Who is the fairest of them all?

Citation for published version:
Munoz-Reyes, JA, Pita, M, Arjona, M, Sanchez-Pages, S & Turiegano, E 2013 'Who is the fairest of them all? The independent effect of attractive features and self-perceived attractiveness on cooperation among women.' ESE Discussion Papers, no. 234, Edinburgh School of Economics Discussion Paper Series.

Edinburgh School of Economics

Discussion Paper Series

Number 234

Who is the fairest of them all?
The independent effect of attractive features and self-perceived attractiveness on cooperation among women

J. A. MUÑOZ-REYES
(Universidad Autónoma de Madrid and Universidad de Playa Ancha, Chile)

M. PITA
(Universidad Autónoma de Madrid)

M. ARJONA
(Universidad Autónoma de Madrid)

S. SANCHEZ-PAGES
(University of Edinburgh)

E. TURIEGANO
(Universidad Autónoma de Madrid)

Date
November 2013

Published by
School of Economics
University of Edinburgh
30 -31 Buccleuch Place
Edinburgh EH8 9JT
+44 (0)131 650 8361
http://edin.ac/16ja6A6

THE UNIVERSITY *of* EDINBURGH

Who is the fairest of them all? The independent effect of attractive features and self-perceived attractiveness on cooperation among women

Running headline: Attractiveness and cooperation in women

Word count: 7,997

MUÑOZ-REYES J.A.[1,2], PITA, M.[1], ARJONA, M.[1], SANCHEZ-PAGES S.[3], TURIEGANO, E.[1]

[1] Departamento de Biología, Universidad Autónoma de Madrid, Spain

[2] Centro de Estudios Avanzados, Universidad de Playa Ancha, Valparaíso, Chile.

[3] Edinburgh School of Economics, UK.

Corresponding author.

Departamento de Biología. Universidad Autónoma de Madrid. C/ Darwin nº2, 28049, Madrid, Spain. E-mail address: enrique.turiegano@uam.es (E. Turiégano). Tel.: +34 914976794.

ABSTRACT

The present paper analyzes the extent to which attractiveness-related variables affect cooperative behavior in women. Cooperativeness is evaluated through a Prisoner's Dilemma Game (PDG). We consider several morphometric variables related to attractiveness: *Fluctuating Asymmetry* (FA)**,** *Waist-Hip Ratio* (WHR), *Body Mass Index* (BMI) and *Facial Femininity* (FF). These variables have been shown to predict human behavior. We also include as a control variable a score for *Self-Perceived Attractiveness* (SPA). We test differences in these variables according to behavior in the PDG. Our results reveal that low FA women cooperate less frequently in the PDG. We also find that women with lower WHR are more cooperative. This result contradicts the expected relation between WHR and behavior in the PDG. We show that this effect of WHR on cooperation operates through its influence on the expectation that participants hold on the cooperative intent of their counterpart. In addition, we show that the effect of attractive features on cooperation occurs independently of the participants' perception of their own appeal. Finally, we discuss our results in the context of the evolution of cooperative behavior and under the hypothesis that attractiveness is a reliable indicator of phenotypic quality.

Keywords: Cooperation; Attractiveness; Fluctuating asymmetry; Waist-hip ratio; Body Mass Index; Facial Femininity.

1.0 INTRODUCTION

Human cooperation is an undeniably appealing phenomenon which has attracted substantial attention from scientists (Hammerstein, 2003). One line of research on cooperative behavior has obtained important insights by using strategic games (e.g. Burnham, 2007; Eisenneger et al. 2010; Kosfeld et al. 2005; Lovejoy et al. 2013; Millet & Dewitte, 2006; Mulford et al. 1998; Sanchez-Pages & Turiegano, 2010, 2013; Takahashi et al. 2006; Van den Bergh & Dewitte, 2006; Zaatari & Trivers, 2007; Zak et al. 2009, Zethraeus et al. 2009). In strategic games, participants face simplified social situations in the laboratory and receive rewards depending on their decisions as well as those of other participants. Because these studies use controlled environments, the behavior displayed by subjects is easily measurable and replicable.

In the present study, we define cooperation as an individual behavior aimed to maximize collective interest rather than pure self-interest. One way of evaluating cooperation with strategic games is through the Prisoners' Dilemma (PDG henceforth). The PDG is a strategic game in which collective welfare and self-interest are in stark conflict. Standard Game Theory postulates that individuals act following their self-interest only and should hence not cooperate in the PDG, even though such behavior eventually leads to a loss in collective welfare. Early experimental studies demonstrated that such prediction is only partially fulfilled. Even in one-shot situations, and when playing against complete strangers, humans tend to cooperate in the PDG in sizeable rates (see Marwell & Ames, 1981 and Dawes & Thaler, 1988, among many). Undoubtedly, it is of a great interest to explore which individual factors, if any, cause some individuals to be more prone to cooperate than others.

Several recent papers describe the effect of physiology-related variables on human behavior in economic experiments (Apicella et al. 2008; Burnham, 2007; Eisenneger et al. 2010; Kosfeld et al. 2005; Millet & Dewitte, 2006; Van der Bergh & Dewitte, 2006; Zaatari & Trivers, 2007; Zak et al. 2009; Zethraeus et al. 2009). However, few studies have focused on the relationship between individual features and cooperative behavior in two-person interactions like the PDG (Lovejoy et al. 2013; Mulford et al. 1998; Sanchez-Pages & Turiegano, 2010; Takahashi et al. 2006). Even smaller is the number of these studies focusing exclusively on women. This gap in the literature is rather unsatisfactory given the important physiological differences, especially endocrine, that exist between sexes (for exceptions see Buser, 2012; Pearson & Schiepper, 2013).

In the present paper, we investigate the relationship between cooperation among women in the PDG and a number of physiology-related variables with well-established effects on human behavior. These variables are Facial Fluctuating Asymmetry, Facial Femininity, Waist-Hip Ratio and Body Mass Index.

