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The numbers of attraction:

the effects of density on the attractiveness of a male face

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Abstract

Ever since, in 1871, Charles Darwin presented his theory of sexual selection, this theme has been extensively studied. Scientists have concluded that mate choice has evolved to maximize female benefits, so female decisions must be based on signals that are evolutionary associated with mates of higher quality. These clues are mostly found in the face and are associated with the attractiveness of an individual, but in a society in which more and more males are available it becomes hard to perceive all these clues. Considering that the density of potential partners has been shown to influence mate choice it is pertinent to question whether it would have any influence in attractiveness. In order to test the hypothesis that density influences the attractiveness of a face, 40 male students of the University of Coimbra were photographed and their attractiveness was classified by female evaluators. The density effect was achieved by creating groups with different sizes (20 and 40) that were presented to the evaluators. Groups of 20 individuals represent smaller sample of male faces and easier to compare than groups of 40 individuals, which may represent an exaggerated number of choices. The attractiveness of each face was established in smaller and larger groups and significant differences were found in these evaluations. The results of this study show that when male faces were presented in smaller groups they achieved higher rating scores than when they were evaluated amongst a larger number of individuals. This outcome adds evidence that the number of potential suitors influences female decisions, namely those relative to the attractiveness of men.

Keywords: mate choice, attractiveness, density.

Resumo

Desde que, em 1871, Charles Darwin apresentou a sua teoria de selecção sexual, este tema tem sido extensivamente estudado. Os cientistas concluíram que a escolha do par evoluiu para maximizar os benefícios que as mulheres recebem, por isso esta decisão é baseada na leitura de sinais, que estão evolutivamente associados a parceiros com uma qualidade mais elevada. Estas pistas são maioritariamente encontradas no rosto e estão associadas à atractividade de um indivíduo mas, numa sociedade em que cada vez há mais homens disponíveis torna-se complicado distinguir todas estas pistas. Considerando que a densidade de potenciais parceiros vai influenciar a escolha do par é pertinente questionar se esta teria alguma influência na atractividade. Para testar a hipótese que a densidade influencia a atractividade de um rosto, 40 estudantes da Universidade de Coimbra foram fotografados e posteriormente avaliadoras femininas classificaram a sua atractividade. O efeito da densidade foi conseguido criando grupos de diferentes tamanhos (20 e 40) para serem apresentados às avaliadoras. Grupos de 20 indivíduos representam uma amostra mais pequena de faces e mais fácil de avaliar do que grupos de 40 indivíduos, que representam um número exagerado de escolhas. A atractividade de cada rosto estabelecida em grupos mais pequenos e maiores foi comparada e verificaram-se diferenças significativas nestas duas avaliações. Os resultados deste estudo mostram que quando as faces masculinas foram apresentadas em grupos mais pequenos atingiram avaliações mais elevadas do que quando foram apresentadas no meio de um número maior de indivíduos. Este desfecho comprova que o número de potenciais parceiros vai influenciar as decisões femininas, nomeadamente as que estão relacionadas com a atractividade dos homens.

Palavras-chave: escolha do par, atractividade, densidade

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Chapter 1 - Introduction

It doesn't take much to realize how significant sexual selection is in our society and how often this subject is discussed in most daily conversations. Scenarios involving women giggling and sharing secrets while men pass by are common and accepted as natural by the public but, for the keen eye of a scientist, this behaviour is seen as the product of millions of years of evolution and is a resourceful topic of interest and another opportunity to learn more about ourselves. Even though many discoveries have been made in this area, there is still a large number of unanswered questions about the way mates are chosen and this study aims to be another piece in the puzzle of knowledge, focusing on the influence of the number of mates available and their attractiveness in female mate choice.

1.1. Sexual selection

Mate choice is one of the most well studied subjects of the sexual selection. The first publication about this selection was presented in 1871 by Charles Darwin in his book *"The Descent of Man,* and Selection in Relation to Sex" and since then the theory of sexual selection has been surrounded in controversy (Andersson, 1994). Darwin declared that heritable traits, that may increase the reproductive success, would continue to spread even though this could not be explained by the natural selection theory. This idea was not accepted by Darwin's colleagues, much less by the rest of the public (Miler, 1998). One of the main obstacles for the acceptance of this thesis was related to the importance of female choice in the selection process which, especially in a Victorian society, was not well received (Jennions and Petrie, 1996). In the years that followed only a few scientists, such as R. A. Fisher, contributed to the development of this theory (Miller, 1998) and it wasn't until so long ago that the same idea was being dismissed by the scientific community, considered unsustained and irrelevant (Andersson, 1994). More than a century had passed since Darwin's publication until the scientists had the proper field work and genetic models to consider the acceptance of his theory (Andersson and Iwasa, 1996; Andersson and Simmons, 2006). Nowadays, the study of sexual selection is expanding not only in the scientific community, taking its place in areas such as biology, anthropology and psychology, but also in most ordinary publications, a growth that has been accompanied by a vast list of literature on the subject (Miller, 1998; Diamond, 2002).

1.1.1. Males and female different roles

When sexual behaviours are considered, even the least informed person can, with all certainty, assure that one of its most obvious characteristics is that there is a big difference between males and females attitudes, an acknowledgment that has been popularized by the moto: men are from Mars and women are from Venus. In fact, stating that there is a disparity between the sexes and that those divergences culminate in two distinct forms of selection this proposition is one of the bases for the study of sexual selection (Buss, 1988; Andersson and Iwasa, 1996). The first one involves competition of individuals within the same sex for mating partners and is called intrasexual selection, and the second one implies the choice of mate by members of the opposite gender (Malte and Iwasa, 1996; Geary *et al*, 2004). The issue of different behaviors has been discussed for many years and three main explanations have been suggested, each one addressing a new point of view and each one and trying to make clearer this dissimilarity.

Trivers (1972) parental investment theory states that the tendency for competition or choosiness is related to the parental investment each sex provides to the offspring. This results in an increased number of fights between individuals of the gender with the least investment and the possibility of choice for the members of the sex with the most responsibility in parental care. Emlen and Oring (1977) operational sex ratio thesis addresses the question of how many males and females are ready to mate in a given moment because, even though the usual ratio of sexes is 1:1 the gender that has a lower paternal investment re-enters the mating pool sooner than their former mates, leading to a different ratio. Finally, the anisogamy explanation and consequent implies that the disparity on the number of female and male produced gametes may influence the behavior of the sexes in terms of sexual selection, as not all male gametes will fertilize a female one (Alcock, 2011). In most studies, males have been identified as the minor parental investor (Geary *et al*, 2004), the most available sex (Puts, 2010) and having the highest gamete count (Alcock, 2011), so they are associated with intrasexual competition, and females are considered the choosier sex. In these conditions it is expected for males to invest more in accessing the female and their companions in choosing a good subject to help in parental care (Miller, 1998).

1.1.2. Intrasexual selection

In gregarious animals sometimes the needs of the individuals intersect and some sort of solution must be provided in order to determine who gains access to resources which, in most cases, leads to competition. This also applies when reproductive success is considered, once fertile females are the desirable resource and the males must engage in competition between themselves for mating access (Buss, 1988).

In humans, intrasexual selection is most commonly described in men and the competition has consequences not only in their anatomy but also in their behaviour (Puts, 2010; Puts *et al*, 2012). Anatomically, it is commonly known that the average man has a larger stature, more robust skeleton and face features, more muscularity and is usually stronger and faster than the average woman and, because these characteristics only arise in adolescence, it can be assumed that their development is sexual related (Frayer and Wolpoff, 1985). Men's faces are usually considered the heritage of a competition past, as they appear to be a threatening instrument and a dominance signal suggested by the beard and thick eyebrows (Puts, 2010) and their voices are also thought to be a way of establishing dominance, as deep low-pitched voices increase apparent size (Puts *et al*, 2012). If these aspects are considered to have evolved in a contest context, the lack of anatomical resemblances to weapons concerned some scientists but it can be explained by invention of combat weapons by the humankind. Also, human males are known to be more aggressive and to get involved more often in fights than females (Archer, 2004).

Even though these aspects could enable a contest situation, nowadays intrasexual selection in humans has a different approach, far from the direct confront, relying on tactics such as the development of skills at locating females, signalling interest, acquiring resources desired by potential mates and change of appearance (Buss, 1988).

