentes durante la tarea y razonablemente estables tras un año de evaluación. Sin embargo, se observó un efecto del sexo de los participantes, de tal suerte que las mujeres mostraron una mayor frecuencia de patrones de no cooperación que de cooperación sistemática, de manera opuesta a la tendencia que se observó en los varones. Estos resultados son coherentes con resultados recientes (e.g. Kurzban & Houser, 2001). Asimismo, de manera coincidente con otros trabajos, se observa que la tendencia a cooperar de los participantes se ve modulada por la tendencia a cooperarar de sus compañeros.

Palabras clave: conducta social, cooperación, interacción diádica, dilema del prisionero.

The research on social behavior developed during the last several decades has allowed differentiating between two types of interaction: cooperation and competition. Nevertheless, major research has focused over the study of cooperation and competition interactions.

Cooperation and competition have been initially treated as contrasting alternatives, in such a way that the former implies benefits for others, whereas competition implies the opposite, to gain advantage over them. However, today, at least from the experimental analysis of behavior and specifically in the operant tradition, both interactions are considered as specific instances sharing the property of consequence interdependence - each person's consequences depend on the behavior of another. Other's behavior typically becomes discriminative stimuli that influences how each person responds. So, other's behavior is treated as the antecedent stimulus of the own responses. Typically, in a dyadic interaction under cooperation contingencies, a specific other's response followed by a complementary response of the subject, is the necessary criteria to get the reinforcement for both of them. In this frame, "*a person's behavior is social when its causes or effects include the behavior of others*" (Schmitt, 1998).

Taking that into account, cooperation and competition are behaviors that occur in the context of particular contingencies that specify behaviors and the criteria for their reinforcement. When cooperative contingencies operate, all participants receive a reinforcer if their responses collectively meet a specified performance criterion. Opposite, under competitive contingencies, reinforcers are distributed unequally based on relative performance (Schmitt, 1998).

In the present studies our interest is concerned with social behavior under cooperative contingencies. So, neither competitive contingencies nor exchange contingencies will be addressed in this paper.

Following Hake and Vukelich (1972) a cooperation procedure is characterized by two essential aspects: 1) the reinforcers of both individuals are at least in part dependent upon the responses of the other individual, and 2) the procedure allows such responses, designated as cooperative responses to result in an equitative division of responses and reinforcers.

An important factor in cooperative settings is the availability of alternative responses to cooperation (Schmitt, 1998). So, three types of cooperation are differentiated (Hake & Vukelich, 1972). The first one called *forced cooperation* refers to those situations in which cooperation represents the only possibility to get the reinforcer. Different contingencies operate when there is more than one alternative response to get the reinforcer, and the individual can choose between them. Such settings are called *alternative response* or *choice situation*. But the most used alternative is that in which there is just one individual response that provides a source of reinforcement, and does not depend on the behavior of the others. This is a *single alternative to cooperation*.

Hake and Vukelich (1972) classify cooperation research in two major categories: performance procedures and choice procedures. The first one measures the behavior that occurs during a cooperative interaction. Choice procedures are not interested in cooperative behavior itself, but just in the options selected, to cooperate or not, independently of the behavior required to make the choice.

From both approximations, performance and choice procedures, experimental approaches to the study of cooperation has been developed through the analysis of minimal social settings. Such studies typically involve two subjects interacting in a dyadic situation. Artificial situations have been traditionally developed for the study of cooperation (e.g. Azrin & Lindsley, 1956; Cohen & Lindsley, 1964; Lindsley, 1966; Mithaug & Burgess, 1967, 1968; Schmitt, 1987; Schmitt & Marwell, 1968; Shimoff & Matthews, 1975). The most frequent artificial setting to study cooperation (and other forms of social behavior) has been the Prisoner's Dilemma (PD).

In the PD two persons have simultaneously to make a choice between four alternatives of responses being ignorant of the partner's choice. Each one of the alternatives has associated a reward for the person (points) that make the choice and for the partner. The outcome and points awarded are announced after each trial. The points obtained for each person are based on the other's behavior. See Schmitt (1998) for a detailed characterization of each alternative and the procedure to compute points for each partner.

Several aspects we would like to consider about PD. First at all, the motivation to cooperate is only one of the several factors that could affect subjects' choices. Each subject can choose between cooperate or not cooperate with the partner. Second, in PD the alternative to cooperate is not a simple individual alternative: cooperation requires mutual reinforcement for some responses. Both subjects must choice the cooperation alternative to be considered that cooperation occurs. So, cooperation requires the agreement of both subjects to cooperate. Third, is essential to highlight that in iterated versions of this setting it has been shown that there is no best strategy as such. It depends on the composition of strategies in the population (Alexander, 1974, Au & Komorita, 2002). Thus, in a population of cooperative individuals the best strategy is to cooperate, even though at the individual level the expected value is higher for non-cooperative behavior (Axelrod, 1984; Macy, 1995).

