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Ecological rationality of moral intuitions: Exploring its description with GARP and its functionality with a jealousy evoking economic game

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Integrative model of moral intuitions

SUMMARY

This introductory theoretical framework describes the existing literature on the approaches that moral psychology has followed in recent years. Specifically, the advantages and disadvantages of constructing this discipline will be exposed using theories and methodologies from other areas such as: neuroscience, evolutionary psychology and microeconomics, which have visions that allow us to understand how individuals respond to their environment and allow us to build models around how and why moral intuitions arise. We will focus on the evolutionary vision that allows us to understand morality as rules that solve certain ancestral problems that are believed to be relevant to our ancestors. In this context, intuitions have an important role in cooperation and consequently in the reproductive success of humans, for this reason we will change the paradigm that exists in the literature on reason vs. intuition. In which intuitions are thought of irrational behavior due to their close link to emotions. We demonstrate that intuitions are rational and explore their functionality from an evolutionary perspective evoking the moral emotion of jealousy.

5.1 From philosophy to moral psychology

Since ancient times philosophers such as Plato and Kant maintained that the morality of the individual came from conscious reasoning about it and their idea of human emotions (Happiness or fear) were involuntary and irrational bodily states called by different names: passions or feelings that nullified the understanding of reason (Kant, 2002 [1785]).
Philosophical reflection has made it possible to establish how reason is a predominant argument in ethical valuations under different schools of thought (Aristotle, 1990/330 BC; Hobbes, 1651; Locke, 1689; Rawls 1971). Thus, before the incidence of other disciplines on the study of moral psychology, research was dominated by an emphasis on conscious processes in the formation of moral judgment, assuming that conscious reasoning was the main psychological resource that people use to guide moral behavior (Haidt & Hersh, 2001; Greene & Haidt, 2002; Kohlberg, 1964). Kohlberg (1964) was interested in the development of moral reasoning, i.e., how the reasons given for a given moral choice vary throughout the ontogeny of the individual, describing that moral development ends when a person upholds Kantian strong principles. These results were criticized, since they ignore the post-hoc rationalization of an election, that is, when the reasons given for the choice do not necessarily reflect the real cause of that election, and on the other hand intellectualizes moral judgment (Haidt et al., 2003). Another clear example of how philosophy has allowed to influence current models, is when, in the models, many moral psychologists emphasize that humans sometimes act as deontologists like Kant or as utilitarian's like Bentham, and that our moral judgments is generated *either* by emotions or by reason (Kahane, 2011). Specifically, philosophical attempts are proposed to reconstruct what goes on in the mind with normative proposals that justify the actions of certain moral dilemmas. (e.g. Greene, 2014, Cushman & Greene, 2012.).

Despite the inclusion of other disciplines with new methods, the idea of normative cognition continues to predominate the moral field with idealized visions of psychological processes, that may have evolved through selection mechanisms that operated in our ancestors and that may persist today, and from which we do not have a guide of accessible norms to give an explanation of how we obtain the faculty to make moral judgments (Tooby & Cosmides ,2010; Cosmides & Tooby, 2013). The purpose of this chapter is to expose how morality can be innate and what characteristics it must have to be considered evolved. But to begin a review of the

evolution of moral sense, we must be clear about what we will call moral judgment and how it is studied. First, we will begin by describing the methodology given to us by the way it is studied. This methodology is based on situations or questions where there is a moral conflict, that is, it incorporates moral dilemmas. Commonly, the scenario we face in a moral dilemma is that we have two options which convey important moral imperatives to support them, and are incompatible with each other. Despite the criticism of Kohlberg's work, he was the first to use moral dilemmas in moral psychology, and since then many studies have followed this methodology. The inspirational dilemmas, which were originally used by ethics to argue the inconsistency of utilitarianism as a normative theory (Williams, 1973), were the Trolley and Footbrigde dilemmas (Foot, 1967; Thomson, 1976). The difference between the two is in how one person is sacrificed to save five people at risk. In the case of the trolley problem the train is diverted to one person to save the other five and in the case of the footbridge one person is pushed to save the same number of people at risk. The results of these dilemmas, despite having the same imperatives at play, show contradictory results, thus leaving a relevant crossroad regarding the moral cognition that is behind the difference in the outcome of these two moral situations.

It should be noted that for most experiments in moral psychology the moral dilemmas used are variations of the Trolley and/or the Footbrigde (Christensen et al., 2012). In spite of the influence of moral philosophy, moral psychology has moved away from the rationalist theories that dominated the discipline by focusing on the formation of moral intuitions. As Haidt points out: "The sudden appearance in consciousness, or at the fringe of consciousness, of an evaluative feeling (like-dislike, good-bad) without the conscious awareness of having gone through steps of search, weighing evidence, or inferring a conclusion" (Haidt, 2001, p. 818). A moral intuition is an unconscious evaluative feeling about what is right or wrong. And from this definition we will center our theoretical framework in which we will consider that in moral judgment predominates an intuition guided by emotions. From this perspective, the study of morality and the creation of models that try to explain what happens in our mind have been based on two main approaches: The first has focused on identifying universal aspects of morality in different cultures (Graham et al., 2013; Haidt and Joseph, 2004), and the second points to an individual approach to biological and neurocognitive processes inspired by decision making (Cosmides and Tooby 1996, 2006; Greene 2004; Gigerenzer 2008; DeScioli and Kurzban 2009). Independent of the approach, all seek to identify the evolved design of moral jugdments (Baumard 2010, Asao & Buss, 2016, DeScioli and Kurzban 2009, Kurzban et al., 2012).

5.2 Interpreting Rationality

Economics has studied the logic of choice for 150 years, generating models that can sensibly predict how changes in external circumstances change people's decisions. These models suppose an axiom of rationality in decision making, where human beings have a rational thinking that allows them to choose the best possible action after deliberately evaluating all available options, specifically they refer to people reasoning logically in the service of a maximization of utility (*Homo economicus*; Berg et. al., 1995, Fehr et. al., 1997, Fehr and Schmidt, 2003, Forsythe et. al., 1994, Mussel et. al., 2013). Gigerenzer (2010) questions this classic model of rationality, arguing that human rationality is limited, that is, the mind takes an information pattern in a given environment to make decisions frequently obtaining convenient results, which do not necessarily have to be the option with the best possible alternative that maximizes its usefulness, because there is uncertainty and therefore, there are no guarantees of choosing the best alternative. This mental tendency to use shortcuts in choice is called by Gigerenzer "heuristic cognition", a cognition that has evolved in a world enveloped by the fog of uncertainty (Gigerenzer, 2008a, 2008b, 2010). Heuristics are solutions where little time and information is required for complex problems (Gigerenzer, 2010). Then, faced with the effort, energy and time required to evaluate all the alternatives (a suggestion of rationality present in neoclassical economic theory), we use intuition to choose a striking option without accurately evaluating all the options. Consequently, we are no longer faced with a process of maximization; in fact, it is not clear what it would mean in this context. In general, Gigerenzer manages to add this evolutionary concept to the axiom of rationality to explain certain violations of rationality, especially in animals (Arkes et al., 2016). Several theoreticians detail the computational heuristic models of morality (Cosmides and Tooby 2006, Gigerenzer 2008). In general, these models describe how complex networks of heuristic decision-making rules guide moral reasoning, and how these cognitive mechanisms may have been shaped by natural selection to address recurrent adaptive problems. In this regard, these models can be considered the foundation of other contemporary theories of moral psychology, to the extent that they identify and elaborate on the cognitive machinery underlying human morality.

Heuristics are "quick" (i.e., they require little time) and "frugal" (i.e., they require little information) solutions to complex problems. With this information one could say that heuristics explains, to some extent, why humans are irrational, but if we reflect, the hypothesis that people reason logically in the service of maximizing short-term profits, Homo economicus, is completely refutable from an evolutionary point of view,

since natural selection favors decision rules that do a better job of promoting their own reproduction over alternative designs, i.e., there are heuristic decision-making rules that guide moral behavior and these mechanisms were influenced by natural selection to address recurrent adaptive problems (Cosmides and Tooby, 2006). In other words, the action or solution that maximizes the utility is not necessarily a solution from an evolutionary point of view, therefore a non-optimal and irrational decision could benefit an individual in a given ecological context. Consequently, an intuition that evolved to regulate recurrent social interactions should not be considered irrational, but many disciplines do, despite not having a clear common criterion of rationality. For example, in several works, depending on the discipline, the concept of rationality is taken with several meanings for example: as a thought process without powerful emotions that evaluates objective facts or decisions that maximize personal benefit or logical decisions (Axelrod, 1984; Greene, 2014, Cushman & Greene, 2012)

In general, rationality is defined, in a broad sense, as the ability to provide reasons for inferring particular beliefs, conclusions or actions (Audi, 2001; Keefer, 1996; Moshman, 1994; Nozick, 1993; Sen, 2002; Siegel, 1997). From this notion logic is part of the concept of rationality, and in turn to use logic we require concepts about the nature and the inferential norms. Therefore, to be rational we need the control of diverse beliefs, inferences and a conscience to integrate them. In other words, cognitive agents are necessary to be rational. Consequently, "Part of reasoning rationally is reasoning about rationality" (Daniel Cohen's (2001, p. 78) this phrase summarizes the perception that exists with rationality and as we can see there is not a satisfactory definition of this, since we know that humans interpret complex information without inferring a particular logic. In other words, in the absence of evidence or conclusions we are capable of making decisions that seem rational to us. (Axelrod, 1984; Bickhard & Campbell, 1996; Blasi & Hoeffel, 1974; Evans, 2002; King & Kitchener, 1994; Koslowski, 1996). (e.g., Coleman and Fararo, 1992; Halpern and Stern, 1998, Schuessler, 2000).