1.1.3. Intersexual selection

In his study on sexual selection Darwin (1871) stated that in many cases females are not passive spectators in the game of mating and are responsible for mate choice, doing it potentially arbitrarily. Later, this choice was proved to be the behavioural product of their unconscious preferences, which influences mating in favour of a specific individual as a result of interaction of a large number of genes and environmental aspects (Miller, 1998). This system is associated with costs that will

influence the direction of evolution (Jennions and Petrie, 1997) but has also benefits to the progenitor and the offspring, and has been preserved because being choosy was confirmed to be beneficial (Buss, 1994).

Genetic mechanisms can be responsible for the differences in directionality of female mate choice (Mead and Arnold, 2004). It has already been proved that there is a genetic basis to the resistance against parasites, considered the immunocompetence of an individual and that this capacity can be advertised to potential mates by exaggerated signals which forms the basis for the immunocompetence handicap hypothesis (Folstad and Karter, 1992). Since that resistance is hereditable and females are able to choose from a group of males the one with the best qualities, engaging in a selection for "good genes" that will be passed to the offspring is advantageous. This theory is sustainable because in order to prevent the occurrence of false signals they follow the "handicap principle" and cannot be easily faked (Zahavi, 1975; Folstad and Karter, 1992). One of the most important genomic regions that controls resistance to diseases is the major histocompatibility complex (MHC) and associated allelic diversity should confer a better defense (Puts, 2010). So, it is expected that females will choose males with more dissimilar MHC in order to, as predicted, increase the resistances of their offspring – MHC-disassortative hypothesis, which has also been documented in humans (Chaix *et al*, 2008).

Another possible explanation for mate choice was proposed by the mathematician R.A. Fisher in his runaway theory, which is based on the preference for aesthetic characteristics in the opposite sex (Wiley, 2000). He proposed that selection would be originated by any sensory modality, such as visual traits, odours, sounds or tactile experiences and suggested that females would prefer males with some particular characteristics (Miller, 1998). Those random traits will then be inherited by their offspring, originating males with the desired traits and females with the preference for them, hence the colloquial name "sexy son hypothesis". This behaviour will create a positive feedback loop and a "momentum" that enables the runaway to continue its progression (Malte and Iwasa, 1996). An important consideration on this theme was pointed by Kirkpatrick (1982), who, mathematically, concluded that the feedback wouldn't occur infinitely, and that the process would arrive to a moment where there is a balance between cost of ornamental traits and reproductive rewards, so the mechanism doesn't collapse on itself. Despite of what has been considered, female mate choice can also be manipulated by seducers who exploit "latent preferences" that can arise either

from previous selective evolutionary processes or can be related to the traits that are being settled by Fisher's runaway process, creating a situation of "sensory exploitation" (Miller, 2000).

The choice of a male can bring direct advantages to the female since it can benefit her fitness (Wiley, 2000). This can be accomplished by an increase of her fitness, if the mate she chooses has good genes, is healthier or is capable of providing better parental care to the offspring (Wiley, 2000; Andersson, 1994). Another aspect to consider is the advantages the female can obtain from the male that will improve her survival chances which can be achieved by the provisioning of high quality food, especially during the gestation period, or by protection against predators or conspecifcs (Miller, 1998).

In humans it has been proved that signals will be recognized and individuals with the best potential will be chosen, but there haven't been conclusive studies to prove the MHC-disassortative mating theory (Moore *et al*, 2011). Also, women tend to choose mates that have stability, resources and preferably a higher social status (Buss, 2003; Shackelford *et al*, 2005) because these characteristics are associated with a lower infant offspring mortality and more stable psychological and physical health (Geary *et al*, 2010).

1.1.3.1. The lek paradox

As it was referred before, female mate choice can vary based on environmental variation or influenced by genetic characteristics when the interests of the female are the hereditarily traits of the partner. In leks, as in human societies, females tend to choose their mates cautiously among large groups of males based on the Fisher "sexy sons" and "good genes" hypotheses, so empirically it could be though that after a few generations all of the males would have the desirable traits females choose, collapsing the mechanism of selection (Wiley, 2000). But, just by looking around, it is obvious that, even though some preferences have been established women tend to choose different subjects for partnership. This problem is called the lek paradox and was addressed by Fisher who predicted that the fixation in the gene pool would cancel the incentive for female choice and diminish the variation in fitness (Miller, 2000). However, three solutions have been proposed for maintaining heritable variation and solve this riddle (Wiley, 2000; Miller, 2000). The first explanation that justifies the maintenance of genetic variation implies a co-evolution between parasites and hosts, a delicate balance

achieved because the alleles associated with resistance may shift after a few generations, and so, women must select from different allelic combinations in order to maximize their offspring potential (Hamilton *et al*, 1990). The second validation for mate choice is related to the geographic space that is occupied by the group. Migration is a well know factor to disturb genetic pools, and in the case of leks is no exception, so the income and outcome of genetic information will break the fixed direction of selection (Wiley, 2000; Miller, 2000). The third factor to be considered is the frequency of mutations that can vary the fitness of their carriers, which deserves special attention considering that sexually selected traits have more heritability and variance than others (Pomiankowski and Moller, 1995; Rowe and Houle, 1996).

1.2. Facial attractiveness

Rhodes (2006) states that a beautiful face is one of the most pleasurable sights someone can see and, just by looking around in a developed country, it is obvious the influence that beauty and fashion have, not only in people, but also in advertisement and the economy. Attractive faces create pathways to reward centers in the brain, originate sexual desires and even help in the development of an intuit for same sex alliances so, independently of the reasons that made the face eye-catching, these characteristics are being exploited (Puts, 2010; Little *et al*, 2011a). Some scientists have considered facial preferences to be arbitrary or strictly culturally controlled, but it has been proven that even though the choice may vary, there is an evolutionary explanation for it. Of course this doesn't mean that cultural aspects should not be considered, and evidence has been provided that social learning influences individual choice and consequently in attractiveness ratings (Little *et al*, 2011) but this study will focus on the most conserved traits of mate choice.

The fact that facial attractiveness is being selected based on evolutionary mechanisms is supported by two presupposes: the first one shows that people in different cultures agree in the attractiveness of other individuals, and the second one which sustains that these preferences start to show before cultural standards of beauty are imposed (Little *et al*, 2011a). Since preferences can be considered as a form of sexual selection these traits might signal reproductive success and the choice must be based on aspects that are common between choosers (Thornhill and Gangestad, 1993; Rhodes, 2006). As there is no exact key for an attractive face there must be some

variables that can vary, such as averageness, symmetry and sexual dimorphic characteristics, among others (Rhodes, 2006; Little *et al*, 2011a).

In this context, the averageness of a face is the measurement of how it resembles the others within a given population and consequently an average face, has no unusual characteristics and has a low distinctiveness as it can be perceive in Figure 1 (Rhodes *et al*, 2001; Little *et al*, 2011a). Thornhill and Gangestad (1993) interpreted these results as to that average faces may be preferred when attractiveness is considered for genetics reasons, since this characteristic may be a signal that the individual bares a more diverse set of genes which gives them a larger immune defence. These results are not definitive conclusion because some studies that have been produced in this area are sometimes inconclusive, so it has been established that average faces are attractive but not that averageness is optimally attractive since there are other factors that may contribute in a larger scale to this evaluation (Rhodes 2006).

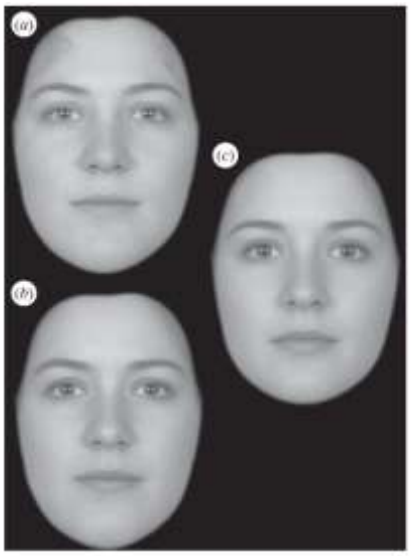

Figure 1 – Averageness and mate choice: composite image of 3 images (a), given the color of 9 images (b) and given the shape and color of 9 images (c) (Little *et al*, 2011a).

The symmetry of a face is the extent to which one half of it is equal to the other half. This characteristic is an important base for mate choice because it is considered to be a signal of healthy development and a good genetic quality indicator (Moller, 1997). Deviations from symmetry, called fluctuating asymmetries, arise during an individual's development, caused by stress and environmental pressures, and result in a sub-optimal outcome associated with less than perfect genetic value which results in women's choice to be skewed towards more symmetrical faces (Thornhill and Gangestad, 1996). Two different levels of symmetry are presented in Figure 2.