There are many situations in real life with PD-like scenarios. Thus, in the world of labor, cooperation with partners usually involves a benefit for the company, but it can produce a loss for the individual, as he/she cooperates with someone who competes for receiving personal rewards. Similarly, in contexts of personnel selection with several job positions available, cooperation with a rival can be seen as an efficient strategy. At first glance, helping a rival could be seen as negative; however, the paradox is solved if we consider that helping others could have as a consequence that the other returns the favor, so that such behaviors can be beneficial for both.

The use of simulated partners has been a common experimental procedure to study cooperation behavior in the last years, specially when the interest has been focused over particular strategies in a social relation (Marwell & Schmitt, 1975; Shimoff & Matthews, 1975; Dougherty & Cherek, 1994; Molm, 1998, 1990; Spiga, Cherek, Grabowsky & Bennett, 1992). How can we avoid possible collateral effects of using simulated subjects? That is, how can we persuade subjects that the partner is real? Recently studies prove that people increasingly interact with computers in a human like manner (Kiesler, Sproull & Walters, 1996), and that there are no major differences in performance when real or simulated partners are used.

In agreement with other authors (Ribes-Iñesta, 2001, Ribes-Iñesta & Rangel, 2002), we think that the studies of cooperation revised (Hake and Vukelich, 1972; Schmitt, 1998) from an operant perspective has been too restrictive. First at all, more valid tools are necessary to study cooperative behavior. In real life, it is not necessary “to discover” a response that in combination with the other’s responses get the reinforcement for us. Usually we choose between cooperate or no cooperate with others by virtue of our own style or specific mode to address our behavior. From a more intuitive approach, it is possible to consider that a person is cooperating with any partner when he/she make something useful to get a common goal. But it is independent of the partner’s behavior. You can cooperate with your partner in spite of that he/she cooperates or not with you. So, we believe that cooperative behavior is not necessarily bidirectional, as it is considered from the operant behavior perspective that we exposed previously. Moreover, experimental situations developed must allow the subject to choose between cooperating or not. We believe that both options should be equally valid to solve the task, in such a way that just the subject’s personal tendencies and no other factors should guide his/her behavior.

Taking that into account, Ribes-Iñesta (2001) developed a suitable task to study social behavior under these requirements. This preparation involves two explicit participants in a dyadic interaction through two computers interconnected (in the same room or in separate rooms). The screens of both monitors show two visual puzzles, one in the left section of the screen and other in the right section. Each subject has to complete the puzzle in the left section of his/her computer. In the right section of each screen appears the partner’s puzzle. Each subject can choose between putting or not pieces in the puzzle of the right section. Both puzzles can be the same or different (see Ribes-Iñesta (2001), Ribes-Iñesta and Rangel (2002) for a detailed description). In this setting the participants can choose between to cooperate or not. No prescriptions are setup regarding desirable behavior. To cooperate implies to put a piece in the partner's puzzle, and the subjects must choose between to solve the puzzle in a personal form or to cooperate with the partner.

We have modified this preparation for studying the behavior of "cooperation with a competitor". Participants in the three studies reported below are candidates for entry to a preparatory course for a job, so that the others are competitors for the same good. Below the candidate's puzzle there is another puzzle that supposedly corresponds to another candidate. The candidate can help the virtual partner and the virtual partner can help the candidate. Both, moving pieces correctly in the own puzzle or in the partner's puzzle produces to get points. Although the ratio between candidates and positions is high (30:1), the number of positions is still high (24). As a consequence, the fact that the partner reaches his/her goal does not reduce significantly the candidate's opportunities. In short, it is a situation in which the subject can choose to cooperate or not to cooperate with a competitor, knowing that mutual cooperation implies a mutual benefit. See later a detailed review of the experimental setting.

It is a choice situation in which each one of the subjects must select to cooperate with the partner, collaborating with him/her in terminate his/her puzzle, or not cooperate, just completing his/her puzzle and then ending the session. We are not interested in the study of the cooperative behavior by itself, but in getting global tendencies of responses as a first step approximating detailed knowledge of social interactions. So, we do not address individualized analyses, but we adopt a global approximation in which participant's samples are considered in order to get a main view of the cooperative tendencies in population. These studies may be considered as a guide to adopt a detailed approach latter. Following Hake and Vukelich (1972) our studies may be considered in the category named *choice procedures*.