Fluctuating Asymmetry (FA) is a variable with a physiological basis and linked to individual's fitness. It can be defined as a departure from symmetry in traits that are symmetrical at the population level (Van Dongen & Gangestad, 2011). FA is considered to be the result of developmental instability, reflecting the ability of an organism to maintain a stable development of its morphology and to overcome possible external perturbations (Møller & Swadle, 1997; Thornhill & Gangestad, 2006; Van Dongen & Gangestad, 2011). Consequently, it has been described as linked to individual fitness in many species (Møller, 1997; Møller & Thornhill, 1998). In humans, there exists a positive average effect of FA on a variety of outcomes, from hormone levels to health problems. These effects are robust, especially those related to reproduction (Van Dongen & Gangestad, 2012). FA has also been related to human behavior (Furlow et al. 1998; Holtzman et al. 2011; Manning & Wood, 1998; Muñoz-Reyes et al. 2012; Pound et al. 2007; Zaatari & Trivers, 2007). In particular, FA has been studied in relation to cooperative behavior in males. Results show that low FA males (more symmetric) cooperate less often in the PDG (Sanchez-Pages & Turiegano, 2010). FA is also a determinant of behavior in the Ultimatum Game (Sanchez-Pages & Turiegano, 2013; Zaatari & Trivers, 2007; Zaatari et al. 2009). In both the PDG and in the Ultimatum Game (UG henceforth), symmetrical men (with lower FA) tend to be less prosocial. Personality measurements corroborate this finding (Holtzman et al. 2011). One possible explanation for the lack of pro-sociality of symmetrical males is their higher capability to obtain resources by themselves, which reduces their need to obtain help from others. An additional aspect related to the link between FA and fitness is that a low FA is considered to be an attractive feature in many human populations (reviewed in Johnston, 2006; Kościński, 2007; Little et al. 2011; Thornhill & Gangestad, 1999; Van Dongen & Gangestad, 2011).

Another morphometric feature described as an indicator of fitness is the Waist-Hip Ratio (WHR), which results from dividing the waist perimeter by the hip perimeter. This measure is strongly influenced in women by hormone levels during puberty, which in turn determine the differential allocation of fat between sexes (Björntorp, 1997; Kirschner & Samojlik, 1991; Lev-Ran, 2001). Since the distribution of fat is very different between males and females, WHR can be considered as a secondary sexual characteristic in women. The standard values of WHR in Caucasian female populations range from 0.67 to 0.80 (Marti et al. 1991). WHR is associated with both health and fertility. Women with ratios around 0.70 present optimal oestrogen levels (Jasieńska et al. 2004) and are less likely to develop serious illness, such as diabetes, cardiovascular disorders and ovarian cancer (reviewed in Singh, 2002). Regarding fertility, women with values of WHR of 0.80 or higher have significantly lower pregnancy rates than women with lower values, independently of their Body Mass Index (Singh, 2002). In addition, it has been pointed out that women with a low WHR present an ideal fat distribution in terms of fertility (Swami & Tovée, 2007). The link of this feature to fertility and resistance to illness is to be expected, given that secondary sex characteristics are linked to fitness in many species (Møller & Alatalo, 1999).

WHR is related to another physiological indicator of health in humans, the Body Mass Index (BMI) (Flegal et al. 2013; Tovée et al. 1998, 1999), also linked to reproductive potential. Extreme values of BMI have a negative impact on fertility (Brown, 1993; Kaplan, 1990; Lake et al. 1997; Reid & VanVugt, 1987). Given its association with both health and fertility, many researchers have proposed BMI as a primary measure of female attractiveness (Tovée et al. 1999), although it is commonly recorded as a nutritional marker. The World Health Organization considers the range 18.50-24.99 as standard for adults. Values under 18.50 are considered underweight, between 25 and 30 as overweight, and equal to or above 30 as obese.

Both WHR and BMI are important indicators of female attractiveness. Although related, they display relatively independent effects. Controlling for BMI, women with a WHR around 0.70 are classified as the most attractive by men of most cultures, including Western Caucasian societies (Singh et al. 2010). Still, the optimal value in terms of attractiveness ranges from 0.60 to 0.80 across different human populations (Dixson et al. 2007; Marlowe et al. 2005). Individuals exhibiting a remarkable deviation in their WHR (for example, women with high WHR and men with low WHR) are commonly seen as less attractive by the opposite sex (Pazhoohi & Liddle, 2012). BMI also influences individual attractiveness. Low values within the standard range, i.e. around 20, are those typically regarded as more appealing (Tovée et al. 1998, 1999).

Another variable related with both phenotypic quality and attractiveness is the degree of facial sexual dimorphism. Facial Femininity (FF henceforth) in women positively correlates with disease resistance (Thornhill & Gangestad, 2006), oestrogen levels and fertility (Law Smith et al. 2006). Some authors have proposed FF as an individual indicator of the historical energy balance and the capacity to allocate energy for reproduction (Gangestad & Scheyd, 2005). Sexual dimorphism in facial features depends on sexual hormones levels during puberty (Johnston, 2006). Sexual development in female faces entails certain noticeable modifications, such as thickening of the lips and thinning of the cheekbones (Johnston, 2000). Hormone levels in puberty (Berenbaum & Beltz, 2011) and, more specifically, the degree of masculinity/femininity of the face, have proven to have an effect on adult behavior (Apicella et al. 2008; Carré et al. 2009; Haselhuhn & Wong, 2012; Pound et al. 2009; Stirrat & Perrett, 2010, 2012), although most of these studies have been performed in men. More importantly, the degree of masculinity/femininity has been described as a good predictor of attractiveness both in women and men (reviewed in Johnston, 2006; Kościński, 2007; Little et al. 2011; Thornhill & Gangestad, 1999).

Attractiveness affects human behavior both in individuals' everyday life and in the laboratory (e.g., Langlois et al. 2000; Mulford et al. 1998; Takahashi et al. 2006; Wilson & Eckel, 2006). This could bring up a potential confound: the observed effects of attractiveness-related features on behavior may operate directly or indirectly, that is, by determining perceived attractiveness which subsequently affects behavior. In order to control for this possibility, we included a score of self-perceived attractiveness (SPA henceforth) as an additional variable. The effect of SPA on cooperation has already been explored. Results show that women who find themselves attractive are less cooperative in the PDG (Mulford et al. 1998). In general, individuals who consider themselves attractive are also considered as such by others (Feingold 1992; Marcus & Miller, 2003; Weeden & Sabini, 2007). Hence, the SPA score allows us to test whether the fitness-related variables we consider influence cooperative behavior directly or through their effect on self-perceived attractiveness.

Our main hypothesis is that women who display features associated with higher fitness -low FA, high FF and low WHR- cooperate less often in the PDG. We base this hypothesis on previous results indicating that men showing higher fitness are less prone to behave pro-socially (Holtzman et al. 2011; Sanchez-Pages & Turiegano, 2010; Zaatari & Trivers, 2007; Zaatari et al. 2009). The standard explanation for these results is based on the idea that cooperative behavior is a tool to receive future help from others. Thus, high fitness individuals, who enjoy a greater capacity to obtain resources by themselves, need to resort to cooperative behavior less often (Zaatari & Trivers, 2007). According to our hypothesis, women with a low WHR (controlling for BMI) and a high FF should show less cooperative behavior in the PDG. We also expect to find a positive effect of FA on cooperation, meaning that we expect symmetric women to cooperate less often. This result has already been found for males (Sanchez-Pages & Turiegano, 2010), and there is no reason to expect the influence of FA on behavior to be sex-dependent.