We propose and test a new standard of rationality for moral cognition, derived from economics: the theory of rational choice. At the core of the methods of microeconomics theory is the assumption about rational choice, i.e. that whatever their preferences and beliefs, people make internally consistent choices (Becker, 1976; Friedman, 1953). The delimitation of this concept of rationality arose thanks to the concern to stop representing preferences through a utility function (maximizing utility rational agent) and reconstruct them from observed data (prices and incomes). The theory of revealed preferences known as the strong axiom of revealed preference, states that there must be transitivity in the order of preferences for there to be a utility function that rationalizes consumer choices, where preferences can be

optimal solutions with changing budget constraints. In this way one can verify the behavior of a rational individual in a manner consistent with neoclassical theory (Samuelson, 1948). However, this method remained restrictive, because it requires preferences to be strictly convex. The preferences are convex if the upper contour assembly is convex. This implies that stockings are preferred to the extremes. For example, suppose for a set of goods X and Y that u(x1, y1) = u(x2,y2). Any point on the line that connects (x1,y1) and (x2,y2) is at least as good like the extremes

Afriat's line of research (1967) facilitated the implementation of a less restrictive methodology of these ideas for data analysis called generalized axiom of revealed preferences (GARP). The basic notion embodied in GARP is that a person's choices must be internally consistent and transitive. For example, if someone selects a basket A over B, then they should not select another point B when A is also available, i.e. A is never strictly within the established budget when B is chosen (Afriat, 1967; Varian, 1982; Varian, 1992). Likewise, if A is chosen over B, B over C and B over D, it is expected that A over D will be chosen, because A was preferred to B (indirectly A is preferred to C), and B was preferred to D, which implies that A is preferable to D. Then choosing D over A would constitute a violation of consistency, therefore options of this type would violate GARP (the Axiom).

Thanks to this tool it was possible to evaluate consistency under scenarios that supposedly violated rationality, as is the case with altruistic behavior. In experiments, such as the prisoner's dilemma, games, public goods and experiments with negotiation, subjects tend to act benevolently towards each other leaving aside the maximization of their own payments. This led to an arduous discussion which claimed that economically altruistic people were irrational, suggesting that neoclassical theory had failed. James Andreoni and John Miller in their work “Giving According to GARP: An experimental Test of the consistency of preferences for Altruism” explored whether altruists had consistent preferences and met the definition of rationality, using GARP. They used an experiment that measured preferences about personal assignments and assignments to other individuals. The results pointed to individuals being rational, further demonstrating that the altruistic preferences are captured in a quasi-concave utility function. On the other hand, they validated a microeconomic tool to measure rationality. Thanks to this we can argue that an individual is irrational when the choice within a set of consumption possibilities is not transitive. With this notion, rationality (consistency) was evaluated in moral intuitions.

5.3 Evolutionary Perspective

From an evolutionary point of view, humans have been forced to live in groups, because the option of independent (or solitary) living is not viable, since the costs involved are excessively high and, on the other hand, in activities crucial for survival (hunting, gathering, war), the cost of dispersion is very high if one considers that resources are limited and distributed heterogeneously. Therefore, the biological, ecological and phylogenetic restrictions of the human species make it possible to explain cooperative behavior aimed at producing benefits for the reproductive success of the individual. In this context, natural selection is the only evolutionary force that can explain the evolution of adaptations, understanding that adaptations are characteristics (morphological, behavioral, anatomical, etc.) that allow the reproduction and survival of the organisms that possess it, relative to other states of alternative character. In other words, it is a character that allows species to have a higher survival and reproduction rate or greater reproductive success. Consequently, for natural selection to operate, three conditions are needed: Variation, differential reproduction and inheritance of some character (Futuyma, 2005).

Evolutionary psychology considers that there are mental adaptations seen as processes or brain structures that allowed us to cooperate and survive on the basis of the restrictions mentioned above. (Tooby & Cosmides, 2008, p. 114). It is important to mention that there are other evolutionary forces that can explain the presence of certain characters in the species, but if these characteristics do not contribute to a fitness we cannot speak of adaptations. For this reason, it is key to ask ourselves how evolution evolved and why it evolved, since in how there can be presence of other evolutionary forces, but in which we can try to know if it contributes to the reproductive success of the species (inclusive fitness) (Kimura, 1970; *Dawkins, 1976)*. The challenge of human evolutionary psychology is to try to find out which interactions were traversed in the demands of a phylogenetic past that allowed for having a greater reproductive success, independently, of whether these adaptations do not fulfill any function today (Buss, 2009). But for evolutionary psychology to find out which "mental programs" are adaptations is a greater challenge than that of a recurrent morphological or anatomical or behavioral character. For example, behavioral ecology and ethology use two approaches to know if a character evolved by natural selection: the first is based on a historical dimension using methods of phylogenetic comparison, and the second requires determining if the character is adaptive today. This requires determining how fitness changes between variants of the trait under study, but there is enormous complexity

in the study of the human mind, since we are able to solve problems that hunter-gatherers never had to solve (Cosmides & Tooby, 2013). It is important to emphasize that when we talk about recurrent problems, those are problems that arose many times in the history of the species and whose solution influenced the reproduction of organisms. In short, to find out which is the universal evolved architecture of the mind in human beings is a purpose of evolved psychology. In the case of morality, individuals had to develop the notion of what was good or bad, enabling them to facilitate cooperation (Buss, 2009; Dunbar and Barrett, 2008). Comisdes and Tooby (1995) point out that evolution has produced specific cognitive specializations, taking into account problems that arose ancestrally linked to different forms of cooperation in life in society. In other words, if we consider that conflicts in the context of social exchange and human cooperation were recurrent in our ancestors, evolution must have favored the emergence of a conflict resolution system that would allow us to generate moral judgments in response to a situation in order to make a decision (Cosmides, 1998).

The empirical evidence to explain the adaptive function of morality is born from the need for reputation tested in economic games, which have become an important method in the study of morality (Axelrod, 1984; Andreoni and Petrie, 2004; Barclay, 2004; Ohtsuki, 2009; Ostrom, 1998; Pounstone, 1992; Schuessler, 2000; Sommerfeld, 2008; Van Vugt and Hardy, 2010) For example: in the dictator's game, an individual receives an amount of money and must decide how much to give to a second participant (The game generally takes place under conditions of strict anonymity). It is observed that dictators do not behave in a strictly selfish manner, in fact, more than 60% of dictators give away money. Intents to explain these results are based on reputation, i.e. s when interacting with others can determine the reliability of an interaction. Therefore, the elaboration of an individual reputation is manifested through intuitive mechanisms of moral evaluation which are necessary for group living (Dawkins, 1976; De Waal, 1996; Tooby & Cosmides, 1996). This individual selection approach was proposed by Trivers, where the best way to acquire reputation is by following moral motivations (Trivers, 1985). The literature has accumulated with evidence in favor of individual selection of morality, where moral behavior is guided by self-interest conditioned by reputation (Bereczkei and Kerekes, 2007; Hoffman and Smith, 1996; Kurzban, 2001).