In short, we first expected that the task would allow classifying candidates, differentiating cooperative subjects and non cooperative subjects, regarding their specific mode to address their behavior. Secondly, far from a strategy for tracking up most points, we expected that the ability of puzzle-solving would not force candidates to cooperate. We also expected that cooperation as a behavioral tendency would show temporal stability after a long period of time. Finally, we expected cooperative behavior to be sensitive to the cooperative tendency of the others.

STUDY 1

The goals of the present study are: (a) to investigate whether the puzzle-solving task with a virtual partner is capable of stimulating the configuration of different cooperative behavior tendencies; (b) to study the distribution of these tendencies and how they relate with gender; (c) to check whether the subject's tendency to cooperate is consistent throughout the task; and (d) to test whether cooperative behavior is independent of the specific ability for solving puzzles.

METHOD

Participants

A total of 713 university graduates, candidates for entering a preparatory course for a job with high status and good salary. The sample was made up of 347 females (mean age 28.2), and 366 males (mean age 28.4).

Materials

The tasks were administered in a large room with individual workplaces conveniently separated. They were administered on PC-compatible computers and Philips 107-s, 17" monitors.

Instruments

The task was presented in a computerized format. The screen was divided into two panels (figure 1), the upper panel corresponding to the candidate and the lower panel supposedly corresponding to another candidate (the partner), present in the same room. On the left side of each panel there was a frame with the participant's puzzle pieces randomly distributed inside, and on the right an empty frame. Each piece was to be moved to its correct place in the empty frame by tracking it with the mouse and releasing it in the right-hand frame. Participants could move their own and their partner's puzzle pieces, and the partner could also move pieces in both puzzles. When a piece was moved to a wrong place the error was indicated by a sound, and the piece moved back automatically to its original place. When the piece was moved correctly, a different sound was made, and the piece remained in its place. Participants could see how the partner moved his/her pieces. There was a button labeled "continue", which could be used to skip the puzzle if the subject had finished his/her own puzzle and did not wish to wait for his/her partner.

Participants were told that the task consisted in completing the puzzle quickly, gaining as many points as possible in the shortest time. However, subject's and partner's scores were linked, in an attempt to make the participant understand that cooperation could be beneficial. Specifically, the participant was informed about the following rules for gaining points:

- If the participant moved a piece correctly in his/her own puzzle, +1 point for s/he.
- If the participant moved a piece correctly in his/her partner's puzzle, +1 point for s/he and for the partner.
- If the participant moved a piece to a wrong place in his/her own puzzle, -1 point.
- If the participant moved a piece to a wrong place in his/her partner's puzzle, -1 point for s/he and for the partner.

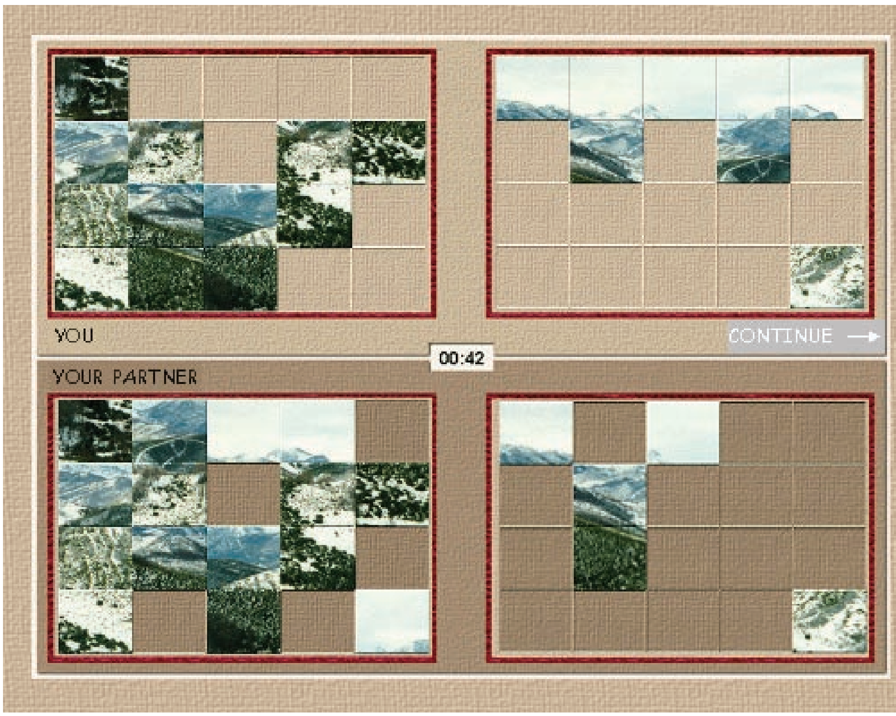

Figure 1. Organization of the screen during the task. In the panel above, the participant's puzzle; in the panel below, the partner's puzzle.