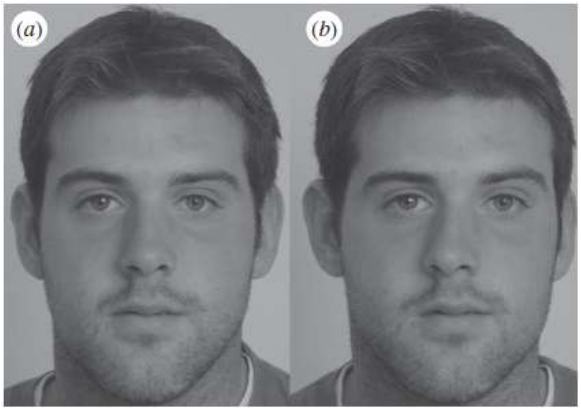

Figure 2 – Symmetry and mate choice: (a) more symmetrical face / (b) less symmetrical face (Little *et al*, 2011a).

As it has already been discussed, there are obvious differences between male and female adult faces resulting in a notorious sexual dimorphism and, because these characteristics start to develop in adolescence, when sexual maturity is achieved, they are good indicators of reproductive potential (Thornhill and Gangestad, 1996). In men's faces, these modifications are associated with higher levels of testosterone and the phenotypic consequences are the growth of the cheekbones and jaw, the appearance of beards and the increase of an overall more robust appearance (Rhodes 2006). Besides being a signal of sexual maturity, these secondary traits are also important to mate choice because, considering that they are very expensive to the organism, high levels of testosterone are difficult to maintain, making them an honest sign of a healthy man that can sustain such handicap (Little *et al*, 2011a). For this reason the choice of a more masculine face can bring indirect benefits to a female because they are a signal of "good genes". Despite this advantage, Carre and McCormick's (2008) sustained that there is a downsize in choosing more masculine faces considering that there is a relation between high levels of testosterone and aggressive behaviours.

Figure 3 – Sexual dimorphism and mate choice: male composite images made more masculine face (left) and a less one (right) (Little *et al*, 2011a).

Of course there are other traits that may influence attractiveness such as eye colour, skin health or beard coloration, but in the end most of these choices are guided by the same principles of sexual selection reviewed before, which sustains the prediction that attractiveness is an evolutionary adaptation considered in mate choice (Miller, 2000; Little *et al,* 2011a).

The factors previously presented are general guidelines for finding a face attractive but there are individual differences in ratings that can be justified by factors that vary more personally (Little *et al,* 2011a). Female hormone levels are an important issue to consider when studying attractiveness (Alvergne and Lummaa, 2010). It has been proved that women's preferences concerning male faces vary during the menstrual cycle and studies show that in their most fertile period, during ovulation, women have a tendency to feel more attracted to more masculine faces then in other phases of the reproductive cycle (Jones *et al,* 2008). Interestingly, women taking birth control pills show more preference for less masculine faces (Feinberg *et al,* 2008). This variation is due to the fact that these contraceptives prevent ovulation, causing an abnormal loss of fertility in women, making them prefer masculine faces (Alvergne and Lummaa, 2010). Self-perception is also an issue to considerer since studies have shown a link between female self evaluation on attractiveness and their assessment of others (Todd *et al*, 2007). Buston and Emlen (2003) concluded that females with higher perception of themselves were usually more selective in their choice of males, in opposition to women with lower self-perception who were less discriminative. Another condition that must be considered was investigated and proven by Little *et al* (2002) and concerns intentions of the female evaluator. These investigators showed that the desired duration of the relationship and relationship status of the evaluator have influence in mate choice, demonstrating that women looking for a partner for a short term relationship or an extra-conjugal relation would prefer a more masculinised face in comparison with those looking for a long term relation.

1.3. Number of available options and mate choice

Mate choice is a very popular theme, and the question of who females chose has been largely studied, but scientists have only recently started to learn more about how this process enrols itself (Lenton and Francesconi, 2010). As presented before, females have to perceive an enormous number of visual clues when evaluating a potential mate and the fact that women are able to access and process so much information in a short

period of time facilitates mate selection, diminishing its costs (Miller and Todd, 1998). In order to, not only be able to consider all these clues and make evaluations about faces, but also make comparisons between them, scientists believe that females must rely on a decision mechanism with cognitive bases (Todd *et al*, 2007). Still, this process can be very time consuming, so female mate choice has to be able to adapt to the different situations and scenarios.

Nowadays, mate choice mechanisms face an uprising challenge in societies in which a huge number of potential mates can easily be found because, in a context of social gathering, females must perform an assessment of the characteristics of a large number of faces (Kokko and Rankin, 2006; Lenton *et al*, 2009). Besides, modern dating also differs from the past because, for the first time, the assessment of a potential mate doesn't even need to be face to face. Internet access and an increased number of social networks now allow women to evaluate men without even leaving their homes and, in some countries, dating websites are popular and commonly acessed (Lenton and Stewart, 2008; Lenton *et al*, 2010). In these contexts, the perception of visual clues is fundamental because these characteristics are the first ones to be observed (Lenton *et al*, 2009). Lenton and Stewart (2008) and Lenton and Francesconi (2010) conducted experiments that proved that females engage in different selection processes when choosing a possible male suitor from different group sizes. In scenarios that mimicked the one described above, females who were faced with a larger group of suitors would rely mostly in quickly and easily assessed clues, contrasting with the ones choosing from smaller groups that would make their decisions based on a higher number of assessed clues.

Scientists have been exploring the ramifications of sexual choice in relation to the number of mate options, trying to understand the implications of this variance in the resulting choice. Experimental evolution has investigated sexual selection and has shown useful results in animals (Garcia-Gonzalez, 2011) and an increasing number of studies have been assembled for humans (Kokko and Rankin, 2006). The results of these studies vary but some conclusions have been drawn. When asked, women usually say that an increased number of options should be an optimal choosing scenario and associate these conditions with higher expectations for satisfaction (Lenton *et al*, 2010). As it was already discussed, women are choosy and some characteristics that are preferred represent universal ideals which results in a non-random variation in selection (Watkins *et al*, 2012). In an experimental scenario, where a large number of suitors was

presented to women Lenton *et al* (2009) found that female choice was altered and the results showed that the mating skew had been increased. This happened because top-ranking suitors were more highly praised and low-ranking individuals fared less well when both were considered amongst other individuals. Therefore, a bigger set of mate options can result in a consistent outcome, in which female mate choices converge and choosiness is established (Watkins *et al*, 2012). Scientists have proposed that the decrease in the costs of looking for a partner and an increase of the use of visual clues can be the base of this behavioural change, since women could choose a male with higher quality characteristics with less effort (Lenton *et al*, 2009), but the scenario previously presented has not always been observed and some scientists agree that the increased abundance of suitors may result in a contrary outcome, because the overload of information may confuse the female evaluators making the choosing process harder (Lenton and Francesconi, 2011). This happens because choosing between too many suitors is more time consuming and sometimes associated with lower satisfaction levels (Lenton and Todd, 2010). Lenton *et al* (2010) and Lenton and Francesconi (2011) addressed this thesis in an experimental manner and came to the conclusion that an increased number of mate options would only generate greater confusion in the outcome of female mate choice, along with less satisfaction and greater regret resulting from the decisions made. These scientists have also reported that the ideal number of options for a mating choice scenario would be 20 suitors of the opposite sex, because a set this size results in the highest levels of satisfaction and enjoyment and lower levels of regret and choice difficulties.

1.4. Objectives and hypothesis

Several studies have shown that the number of potential suitors has an influence in the outcome of sexual selection but, so far, none of these experiments has tested the effect of this factor in female evaluations of facial attractiveness. The goal of this research is to determine if the manipulation of the number of male faces presented to women will result in variation of their evaluations of attractiveness and, in order to do that, the hypothesis that there are differences between evaluations of a men's face in distinct density groups was tested.

Chapter 2 - Methodology

2.1. Male sample

The field work necessary to carry out this study took place in two separate phases: the first one was designed to produce a primary rating of the attractiveness of the male faces and the second one aimed to obtain information about the effect of the number of options in female evaluations.

The male sample consisted of 40 men, all students at the University of Coimbra and with ages between 20 and 29 years old (Mean = 22,28, SD = ±2,69), that were randomly recruited in the university area. They were escorted to the photography studio where pictures of their faces were taken with a Canon 1000D camera in standardized light and focus conditions and with a neutral background. The subjects were asked to display a neutral expression for the photography and to remove any visible accessories, including glasses. These conditions were similar to the ones used by Lie *et al* (2010), Stephen *et al* (2012) and Watkins *et al* (2012).