But how do you explain that there is cross-cultural consistency in that dictators would actually be better off without giving that money or is there a concern for reputation? To answer this Haley and Fessler (2005), manipulated factors that could influence the reputation of the participants. At one condition, for example, the wallpaper showed two stylized eyes as shapes and more participants gave money than in the

control condition (where, instead of eyes, the wallpaper showed the lab logo). In another, in contrast, participants were given noise-canceling earmuffs: in this case, fewer of them gave. These suggest that eyes and certain noises are unconsciously processed by the brain as clues to a social situation where reputation is at stake, making more participants generous. It should be noted that in several investigations results suggest that people are influenced by a so-called "reputational concern", describing the function of moral behaviour as that of bringing individuals a reputation as cooperator (Andreoni and Petrie, 2004; Barclay, 2004; Bereczkei, Birkas and Kerekes, 2007; Bourrat, Baumard and McKay, 2011; Burnham, 2003; Burnham and Hare, 2007; Ernest-Jones, Nettle and Bateson, 2011; Haley and Fessler, 2005; Hardy and Van Vugt, 2006; Hoffman, McCabe and Smith, 1996; Kurzban, 2001; Kurzban, DeScioli and O'Brien, 2006; Mifune, Hashimoto and Yamagishi, 2010; Milinski et al., 2002; Piazza and Bering, 2008a, 2008b; Rigdon, Ishii, Watabe and Kitayama, 2009; Van Vugt and Hardy, 2010). This conclusion is plausible from an evolutionary perspective, because there may have been selective pressures for a moral disposition whose function is to contribute to the moral reputation of the individual. But it is also plausible that there may be selective pressures for a disposition to be directly concerned about the effects of one another's actions or that both mental adaptations exist. However, regardless of the specific adaptive function of morality, we know that it regulates cooperative behavior. One example, which is raised, is that evolution allowed well-intentioned and ill-intentioned "free riders" to be identified. The first case would be to be sick and use resources generated by others in order to survive. The second case would be to pretend to be sick in order to take advantage of resources. The concept of free rider refers to an unobservable state of mind, a desire to exploit other people's resources that is identifiable in order to be punished and/or excluded (Delton, Cosmides, Guemo, Robertson, & Tooby, 2012; Delton, Nemirow, Robertson, Cimino, & Cosmides, 2013).This was concluded thanks to the work of Delton (2013) who manipulated the observable and quantifiable contributions of certain members of a group. Although people identified this difference, they only saw people with minor contributions as less competent, without giving rise to a moralistic response as an ill-intentioned freerider In contrast, a similar experiment was carried out, but instead of manipulating the contributions it was announced that certain people had stolen some property that was the property of the group. In this case the burglars were identified as free riders, because they stole the property of the group. Although in both cases the resources of others are extracted, the moral judgment is different. For this reason, from now on we will call free rider the second case, which provokes the motivation to adjudicate a moral judgment with the purpose of punishing the freeriders to sustain the cooperation in the group (Hamlin, Wynn, & Bloom, 2007; van Leeuwen, Park, & Penton-Voak, 2012). Other examples of recurrent social interactions were when food must be shared and when food success is determined more by luck than by effort or infliction

of harm. This may be adaptive and morally required during war or punishing freeriders to sustain group cooperation, but not reciprocity between two individuals, where changing partners is more profitable than punishing freeriders (Delton, Nemirow, Robertson, Cimino, & Cosmides, 2013; Forsythe, 1994; Fehr et al., 2002; Fehr et al., 2003; Fehr et al., 2010; Tooby et al., 2006).

In short, following the evolutionary approach, there are psychological adaptations that characterize the human species (Tooby and Cosmides, 1992). These adaptations can be defined as specialized components (later we will call them domains) that are designed to reason about our social interactions and, in turn, these specialized components are moral intuitions that give rise to rapid automatic evaluations about a conflict in a specific interaction. Consequently, individuals who have inherited from their ancestors these components, which are sensitive to particular interactions, reach a successful solution of a particular adaptive problem.

Models in moral psychology attempt to identify the psychology underlying moral intuitions and their study is under two main glances: the first is a cultural gaze where universal characteristics of morality are organized (Graham et al., 2013; Haidt and Joseph, 2004) and the second is an individual gaze that points to results of biological processes and rules of neurocognitive decision-making (Asao and Buss, 2016; Baumard, 2010; Cosmides and Tooby 1996, 2006; DeScioli and Kurzban 2009; Greene 2004; Gigerenzer 2008;, Kurzban et al., 2012) This evolutionary plausibility comes from the idea put forward by Comisdes and Tooby emphasizing that evolution has produced specific cognitive specializations, taking into account problems that arose ancestrally linked to different forms of cooperation.

5.4 Evolution of cooperation to understand human morality

If we define morality as "standards or guidelines that govern human cooperation" (Rest, 1983), we must relate this behavior directly to the evolution of cooperation, and this in turn can affect and modify individual fitness. It is necessary for the proper functioning of cooperative groups that animals are able to maintain a mental balance of the state of their relations of social behavior exchange or reciprocal favors (Wilson et al., 2008). This is the most controversial point, since it assumes that all animals that present cooperation should present a "social brain". For this it is necessary greater cerebral capacities for processing the information from the social environment. In this way, the reciprocal behaviors and cognitive mechanisms necessary to develop a sense of right or wrong for a given situation could be the products of a need to know with whom to cooperate and maintain a reputation as a trusted member of a group (De Jong, 2011). In other words, morality is very similar to our innate sense of language, where both senses are structures that are governed by universal rules for all human beings. From here is born the hypothesis of a universal moral grammar which gathers three main theses: 1) the moral faculty is an intuitive and unconscious grammar, 2) it is only on the mental domain, and 3) it has the capacity to differentiate between moral judgments (universal) and social judgments (culturally constructed; Hauser, 2007). With the first point there is no further discussion, as the mind intuits whether an action is morally correct or not, so understanding the cognitive processes that lead to our moral intuitions is a fundamental task in the scientific effort to understand human nature. However, if we consider that our ancestors were involved in different social interactions (e.g., exchange, family altruism, mating, cooperative foraging, war) our mind must have the capacity to resolve conflicts for every relevant social interaction in order to survive and reproduce successfully for humans. In this context, the evolved mind should possess domain-specific programs that represent adaptations that guided our ancestors to the solution of a set of recurring problems in social interaction. Several theorists detail computational heuristic models of morality (Cosmides and Tooby 2006, Gigerenzer 2008). In general, these models describe how complex networks of heuristic decision-making rules guide moral reasoning and how these cognitive mechanisms may have been shaped by natural selection to address recurrent adaptive problems. In this regard, these models can be considered the foundation of other contemporary theories of moral psychology to the extent that they identify and elaborate on the cognitive machinery underlying human morality. Therefore, from the evolutionary point of view there are many domains of human social interactions, and these domains require specialized subsystems of moral cognition, which should work to evaluate the course of action in moral terms,

weighing multiple moral considerations (Cosmides and Tooby 2006). It is important to point out that there is complexity in the integration of the different moral evaluations, because each situation calls different moral emotions and that it is difficult to understand how and in what way the emotions are integrated in these domains to generate the moral judgment and to trigger a behavior, but we know that they form an important part of the moral intuition (Cosmides and Tooby 1996, 2006) In this way, the brain can be seen as a set of evolved computational systems that analyze situations and generate options (Greene 2004; Marczyk, 2015; Mikhail 2007). Where, specifically, each domain has programs designed to track fitness in a social interaction and generate options for greater reproductive success (Cosmides and Tooby 1996, 2006; Tooby and Cosmides 2010; Tooby et al. 2006). For example, cooperative hunting should possess a domain and this would possess a program that requires characteristics not possessed by other domains of interaction (e.g., with intrasexual competition). In other words, each domain will have a different computational design: a different set of intertwined characteristics, including specialized domain concepts, inferences, motivational states, emotions, moral feelings, and decision rules (Tooby and Cosmides, 2006). When activated, these features will function in a concerted fashion, producing judgments and options that would have promoted reproduction in the environments they selected for their design, i.e., they promote better fitness outcomes over others that do not. So if the human cognitive architecture has several different cognitive systems that regulate social behavior, each adapted to a different class of social interactions, the evolved intuitions about right, obligation, and prohibition should vary among the evolutionarily relevant domains (e.g., high risk foraging vs. courtship) as a result, what counts as right or wrong will systematically change depending on the domain. In short, this idea is reflected in a heuristic model of morality consists of "basic rules" that allow moral intuitions to be formed, and these rules let solutions to problems to be reached quickly and efficiently. This model encompasses the central axis of an inherited moral psychology (Barrett and Kurzban, Cosmides and Tooby, 1996; Cosmides and Tooby 2006, Gigerenzer 2008). At the same time, there are other models compatible with the computational heuristic models of morality. Among them we find the theory of moral foundations, proposed by Haidt (2001), which describes the existence of collections of universal and functionally distinct moral intuitions called foundations. Each foundation belongs to a functionally distinct set of psychological domains and assumes that it has been shaped by natural selection from recurring interaction problems in the past. For example, the foundation of care/harm refers to intuitions that allow individuals to easily and automatically process the suffering signals of other individuals and originated in the domain that motivates interaction between family members and their altruism. In the same way, the foundation of equity/deception refers to intuitions that individuals have developed to identify and judge the reliability of cooperative interaction to avoid exploitation in a domain of