This scoring system served to foster the participant's predisposition to cooperate while suggesting that a good performance in one's own puzzle also leads to gaining points. This procedure would not be useful if there were only one position available, as in that case would be a non-sense to put pieces in the partner's puzzle. However, the fact that there were many positions available makes a reasonable decision to put pieces in the partner's puzzle, as it scores on the own puzzle although also serves to the partner's goal. The virtual partner was programmed to cooperate with the subject at a few fixed moments throughout the task if the participant did no cooperate at all. However, once the participant cooperates, the virtual partner essentially mimicked the participant's behavior.

A critical aspect of the task is that it assesses the subject's predisposition to cooperate, but this should be independent of his/her puzzle-solving ability. The test is presented as one of ability for puzzle-solving in which performance is the key to pass. In that way, the real goal (propensity to cooperate) is hidden. So, it is important to remove from the measurement procedure any contamination from the puzzle-solving ability. This can be done making the task easy to solve and incorporating training trials to the experimental session.

Procedure

The puzzle task was used in the selection process of candidates for taking the course, together with other tests of personality and cognitive abilities. Each participant solved four puzzles with pictures of natural landscapes. They had a maximum total time of 10 minutes for solving them.

We defined two indices, one for assessing the tendency to cooperate and the other for assessing the efficiency in puzzle solving. The *index of cooperation* was calculated with the following equation:

$$C = \frac{H_A}{H_A + H_E}$$

where H_A and H_E stand for the number of *H*its in one's own puzzle (*E*go) and in the partner's puzzle (*A*lter). As is obvious from its structure, the *C* index reflects the degree to which participants share their hits with the partner. A participant that never cooperates with the partner will have C = 0. A systematic cooperator, that is, a participant that always shares hits with the partner, will have a .50 value. Intermediate values reflect different degrees of cooperation during the task, rather than a systematic way of facing it. Values significantly higher than .50 would be considered as reflecting a "perverse behavior", because it would indicate that the participant is checking the correct place by using the partner's panel. The *index of efficiency* was calculated with the following equation:

$$E = \frac{(H_E + H_A) - (F_E + F_A)}{T}$$

where H_E and H_A mean the same as above, F_E and F_A stand for the number of *F*ailures (wrong movements) in each puzzle, respectively, and T is the time taken to finish the puzzle, in seconds. Index *E* increases as hit rate increases, and failure rate decreases, but is modulated by time. Thus, if two participants have the same number of hits and failures, the one that finishes the puzzle in the shortest time has a higher *E* value. Both indexes were calculated for each puzzle of each candidate.

RESULTS

As there was an unexpectedly high number of subjects that did not finish the fourth puzzle before the maximum 10-minutes period allowed, the data from this puzzle were excluded from the analyses. A first look at the results of the other three puzzles suggests that the data from puzzle 1 were different from those of the other puzzles. The suspicion that puzzle 1 may have served as practice and that the behavior was not yet stabilized, led us to analyze the scores of the *C* index in the first three puzzles with a within-subjects ANOVA with three levels (the first three puzzles). We found a significant effect of the factor [$F(2,1424) = 50.809$; $p < .001$]. Post hoc comparisons with the Bonferroni test showed that mean score in cooperation in puzzle 1 was significantly lower than in the other two ($p < .001$ in both cases), while the difference between the mean scores of puzzles 2 and 3 was not statistically significant ($p = .149$). We therefore decided to consider puzzle 1 as a warm up necessary to stabilize the behavior, and its results were excluded for the rest of the analyses, for which only the data from puzzles 2 and 3 were employed.

The correlation between the *C* scores in puzzles 2 and 3 is .89 ($p < .001$), and the Cronbach's alpha, considering them as two items is .94; as we have already pointed out, the mean difference in *C* for puzzles 2 and 3 is not statistically significant [$t(712) = 1.444$; $p = .149$]. In short, the cooperative behavior was very stable after puzzle 1.

Figure 2 shows the distribution of scores of the *C* values. We expected to find three different tendencies of cooperation: (a) those that never cooperate, with $C = 0$; (b) those with a systematic sharing of hits, with C values close to .50; and (c) those with some intermediate value that does not reflect an extreme strategy, but a degree of cooperation. Notice that a systematic cooperator will not necessarily have a value exactly equal to .50, since the task may finish after one piece being correctly moved but before it is shared with the partner, or the reverse. This wide distribution of the cooperative behavior allows us to state that the setting does not guide the subjects in a specific path, facilitating either cooperation or not cooperation, as prescribes previous research in social behavior.