Even though, according to the article 79, number 2 of the Portuguese Civilian Code (2010), the photographs could be used for the purpose of this thesis, participants signed a consent form allowing their use. Each subject's photograph was then associated with a number between 1 and 40 (Idphoto) that became their identification number. The photographs were manipulated with the program Adobe Photoshop® CS6 in order to correct slight differences in light and framing. The photographs are presented in appendix 1, in a randomized order and unnumbered to prevent its identification by the public. In figure 4, three examples of the photographs taken are presented.

Figure 4 – Example of photographs of masculine sample

2.2. Initial attractiveness' classification

An inquiry was designed in a excel file with an associated database, so that the photographs could be rated. In the first page instructions were presented informing the evaluators not only about the confidentiality of the study, but also about the procedure,

and females were asked to indicate their age. After this, the photographs were randomly presented in association with a 1-7 Likert scale, in which 1 represented the lowest attractiveness and 7 the highest, measures that were used in the study developed by Moore *et al* (2011). There was no time limit for each evaluation and once a face was rated the inquiry would automatically pass to another photograph.

To establish an initial attractiveness score for each of the male faces, 42 female students, with ages between 20 and 26 years old (Mean=22,21, SD=±1,74), were randomly recruited in the university area. They were asked to rate the subjects individually in a computer session. The evaluators who rated all the faces with just one value (1) were discarded, indicating they were not attempting to rate. Interrater reliability was calculated for the remaining 30 evaluators and, since its value was high (Cronbach's $\alpha = 0,95$), the results were considered consistent.

2.3. Density effect in attractiveness

The average attractiveness for each individual face was calculated and these values were used to divide the initial sample in two adicional groups. In order to make these divisions the means of attractiveness of the individuals were ordered, from lowest to highest score. A second series, 20EqDist, comprised a set of 20 photographs extracted from the original 40, randomly selecting one from each pair of faces with similar scores, to achieve an equal distribution to the original set. A third series, 20Most, grouped the 20 highest scores from the original 40 faces. The groups of 20 individuals intend to represent an ideal set size for decision making, while the group of 40 individuals, 40A, represent an exaggerated scenario with a higher than desirable number of potential suitors for evaluation, as concluded by Lenton *et al* (2010) and Lenton and Francesconi (2010).

The density effect, on whether attractiveness ratings would be influenced by the number of members of the opposite sex presented, was tested through an online anonymous questionnaire. This new questionnaire was developed, and made available online and shared publicly through social networks and e-mail. Raters were informed, in the first page about the study and to whom it was destined - portuguese women with ages between 20 and 30 years. This page also contained information about the nature of the inquiry, the assurance of anonymity and confidentiality and instructions about the evaluation process. The second page required the participant to answer a few questions about their age, nationality, gender, district and scholarity. After this, evaluators were

asked to answers questions concerning contraceptive use, relationship status and own self-perception in terms of attractiveness, factors that have been proved to alter mate choice. Participants were also asked to answer in a short text what was the importance they gave to attractiveness of a member of the opposite sex in a social context. This question worked as a control question. The raters were then directed to one of three different paths containing the photographs of the series 40A, 20EqDist and 20Most, a separation that was determined in conformity with their identification number in the database and obeyed to a proportion of 2:1:1. This meant that each evaluator would only rate faces from one of the three sets previously defined and no clues were presented as to the existence of different sets of faces.

Independently of the set of faces presented, the photographs were show in a slideshow containing all the faces in that set to be evaluated. The order of the pictures was randomized and each photo was shown for 1 second fading out before the next one started to fade in. Next, females would see, for 5 seconds, a page showing thumbnails of all the pictures previously presented after which the evaluation process would begin. This two presentation of photographs acted as stimuli to the density effect. Similarly to the classification phase of the project, each photo was presented alone in the screen with a 1-7 Likert-type scale and, without any time restrains, females could rate the faces from the lowest to highest attractiveness (1 to 7, respectively) and, once the evaluation was made, it would automatically proceed to the next face to be evaluated. The inquiry ended with a note of acknowledgement for the participants. No moving backwards was permitted.

The website registered 903 entries, but some inquiries were automatically discarded, since the database was set to filter out some of the inquiries, based on characteristics of the evaluator such as gender, age and nationality, since the inquiry was only destined for portuguese females with ages between 20 and 30 years. This primary selection process also considered invalid inquiries in which the evaluation was not completed. These eliminations resulted in the discard of 431 inquiries. Of the remaining 472 valid inquiries, 8 were excluded following the same criteria from the first phase of the study which stipulated that when participants rated all the faces with the classification of 1 their contribution would not be considered. In the remaining 464 evaluators (Mean age=23,55, SD=±2,76) the series 40A registered 193 valid inquiries, the series 20EqDist 129 and the series 20Most 142. These evaluators represented a sample from the entire country, since every district was represented.

2.4. Statistical analysis

The data recollected from the inquiries was then analyzed. First, a fourth series was computed, 40B, by withdrawal of half the results of 40A, using a pseudo-random process of alternate selection. After this, the data recollected from the 464 valid questionnaires was statistically analyzed starting with the distribution of Ratings in each series. Figure 5 shows the graphics of these results.

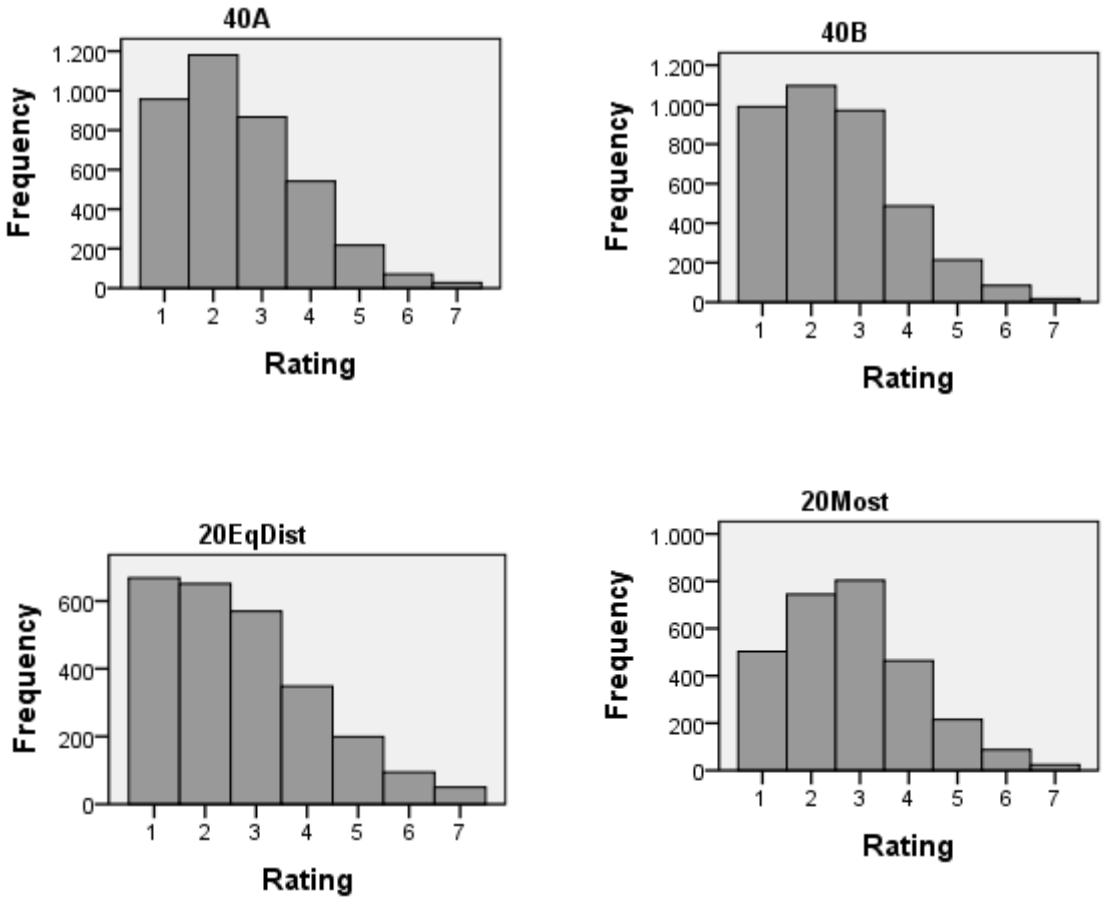

Figure 5 – Distribution of evaluations per Series
N_{40A}=3860; N_{40B}=3860; $N_{20EqDist}$=2580; $N_{20EqDist}$=2580; N_{20Most}=2840

In all four series the distribution did not have a Gaussian distribution. The results of the test of Kolmogorov-Smirnov were highly significant for any of the series ($p<0.0001$) all subsequent analyses used non-parametric tests. As it can be perceived from the graphs above, the distribution of data for this analysis is very positively skewed so a Poisson Loglinear distribution was used for the Generalized Linear Model (bellow).