exchanges and cooperative relations of "non-zero" sum. Although this theory has a plausible evolutionary basis, the moral foundations that are described make reference to normative constructs and it is not clear that the foundations belong to a single domain of interaction. In addition to these, assessments are added criticisms that indicate that the proposed foundations ignore other good candidates for foundations and, in addition, there are categories that do not agree with findings found in neuroscience (Suhler and Churchland, 2011). So far, no model could satisfactorily explain some moral behaviors such as impartial judgments in certain situations. With this inspiration, a model emerged that proposes that adaptations leading to moral judgement work strategically to impose and avoid punishment from others (DeScioli and Kurzban, 2009, 2013). This model called "Third Party Moral Condemnation" describes two systems of moral cognition: The moral conscience referring to adaptations that regulate one's own moral behavior and the moral condemnation pointing to adaptations that specialize in judging the moral behavior of others. Its empirical basis is in studies where individuals are willing to receive money by omission rather than by commission when they are threatened to punish a third party, i.e., omission would be a strategy to reduce the probability of condemning others. In other words, adaptations for altruism (i.e., kinship selection and reciprocity) and moral judgment are separate systems and can sometimes be in opposition (Kurzban et al., 2012). It is important to note that this model is the only one that supports the idea that moral judgment can be impartial (impartiality understood as a response to an individual's behavior rather than the result of that behavior; DeScioli and Kurzban 2009). Evidence of impartiality shows that, in some cases, the influence of kinship influences the impartiality of moral judgment such as when the criminal was a brother or stranger (Lieberman & Linke 2007). On the other hand, in games, it was found that impartiality is affected by the certainty of guilt (Van Prooijen, 2006). Returning to the evolutionary approach, an explanation for this impartiality is that it arises as a social norm in very specific and modern conditions, therefore it would not form part of an evolved architecture, but, if we look at the different domains of interaction, previously described, each domain must possess different notions of what is right or wrong according to the specific interaction we are focusing on. Supporting this point, there are sexual selection theories and empirical findings that establish differences in goodness, justice, integrity and loyalty. Baumard et al. (2013) present a model that explains how partner choice may have been a key selective pressure by which justice evolved, a key characteristic of morality. Their model is based on conclusions drawn from game theory and mutualism models showing that cooperative exchanges are mutually beneficial and allow individuals to accumulate benefits. However, because people differ in their notions of how mutually accumulated resources should ideally be distributed, individuals should be selective about whom they cooperate with. Therefore, individuals whose cooperation provides a net benefit will be favoured as partners

over those whose cooperation provide less benefit (or inflict costs). For example, there are costs of missed opportunities with other cooperators or a risk of cheating to get more benefits without being identified. These costs can translate into a bad reputation for re-cooperation. This theory coincides with the evolved architecture of the human mind and does not rule out the participation of different domains for different types of interaction. On the contrary it gives an explanation of how the choice of partner allowed for the formation of moral judgment and has a solid argumentative line to explain how humans maintain mutualistic relationships.

The models described above point out that morality is related to cooperation, and human beings depend on this behavior for survival and reproductive success, since moral judgments lead us to coordinate individual behavior, through intuitions as a code of rules for social interactions. Thus, we can say that moral intuitions are solutions to the recurring problems of cooperation and conflict in the human social life of our ancestors. In other words, the adaptive function of morality can be explained by cooperation. This has, for the most part, empirical support, through game theory that allows predictions to be made about the function of morality in human cooperation. However, this experimental approach rescues an empirical study of the moral judgments after the participation in the tasks of the game where the experimental montage and the variability that can take place when different individuals intervene in experiments that do not allow for games to be a good tool to study satisfactorily the generation of moral judgments (Takezawa et al., 2006; Hofmann and Baumert, 2010). In contrast, as we will review in the methods, moral dilemmas present an important experimental advantage, because they allow to control and include variables in unique sentences and at the same time, there is a higher level of experimental control, because these are exactly the same for each individual and are not subject to any change that can appear when different actors intervene in an experiment (Christensen, 2012, 2014; Costa, 2014; Kogut, 2005). Finally, the extreme nature of some moral dilemmas allows us to ensure that we activate the mental moral intuition of individuals, capturing attention strongly, indeed, subtle variations in the formulation of a dilemma are sufficient to trigger distinct moral intuitions. Despite the benefits described, empirical evidence shows that many dilemmas are used without thoroughly controlling their parameters or variables in play. Curry (2016) presents a review where he describes the role of morality in human cooperation in the last 40 years, highlighting that morality solves more than one cooperation problem. Therefore, from an evolutionary point of view there are domains centered on certain problems such as the allocation of resources to relatives (kinship), the coordination of mutual benefits (mutualism), when the coordination of mutual benefits is uncertain (exchange) and conflict resolution in general. Morality, in the case of allocating resources to relatives, makes possible to help genetic relatives, parental care, and avoid inbreeding, among others (Chapais,

2014). Research on adaptations for family altruism in humans has focused on the detection of kinship and aversion to incest (Lieberman, Tooby and Cosmides, 2003, 2007). On the other hand, the problems of benefit coordination are solved with moral mechanisms that implement reciprocity. Direct reciprocity captures moral norms with specific known and cooperative individuals for mutual relations. In contrast, indirect reciprocity captures moral obligations when the benefits of mutuality are uncertain, because benefits are transferred at different times. These situations are modeled with modifications of the prisoner's dilemma (Ostrom & Walker, 2000). Thus, this theory of "morality as cooperation" incorporates the best elements of the previous models and responds to the pertinent evolutionary restrictions of the human species, in addition, with this we can create a taxonomy based on moral values dependent domains.

5.5 Who do we choose to cooperate?

From biology, the theory of evolution predicts that organisms must have adaptations to avoid harm and deliver benefits to individuals who carry copies of their genes, in order to promote the replication of their own progeny. The genes that benefit the individual will be favored by natural selection; therefore, if the cost of helping is offset by the benefit of genetic quality for the offspring of these genes, evolution had to design adaptations that allow these genes to remain in the species (Dawkins, 1979, Hamilton, 1964). For example, in the case of moral intuitions, in a parental relationship there might be an intuitive moral norm to help a loved one rather than an anonymous person. The problem is that cooperative relationships do not occur only with relatives, since, due to our biological restrictions, we must coordinate behaviors to obtain direct benefits for survival. The problem of coordinating these mutual benefits has been a recurrent feature of the social life of humans and their recent ancestors, especially with regard to collaborative hunting (Alvard, 2001; Alvard and Nolin, 2002). In this context, research on adaptations for mutualism and coordination in humans has focused on coalitional psychology (Kurzban, Tooby and Cosmides, 2001; Tooby and Cosmides, 2010), and 'theory of mind' (Curry & Jones Chesters, 2012). Therefore, there is market competition for the "best partners". In this way moral intuitions must be different for each type of interaction. Consequently, mutual interaction has three main challenges at the evolutionary level: the choice, attraction and retention of the interaction partner. The literature states that these challenges have principles that consider the supply and demand of different members, the costs and benefits of choosing, attracting and retaining members, and the total benefits provided by a member (including mutual benefits). The principles of member selection and retention apply to both mating and other relationships (e.g., friendship). In this context, despite intensive research there is no definitive consensus on which moral standards promote cooperation and whether they solve problems in different domains of interaction or whether the same moral standards operate for these domains. In other words, each program was designed by natural selection to solve different problems, so the main question is what happens if they are activated simultaneously, as they could conflict with each other and interfere with each other's functioning. According to Tooby and Cosmides (2008), this coordination occurs through a special class of programs they denominate "superior". An example of these programs are the emotions that evolved to resolve these higher demands (Tooby and Cosmides, 2008). From this point of view of moral psychology Buss (2007) describes that morality cannot be separated from the social adaptations that human beings possess, clarifying that emotions are essential for the practice of morality and lead to a moral conduct in accordance with our evolutionary history,

serving as promoters of prosocial acts and punishment of freeriders (Buss, 2007). This approach is inspired and aligned to the advance of the methods in the study of moral psychology, which has allowed demonstrating that emotions are equally important in relation to other human faculties as conscious reasoning in the formation of moral judgment. Thanks to this we know that moral emotions must directly influence real behavior, through the production of a moral intuition and are a good way to study or describe certain moral norms in specific interactions, since emotions have different evolutionary roles (Prinz and Nichols, 2010).

5.6 Role of emotions in moral judgment

Several lines of research support and elaborate computational heuristic models, including many contemporary theories that have their empirical basis on neuroscientific methods. These contemporary theories generated a paradigm shift in moral psychology, because since Kohlberg the study of Moral Psychology had focused on the importance of moral reasoning in moral dilemmas (Kohlberg, 1976). However, progress in the study of moral phenomena in recent years has allowed us to obtain valuable information about the functioning of our brain and the influence of emotions on the formation of these phenomena, gathering evidence that affective and automatic processes are present in moral cognition. One of the first researchers who revealed, through work with neuroimaging, that emotions were involved in decision-making was Damasio (1995) formulating the "somatic marker hypothesis". This hypothesis proposes, in neurobiological aspects, the existence of a collaboration between modern prefrontal brain structures and the amygdala. Thus, in any scenario, the prefrontal cortex is capable of creating a descriptive representation of the situation and this representation is "marked" by an emotional reaction that the situation triggers in each individual. From this, many authors have generated models to describe the formation of moral judgment and make decisions linking emotion as part of the mechanism that triggers this judgment. Among the outstanding researchers in the area we find Haidt (2001), who described a model called social intuitionism, which states that moral judgment is an unconscious process subject to an emotional reaction in a given situation and that although this judgment is conscientious, it is still driven by emotions. In other words, moral evaluation is prior to any kind of conscious thought we can do about a situation and therefore, conscious processing occurs at the end (post-hoc) in the formation of a moral judgment. Following this line, the center of analysis has been to find the causal role of emotions in the formation of moral judgments. In this field, Greene (2001) has developed experiments, with healthy subjects, in which it is shown that there is an activation in the prefrontal cortex, ventromedial and amygdala (regions of the brain associated with emotions) when individuals face a particular type of moral dilemmas, specifically, when personal moral dilemmas activate the areas of the brain associated with emotions. This lead to admitting, as Haidt did, that emotion plays a fundamental role in the formation of moral judgement (Greene, 2001). On the other hand, when people are presented with another type of dilemma (e.g., Trolley), individuals show activity in the Prefrontal Cortex, Dorso- lateral and brain regions associated with cognitive control and reasoning. Greene concludes that the associated structures that emotions would conflict with a welfare maximization reasoning that differs in each situation. This conflict is summarized in his hypothesis