In practical terms, we have classified participants in the three groups according to the following criteria:

Non-cooperation (NC): $C_i = 0$
Graded cooperation (GC): $0 < C_i \leq .45$
Systematic cooperation (SC): $C_i > .45$

Once classified according to these criteria, we found that the distribution of the tendencies is very close to 25% for each systematic attitude and to 50% for the GC. As expected, the graphic representation shows a three-peak distribution, two of them in the values 0 and .5, corresponding to the systematic strategies of non-cooperation and systematic cooperation, and the third one around the .25 value, the intermediate value between 0 and .50 (see figure 2).

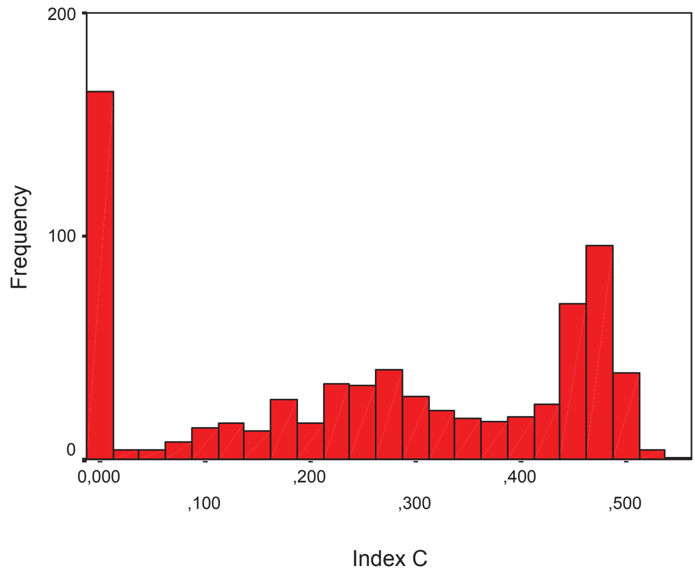

Figure 2. Distribution of C scores in study 1.

When crossed with gender, we found that the distribution is not independent of it [$\chi^2(2) = 8.838$; $p = .012$]. Data in Table 1 show that this is due to the fact that the non-cooperation style is more frequent in females than systematic cooperation, while the opposite occurs in males. The correlation between cooperation and efficiency, as measured by *C* and *E*, is statistically significant (.435; $p < .001$).

Table 1. Percentages of participants showing each of the interactive styles, conditionalized to gender, in studies 1, 2, and 3 (NC, non-cooperation; GC, graded cooperation; SC, systematic cooperation; see text).

		COOPERATIVE STYLE			
		NC	GC	SC	
Study 1	Males	19.7	51.6	28.7	N=366
	Females	26.8	52.7	20.5	N=347
Study 2	Males	15.4	64.8	19.8	N=999
	Females	22.7	60.6	16.7	N=999
Study 3	Males	13.5	64.8	21.7	N=355
	Females	21.4	57.2	21.4	N=271

DISCUSSION

All of the cooperation strategies described in the literature appear in a task designed to allow participants to show their propensity to cooperate with a competitor. Both Suleiman and Rapoport (1992) and Weimann (1994) suggested that there are three types of player. The task they used is also suitable for the study of this behavior, as participants show the same three tendencies. The tendencies are distributed non-uniformly, with about 25% of participants in each of the systematic styles and around 50% in the GC style. However, the distribution is different according to gender. Systematic non-cooperation is more frequent than systematic cooperation in females, while the opposite is the case in males. Nevertheless, participants present high levels of consistency throughout the task, as behavior does not change between the puzzles.

Unexpectedly, we found a moderate but significant correlation of cooperation with the efficiency index. We believe that this coefficient is artificially inflated by the way *E* was constructed. In the formula of *E* it is clear that for a given level of efficiency a subject that shares hits will have a higher *E*, as H_A and H_E combine separately in the numerator. Consequently, *E* and *C* must covariate significantly. We have defined another index that takes this in account, defined as

$$E' = \frac{H_E - (F_E + F_A)}{T}$$

The correlation of cooperation with efficiency, as measured by *E'*, is dramatically reduced (.131; p < .001). Nevertheless, we do not know the degree to which this index of efficiency is contaminated by the fact that it is derived from a situation open to cooperation. A cooperator candidate, for example, will expend time when sharing hits. His/her efficiency, as measured by *E'*, will decrease as compared to a non-cooperator subject. We need a measure of puzzle-solving efficiency that is completely independent of any tendency of participants to present cooperative behaviors. This was one of our goals in study 2.