Considering that several factors can influence individual preferences, as it was referred before, the effect of factors such as relationship status, contraceptive use and self-perception were tested to assess if they varied between the evaluators of each series which could influence the results of this experiment. The responses to these questions, presented in the beginning of the questionnaire, were computed and an analysis was made to check the effect of these factors in female evaluations. In order to establish if the factors referred had had any influence in the results of attractiveness, their differences between series were analyzed in a generalized linear model (GLM). In this analysis the dependent variable was considered to have a Poisson distribution. The observers were the subject effect, and the photographs were the within-subject effect. The series were a between subjects factor. The influence of self-perception in overall evaluations was calculated using a regression model.

Finally, the effect of density of faces on their evaluation of attractiveness by females was tested. In order to determine if the attractiveness of male faces varied between different size groups the ratings that each face obtained in the group of 40 individuals was compared to the values got in one of the two groups of 20. These comparisons were made using a GLM that considered rating the dependent variable, the photographs as subject effects, the observers as within-subject effects and the different series as factor. As referred before the chosen distribution of the dependent variable, rating was the Poisson Loglinear distribution. Because this comparison was pairwise, the results analysed corresponded only to the ratings of faces presented in both groups. The statistical test used in the GLM was the Wald Chi-square.

All analyses were made using the program IBM SPSS Statistics® 20.

Chapter 3 – Results

A Spearmen correlation was computed to calculate the correlation between the values of attractiveness from the first evaluation (Initial_Classif) and those obtained on the second phase of the study (Rating). As figure 6 shows this correlation proved to be very strong (r_s=0.937) and highly significant (p<0.0001). A high correlation value reassures the selection of individuals for the series 20EqDist and 20Most, initially based on a first evaluation of attractiveness by a lower number of female evaluators.

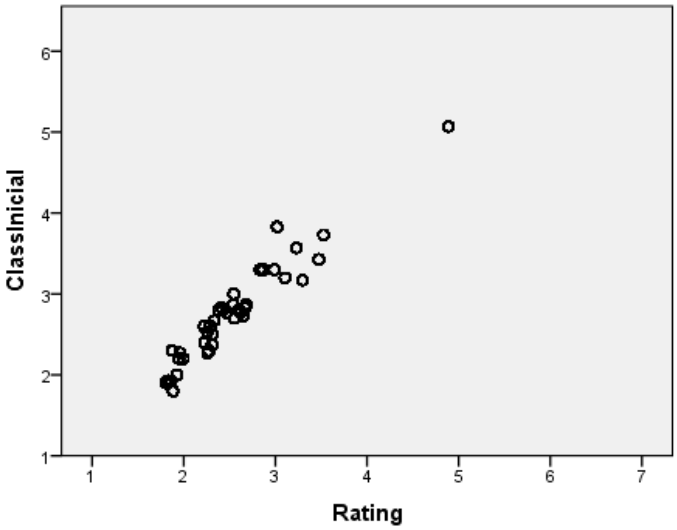

Figure 6 – Correlation between initial classification and rating (r_s=0.937; p=0.000)

In figure 7 we can observe the distribution of the average attractiveness of the all 40 photographs used in the study. As predicted by the positive skew in the distribution of ratings presented in figure 5, most individuals present a low average value of attractiveness. The only exception is the individual 34, having a rating substantially higher than his peers. Analysis was repeated without this subject but the results were proven not to be significantly different.

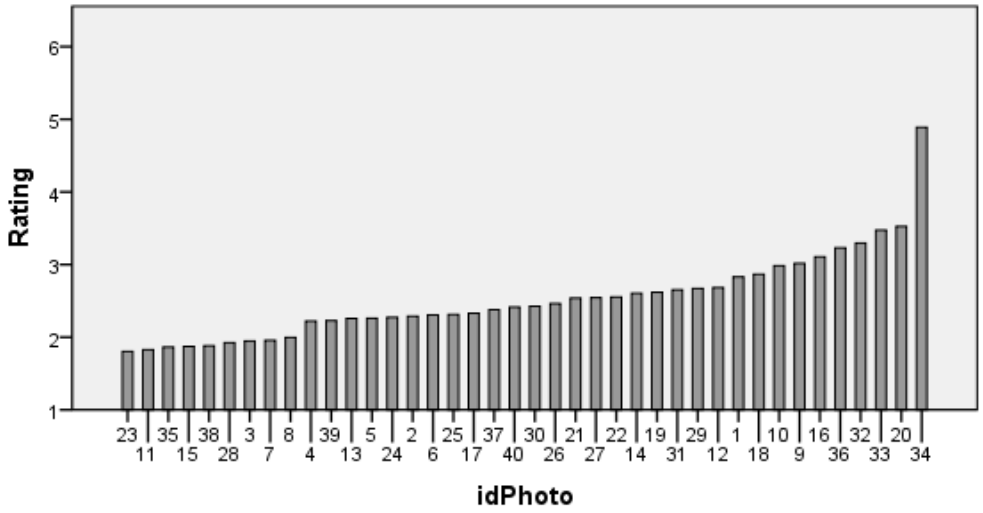

Figure 7 - Mean rating of attractiveness for all 40 individuals

When testing if differences of evaluation per series could be affected by factors such as relationship status, contraceptive use or self-perception, it was found that in all cases the results were not significant (relationship status: p=0,493; contraceptive use: p=0,461; self-perception p=0,056). Thus, these factors were not responsible for any differences between groups. To determine if there was a significant relation between self-perception and evaluations attributed by women, the mean result of all the classification attributed by each rater was calculated. These results were then compared to the self-perception of raters in a linear regression. This model considered the classification as the dependent variable and self-perception as the independent one, and a marginally significant correlation was found (r=0.092: p=0.047).

In order to determine if density had an influence over female ratings of attractiveness, two kinds of comparisons were made. In both, the classification of 20 faces when presented in a group of 40 were compared to when they were presented in a group of 20. In the first case 20 faces were randomly chosen that had the same attractiveness distribution as the 40 from where they were extracted (this was the 40A-20EqDist). In the second case we comparedthe 20 most attractive faces in a group of 40 or just the 20 (this was the 40B-20Most). The differences were tested using a GLM. In a first comparison of the 40A-20EqDist it was found that the attractiveness of the 20 average faces increased significantly ($\chi^2_{=}$ 9.679, p=0,002) when presented alone, by comparison with when presented in a group of 40 (Figure 8).

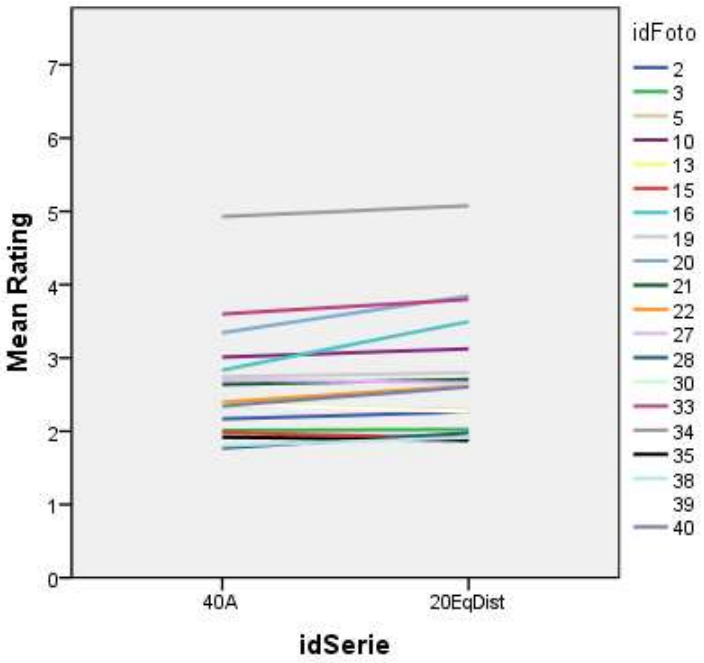

Figure 8 – Attractiveness rating differences between series 40A and 20EqDist

The attractiveness of the most attractive faces was also tested to verify if it had been affected by the density of presented subjects. For this the 20 most attractive faces (20Most) were compared when alone (in a group of 20) or when mixed in the group of 40 faces. There was also a significant difference (χ^2= 6,509; p=0,011) with the faces showing a general (decrease) increase in attractiveness when presented alone by comparison with the group of 40 (figure 9).