We are also interested in whether the effects of these variables on cooperation are mediated by attractiveness. One plausible hypothesis might be that these features solely influence cooperative behavior through attractiveness because high-fit individuals are perceived as more attractive and also feel more attractive themselves. This can be very important since attractive people tend to receive benefits from others without the expectation of costly reciprocation. Under this hypothesis, the attractiveness of high fit individuals accustoms them to receive benefits which lead them to behave less prosocially. In the present study, we can examine this hypothesis by analyzing whether the effect of FA, WHR and FF on cooperative behavior depends on SPA. Still, we conjecture that these variables do not exclusively operate through attractiveness. This is because high fit individual is more capable of obtaining resources independently of whether they receive them from others who consider her as attractive. So, as a second hypothesis, we postulate that all these three features exert their effect on cooperation independently of SPA. Such result would imply that the biological determinants behind the studied features (such as developmental stability and hormone levels) wield their influence on behavior regardless of whether the individual considers herself as attractive or not.

2.0 METHODS

- *2.1 Design and performance of experiments*

Experiments were performed at the Faculty of Sciences of the UAM (Madrid, Spain). Participants were recruited among the student population few weeks before the semester exams in the spring and autumn of 2012**.** Recruitment was made by means of advertisement billboards and e-mail (sent by non-teaching staff) as the UAM ethical committee requires. In total, 176 White Spanish females took part in this study.

Participants played the PDG within a set of different tests (not considered in the current paper). In the PDG, subjects have to choose between two possible strategies: "cooperate" or "defect". If the two players choose "cooperate" they both get 90 points, if both choose "defect" each one gets 30 points. If they choose different actions, the one who cooperates gets 10 points and the one who defects obtains 160 points. The exchange rate used in the experiment was 100 points = 1€. Under the standard game-theoretical approach "defect" is a dominant strategy because it is the strategy that maximizes the individual benefit regardless of the decision of the counterpart. In addition to playing the PDG, participants were asked to guess the decision of their opponent (Expected Behavior, EB). This variable has been shown to be a strong determinant of behavior in the PDG (Sanchez-Pages & Turiegano, 2010). Participants played a single round of the PDG. They were informed that they were playing against another female participant from a previous session. They did not know anything else about their counterpart. Subjects knew that their decisions would affect participants of a future session in the same way. The experiment was run employing the Z-Tree 3.2.10 software (Fischbacher, 2007). Each participant was allocated a computer terminal. Experimental sessions had less than 20 subjects each. Participants received a show-up fee (5€) and a variable reward dependent upon the decisions taken in the different games implemented in the experiment. Final payment was 13.25±0.08€ (av±SEM) per person (PDG average payment was 0.87±0.04€). Prior to the experiment, participants were informed that their final payment would depend upon their decisions in several items of the study, but not in all of them. Few weeks after the experiment, subjects were informed about the exact payment procedure.

At the end of each experimental session, pictures of each participant were taken to prospectively measure individual FA and FF. Their height, weight, and both waist and hip perimeter were measured in order to estimate BMI and WHR. Participants also provided some personal data by filling up a questionnaire (age, current studies, ethnic group, sexual orientation, SPA). All data remained completely anonymous as required by the ethical committee of the UAM.

- *2.2 Measurement of morphometric variables*

Three full frontal facial color photographs were taken of each participant, at three meters of distance and under standardized light conditions with the zoom completely opened in order to avoid distortion of the facial shape. Participants were asked to remove any facial adornment, to pose with a neutral expression and to look directly into the camera. To measure FA from these images, the shape of each face was defined by manually setting 39 predetermined *Landmarks* (LMs). These 39 points can be unambiguously identified in each photo (Figure 1). The LMs were placed twice by two of the authors in order to detect possible placement errors. LMs were located employing the TPS software (by FJ Rohlf, available at http://life.bio.sunysb.edu/morph/)

To calculate the FA of each image, we compared the LMs of each face and its mirror-image (Klingenberg et al. 2002). The asymmetry of a bilateral object can be partially attributed to directional asymmetry (differences in the population between average right and left size) and partially to FA (deviation of each individual's asymmetry from the overall average asymmetry). We obtained FA by decomposing the Procrustes distance between each image and its mirror-image using the Procrustes ANOVA method (Klingenberg & McIntyre, 1998). This decomposition was performed with the Morpho J software (available at http://www.flywings.org.uk/MorphoJ_page.htm). As an individual measure of symmetry we used the Mahalanobis distance, which avoids the effect of correlation between variables (Rodríguez-Salazar et al. 2001). We thus employed a value of FA that is highly independent of the selected LMs. To control for the potential error in the LMs placement, FA computation in Morpho J requires two sets of LMs for each face (each set placed by a different researcher). Error in LM positioning was not significant (Procrustes ANOVA, error SS=9,297 x 10^{-3}, df=13172, F=0,006, p=0.989).

We estimated Facial femininity (FF) by measuring the Procrustes distance between each participant's average face and a masculine reference face. The masculine reference face was built from the images of 100 males belonging to the same age and population as the subjects of study. Participants' average face was obtained as an average of the three captured pictures and their mirror-images. The use of symmetrical average faces for comparison with the masculine reference face avoids any undesired effect of individual symmetry in the measure of FF.

We computed the WHR by dividing the waist perimeter by the hip perimeter of each participant and trying to minimize the error caused by clothes. Waist perimeter was measured in the lower girth region of the natural waist, generally right above the umbilicus. Hip perimeter was measured in the wider point of the gluteus. During measurements, participants stood feet together, loosen arms, normal breath, and with their body weight uniformly distributed. In order to estimate BMI, the weight and height of each participant was measured barefoot and without heavy clothing. A female researcher took these measurements from each participant privately and just once.

- *2.3 Self-perceived Attractiveness (SPA)*

To obtain SPA, each participant reported an estimation of its own attractiveness in a 1 to 7 Likert-like scale, being 1 the lowest score and 7 the maximum, assessed as deviations of the population average. Participants who consider themselves on the average were advised to score themselves with 4.

- *2.4 Statistical analyses*

We tested for the normality of all variables by means of the Shapiro-Wilk test. For those variables not normally distributed, we performed the usual logarithmic transformations. However, both SPA and BMI were resistant to that transformation. To analyze the results, we employed (non-parametric) Spearman Rho (σ) for correlations, two-tailed Student-t tests for the normally distributed variables and Mann-Whitney test for SPA and BMI. We also employed logistic regressions to analyze the simultaneous effect of several variables on our dichotomous dependent variable ("Cooperate" or "Defect"). We employed SPSS 15.0 (SPSS Inc.) in all the statistical analyses.