(Greene, 2004) that indicates that there are substructures distributed in different parts of the brain dedicated to a utilitarian function and other substructures dedicated to a deontological function, in the latter emotions would trigger the moral judgment. From now on we will call these substructures processes. The competence of these two processes would explain why individuals tend to decide deontologically in some dilemmas (Footbridge) and in a utilitarian way in others (Trolley). Greene uses different dilemmas, between these personal and impersonal moral dilemmas (described in the analysis of methods) to differentiate when the utilitarian module wins and when the deontological one wins in the formation of a judgment (Greene 2001, 2004). The question, until now, that followed Greene's hypothesis was whether the emotions are consequence of the emission of a moral judgment or constitutive of this one. Ciaramelli et al. (2007) and Koenigs et al. (2007) using the same methodology as Greene, designed an experiment with individuals that had brain lesions in the prefrontal ventromedial cortex (patients with ventromedial damage are characterized by possessing their emotional capacities for social interaction seriously compromised). As a result, individuals with brain injuries show a tendency to make "utilitarian" judgments on dilemmas in which healthy individuals commonly tend to choose deontological options. Next, I will expose two of these dilemmas (Transplant and Footbridge) where the hypothesis of an abnormal inclination to utilitarianism is supported in these experiments.

Transplant: A surgeon has five patients, each in need of a different organ, without which each of them would die. Unfortunately, there are no organs available to perform any of these five transplant operations. A young, healthy traveler who is passing through the city comes in for a routine check-up. While being screened, the doctor discovers that his organs are compatible with all five of his dying patients. Suppose, moreover, that if the young man disappeared no one would suspect the doctor. Is it morally permissible for the doctor to use this traveler to save the lives of the five people? [1]

Footbridge: An out-of-control train goes at full speed towards five people on the train track, who will die if the tram runs its current course. You stand next to a fat man on a pedestrian bridge over the track. The only way to save the five people is to push this man off the pedestrian bridge into the path of the train. Is this morally permissible?

1 dilemma were obtained from supplementary material by Greene et al. 2004

In both cases, a majority of healthy subjects reject the proposed action to save 5 people, but patients with injuries or high scores on antisocial personality tests are inclined to approve of those actions. Despite the fact that, in these studies, patients effectively tended to avoid the deontological response. Strictly, the conclusion must have been that the results showed that emotion was constitutive of moral judgment. But as mentioned above, they formulated their results following the speculative hypothesis of Greene et al. (2004), asserting that patients have a tendency to judge personal moral dilemmas counterintuitively or abnormally utilitarianly. Greene (2007) also defended his hypothesis of the two processes thanks to these studies, arguing that patients had lost their areas of ethics, whether due to front-temporal dementia or injuries. The interesting thing is that these results can only be explained by alluding to the lack of emotions, without the intervention of a utilitarian process. In fact, in this line, Wiech et al. (2012) designed an experiment to contrast these two possible explanations. In the work they conducted questionnaires to measure personality traits (hypercognition and empathic poverty) in healthy subjects and correlated these traits with utilitarian responses in personal moral dilemmas, using functional magnetic resonance imaging (fMRI). They found that both personality traits correlate positively with the tendency to give utilitarian responses and that there was a positive correlation between poverty in empathy and the absence of activation of the Subgenual Cingulate Cortex (SCC), which is activated when subjects feel empathy or guilt (Zahn et al. 2009). Surprisingly, they found no correlation between high values for the psychological trait of hyper cognition and activation of the Dorso-lateral Prefrontal Cortex, an area that Greene et al. (2001) related to utilitarian judgment in healthy individuals. This study supports Moll et al. (2007) and Prinz (2007) who stated that the tendency towards "utilitarian" judgments, in these cases, is a dysfunction in the processing of emotions and not a competition between processes, that is to say, it is the lack of empathy that would explain when a deviation occurs in the normal moral judgment, which is sometimes "deontological" and sometimes "utilitarian" (Moll and de Oliveira-Souza 2007).

On the other hand, Greene argues that the two processes have defined characteristics, that is, the deontological process must be more emotional, intuitive and automatic and the utilitarian process more controlled, counterintuitive and prolonged (Greene et al., 2001, 2004). Then, we could say that Kahane (2011), following this line of criticism, examined in detail whether each process had the characteristic of intuitive for the deontological and counterintuitive for the utilitarianist respectively (Greene 2001 and 2004). The results revealed, through fMRI, that the difference in activation in certain areas of the brain could be better explained by the distinction between intuitive/non-intuitive judgments than the distinction between utilitarian/deontological judgments. To achieve this result, Kahane modified

Greene's experimental method by creating a new battery of moral dilemmas where the intuitive utilitarian option existed. (e.g., the lie to avoid suffering), revealing a methodological bias in the experiments. Despite Greene's attempt to correct all the accumulated critiques in the literature regarding his model, he has not given a satisfactory answer to the alternative hypothesis in which all emotions are behind moral judgments (Haidt, 2001; Moll et al, 2008).

In general, the contribution of neuroscience has allowed for assigning correlations between brain structures and cognitive functions in order to infer the functions necessary for certain tasks by observing neuronal activation patterns. It has also contributed to dilucidated the areas or substructures of the brain that correlate with the formation of moral judgments (see Table 1).

Brain Region	Functions
Prefrontal Cortex Ventromedial	Understanding other people's behavior (Mind Theory). Central role in the association of emotions and social experiences for decision making. Participates in the regulation and emotional reaction (Damasio 2004; Fritz 2006; Greene 2014)
Orbito frontal cortex	Involved in processes that modulate subcortical systems that mediate social cognition and reactive aggression. (Blair 2000 and 2004). He makes computation of expectations regarding prizes and punishments (Walton 2004; Camille 2004). It is activated before negative emotional expressions (anger and fear). (Kesler-west, 2001)
Amygdala	Emotional processing with respect to negative stimuli and signs of threat (LeDoux; Russell, 1999). Participates in aversive conditioning and instrumental learning (Damasio, 1995; Davis, 2000).
Dorso-Lateral Prefrontal Cortex	Participates in processes of control, task monitoring, and inhibitory control during the selection of rule-based responses (Bungue, 2004). Facilitates

	the abstract reasoning of costs and benefits (Greene, 2004).
Anterior Insular Cortex	It associates visceral states with emotional experience, projecting itself into the limbic system (Mutschler, 2009)
Anterior cingulate Cortex	It participates in the control of conflicts, specifically, it is activated when simultaneously two incompatible options, suggesting that this area is involved in the solution of conflicts (Botvinick, 2001)

Table 1: Possible functions that the different areas of the brain have in the formation of moral judgment.

It is important to mention that from neuroimaging and lesion studies it was identified that the ventromedial prefrontal cortex (vmPFC) is the crucial structure for the formation of moral judgment, but its specific function is not defined and continues to be studied (Greene, 2007; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Moll and De Oliveira-Souza, 2007). In the work of Shenhav and Greene (2014), in order to differentiate the different mental processes in moral judgment, participants were asked to make one of three types of judgment in the face of a moral dilemma: an emotional assessment (EA) or a utilitarian assessment (UA) or an integrative assessment (IMJ), in which the overall acceptability of each option was judged. The vmPFC was more activated in the IMJ condition. These results led Shenhav and Greene to conclude that vmPFC's role in moral judgment is to "integrate signals of disparate values into a more abstract and highly representative representation," i.e., vmPFC has an integrative function. This integrative vision disagrees with the results obtained by brain injuries, since if vmPFC is integrating the emotional evaluation it is expected that if individuals are injured, they will be more deontological in their judgments. Chuanpeng Hu and Xiaoming Jiang (2014) propose that this discrepancy could be resolved from an emotional regulation perspective of vmPFC, which proposes that vmPFC appreciates (or re-evaluates) the affective meaning of moral events when making moral judgments. The vision of emotional regulation can be applied to the real-world dilemma when the moral (social) standard has to be violated because of a positive consequence of an action (e.g., the child steals money for a sick parent). The meaning of moral rape may vary depending on the positivity with which the consequence of that action is evaluated. However, the exact function of vmPFC is not yet specified (Riva, 2019; Tassy, 2012 Can this evidence tell us anything about a mental model where there is competition between the utilitarian and deontological? Before approaching any answer, the first step must be to analyze the methodology used in all the studies exposed which will be discussed later.