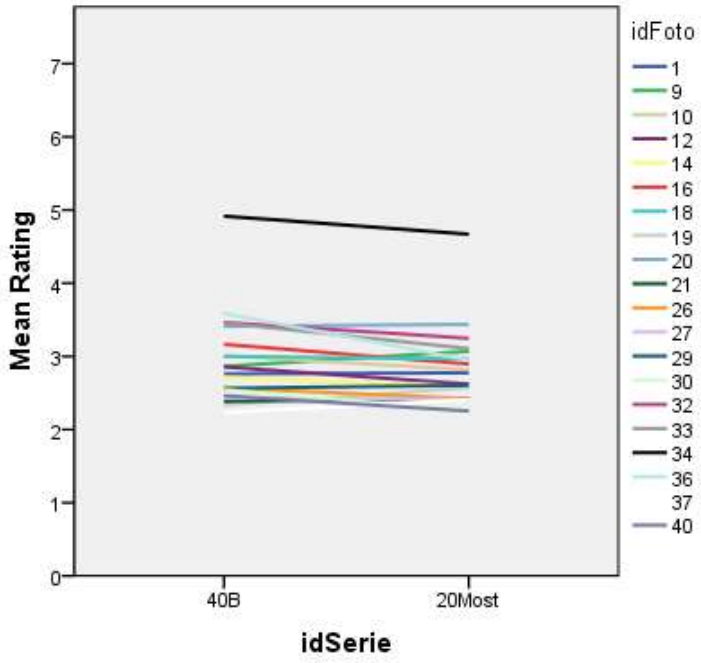

Figure 9 - Attractiveness rating differences between series 40B and 20Most

To determine the reason why differences between evaluations attributed to male faces in different set size groups varied the medians and variance of the distribution was analyzed. Figure 10 presents these results for the comparison of the series 40A and 2EqDist.

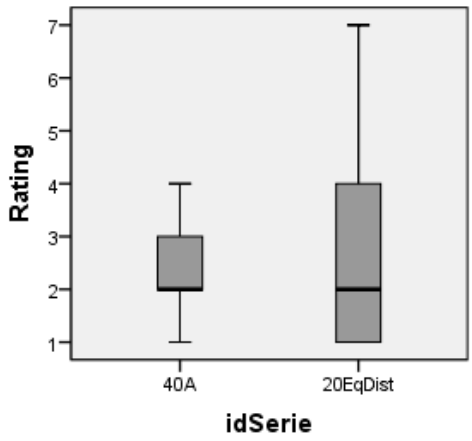

Figure 10 – Distribution of ratings in series 40A and 20EqDist

When the evaluations of attractiveness of individuals rated in both sets 40A and 20EqDis are compared it is noticeable that higher evaluations are associated with the smaller set of individuals presented to evaluation, which once again indicates a loss of attractiveness of individuals when rated in a larger group set. In the case of the series 20EqDist, a higher value of variance corroborates the idea that evaluations in this set were very disperse and ranged in a larger number of ratings, contrary to what happened to the evaluation of the individuals when presented on the set of 40A. The results of the second analysis, that compared the results of the series 40B and 20Most are presented in the graph below (Figure 11).

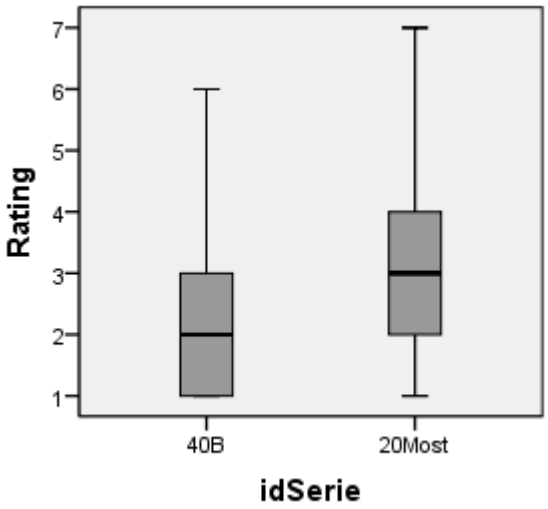

Figure 10 - Distribution of ratings in series 40B and 20Most

The results of the comparison made between the groups 40B and 20Most demonstrate, once again, that higher scores of attractiveness were attributed to the individuals when they were presented in a smaller group, rather than when they were amongst a larger number of individuals.

Chapter 4 – Discussion

4.1. Density effect on mate choice

Despite being a well conserved evolutionary mechanism, scientists have shown that sexual selection sustains a high degree of variation that allows the process to adapt to different situations (Kokko and Rankin, 2006). The number of potential mates is one of the factors that influences the process of selecting a mate and differences have been observed in studies that compared female choices between smaller and larger groups of suitors (Lenton and Stewart, 2008; Lenton *et al,* 2009; Lenton and Francesconi, 2010; Lenton*et al,* 2010; Lenton and Francesconi, 2011). Because these studies have been developed based on dating web-sites or speed-dating scenarios females have access to both visual clues of attractiveness and information about the suitor such as age, carer, hobbies and likes, so the question of how attractiveness ratings would be influenced by the number of potential mates of a group isn't really explicit. Here the intention was to understand how density affects the mate choice, and in particular the attractiveness of males for females. The results of this study provide some answers to this question by analysing the results of female evaluations of photographs of male faces when these were presented in different densities, in groups of 40 or 20 individuals.

The results of the comparisons between the scores of subjects whose pictures were presented in both sets of 40 and 20 photographs showed that there were significant differences between the two. Average attractive individuals gain globally attractiveness, whne presented in smaller groups. An opposite tendency exists for the most attractive faces of a set: they globally loose attractiveness when presentedjust by themselves and not having less attractive faces to be compared with., These differences are explained through a change in the way women perceived different visual cues in situations involving a larger or smaller number of potential mates, as has been proposed by Lenton and Stewart (2008). As predicted in previous studies (Lenton and Stewart, 2008; Lenton *et al,* 2009; Lenton and Francesconi, 2010; Lenton *et al,* 2010; Lenton and Francesconi, 2011; Watkins *et al,* 2012), these results agree with the assumption that mate choice can be influenced by the number of potential mates available and corroborate the idea that female evaluations of men attractiveness were biased by the effect of number of male faces. Lenton *et al,* 2009 and Lenton *et al,* 2010 concluded that an increase of number of potential mates would affect female mating choices, and that women responded either with increased choosiness or with increased confusion. In order to determine the outcomes of this study, and to perceive if the results resemble the ones of the studies

developed in different scenarios such as speed-dating sessions, the results of distribution and variance were analyzed.

The comparison between first and second series evaluations encompassed results from high and low levels of attractiveness. The fact that the value of variance is higher in the evaluation of the set of photographs presented in the series 20EqDist indicates that in this case evaluators did not restrain their scores to single values, which resulted in a more reliable evaluation. The opposite happened in the series 40A in which it is observed that the scores variation is small. The second comparison, between the series20Most and 40B, presented similar results and again there was a loss of attractiveness in the individuals evaluated in the larger set of photographs. The results of these two comparisons indicate that increasing the number of potential mates in a group will result in female evaluations of attractiveness to get confused and converge into a lower score value. These results converge with the ones presented by Lenton *et al* (2010) and Lenton and Francesconi (2011) by demonstrating that increasing the number of potential suitors generates confusion amongst evaluations, and extends these assumptions to attractiveness assessments. The fact that the evaluations of attractiveness varied between the series also demonstrates that female evaluations were relative and not absolute, and that the context in which men are presented influenced their decisions.

4.2. Sample and evaluation concerns

The recruitment of male subjects, was conducted randomly in the university area and, as all the subjects recruited were students of this university, the photographs taken assure a representative sample from the men of the University of Coimbra. The age of the subjects was also a selection parameter, since the study would be conducted with subjects with ages between 20 and 30, but the fact that only students were recruited lowered the average age of the sample which was approximately 22 years. The fact that the age of the male sample was so low was not a concern in the study because evaluators also presented a similar average age, approximately 22 years for the initial classifiers, and 23 years for the evaluators of the second phase of the project. All the photographs were taken in standardized conditions, which has the advantage of eliminating possible deviations from the study as a result of evaluating other factors than the attractiveness of the male face. One limitation of this study at this point concerned the fact that, even though subjects were asked to remove any accessories, some details of their clothing still appeared in the photographs which is not

recommended, since outfits could influence the decision of the evaluators (Willems *et al*, 2012). This is not so much of a concern in this study because the comparisons were made pairwise, and each face was only compared to itself in two different density contexts.