STUDY 2

As we have already pointed out in the discussion above, it is important to have a measure of the ability for the specific task employed, independent of the tendency to cooperate. The present study has two main goals: (1) to provide an independent measure of the task ability and explore its relationship with the tendency to cooperate, and (2) to study temporal stability after one year. We also slightly modified some aspects of the task in order to fix it according to the results of study 1. The main change is that in the fourth puzzle there is no partner; the lower panel is empty. Responses in this last puzzle are intended to assess puzzle-solving ability with no contamination from the presence of a partner situation.

METHOD

Participants

They were 1998 university graduates, candidates for taking the same course as in study 1; the selection process took place one year after that of study 1. A total of 381 individuals participated in both studies (studies 1 and 2). The sample was made up of 999 females (mean age 27.7), and 999 males (mean age 28.2).

Materials

The same as in study 1.

Instruments

The task was the same as in study 1 with the following exceptions. We selected a simpler image (a cartoon) for puzzle 1, as it was definitively considered as practice with the task and its data were not included in the analysis. Puzzle 4 was presented without a partner, with only the upper panel of figure 1. Before the presentation of the puzzle a message was displayed indicating that connection with the partner's computer was impossible, and that the participant could only work on his/her own puzzle.

Procedure

The same as in study 1.

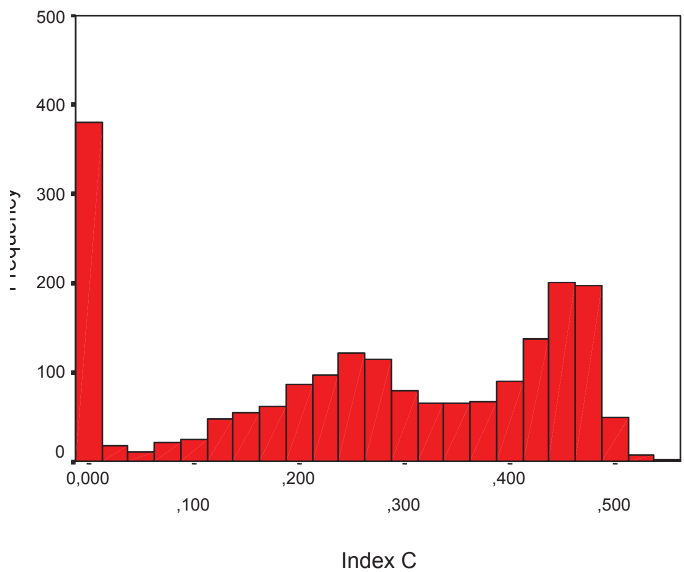

Figure 3. Distribution of C scores in study 2.

RESULTS AND DISCUSSION

Correlation between the *C* scores in puzzles 2 and 3 was .83 ($p < .001$) and Cronbach's alpha is .91, values very similar to those of study 1. The difference between the mean values of *C* for puzzles 2 and 3 was statistically significant [$t(1997) = 6.888$, $p < .001$]; that is, participants were more cooperative in the third than in the second puzzle, though the difference is very small (effect size, $d = .09$).

Figure 3 shows that the distribution of scores of the *C* values had the same shape as that of study 1. There are again three different groups. Once classified according to the same criteria as in study 1, the distribution of these styles is very similar. When crossed with gender, the distribution is not independent of it [$\chi^2(2) = 18.029$, $p < .001$]. Table 1 shows that the reason is the same as in study 1: non-cooperation behavior is more frequent than systematic cooperation in females, whereas systematic cooperation behavior is more frequent than non-cooperation in males.

The correlation coefficients between *C* and the two indexes of efficiency, *E* and *E'*, are .482 ($p < .001$) and .109 ($p < .001$), respectively, values that are also very close to those of study 1. Taking the new measure of efficiency, that is, efficiency in the fourth puzzle (without a partner), the correlation with the index of cooperation is .125 ($p < .001$). It is significant because of the large sample used, but it is not relevant, since it accounts for only 1.5% of the variance. Notice that when there is no partner the efficiency scores are identical, taking either *E* or *E'*.

Stability of the tendency to cooperate. The correlation between the cooperation index values of the two applications could be calculated for 381 individuals that participated in both selection processes. The coefficient equals .404 ($p < .001$). Table 2 shows the contingencies between the types of cooperation in the two applications. 54.4% of the participants are classified in the same category, while most changes are shifts to a higher degree of cooperation (from NC to GC or from GC to SC).

The stability is reasonably high, taking into account that there is a one-year interval between the applications. Furthermore, as the sample is composed by candidates that did not pass the first selection process, it is conceivable that in the second application some of them were suspicious of the real goal of the test and moved to a more cooperative strategy.