3.0 RESULTS

Table 1 presents the summary statistics of all the variables considered. First, we analyzed how the physiological variables relate to SPA. As expected, SPA correlates negatively with WHR, BMI and FA (Table 2). Although our measure of FF did not correlate with SPA, it negatively correlates with WHR. This is quite remarkable given that both features are strongly influenced by hormone levels during puberty. Age did not correlate with any of the morphometric variables or with SPA, although it must be noted that the age range of our subjects was very narrow. Although WHR and BMI do not show a significant correlation in our data, we followed the literature and controlled for BMI in any further analysis including WHR.

Regarding behavior in the PDG, 31.30% (n=55) of the 176 participants did not cooperate, a fraction consistent with results previously observed in the literature. We also tested for differences in behavior according to the expectation that participants had on the behavior of their counterpart. There was a strong and significant association between the behavior of a participant and the behavior she expected from her counterpart ($\chi^2 = 42.718$, $p<0.001$). Of the participants who expected their counterpart to cooperate (n=123), 83.74% (n=103) of them cooperated, whereas of the other 53 participants who expected their counterpart to defect, 66.04% (n=35) defected.

Next, we analyzed the relationship between behavior in the PDG (cooperate or defect) and the individual variables considered (Table 1). Results reveal that those subjects who defected displayed a higher WHR and a lower FA than those who cooperated. In addition, and in line with the literature, participants who defected perceived themselves as attractive (high SPA). Age, FF and BMI were not significantly different between participants who cooperated and those who defected.

We performed a set of logistic regressions in order to test simultaneously the effect of these variables on cooperation in the PDG (Table 3). In an initial analysis, we included all the morphometric variables plus Age (first row of Table 3). We observed that WHR and FA were statistically significant. Note that the coefficients associated to these variables are negative and positive respectively. In other words, participants with low WHR and high FA tended to cooperate more in the PDG. Next we built a simpler model excluding Age and FF given that they were not significant (second row of Table 3). In this model, the variables FA and WHR remained significant. In the following model (third row of Table 3) we included the variable SPA (which correlates with both WHR and FA) in order to test whether the effect of the morphometric variables on the decision in the PDG depends on how attractive participants find themselves. In that model, all SPA, WHR and FA were significant. High values of SPA and WHR led to defection, whereas high values of FA led to cooperation. Hence, the physiological variables FA and WHR remained significant after including SPA in the logistic regression model. It is remarkable that both a low SPA and a low WHR relate with a tendency to cooperate considering that WHR negatively correlates with attractiveness. Women who see themselves as relatively unattractive cooperate more often, but women with low WHR –an attractive feature- tend to be more cooperative as well.

Finally, we included the variable Expected Behavior (EB) which has been described to strongly affect participants' decision in the PDG (fourth row of Table 3). The resulting model confirmed this finding: When participants expected their counterpart to cooperate, they were more inclined to cooperate. It is worth noting that the significance of FA and SPA barely changed after the inclusion of EB. This result suggests that the effect of FA and SPA on behavior in the PDG does not operate through EB. However, the inclusion of EB in the model rendered WHR non-significant at the 95% confidence level. This leads us to conclude that the effect of WHR on cooperation operates mostly through its influence on the expectation that subjects hold on the behavior of their counterpart. In fact, there were no significant differences in FA (t_{174}=-1.104; p=0.312) nor SPA (U=3001.5; N_1=53, N_2=122; p=0.374) between those who expected their counterpart to cooperate and those who expected the opposite. But there were significant differences in WHR between the two groups (t_{174}=2.519; p=0.013): those participants who expected their opponent to cooperate displayed lower ratios (0.715±0.004) than those who expected defection (0.732±0.006).

4.0 DISCUSSION

The goal of the present study is to analyze the existing relationship between cooperative behavior in women and a set of individual characteristics previously categorized as indicators of phenotypic quality (high fitness), that are also known to be related with female attractiveness.

Of the studied variables, FA and WHR showed an effect on the decision to cooperate. Even more interestingly, and in line with our second hypothesis, their effect seems to be independent of the perception that individuals have of their own attractiveness. This is shown by the fact that FA and WHR maintained their significance after controlling for SPA, This independent effect of the physiological variables and

SPA on participants' cooperative behavior in the PDG is undoubtedly the more outstanding result of our study.

Several studies reveal an association between behavior and fitness related features, particularly symmetry, in humans (Furlow et al. 1998; Manning & Wood, 1998; Muñoz-Reyes et al. 2012; Pound et al. 2007), and more specifically in relation to cooperative or prosocial behavior (Holtzman et al. 2011; Sanchez-Pages & Turiegano, 2010; Zaatari & Trivers, 2007; Zaatari et al. 2009). Nevertheless, to date, no study had explored whether the effect of symmetry (or other physiological variables) works through the self-perception of personal attractiveness**.** A plausible explanation of the observed effect of FA on cooperative behavior might be that a symmetric person should feel more attractive and, therefore, more entitled to obtain resources autonomously due to the benefits conferred by attractiveness (reviewed in Langlois et al. 2000; Mulford et al. 1998). Our results, however, cast doubts on this explanation. The effect of FA on cooperation is independent of the effect of self-perceived attractiveness given that the effect of phenotypic quality on women's behavior remains significant after controlling for self-perception of attractiveness. While remarkable, the independent effect of these two factors is not entirely unexpected. Results observed in studies with males reveal that although men who find themselves attractive tend to cooperate more (Mulford et al. 1998, but see Takahashi et al. 2006), highly symmetrical males cooperate less often (Sanchez-Pages & Turiegano, 2010). This occurs even though attractiveness and symmetry are correlated (reviewed in Johnston, 2006; Kościński, 2007; Little et al. 2011; Thornhill & Gangestad, 1999; Van Dongen & Gangestad, 2011). The basis of this intriguing relationship between FA and behavior, triggered independently of SPA, could be explained by an unconscious self-adjustment of behavior to its expected consequences based on previous experience. It has been described that several animal behaviors adjust to mathematical models based on their cumulative rate of success and failure despite animals do not use such models consciously (Dugatkin & Reeve, 2000). The link between symmetry and a low tendency to cooperate might be due to other individual characteristics which could be associated to FA, such as self-confidence or perceived self-sufficiency (the estimation of the own ability to obtain resources). As a matter of fact, symmetry is correlated with several personality traits, like neuroticism, agreeableness and openness to experience, the last two negatively (Fink et al. 2005; Holtzman et al. 2011). This association might be behind the link we observe between low FA and a weaker tendency to cooperate. Even though we find these questions quite interesting, they are beyond the scope of this study.