After photographing all the male subjects and designing the excel file in which the first evaluations were made, female students were randomly recruited from the university area to establish an initial classification for the attractiveness of the male faces. Of the 42 evaluations made, 12 had to be discarded based on the criteria that evaluations in which all the individuals were rated with the lowest value did not represent a valid response. This situation might have occurred because female evaluators did not understand the study, read the instructions, or made any effort in favour of the investigation. Despite this setback the remaining evaluations presented a high interrater reliability, assuring the consistency of the results. The results of these first means of attractiveness for each individual were used in the establishment of the different series. When these evaluations were correlated with the ones of the second phase of the project, a high correlation was found that sustained the first separation.

The second attractiveness evaluation was made online and, through a social network of friends and collaborators, was spread across the country, as this was the best way to assure that the evaluators sample would be diversified and representative of the population. There are some general disadvantages associated with this kind of questionnaire, as the investigator can never truly control the course of the investigation at this point. Most of the weaknesses related to this kind of inquiry concern the target individuals, because considering that the questionnaire was anonymous, people might have a greater tendency not to tell the truth and, especially considering that the topic of facial attractiveness is a popular one, evaluators might be tempted to repeat the test. As there was no mechanism to prevent the repetition of the test, the last question presented to the evaluators asked them to write a short answer about their opinion on the subject of attractiveness, which was later analysed and assumed as a control question. In the particular case of the questionnaire adopted for this study there is another problem that should be considered. Even though evaluators could not move backwards, as in every other website, there was no way to prevent women from leaving the tasks in the middle and coming back to the page later. This would be potential armful if evaluators left the page during the presentation of the slideshow or thumbnails display, since these acted as stimuli to the density effect, possibly compromising the study.

Of the 903 registered entries in the database, only 472 were considered valid, based on a selection process that eliminated all the results that did not match the pre-established parameters. The high number of registrations on the website is possibly explained by the popularity of the theme of mate choice, which drew attention to the questionnaire. Once again, some evaluators rated all the individuals with a single value (1), possibly because they didn't understand the assignment or because they were not actually rating the faces and accessed the inquiry just by curiosity. The fact that some inquiries were discarded resulted in a slightly uneven number of responses per series.

Chapter 5 – Conclusions

In the study here presented the effect of density in female evaluations of attractiveness was tested in an experience that manipulated the number of individuals rated by female evaluators. The results showed that scores of facial attractiveness were influenced by the number and average attractiveness of men in the group to be evaluated (20 or 40 photographs per set) and that faces presented in smaller groups were rated with higher scores of attractiveness than the ones showed in larger sets. The fact that the same face was rated differently, as a result of a change in context, implies that evaluations of attractiveness are relative and can vary in different situations.

Understanding what happens when women are confronted with a larger or smaller set of suitor options is an important issue, because the change of lifestyle that has occurred in the past century resulted in conditions that are, from an evolutionary perspective, strange to the human species. Even though mechanisms of mate selection have shown a plasticity that allows them to adapt to different conditions and consequently increase its effectiveness, nowadays, the increased encounter rate and consequent number of potential mates will constitute a new challenge for the mate choice modules that evolved in different contexts. One possible consequence is an increase in confusion or inconsistency of female choice, so the results of this study have a practical relevance in human societies because they adds evidence to explain the difficulties of some women to choose a partner and possibly some overall disappointment related to dating.

Future research on the theme of mate choice and density should continue to focus on the aspects that can vary by manipulation of number of available individuals in an effort to enhance society's lifestyle.

Chapter 6 – References

Alcock, J. 2011. *Comportamento Animal: Uma abordagem evolutiva*. Brasil, Artmed.

Alvergne, A., Lummaa, V. 2010. Does the contraceptive pill alter mate choice in humans?. *Trends in ecology & evolution*, 25(3): 171-179.

Andersson, M. 1994. *Sexual Selection.* Princeton, Princeton University Press, Monographs in Behaviour and Ecology.

Andersson, M.; Iwasa, Y. 1996. Sexual selection. *Trends in ecology and evolution*, 11(2): 53-58.

Andersson, M.; Simmons, L. W. 2006. Sexual selection and mate choice. *Trends in ecology and evolution*, 21(6): 296-302.

Alvergne, A.; Lummaa, V. 2010. Does the contraceptive pill alter mate choice in humans? *Trends in ecology & evolution*, *25*(3): 171-9.

Archer, J. 2004. *Sex differences* in aggression in *real-world settings: A meta-*analytic review. *Review of General Psychology*, 8 (4): 291-322

David M. Buss. 2003. *The Evolution of Desire: Strategies of Human Mating*. New York. Basic Books.

Buston, P. M.; Emlen, S. T. 2003. Cognitive processes underlying human mate choice: The relationship between self-perception and mate preference in Western society. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(15): 8805-10.

Buss, D. M. 1988. The evolution of human intrasexual competition: tactics of mate attraction. *Journal of personality and social psychology*, 54(4): 616-28.

Chaix, R.; Cao, C.; Donnelly, P. (2008). Is mate choice in humans MHCdependent? PLoS Genetics, 4(9): e1000184

Diamond, J. 2002. *The rise and fall of the third chimpanzee.* United Kingdom, Vintage.

Carré, J. M.:McCormick, C. M. 2008. In your face: facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. *Proceedings. Biological sciences / The Royal Society*, *275*(1651): 2651-6.

Emlen, S. T.; Oring, L. W. 1977. Ecology, sexual selection, and the evolution of mating systems. *Science*, 197(4300), 215−223.

Feinberg, D. R.; DeBruine, L. M.; Jones, B. C.; & Little, A. C. 2008. Correlated preferences for men's facial and vocal masculinity. *Evolution and Human Behavior*, 29(4): 233-241.

Folstad, I.; A.J. Karter. 1992. Parasites, bright males and the immunocompetence handicap. *The american naturalist*, 139(3): 603-622

Frayer, D. 1985. Sexual Dimorphism. *Annual Review of Anthropology*, 14(1): 429-473.

Geary, D. C.; Vigil, J.; Craven, J. B.; Geary, D. C.; Vigil, J.; Byrd-craven, J. 2010. Evolution of human mate choice, *The Journal of Sex Research*, 41(1): 37-41.

Hamilton, W. D.; Axelrod, R.; Tanese, R. 1990 Sexual reproduction as an adaptation to resist parasites (a review). *Proceedings of the National Academy of Sciences of the United States of America*, 87(9): 3566-73.

Jennions, M. D.; & Petrie, M. 1997. Variation in mate choice and mating preferences: a review of causes and consequences. *Biological reviews of the Cambridge Philosophical Society*, *72*(2): 283-327.

Kirkpatrick, M. 1982. Sexual selection and the evolution of female choice. *International journal of organic evolution*, 36(1): 1-12.

Kokko, H.; Rankin, D. J. 2006. Lonely hearts or sex in the city? Density-dependent effects in mating systems. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 361(1466): 319-334.

Lenton, A. P.; Stewart, A. 2008. Changing her ways: The number of options and mate-standard strength impact mate choice strategy and satisfaction. *Judgment and Decision Making Journal*. 3: 501-511.

Lenton, A. P., Fasolo, B.; Todd, P. M. 2009. The relationship between number of potential mates and mating skew in humans. *Animal Behaviour*, 77(1), 55-60.

Lenton, A. P.; & Francesconi, M. 2010. How humans cognitively manage an abundance of mate options. *Psychological science*, *21*(4): 528-33.

Lenton, A. P.; Francesconi, M. 2011. Too much of a good thing? Variety is confusing in mate choice. *Biology letters*, *7*(4): 528-531

Lenton, A. P.; Fasolo, B.; Todd, P. M. (in press). Who's in your shopping cart? Expected and experienced effects of choice abundance in the online dating context. *In* N. Kock (Ed.), *Evolutionary psychology and information systems research: A new approach to studying the effects of modern technologies on human behavior*. New York, NY: Springer.

Little, a C.; Jones, B. C.; Penton-Voak, I. S.; Burt, D. M.; Perrett, D. I. 2002. Partnership status and the temporal context of relationships influence human female

preferences for sexual dimorphism in male face shape. *Proceedings. Biological sciences / The Royal Society*, *269*(1496): 1095-1100.