Table 2. Percentages of participants showing each combination of the interactive styles in the first and second applications of study 2 (NC, non-cooperation; GC, graded cooperation; SC, systematic cooperation; see text).

			Second		
		NC	GC	SC	
	NC	6.3	13.6	3.9	N=91
First	GC	3.7	33.1	14.7	N=196
	SC	0.8	8.9	15.0	N=94
		N=41	N=212	N=128	

STUDY 3

One of the conclusions from reviews of research with PD is that the behavior of the participants in iterated versions is sensible to the behavior of the others (e.g., Au & Komorita, 2002; Monterosso, Ainslie, Mullen & Gault, 2002). It has also been showed that a “best strategy” as such cannot be defined without taking in account the type of competitors in the population that provides the context (Alexander, 1974). The goal of the present study was to check whether the puzzle task is also sensible to the behavior of the partner. A sample of participants faced the task two times. The first one was identical to the version of study 2, whereas in the second one the partner could show any of the three cooperation styles found in previous studies. We will test whether the behavior of the candidates changes when that of partner changes.

METHOD

Participants

They were 626 fresh candidates from the same pool as those from study 2. The sample was made up of 271 females (mean age 27.9), and 355 males (mean age 28.8).

Materials

The same as in study 2.

Instruments

Participants took two versions of the task. The first one was exactly the same as in study 2. That is, the partner showed a pattern of behavior that essentially mimicked the degree of cooperation of the candidate. In the second one the behavior of the virtual partner did not change according to the behavior of the participant. It was fixed following one of the three patterns previously described (NC, GC, and SC). Participants were randomly distributed between the three conditions before running the first version of the task; that is, before knowing his/her tendency to cooperate with the task.

Procedure

The first version of the puzzle task was applied, as in study 2, together with other personality and cognitive abilities measures and in the same order. The second version was administered at the end of the session, about one hour after the other.

RESULTS

We first checked that the results from the first application were similar to those of the previous studies. Furthermore, as we did not know the pattern of behavior of the participants before being assigned to an experimental group, we expected also a good distribution between the groups. Table 3 shows the subsamples generated with this blind procedure. The marginals show that the behavioral tendencies have a distribution close to that of previous studies and that their distributions over the experimental groups is homogeneous [$\chi^2(4) = 4.32$, $p = .37$].

As in our previous studies, the distribution of tendency to cooperate is not independent of gender [$\chi^2(2) = 7.08$, $p < .03$]. Data in Table 1 show again that this is due mainly to a higher frequency of females in the non-cooperation category.

Table 3. Frequencies of the three patterns of behavior in the first application of the task in study 3, and their assignment to the three experimental conditions for the second application (style of the virtual partner).

		Style of virtual partner in the second application			
		NC	GC	SC	
Style showed in the first application	NC	39	35	32	106 (16.9%)
	GC	130	129	126	385 (61.5%)
	SC	53	33	49	135 (21.6%)
		222 (35.5%)	197 (31.5%)	207 (33.1%)	

Table 4. Joint frequencies of the patterns of behavior showed in both applications of the task, conditionalized to the style of the virtual partner in the second application (experimental group).

		Experimental Group	SECOND APPLICATION		
			NC	GC	SC
FIRST APPLICATION	NC	NC	66.7	33.3	0
		GC	65.7	34.3	0
		SC	53.1	40.6	6.3
	GC	NC	10.0	89.2	0.8
		GC	7.8	86.8	5.4
		SC	2.4	76.2	21.4
	SC	NC	1.9	75.5	22.6
		GC	0	69.7	30.3
		SC	0	14.3	85.7

Table 4 shows the contingency between the propensity to cooperate showed in both applications, conditionalized to the tendency to cooperate of the virtual partner (experimental group). Statistical tests show that the distribution of patterns of cooperation changes significantly with the style of the virtual partner when the pattern of the participant in the first application was that of Graded Cooperation [$\chi^2(4) = 40.15$, $p < .001$] or Systematic Cooperation

[$\chi^2(4) = 46.67$, $p < .001$], but not when it was Non- Cooperation [$\chi^2(4) = 5.54$, $p < .24$]. The biggest change is produced in participants that were Systematic Cooperators in the first application. If their partner in the second application is not now a systematic cooperator most of them reduce their degree of cooperation to the GC or even to the NC level.

GENERAL DISCUSSION

Cooperation has been a major point in the study of social behavior. During the last several decades, some experimental settings have been developed, studying minimal social settings configured by two participants in interaction. In this paper we argue that these preparations are quite artificial and that the approximation to study cooperation from an operant perspective is too restrictive.