Independently of the mechanism behind it, the link we find between FA and cooperative behavior in women is to be expected given the results already found in men. More symmetrical males are less pro-social in the PDG (Sanchez-Pages & Turiegano, 2010) and in the UG (Zaatari & Trivers, 2007), and display fewer pro-social personality traits (Holtzman et al. 2011). Considering their higher phenotypic quality (Thornhill & Gangestad, 2006), low FA individuals depend less on maintaining a good relationship with their social environment, and, hence, are not prone to sacrifice personal benefits in order to favour others (Zaatari & Trivers, 2007). This explanation (already proposed in Mulford et al. 1998) also fits with the relationship between attractiveness and cooperative behavior described in this paper under the hypothesis that attractiveness is a valid indicator of fitness (Langlois et al. 2000). We do not want to imply that the need for resources was behind participants' behavior in our experiment. We rather suggest that their different capabilities in obtaining resources and their experiences when sharing them might have shaped subjects' daily behavior and made them more or less pro-social independently of their short-term needs.

The independence between the effects of attractive-related physiological features and of SPA is evident in the case of WHR (once controlled for BMI). Even though low WHR scores are associated with attractiveness in women (Singh et al. 2010), we show that low WHR values associate with cooperative behavior. This result is unexpected if one exclusively focuses on the relationship between WHR and attractiveness. It confirms our conclusion that the effect of the attractive-related variables on cooperation does not operate exclusively through their influence on SPA. A likely explanation for this result stems from the positive association we found between a high WHR and the belief in the defection of the opponent. The effect of WHR on EB seems to be the strongest determinant of participants' behavior; Table 3 shows that EB explains individual behavior in the PDG better than any other variable (also in Mulford et al. 1998; Sanchez-Pages & Turiegano, 2010). That is, a high WHR is associated with a tendency to believe that the opponent will not cooperate, and this belief leads to defection. The relationship we observe between high WHR and the belief on the counterpart's defection is to be expected, especially given the associations already described in healthy women between this variable and different distrustful behaviors, such as hostility (Kaye et al. 1993), low self-perceived social status (Adler et al. 1993), and social anxiety (Landén et al. 2004). This may suggest that WHR, beyond of its relationship with fitness (Jasieńska et al. 2004; Singh, 2002; Swami & Tovée, 2007), may be indicating 'desirability as a social partner' which, in turn, leads to women showing higher values (low desirability) to behave distrustfully in social interactions because of their previous experiences.

The FF of the participants had no significant effect on the propensity to cooperate in the PDG. Although the degree of sexual differentiation of the face has a well-known association with several behaviors, to date, most of the studies on this issue have focused only in men (Apicella et al. 2008; Pound et al. 2009; Stirrat & Perrett, 2010, 2012). These studies employ the ratio between facial width and height (both in men and women) as a measure of masculinization/feminization. This feature was initially described as dimorphic between sexes (Carrè & McCormick, 2008; Weston et al. 2007), but has recently been questioned as such (Kramer et al. 2012; Lefevre et al. 2012). In any case, in studies which included female participants, this measure of masculinity (or femininity) showed no effect on the propensity to engage in deception or cheating during a negotiation (Haselhuhn & Wong, 2012), nor in dominance (Carrè & McCormick, 2008). However, the same measure showed an effect on male behavior under the same experimental conditions. Therefore, our results are consistent with those stating that facial sexual dimorphism may influence behavior in men but not in women. It might be argued that we are not measuring facial femininity properly, but the strong correlation between FF and WHR substantiates the robustness of our femininity measure (see Table 2). This correlation is in line with the relationship previously observed between facial and body attractiveness when measured separately, which confirms that these two variables are valid indicators of fitness (Thornhill & Grammer, 1999). Although both FF and WHR are related to oestrogen levels, it is remarkable that they do not have the same effect on cooperative behavior. This fact suggests that considering the stage of development in which the feminizing effect of hormones occurs is important in order to ascertain its effects on a specific behavior. Obviously, additional experiments and physiological studies are needed to deepen our understanding of this result.

Regarding our first hypothesis, of the three variables related to fitness, only FA displayed the expected effect on cooperation, while FF showed no effect and WHR yielded the opposite. However, the effect of SPA fits with our hypothesis if one considers it as a reliable signal of fitness (Langlois et al. 2000). In summary, two variables confirmed our expectations and two did not. It is very interesting that WHR and FA, which are strongly correlated (see table 2) and linked to fitness, have opposite effects on cooperative behavior. The strong correlation between them and their correlation with SPA confirm them as measures of phenotypic quality, like facial and body attractiveness (Thornhill & Grammer, 1999), facial and voice femininity (Feinberg et al. 2005) and symmetry and sexual dimorphism (Little et al. 2008). The fact that their effects on behavior in the PDG follow different directions suggests that they relate to different kinds of high-fit features (Gangestad & Scheyd, 2005; Singh, 2002; Swami & Tovée, 2007; Van Dongen & Gangestad, 2011). That aside, this contradiction also casts doubts on the idea that the motivation to cooperate is only related to the possibility of obtaining resources from others through reciprocation. This is only one of the possible, and not mutually exclusive, motivations of pro-social behavior (social norms and ethical beliefs are also obvious factors). The mixed results obtained here demonstrate the difficulty of associating any behavior to a single motivation.

Let us remark that the present study is one of the few analyzing pro-social behavior solely in women. In a public good game played only by females, Buser (2012) found that contributions were higher during the menstrual phase of the menstrual cycle and that those participants with a lower 2D:4D ratio contributed less. Nevertheless, there exists a vast literature comparing behavior between men and women in strategic games (reviewed in Balliet et al. 2011). Results show consistently that men and women act differently depending on the sex of their counterpart in social dilemmas. The lowest levels of cooperation are usually found in setups where only women participate. While in mixed-sex interactions women tend to be more cooperative, men tend to be more cooperative in same-sex interactions (Baillet et al. 2011; Croson & Gneezy, 2009). Under an evolutionary perspective, these differences are usually attributed to the advantage of males when forming coalitions aimed to obtain resources in hunting and war. This difference between men and women could in turn mediate the effect of SPA, WHR and FA when women face mixed-sex instead of single-sex strategic interactions.

To conclude, and beyond the interest of the results obtained and their implications, it is important to remark that this study, as many others, was performed using exclusively a university population within a western culture. For this reason, before generalizing results to the human species, it would be needed to extend the experiments to a major range of ages and socio-cultural strata, including a wider range of ethnicities. This is particularly necessary when considering WHR given that its association with numerous features relies partially on the ethnicity of the subjects (Kaye et al. 1993). However, we can conjecture what could be the effect of fitness related variables on cooperative behavior in non-western industrialized societies. As it has been described (Henrich et al. 2010), people in many of these societies behave more in line with the predictions of Standard Game Theory. Following this pattern, one should expect less people to cooperate in the PDG in non-industrialized societies. Therefore, under the assumption that cooperative behavior is a tool to receive future help from others, only extremely low-fit individuals (showing remarkable unadaptative values in these variables) should cooperate often in these societies. Of course, this can only be elucidated by performing comparable experiments in other societies.