5.7 Moral Mating: Jealousy as a moral emotion that regulates cooperative interactions

The most studied biological market is the mating market, because this mutualistic relationship directly affects the reproductive success of individuals, increasing the possibility of leaving extensive offspring (Buss and Duntley, 2011). Remember that sexual selection describes adaptations in terms of reproduction and not survival (inclusive fitness), and these adaptations trigger a series of differentiated strategies for both men and women, where each strategy was designed by evolution as a solution to the problem of matching. In the case of long-term relationships, individuals take advantage of all the benefits inherent in a mutual relationship for survival. In these long-term relationships the challenges that our ancestors had to solve were the attraction of a mate and on the other hand their retention (Buss, Schakelford & McKibbin, 2008). These challenges include a focus on the supply and demand of diverse partners and the costs/benefits of choosing and attracting a mate. Consequently, there are moral strategies that vary depending on the specific challenge, promoting moral intuitions that trigger different patterns of engagement and perceptions of partners' offerings. Organisms choose partners based on signals of direct benefits (including all mutual benefits) or indirect benefits (i.e., genetic quality for offspring), and also compete to appear as the best partners (Barclay, 2013 Bhogal, 2018, 2019). In this partner selection process, moral intuitions may have been shaped to assess the willingness, availability and skills of partners for cooperation. In evolutionary terms an open question in this area is what signals evolved for us to acquire relevant information about a partner's abilities? The literature posits that people who offer equity and commitment in relation to the profits produced by mutuality are more likely to be selected as partners (Baumard, et al 2013). Therefore, if we consider that in a couple's relationship sexual and natural selection operates in tandem we must visualize this cooperation considering the restrictions of each sex to give and maintain resources. In this context the theory of parental investment (Trivers, 1972) gives us a basis of the reproductive costs that has each sex. Specifically, women's large biological investment in offspring causes them to be highly demanding in terms of courtship and signals of commitment in mating in contrast to men. Consequently, the man is under pressure to surrender resources into ensuring a high rate of investment in child rearing preventing cuckoldry and to ensure that the descent belongs to him (Buss, 2013a).

Following this line, controlling resources is essential to guarantee reproductive success and the way in which people behave can generate intuitions to impede this control of resources as well as to facilitate it, assuming that the decisions of this control of cooperative resources have costs, that is to say, there are costs of

making bad decisions and they are, as indicated by the theory of parental investment, normally greater for women than for men, so a moral conflict for cooperation is generated (Buss, 2017). In other words, we can see sex as an extremely valuable resource, and it is moralized to access or control this resource and this moralization is due to the fact that there are these restrictions of unequal investment, but at the same time cooperation must be achieved (Comroy-Beam et al., 2015). In general, we have moral intuitions to know what is bad and good, for choosing the right person to cooperate and also to control and retain these resources. An example of this is infidelity. Infidelity is a moral dilemma where there are moral imperatives at play that are in opposition to each other (Asao, 2016). On the one hand, to transgress the exclusivity of resources (sexual or emotional) of an implicit contract of cooperation by the members of a couple, and on the other hand is breaking explicitly with this exclusivity. Each option has its individual consequences, but let's remember we are talking about cooperative relationships, where reputation is important in order to be selected and retained to cooperate again (Comroy-Beam et al., 2015). Then it is not a good social strategy to deceive a partner and that this one knows, since in our species the long term unions are valued, but in reproductive terms since it increases my possibility of reproductive success, that is to say, in biological terms to look for another couple is a technique to assure descendants (Lieberman et al., 2007; Boehm, 2012; Buss,2016) Consequently, in terms of evolutionary psychology two domains of interaction come into conflict in the mind: one is that of mating and the other is that of cooperation. Each domain has different rules of decisions and the mind must be able to ponder the conflict and together with the emotions obtain an intuition that regulates the individual or group behavior of that instant. Buss (2017) emphasizes that infidelity is rarely not morally sanctioned and constitutes one of the fundamental pillars of human sexual morality (Bendixen, Kennair & Buss, 2015; Buss 2017), stressing a model of how different judgments can be generated with the same situation and where social influence and individual consciousness play an important role (Buss, 2016). In this way the double (moral) standard or moral hypocrisy can be explained where an outcome can be socially pondered bad, but the decision is made to deceive even if it is so. An explanation for this is that the members of couples aim to control the sexuality or emotions of their partners, while excusing themselves for having sexual or emotional relations with other partners, it is certainly an example of moral hypocrisy, but it is also consistent with psychological adaptations such as a greater desire for sexual variety or a lesser willingness to lament casual sex (Buss, 2013, 2016).

In short, on the one hand we have psychological adaptations such as love and attachment that guide our intuitions to maintain a long-term cooperation in order to

give protection to a descendant who needs an extended childhood and on the other hand (Attridge, 2013; Dunbar, 2012) and we have psychological adaptations oriented to defend ourselves against infidelity of the partner by jealousy, where the strategy that triggers this emotion is the retention of the partner to optimize resources that are at stake in a long-term relationship (Bendixen, Kennair & Buss, 2015). If we detail a definition, we can describe jealousy as an emotion that motivates strong behavioral and psychological responses, and that was designed to protect a valuable relationship potentially threatened by a third person or a rival. This emotion occurs mainly in the context of romantic relationships, but has also been widely studied in other interactions such as friendship (Buss, Larsen, Westen, & Semmelroth, 1992; Buss, 2013; Buunk, 1997; Buunk, Zurriaga, González-Navarro, and Monzani, 2016). It should be noted that retention strategies are differentiated for men as well as women, and allow for different responses to jealousy (Buss et al., 2008). These responses are directly related to other adaptations that solve problems related to reproductive strategies in order to maintain a long-term partner, such as the certainty of paternity in men and the investment of resources for women (Buss and Schmitt, 1993; 2018). Consequently, because there are direct benefits of long-term relationships, people must participate in actions that ensure access to and retention of these inherent benefits (Buss and Duntley, 2011). So, if we consider that losing a partner to infidelity is more costly than suspecting a probability of deception, natural selection must have created a cognitive bias to scare away the possible betrayal of a partner. On the other hand, one of the hypotheses exposed in the literature is that jealousy is produced due to mistrust in the partner that triggers the belief that she or him can abandon the relationship for a better alternative.

The scares literature on the topic describes trust as an important factor in the development of safe and satisfying relationships (Dunbar, 2009; Dunbar & Shultz, 2010; Lount, 2010; Porges, 2011; Simon, 1990). Consequently, if a relationship lacks trust, jealousy develops as a damaging and disappointing cognitive pattern that arises from this insecurity (McAnulty & Brineman, 2007). This hypothesis presents its theoretical base in the attachment theory where an association is established through the examination of trust and jealousy (Bowlby, 1969) and the link between love and jealousy discreetly, proposing that when closeness is not assured and the experience of caring for the other is unstable; people develop anxiety in their relationships, leading to a greater experience of jealousy (Most et al., 2010). Specifically, attachment anxiety moderates the association between trust and jealousy, so anxious individuals experience much higher levels of jealousy when reporting lower levels of trust (Rodríguez, 2015). In general, there are a number of documents that indicate that distrust is an important determinant of experiencing and expressing jealousy (Marshall et al., 2013; Vinkers et al., 2011). In these papers, it is suggested that people with lower levels of confidence tend to monitor and assess

their partner's level of support and responsiveness from time to time. Adding to this, research has found a strong association between jealousy and partner conflict, aggression and violence (Hansen, 1991; Buss, 2000; Harris, 2003; Langhinrichsen-Rohling et al., 2012).

We cannot deny that trust is fundamental in the development of secure and satisfying relationships, and attachment theory (Bowlby, 1969; Simpson, 2007a) provides a useful framework for understanding how trust develops over time and the associations between this trust and the romantic bond (Givertz, 2013). But this theoretical base are based on self-reports in different situations and are not sufficient to describe the phenomenon of confidence/trusting in relationships, since they do not allow understanding how individuals behave before representations of real problems. In summary, in spite of the empirical base of this hypothesis, it does not have evolutionary plausibility, because it describes jealousy as a maladaptive emotional reaction. Then, if we see jealousy as an evolutionary strategy,
it was developed to solve the conflicts directed to the maintenance of the pair bond (Fernandez, 2012. Jealousy would be an emotional response designed to protect a loving bond; therefore, the experience of jealousy is complementary to attachment, arising when there is a real or imaginary threatened attachment relationship (Attridge, 2013; Fernandez, 2017). This is complemented by the literature that tells us that trust has an adaptive function directed at prosociality (Dunbar & Schultz, 2010), but which not necessarily would respond to mating threats. In other words, we hypothesize the degree of trust should not affect jealousy, because the adaptive function of the latter points to a different recurrent problem that is the possibility of losing the romantic cooperator to a rival. This is how we can say that in the same way that intuition tells us that it is okay to give resources to a child without receiving anything in return, the same intuition, through the emotion of jealousy, should indicate to me the notion that it is wrong for a resource to be diverted to a third party. So far, the literature directly suggests to us that moral emotions are essential to the practice of morality and would lead to behavior according to their evolutionary history. Consequently, exploring jealousy in the context of human cooperation allows us to establish that moral norms were key to the development of long-term relationships. This exploration of an evolutionary hypothesis has a methodological challenge to find a functionality of jealousy which will be discussed in chapter 3.