We think that these problems are solved through the task developed by Ribes-Iñesta (2001) and Ribes-Iñesta and Rangel (2002). In their studies, they use a computerized behavioral task consisting to solving puzzles. This is a more naturalistic setting than those used previously. Moreover, different from tradition in study of cooperation, there is not a common criterion to be reached for both subjects to consider that a cooperation event has occurred. Each subject can choose between cooperate or not with the other, independently of the partner's behavior, even when the benefits are mutual under cooperative contingencies.

In this experimental preparation children can choose between a dual-puzzle and a single-puzzle version of the task. The dual-puzzle version includes different sub-versions in which the behavior of each participant can influence the performance of the others (as in our task) in competitive or non-competitive settings, or in which the children can simply help their partner. The children preferred the individual version, where they do not have to make decisions about cooperative behavior. Nevertheless, their very choice of version reflects their preferences. Even when they were initially exposed to the forced cooperation and sharing condition, in which they could learn the benefits of mutual cooperation, most children choose to solve the puzzle individually.

We use in our three studies an experimental situation developed from previous work of Ribes-Iñesta et al. Different from these studies, when huge samples of participants are considered, cooperative behavior is observed, but a tendency to not cooperate is the main option yet. Nevertheless, the three different modes to address behavior defined, non-cooperation, graded cooperation and systematic cooperation, could be observed in significant proportions.

The studies show that the participants were quite consistent throughout the task and reasonably stable after a one-year interval between applications. The former permits to conclude that in spite of the setting used, when the participants can choose between cooperate or not, their specific tendency will be observed. But, as we analyze after, participant's cooperative tendency is influenced by the partner (see study 3), so that consistency is modulated by specific properties of the setting used. Moreover, participants were stable in their behavior when a test-retest study was done. Both, consistency and stability, permit to address future studies in which the analysis of participant's specific behavioral patterns will be considered.

We may conclude that we have a suitable naturalistic task for the study of social behavior, where contingencies do not prescribe any specific path in social interaction. The participants can choose how to behave with the others, and so, we can access to their specific behavioral tendencies under social contingencies.

We believe that this experimental preparation can be used to study in general social behavior, under cooperative, competitive or even exchange contingencies. In this sense, it is clear that more research is necessary using this type of natural settings.

One obvious advantage of this kind of tasks is that the assessment of cooperation is realized from the analysis of real behavior in situations that are not strange to the subjects. So, we have a direct assessment of subject's behavioral tendencies, in spite of other possible assessment procedures based on verbal communications. As we can conclude from the three studies, subjects are not only consistent and stable in their personal communications. They are consistent and stable in their behavior, too.

As well as it has been widely found that females are more altruistic than males there is contradictory evidence of the effect of gender on cooperation. Kurzban and Houser (2001) found that males were more likely to be strong cooperators than females. Our data also have shown that females display a higher frequency of non-cooperative styles and males show a higher frequency of systematic cooperation. It is possible that previous results are caused from the artificial paradigms used to study social behavior or, perhaps, that the natural setting used in our study is more sensible to extreme tendency of the cooperative behavior continuum. More research is necessary to validate evidence observed in our research.

We also found that the tendency to cooperate is essentially independent of the ability to solve the puzzles. It could be argued that people would be prone to cooperate the higher their ability for the task, as less able people would be more concerned with doing the task properly, so that they spend more time on the procedures involved in solving the puzzles than thinking about whether to cooperate. Our results show a significant correlation between cooperation and problem-solving ability, but only as a consequence of the very large sample employed; in fact, the percentage of variance accounted for is less than 2%.

In the version of the task employed in studies 1 and 2 and in the first application of study 3 the simulated partner has been programmed to behave in exactly the same way for all participants. Study 3 showed that the participant's tendency to cooperate (real persons) is sensible to the partner's behavior (simulated partner), so that it can be considered as part of the context (Axelrod, 1984). These results show that in the study of social behavior the partner's behavior is an essential cue, so that participants adjust their behavior to other possible participants implicated in the same context. If the partner behaves in a collaborative way then it is possible that the participants equal this specific mode of behavior, shadowing their real tendency to cooperate or not. Once again, using of naturalistic situation in which the participant may choose between cooperate or not, independently of the behavior of the others, is a necessary requirement for the study of social behavior.

When gains and losses are included in the same task, different behavior responses can be expected. Although merely at a speculative level, we might see cooperative behavior as sensitive to the way the person interprets the positive or negative results of cooperation. Some participants may interpret the cooperative option as better in the long term. Our three-mode distribution reflects, in fact, three different ways in which cooperative behavior may take place. The competitive situation of a selection process may contribute making participants to look at it as a potential danger, or as an opportunity to obtain the most benefit from it. It would be interesting to explore collaborative behavior using other contexts and task configurations.

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