Acknowledgements

The authors gratefully acknowledge I. Monedero for his assistance during the sessions, one associated editor and two anonymous reviewers for their comments, and the financial support from the Ministry of Economics and Competitiveness, grant ECO2011-28750.

5.0 REFERENCES

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. *Health Psychology, 19*, 586-592.

Apicella, C. L., Dreber, A., Campbell, B., Gray, P. B., Hoffman, M., & Little, A. C. (2008). Testosterone and financial risk preferences. *Evolution and Human Behavior, 29*, 384-390.

Balliet, D., Li, N. P., Macfarlan, S. J., & Van Vugt, M. (2011). Sex differences in cooperation: A meta-analytic review of social dilemmas. *Psychological bulletin, 137*, 881-909.

Berenbaum, S. A., & Beltz, A. M. (2011). Sexual differentiation of human behavior: Effects of prenatal and pubertal organizational hormones. *Frontiers in Neuroendocrinology, 32*, 183-200.

Björntorp, P. (1997). Body Fat Distribution, Insulin Resistance, and Metabolic Diseases. *Nutrition, 13*, 795-803.

Brown, J. E. (1993). Preconceptional nutrition and reproductive outcomes. *Annals of the New York Academy of Sciences, 678*, 286-292.

Burnham, T.C. (2007). High-testosterone men reject low ultimatum game offers. *Proceedings of the Royal Society B, 274*, 2327-2330.

Buser, T. (2012). Digit ratios, the menstrual cycle and social preferences. *Games and Economic Behavior, 76*, 457-470.

Carré, J. M., & McCormick, C. M. (2008). In your face: Facial metrics predict aggressive behavior in the laboratory and in varsity and professional hockey players. *Proceedings of the Royal Society B, 275*, 2651-2656.

Carré, J. M., McCormick, C. M., & Mondloch, C. J. (2009). Facial structure is a reliable cue of aggressive behavior. *Psychological Science, 20*, 1194-1198.

Croson, R & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature, 47*, 1–27.

Dawes, R. M., & Thaler, R. H. (1988). Anomalies cooperation. *Journal of Economic Perspectives, 2*, 187-197.

Dixson, B. J., Dixson, A. F., Morgan, B., & Anderson, M. J. (2007). Human physique and sexual attractiveness: Sexual preferences of men and women in Bakossiland, Cameroon. *Archives of Sexual Behavior, 36*, 369-375.

Dugatkin, L. A., & Reeve, H. K. (2000). *Game theory and animal behavior*. New York: Oxford University Press.

Eisenegger, C., Naef, M., Snozzi, R., Heinrichs, M., & Fehr, E. (2010). Prejudice and truth about the effect of testosterone on human bargaining behavior. *Nature, 463*, 356-359.

Feinberg, D. R., Jones, B. C., DeBruine, L. M., Moore, F. R., Law Smith, M. J., Cornwell, R. E., . . . Perrett, D. I. (2005). The voice and face of woman: One ornament that signals quality? *Evolution and Human Behavior, 26*, 398-408.

Feingold, A. (1992). Good looking people are not what we think. *Psychological Bulletin*, *111*, 304-341.

Fink, B., Neave, N., Manning, J. T., & Grammer, K. (2005). Facial symmetry and the 'big-five' personality factors. *Personality and Individual Differences, 39*, 523–529.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics, 10*, 171-178.

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of all-cause mortality with overweight and obesity using standard body mass index categories a systematic review and meta-analysis. *Journal of the American Medical Association, 309*, 71-82.

Furlow, B., Gangestad, S. W., & Armijo-Prewitt, T. (1998). Developmental stability and human violence. *Proceedings of the Royal Society B, 265*, 1-6.

Gangestad, S. W., & Scheyd, G. J. (2005) The evolution of human physical attractiveness. *Annual Review of Anthropology, 34*, 535-548.

Hammerstein, P. (2003). Genetic and cultural evolution of cooperation. Dahlem workshop report. Cambridge, M. A: MIT Press.

Haselhuhn, M. P., & M., Wong E. (2012). Bad to the bone: Facial structure predicts unethical behavior. *Proceedings of the Royal Society B, 279*, 571-576.

Henrich, J., Heine, S. J., & Norenzayan A. (2010) The weirdest people in the world? *Behavioral and brain sciences, 33*, 61-135.

Holtzman, N. S., Augustine, A. A., & Senne, A. L. (2011). Are pro-social or socially aversive people more physically symmetrical? Symmetry in relation to over 200 personality variables. *Journal of Research in Personality, 45*, 687-691.

Jasieńska, G., Ziomkiewicz, A., Ellison, P., Lipson, S., & Thune, I. (2004). Large breasts and narrow waists indicate high reproductive potential. *Proceedings of the Royal Society B, 281*, 1213-1217.

Johnston, V. S. (2000). Female facial beauty: The fertility hypothesis. *Pragmatics and Cognition, 8*, 107-122.

Johnston, V. S. (2006). Mate choice decisions: The role of facial beauty. *TRENDS in Cognitive Sciences, 10*, 9-13.

Kaplan, A. S. (1990). Biomedical variables in the eating disorders. *The Canadian Journal of Psychiatry, 35*, 745-753.

Kaye, S. A., Folsom, A. R., Jacobs, D. R. Jr., Hughes, G. H., & Flack, J. M. (1993). Psychosocial correlates of body fat distribution in black and white young adults. *International Journal of Obesity and Related Metabolic Disorders, 17*, 271-277.

Kirschner, M. A., & Samojlik, E. (1991). Sex hormone metabolism in upper and lower body obesity. *International Journal Obesity, 15*, 101-108.

Klingenberg, C. P., Barluenga, M., & Meyer, A. (2002). Shape analysis of symmetric structures: Quantifying variation among individuals and asymmetry. *Evolution, 56*, 1909-1920.

Klingenberg, C. P., & McIntyre, G. S. (1998). Geometric morphometrics of developmental instability: Analyzing patterns of fluctuating asymmetry with procrustes methods. *Evolution, 52*, 1363-1375.

Kościński, K. (2007). Facial attractiveness: General patterns of facial preferences. *Anthropological Review, 70*, 45-79.

Kosfeld, M., Heinrichs, M., Zak, P. J., Fischbacher, U., & Fehr, E. (2005). Oxytocin increases trust in humans. *Nature, 435*, 673-676.