5.8 The Moral Dilemma: A method for activating moral intuitions

The first step before characterizing the internal working mechanisms of the mental machinery that generates moral intuitions is to analyze the methodology used to activate this machinery, and thus be able to implement tools from other disciplines. Experimental economics, through game theory, studies moral behavior under different incentive structures and different contexts (Binmore, 1990; Camerer, 1993, 1997). Specifically, economists have developed a battery of games in a controlled environment, which are abstract representations of archetypal types of social interactions between human beings, and aim at capturing the essential components of different types of interactions. The main experimental games are social dilemmas, trust games, investment game, the ultimatum game and the dictator's game. All of these were designed to represent situations in which all members of a group would benefit from cooperation, but there are individual incentives not to cooperate (Fehr, 2002, 2004). For example, the prisoner's dilemma is the simplest social dilemma: the subjects of the experiment have two options, which they must do simultaneously: either to cooperate or not to cooperate. Each player gets a higher reward for not cooperating, regardless of the other player's choice. However, both would get a higher reward if they could commit to cooperate with each other. The other games represent situations with similar incentive structures, such as teamwork or the exploitation of a natural resource.

In general this experimental approach rescues an empirical study of moral judgments after participation in the tasks of the game, but the experimental montage and the variability that can occur when different individuals intervene in the experiment does not allow for it to be a good tool to study satisfactorily the generation of moral judgments (Takezawa et al., 2006; Hofmann and Baumert, 2010). The predominant methodology, taken from moral philosophy, is based on the use of situations or questions where there is a moral conflict, i.e. moral dilemmas. Moral dilemmas present a series of experimental advantages, among them; they allow a moral conflict to emerge. In fact, subtle variations in these variables are sufficient to trigger different moral judgments. Another advantage is that the dilemmas are exactly the same for each participant in the experiment. These characteristics make moral dilemmas a valuable tool for studying the psychological processes of moral cognition.

And as it has just been mentioned, there is a great experimental advantage in using this tool, but the dilemmas exposed in most of the studies mentioned above are extremely heterogeneous, to the extent that many of these studies are neither

comparable nor replicable (Christensen and gomila, 2012; Feldman, 2012). In fact, many of the dilemmas are not genuine moral dilemmas, in which two or more principles should be opposed, and some cases are not plausible or are not dilemmas. It also stands out the fact that the classification of the different dilemmas is not clear, and identifying moral violations and variables becomes difficult, and consequently the interpretation of the results varies. Despite this, dilemmas have allowed us to generate models of how the moral mind works. An example is the hypothesis of the dual process, described by Greene (2001), which tries to realize what makes us differ in our moral judgments. However, this appears as a dichotomous view of the processes involved, taking into account the problems in identifying contextual and conceptual variables present in the dilemmas.

In general, for experimental purposes, a moral dilemma is a brief story about a situation of risk of harm to one or more persons, and in the last part an alternative proposal of the courses of this action is presented. The two actions and their results are incompatible with each other, and this triggers a moral conflict (Kohlberg, 1964). As Hauser says, the use of this tool (moral dilemmas) is what has so far allowed us to explore and control relevant aspects of moral psychology: *"The use of artificial moral dilemmas to explore our moral psychology is like the use of theoretical or statistical models with different parameters; parameters can be added or subtracted in order to determine which parameters contribute most significantly to the output."* (Hauser et al., 2007, page. 4)

Regardless of the good characteristics of moral dilemmas, their empirical basis shows high sensitivity, since the moral judgement of the participants in the experiments varies according to the weighting of the different variables in a dilemma. For this reason, Christensen and his colleagues (2012) conducted an extensive review and discussion of 19 parameters that are relevant when designing a moral dilemma in a selection of 25 different studies published in the precedent 10 years. Among the parameters that stand out is the structure in which the dilemma is carried out, i.e. the perspective of the participants in the dilemma can vary, specifically, 56% of the studies were used with a first-person perspective, 36% with a third person perspective, and 8% with a combination of the first and the third person. On the other hand, evidence from moral philosophy and neuroscience indicates that intentionality is an important variable in less than half of the studies controlling the intentionality variable; on the contrary most of them are guided by how directly or indirectly the damage was generated (Christensen et al., 2012).

Let us remember that moral behavior is influenced by moral intuitions, guided by moral emotions, which have allowed throughout evolution to promote the social behavior for reproductive success. In this area, Moll and his group proposed that

moral intuitions should be seen as predispositions evolved to motivate pro-social behaviors and that they can interact with the moral values to motivate moral judgement. The interesting thing is that there is no analysis that conceptually distinguishes the moral judgment from the moral intuition (Moll et al., 2002; Moll et al., 2007).

The battery of dilemmas that led to the experimental induction of this conflict (utilitarianism vs deontology) contains non-moral dilemmas and personal and impersonal moral dilemmas. Broadly speaking, under a conflict situation where individuals must decide whether or not to save the lives of several people at the expense of one, in personal dilemmas, individuals must victimize one person to deflect the pre-existing threat. This condition tries to capture the difference between the personal version of the dilemma where the protagonist pushes another person to his death to stop the train that will kill five(Footbridge) and in the impersonal version the protagonist only diverts the train, where, fortuitously, there is only one instead of five persons who will die (Trolley). Another way of capturing this difference is that in the Footbridge a person is used as a means and in Trolley the death of a person is a secondary or collateral effect to save lives. It is not the purpose of this section to discuss which is a best explanation for a personal dilemma, but we will discuss the battery of personal dilemmas used by Greene, since from them he gets the prediction that there is an intuitive, irrational, automatic, and deontological mental process that explains why people do not sacrifice the victim to save more people in these dilemmas.

The heterogeneity of variables in the personal dilemmas used in the experiments does not ensure a "dual-process" cognitive conflict. According to Rosas (2014) of the 25 personal dilemmas used, in 16 stories the person facing the dilemma is one who is saved, specifically in six stories only the person facing the dilemma (protagonist) is saved, and in the remaining 10 the protagonist and other individuals are saved as well. In this way, we find that the decision towards choosing an option could be explained by egoism and not by the utilitarian/deontological option. Therefore, it is important that the protagonist is not one of those who are saved, since if he is, his reason evidently poses a bias to give prediction to a cognitive model. As this example, there are more variables that can explain the decision of a moral dilemma in the battery of dilemmas that are commonly used in moral neuroscience.

It should be noted that the design of a moral dilemma depends on the hypothesis at stake and the behavioral or neuroscientific approach to be investigated. Considering the above, it is clear that an adequate design of a moral dilemma allows us to systematically explore the parameters that modulate our moral judgments.

5.9 Description vs. functionality of moral intuitions

With all the moral dilemmas we only point to hypothesis descriptions of attributes that the moral intuitions possess when a situation arises, since we make sure that we are activating our moral rules under a specific situation of interaction. With this description we can create models that explain how the mind weighs certain relevant parameters to generate a moral intuition (Harris and Christensen, 1996). Consequently, seen from a microeconomic point of view, a moral dilemma is a budgetary restriction, where those involved in the dilemma have prices and we can know which parameters make the prices of those involved change (Ostrom, 1998; Bowles, 2004). The challenge is to have clarity of the parameters involved in the dilemma that range from emotions to double effects of history. In this way, we can evaluate characteristics attributed to it in literature as rationality, but we cannot evaluate all the hypotheses related to moral intuitions with this tool. For example, with the forced choice dilemma of infidelity, Buss et al. (1992) was able to obtain sexual differences in jealousy, contributing to the description of this complex emotion, although there is an evolutionary functional theory that would explain the evocation of different jealousies for each sex, which cannot be measured with forced choices (De Steno & Salovey, 1996),

Asao and Buss (2016) poses infidelity as a moral dilemma, where the option to cheat sexually or emotionally has a probability and a net cost associated with incurring this infidelity and those consequences trigger moral intuitions directed by emotions such as disgust, feelings of betrayal and jealousy and in turn these judgments directed by these intuitions allow the identification of cheaters and store information about the quality of couples. The positive and negative consequences of the probabilities of cheating generate a cost-benefit relationship and this cost is different between men and women which triggers different notions of moral injustice (Buss, 2009). Since infidelity continues to be a dilemma where extreme scenarios are presented where dichotomous options force people to decide one scenario vs. the other. In addition, it should be noted that when we evaluate some functional hypotheses these must have ecological validity and therefore the results of any methodology depend on what several agents do, the best option of an agent may depend on what other agents choose. For this reason, a moral dilemma is not the best option. In other words, the dilemma of infidelity serves to describe moral emotions that activate the situation as jealousy, but through this we will not get an answer from the specific function that fulfills this moral emotion in a specific interaction. So far, the literature directly suggests that moral emotions can lead to ecologically rational behavior according to their evolutionary history. Consequently, the following chapters will deal with hypotheses that allow us to give evidence to the description and functionality of moral intuitions guided by emotions.