Little, A. C.; Jones, B. C.; DeBruine, L. M. 2011. Facial attractiveness: evolutionary based research. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 366(1571): 1638-1659.

Little, A. C.; Jones, B. C.; Debruine, L. M.; Caldwell, C. 2011a. Social learning and human mate preferences: a potential mechanism for generating and maintaining between-population diversity in attraction. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences* 366(1571): 366-375.

Mead, L. S.; Arnold, S. J. 2004. Quantitative genetic models of sexual selection. *Trends in ecology and evolution*. 19(5): 264-71.

Miller, G. F. 1998. How mate choice shaped human nature: A review of sexual selection and human evolution. *In*: Crawford C.; Krebs D. (Eds.) *Handbook of evolutionary psychology: Ideas, issues, and applications*. USA: Lawrence Erlbaum: 87-130

Miller, G. F.; Todd, P. M. 1998. Mate choice turns cognitive. *Trends in cognitive sciences*, 2(5): 190-198.

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

Moore, F. R.; Cornwell, R. E.; Smith, M. J. L.; Al Dujaili, E. S.; Sharp, M.; Perrett, D. I. 2011. Evidence for the stress-linked immunocompetence handicap hypothesis in human male faces. *Proceedings. Biological sciences / The Royal Society*, 278(1706): 774-80.

Otta, E.; Abrosio, F.; Hoshino, R. 1996. Reading a smiling face: messages conveyed by various forms of smiling. *Perceptual and motor skills.* 82: 1111-1121.

Otta, E.; Lira, B.B.P.; Delevati, N.M.; Cesar, O.P.C.; Pires, C.S.G. 1994. The effect of smiling and of head tilting on person perception. *Journal of Psychology Interdisciplinary and Applied*, 128: 323-331.

Pomiankowski, A.; Moller, A. P. 1995. A Resolution of the Lek Paradox. *Proceedings of the Royal Society B: Biological Sciences*, 260(1357): 21-29.

Puts, D. 2010. Beauty and the beast: mechanisms of sexual selection in humans. *Evolution and Human Behavior*, 31(3): 157-175.

Puts, D.; Jones, B. C.; DeBruine, L. M. 2012. Sexual selection on human faces and voices. *Journal of sex research*, 49(2-3): 227-243.

Rhodes, G. 2006. The evolutionary psychology of facial beauty. *Annual review of psychology*, 57: 199-226.

Rowe, L.; Houle, D. 1996. The Lek Paradox and the Capture of Genetic Variance by Condition Dependent Traits. *Proceedings of the Royal Society B: Biological Sciences,* 263(1375): 1415-1421.

Shackelford, T. K.; Schmitt, D. P.; Buss, D. M. 2005. Universal dimensions of human mate preferences. *Personality and Individual Differences,* 39(2): 447-458.

Sing, L. 1982. The Effect of Smiling on Person Perception. *The Journal of Social Psychology*.117(1): 63-67

Thorrthill, R.; Gangestad, S. W. 1993. Human facial: Averageness, Symmetry, and Parasite Resistance. *Human nature*. 4(3): 237-269.

Todd, P. M.; Penke, L.; Fasolo, B.; Lenton, A. P. 2007. Different cognitive processes underlie human mate choices and mate preferences. *Proceedings of the National Academy of Sciences,* U.S.A., 104: 15011–15016.

Trivers, R. L. 1972. Parental investment and sexual selection. *In* B. Campbell (Ed.) *Sexual selection and the descent of man*, 1871-1971 (pp 136–179). Chicago, Aldine.

Wiley, R. H. 2000. Sexual selection and mate choice: trade-offs for males and females. *In* Apollonio M.; Festa-Bianchet M.; Mainardi D. (eds), *Vertebrate Mating Systems*. World Scientific Publishing 8-46.

Watkins, C. D.;Jones, B. C.; Little, A. C.; DeBruine, L. M.; Feinberg, D. R. 2012. Cues to the sex ratio of the local population influence women's preferences for facial symmetry. *Animal Behaviour*, *83*(2): 545-553.

Willems, K.; Janssens, W.; Swinnen, G.; Brengman, M.; Streukens, S.; Vancauteren, M. 2012. From Armani to Zara: Impression formation based on fashion store patronage. *Journal of Business Research, 65*(10): 1487-1494.

Zahavi, A. 1975. Mate selection - a selection for a handicap. *Journal of theoretical biology*. 53(1): 205-14.

Appendix 1

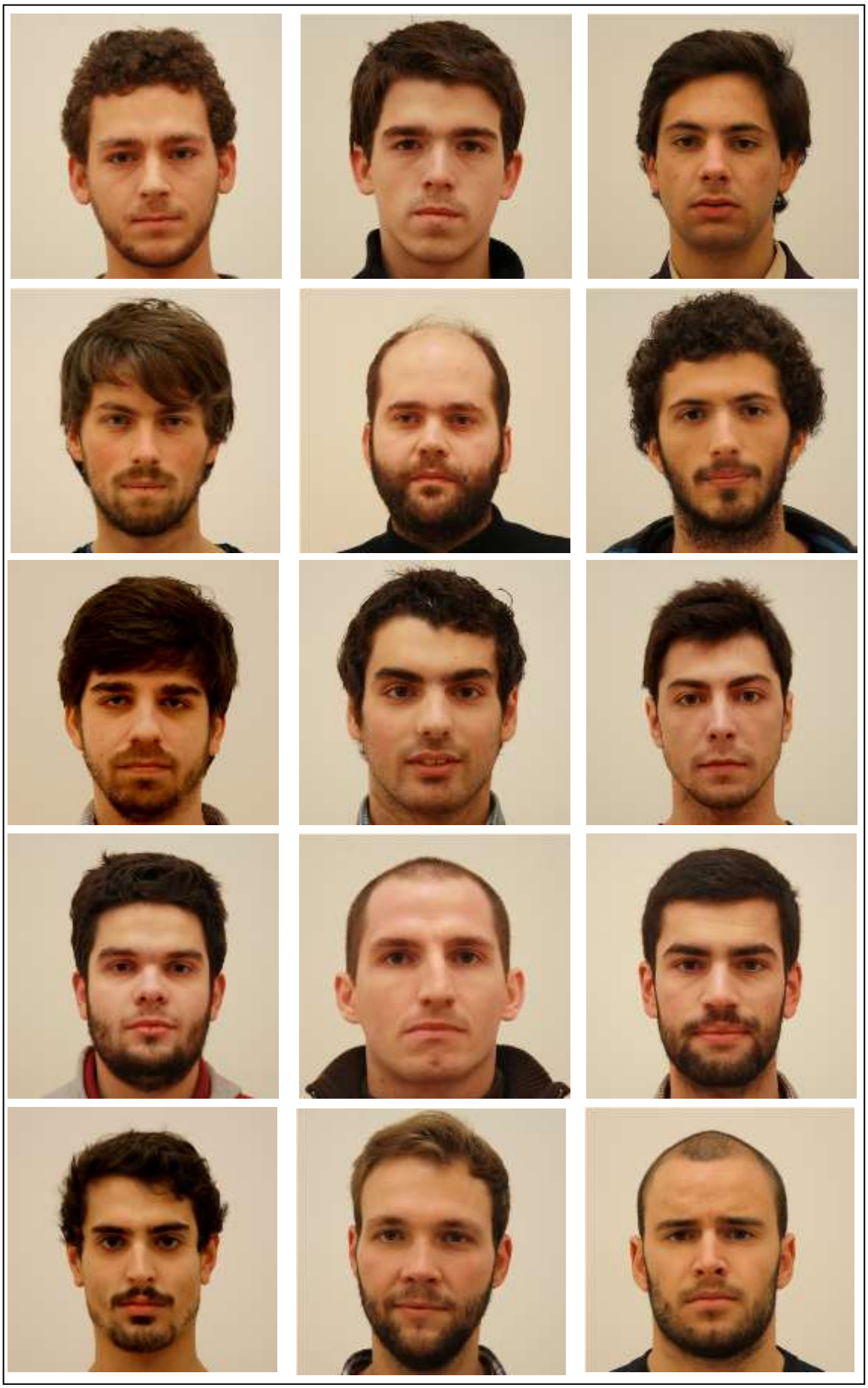

Figure 11 – Photographs of the male subjects (part 1)

Figure 12 - Photographs of the male subjects (part 2)

Figure 13 - Photographs of the male subjects (part 3)