Kramer, R. S. S., Jones, A. L., & Ward, R. (2012). A lack of sexual dimorphism in width-to-height ratio in white European faces using 2D photographs, 3D scans, and anthropometry *PLoS ONE, 7*, e42705.

Lake, J. K., Power, C., & Cole, T. J. (1997). Women's reproductive health: The role of body mass index in early and adult life. *International Journal Obesity, 21*, 432-438.

Landén, M., Baghaei, F., Rosmond, R., Holm, G., Björntorp, P., & Eriksson, E. (2004). Dyslipidemia and high waist-hip ratio in women with self-reported social anxiety. *Psychoneuroendocrinology, 29*, 1037-1046.

Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A., Hallam, M., & Smoot, M. (2000). Maxims myths of beauty? A meta-analytic and theorical review. *Psychological Bulletin, 126*, 390-423.

Law Smith, M. J., Perrett, D. I., Jones, B. C., Cornwell, R. E., Moore, F. R., Feinberg, D. R., . . . Hillier, S. G. (2006). Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society B, 273*, 135-140.

Lefevre, C. E., Lewis, G. J., Bates, T. C., Dzhelyova, M., Coetzee, V., Deary, I. J., & Perrett, D. I. (2012). No evidence for sexual dimorphism of facial width-to-height ratio in four large adult samples. *Evolution and Human Behavior, 33*, 623-627.

Lev-Ran, A. (2001). Human Obesity: An evolutionary approach to understanding our bulging waistline. *Diabetes/metabolism research and reviews, 17*, 347-362.

Little, A. C., Jones, B. C., Waitt, C., Tiddeman, B. P., Feinberg, D. R., Perrett, D. I., . . . Marlowe, F. W. (2008). Symmetry is related to sexual dimorphism in faces: data across culture and species. *PLoS One, 3*, e2106.

Little, A. C., Jones, B. C., & DeBruine, M. (2011). Facial attractiveness: Evolutionary based research. *Philosophical transactions. Proceedings of the Royal Society B, 366*, 1638-1659.

Lovejoy, K., Catellier, J., Evans, C., Lohiser, A., & Chiu, I. H. (2013). Exploring individuals' social value orientation and decisions in a Prisoner's Dilemma. *Communication & Science Journal, in press*.

Manning, J., & Wood, D. (1998). Fluctuating asymmetry and aggression in boys. *Human Nature, 9*, 53-65.

Marcus, D. K., & Miller, R.S. (2003). Sex differences in judgments of physical attractiveness: A social relations analysis. *Personality and Social Psychology Bulletin, 29*, 325-335.

Marlowe, F., Apicella, C., & Reed, D. (2005). Men's preferences for women's profile waist-to-hip ratio in two societies. *Evolution and Human Behavior, 26*, 458-468.

Marti, B., Tuomilehto, J., Saloman, V., Kartovaara, L., Korhonen, H. J., & Pietinen, P. (1991). Body fat distribution in the Finnish population: Environmental determinants and predictive power for cardiovascular risk factor level. *Journal of Epidemiology & Community Health, 45*, 131-137.

Marwell, G., & Ames, R. (1981). Economists free ride, does anyone else? *Journal of Public Economics, 15*, 295-310.

Millet, K., & Dewitte, S. (2006). Second to fourth digit ratio and cooperative behavior. *Biological Psychology, 71*, 111-115.

Møller, A. P. (1997). Developmental stability and fitness: a review. *American Naturalist, 149*, 916–932.

Møller, A. P., & Swaddle, J. P. (1997). *Asymmetry, developmental stability and evolution*. New York: Oxford University Press.

Møller, A. P., & Thornhill, R. (1998) Bilateral Symmetry and Sexual Selection: A Meta-Analysis. *American Naturalist, 151*, 174–192.

Møller, A. P., & Alatalo R.V. (1999). Good-genes effects in sexual selection. *Proceedings of the Royal Society B, 266*, 85-91.

Mulford, M., Orbell, J., Shatto, C., & Stockard, J. (1998). Physical attractiveness, opportunity, and success in everyday exchange. *American Journal of Sociology, 103*, 1565-1592.

Muñoz-Reyes, J. A., Gil-Burmann, C., Fink, B., & Turiegano, E. (2012). Facial asymmetry and aggression in Spanish adolescents. *Personality and Individual Differences, 53*, 857-861.

Pazhoohi, F., & Liddle, J. R. (2012). Identifying feminine and masculine ranges for Waist-to-

Hip ratio. *Journal of Social, Evolutionary, and Cultural Psychology, 6*, 227-232.

Pearson, M., & Schipper, B. C. (2013). Menstrual cycle and competitive bidding. *Games and Economic Behavior, 78*, 1-20.

Pound, N., Penton-Voak, I. S., & Brown, W. M. (2007). Facial symmetry is positively associated with self-reported extraversion. *Personality and Individual Differences, 43*, 1572-1582.

Pound, N., Penton-Voak, I. S., & Surridge, A. K. (2009). Testosterone responses to competition in men are related to facial masculinity. *Proceedings of the Royal Society B, 276*, 153-159.

Reid, R. L., & Van Vugt, D. A. (1987). Weight related changes in reproductive function. *Fertility and Sterility, 48*, 905-913.

Rodríguez-Salazar, M. E., Álvarez-Hernández, S., & Bravo-Nuñez, E. (2001). Coeficientes de asociación (pp. 47). City of Mexico: Plaza y Valdés.

Sanchez-Pages, S., & Turiegano, E. (2010). Testosterone, facial symmetry and cooperation in the Prisoners' dilemma. *Physiology & Behavior, 99*, 355-361.

Sanchez-Pages, S., & Turiegano, E. (2013) "Two studies on the interplay between social preferences and individual biological features". *Behaviour, In press.*

Singh, D. (2002). Female mate value at a glance: Relationship of waist-to-hip ratio to health, fecundity and attractiveness. *Neuroendocrinology Letters, 23*, 81-91.

Singh, D., Dixson, B. J., Jessop, T. S., Morgan, B., & Dixson, A. F. (2010). Cross-cultural consensus for waist-hip ratio and women's attractiveness. *Evolution and Human Behavior, 31*, 176-181.

Stirrat, M., & Perrett, D. I. (2010). Valid facial cues to cooperation and trust : Male facial width and trustworthiness. *Psychological Science, 21*, 349-354.

Stirrat, M., & Perrett, D. I. (2012). Face structure predicts cooperation: Men with wider faces are more generous to their in-group when out-group competition is salient *Psychological science, 23*, 718-722.

Swami, V., & Tovée, M. (2007). Perceptions of female body weight and shape among indigenous and urban Europeans. *Scandinavian Journal of Psychology, 48*, 43-50.

Takahashi, C., Yamahishi, T., Tanida, S., Kiyonari, T., & Kanazawa, S. (2006). Attractiveness and cooperation in social exchange. *Evolutionary Psychology, 4*, 315-329.

Thornhill, R., & Gangestad, S. W. (1999). Facial attractiveness. *Trends in Cognitive Sciences, 3*, 452-460.

Thornhill, R., & Gangestad, S. W. (2006). Facial sexual dimorphism, developmental stability, and susceptibility to disease in men and women. *Evolution and Human Behavior, 27*, 131-144.

Thornhill, R., & Grammer, K. (1999). The body and face of woman: One ornament that signals quality? *Evolution and Human Behavior, 20*, 105-120.

Tovée, M. J., Maisey, D. S., Emery, J. L., & Cornelissen, P. L. (1999). Visual cues of female physical attractiveness. *Proceedings of the Royal Society B, 266*, 211-218.

Tovée, M. J., Reinhardt, S., Emery, J. L., & Cornelissen, P. L. (1998). Optimum body-mass index and maximum sexual attractiveness. *Lancet, 352*, 548.

Van den Bergh, B., & Dewitte, S. (2006). Digit ratio (2D:4D) moderates the impact of sexual cues on men's decisions in ultimatum games. *Proceedings of the Royal Society B, 273*, 2091-2095.

Van Dongen, S., & Gangestad, S. W. (2011). Human fluctuating asymmetry in relation to health and quality: A meta-analysis. *Evolution and Human Behavior, 32*, 380-398.

Weeden, J., & Sabini, J. (2007). Subjective and objective measures of attractiveness and their relation to sexual behavior and sexual attitudes in university students. *Archives of Sexual Behavior*, *36*, 79-88.

Weston, E. M., Friday, A. E., & Lio, P. (2007). Biometric evidence that sexual selection has shaped the hominin face. *PLoS ONE, 2*, 1-8.

Wilson, R. K., & Eckel, C. C. (2006). Judging a book by its cover: Beauty and expectations in the trust game. *Political Research Quarterly, 59*, 189-202.

Zaatari, D., Palestis, B. G., & Trivers, R. (2009). Fluctuating asymmetry of responders affects offers in the Ultimatum Game oppositely according to attractiveness or need as perceived by proposers. *Ethology, 115*, 627-632.

Zaatari, D., & Trivers, R. (2007). Fluctuating asymmetry and behavior in the ultimatum game in Jamaica. *Evolution and Human Behavior, 28*, 223-227.

Zak, P. J., Kurzban, R., Ahmadi, S., Swerdloff, R. S., Park, J., Efremidze, L., & Matzner, W. (2009). Testosterone Administration Decreases Generosity in the Ultimatum Game. *PLoS ONE, 4*, e 8330.

Zethraeus, N., Kocoska-Maras, L., Ellingsen, T., Von Schoultz, B., Hirschberg, A. L., & Johannesson, M. (2009). A randomized trial of the effect of estrogen and testosterone on economic behavior. *PNAS, 106*, 6535-6538.

Tables and figures

Table 1: Summary statistics for the entire subject population and according to choice in the PDG.

(Mean ± SEM. For statistics analysis, the natural logarithm of WHR was employed).

	TOTAL	**Defect (n = 55)**	**Cooperate (n = 121)**	
Age (yr)	21.42 ± 0.19	21.31 ± 0.31	21.48 ± 0.24	t_{174} = -0.419; p = 0.675
WHR	0.7198 ± 0.003	0.7300 ± 0.006	0.7152 ± 0.004	t_{174} = 2.184; p = 0.030
BMI	22.746 ± 0.291	23.294 ± 0.592	22.497 ± 0.326	U = 3000; N_1 = 55 N_2 = 121; p = 0.296
FA	4.248 ± 0.038	4.101 ± 0.065	4.3155 ± 0.046	t_{174} = -2.631; p = 0.009
FF	8.318 ± 0.131 x 10^{-2}	8.238 ± 0.204	8.354 ± 0.166	t_{174} = -0.412; p = 0.681
SPA	4.313 ± 0.071	4.564 ± 0.132	4.198 ± 0.083	U = 2666.5; N_1 = 55 N_2 = 121; p = 0.024

Table 2: Spearman Rho correlation between considered variables

	LN [WHR]	BMI	FA	FF	Age
SPA	σ_{176} = -0.255 p = 0.001	σ_{176} = -0.190 p = 0.011	σ_{176}= -0.178 p = 0.018	σ_{176} = -0.070 p = 0.357	σ_{176} = 0.084 p = 0.265
	LN [WHR]	σ_{176} = 0.118 p = 0.119	σ_{176} = 0.235 p = 0.002	σ_{176} = -0.217 p = 0.004	σ_{176} = 0.027 p = 0.720
		BMI	σ_{176} = 0.106 p = 0.162	σ_{176} = -0.129 p = 0.087	σ_{176} = 0.117 p = 0.124
			FA	σ_{176} = -0.046 p = 0.546	σ_{176} = 0.040 p = 0.602
				FF	σ_{176} = 0.042 p = 0.577

Table 3: Estimation of the probability of cooperation in the PDG: Logistic models. (Expected Behaviour of the opponent (EB) was coded as 1 if cooperation was expected and 0 if defection was expected.)

Variables in the model	MODEL				VARIABLE				
	-2LL	Likelihood Ratio Test	df	p	variables	coef	Wald	df	P
Ln(WHR), BMI, FA, FF, Age	202.882	15.741	5	0.008	Constant	-7.246	5.657	1	0.017
					Ln(WHR)	-8.394	6.008	1	0.014
					BMI	-0.023	0.229	1	0.632
					FA	1.137	9.551	1	0.002
					FF	-0.113	0.001	1	0.991
					Age	0.048	0.467	1	0.494
Ln(WHR), BMI, FA	203.360	15.262	3	0.002	Constant	-6.210	5.951	1	0.015
					Ln(WHR)	-8.284	6.043	1	0.014
					BMI	-0.020	0.176	1	0.675
					FA	1.125	9.475	1	0.002
SPA, Ln(WHR), BMI, FA	191.849	26.773	4	<0.001	Constant	-3.089	1.263	1	0.261
					SPA	-0.715	10.410	1	0.001
					Ln(WHR)	-11.407	9.736	1	0.002
					BMI	-0.056	1.280	1	0.258
					FA	1.085	8.194	1	0.004
EB, SPA, Ln(WHR), BMI, FA	157.962	60.660	5	<0.001	Constant	-2.776	0.754	1	0.385
					EB	2.293	29.791	1	<0.001
					SPA	-0.671	7.572	1	0.006
					Ln(WHR)	-7.649	3.414	1	0.065
					BMI	-0.096	2.865	1	0.091
					FA	1.127	6.315	1	0.012

Figure 1: Example of landmarks placement.