5.10 References

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CHAPTER 2

Rational moral intuitions

SUMARY

The human cognitive architecture should contain many domains of human social interaction: (consider, e.g., exchange, kin altruism, mating, cooperative foraging, warfare). These different types of social interaction require different concepts, inferences, sentiments, and judgments to regulate behavior adaptively. Therefore, the different domains require specialized subsystems of moral cognition that takes into account many moral considerations that are often contradictory (e.g., incompatible duties). If we consider that selection produced adaptations designed to weight conflicting moral sentiments to produce judgments of the subjects choosing the option they “feel is morally right”, will eventually produce judgments that are internally consistent. We experimentally explored the design of the integrative psychological process that weighs the different moral considerations to produce all-things-considered moral judgements. Specifically, we wanted to know whether the subjects produced rational moral judgments in the sense of GARP (general axiom of revealed preferences), and whether they responded to relevant moral categories (such as motivations) in a consistent way. Using three moral dilemmas involving warfare, we quantitatively varied morally-relevant parameters: Each dilemma presented 21 scenarios in which sacrificing C civilians would save S soldiers ($0 \leq C < S$), varying S, C, and S/C (soldiers saved per civilian sacrificed). Judgments were highly consistent. Bootstrapped choices would violate aprox GARP 50 times, yet there were no GARP violations for 49% and 64% of subjects (unwilling conscripts vs. willing warriors). Of the >250 who sacrificed some, but not all, civilians, 55% and 62% made 3 or fewer GARP violations. Fewer civilians were sacrificed when soldiers had volunteered.

6.1 Introduction

Natural selection produced cognitive systems responsible for moral computation to regulate our social behavior and influence others, there is evidence that these cognitive systems are intuitions that promoted fitness ancestrally (Haidt et al., 2001; Gigerenzer, 2010; Cosmides et al., 2013). The brain can be seen as a set of evolved computational domains that analyze situations and generate options. Each domain must have a different computational design: including specialized domain concepts, inferences, motivational states, emotions, moral feelings, and decision rules. In general, the computational systems produced by natural selection should be designed to make tradeoffs between moral goods in ways that promoted fitness ancestrally. Consequently, when two moral values are in conflict, these systems should be able to negotiate and compromise solutions, by choosing actions that partially satisfy both values. For moral cognition, better combinations would be those that produce greater moral value given how the chooser weights different ethical criteria (e.g., a duty to not harm versus a duty to save the most lives).

Considering the above, in this chapter we explore the hypothesis that moral cognition generated intuitions with ecological rationality and that each domain generates an output subject to a budgetary constraint (moral or social dilemma), where you must choose between a finite set of actions (the most correct), being able to do so for any given set of actions. This ecological rationality is consistency in the sense of GARP (when people be transitive). That is, people will negotiate tradeoffs in moral dilemmas, and their choices will be both internally consistent (GARP-respecting) and coherent (Coherent choices are those that respond appropriately to moral considerations, such as whether an agent is being coerced or acting voluntarily). Despite this, there is an alternative hypothesis where predictions about the "negotiability" of moral conflicts are sharply different and link intuitions with irrationality triggered by emotions and is one of the most predominant models in the area, Greene's (2001) dual process model of moral judgment.

6.2 Negotiability and the dual process model of moral cognition

According to Greene's dual process model, emotions are specialized systems that evolved for a specific function: to regulate face-to-face interactions in the small-scale world of our hunter-gatherer ancestors. Their operation is fast, automatic, and inflexible because they evolved to negotiate real-time interactions with others by rapidly producing best-bet social responses. In a competitive "biological market", that is, when alternative cooperative partners are available and the costs of switching partners is low, harming a cooperative partner to gain an immediate material advantage risks losing that partner (Tooby and Cosmides, 2008; Buss, 2007; Alvard, 2001; Alvard and Nolin, 2002; Buss and Duntley, 2011). Occasions arise when cheating, stealing, breaking promises, or using violence would benefit an individual in the short-run, but acting on these opportunities would disrupt cooperative relationships that pay off in the long run. Social emotions produce deontic moral intuitions, don't cheat, don't harm, keep promises, because these are best-bet responses for attracting and keeping valuable cooperative partners (Baumard 2010, Asao & Buss, 2016, DeScioli and Kurzban 2009, Kurzban et al., 2012). The prospect of violating these prohibitions sets off an emotional "alarm-bell," and the emotion activated issues a behavioral command, such as "do not harm" or "must keep promise." These commands are not produced by a reasoning process; when reasons for a moral judgment are offered, they are post-hoc rationalizations.

According to the dual process model, moral scenarios are experienced as dilemmas when emotions produce deontic judgments that conflict with reasoned choices about maximizing aggregate welfare. A classic example is the following trolley problem: Should you stop a runaway trolley by pushing a large man onto the tracks, sacrificing his life to prevent the trolley from killing five people? The flexible reasoning system, operating on emotionally neutral representations of the situation, does a cost-benefit analysis; it yields a utilitarian judgment, "Push the man", because it computes that this action will save more lives. But the prospect of pushing the man to his death activates an "alarm-bell" emotion that generates an inflexible behavioral response: "Don't kill this innocent bystander!", a deontic judgment. According to the dual process model, this deontic judgment is "non-negotiable": the alarm signal is like an internal command, do not harm, which is, by design, difficult to override (because its function is to prevent one from disrupting cooperative relationships). We experience the trolley problem as a dilemma because "two [dissociable psychological] processes yield different answers to the same question". Which answer dominates depends on subtle elements of the scenario (Christensen et al., 2012). But a

subject’s answer will be either deontic or utilitarian because there is no psychological machinery for negotiating a compromise solution.

To test the "negotiability" of the model, inspired by the presence of emotions, we must test several hypotheses:

1. The system is capable of taking charge of situations in which there are intermediate (compromise) solutions for moral dilemmas.

2. For a given domain of interaction, the moral intuitions of a person must respect GARP.

3. When a decision problem involves multiple domains of interaction, a person's moral intuitions must respect GARP (Intra domain integration).

4. Moral intuitions are expected to be affected (be different) as the motivations of the individuals involved in a conflict situation change.

Here we present an empirical test. The results suggest that moral conflict is like motivational conflict: negotiable, produced by a cognitive process that weighs competing moral values against one another, making tradeoffs between them. Moreover, the moral tradeoffs people made were largely rational: their choices respected GARP

6.3 Methods

Subjects

We recruited 4576 subjects from Amazon Mechanical Turk ™. The subjects gave a test to evidence that they understood the instructions and paid attention during the experiment. Only N = 1746 subjects answered all the questions correctly. The rest were excluded from the analyzes. The final sample consisted of 945 women and 801 men. Their ages ranged from 18 to 87 years, with an average of 36 years.

Materials

The questionnaire consists of 21 different scenarios of the carpet-bombing dilemma. In its general form, the carpet-bombing dilemma is as follows:

Two foreign countries, A and B, have been at war for several years (you are not a citizen of either of these two countries). The war was initiated by the rulers of country B. The war has been bloody: Millions have died during the conflict, which so far had been deadlocked. Recently, the military equilibrium has broken, and it is now certain that Country A will win the war sooner or later. The question is how, when, and at what cost.

Country A has two strategies available. Country A could use one, the other, or a combination of both.

The First strategy is to attack the opposing army with conventional weapons, preventing civilian casualties almost completely. If Country A applies this strategy, the war will continue for some time (perhaps years). The delay in the end of the war will cause the deaths of a great number of soldiers of both sides. Of the soldiers that die, about half will be from country A and half from country B.

The second strategy available to Country A is to bomb cities of Country B, killing civilians (who opposed the war since the beginning) and almost no soldiers. This strategy would demoralize Country B and force it to surrender quickly. The war would end soon. There is a third approach. Country A could bring the war to an end by using both strategies, resulting in the deaths of some civilians and some soldiers. The more civilians are sacrificed (killed) during the bombings, the sooner Country B will surrender, and the fewer soldiers will die on the battlefield.

How should Country A end the war?

A particular scenario of the dilemma is a set of alternative outcomes to the war. Each outcome corresponds to a possible number of dead soldiers and a number of dead civilians. The scenarios differ in two aspects: (1) the number of soldiers that would die in battle if nothing is done to prevent it, and (2) the approximate number of soldiers that will be saved for each civilian killed in the bombings. These parameters are translated into a set of alternative outcomes. From this set, the subject must choose the one that he "feels is morally right" Figure1 is a screenshot of two scenarios, as presented to the subject. Figure 2 summarizes the different sets of alternative outcomes available in the 21 scenarios.

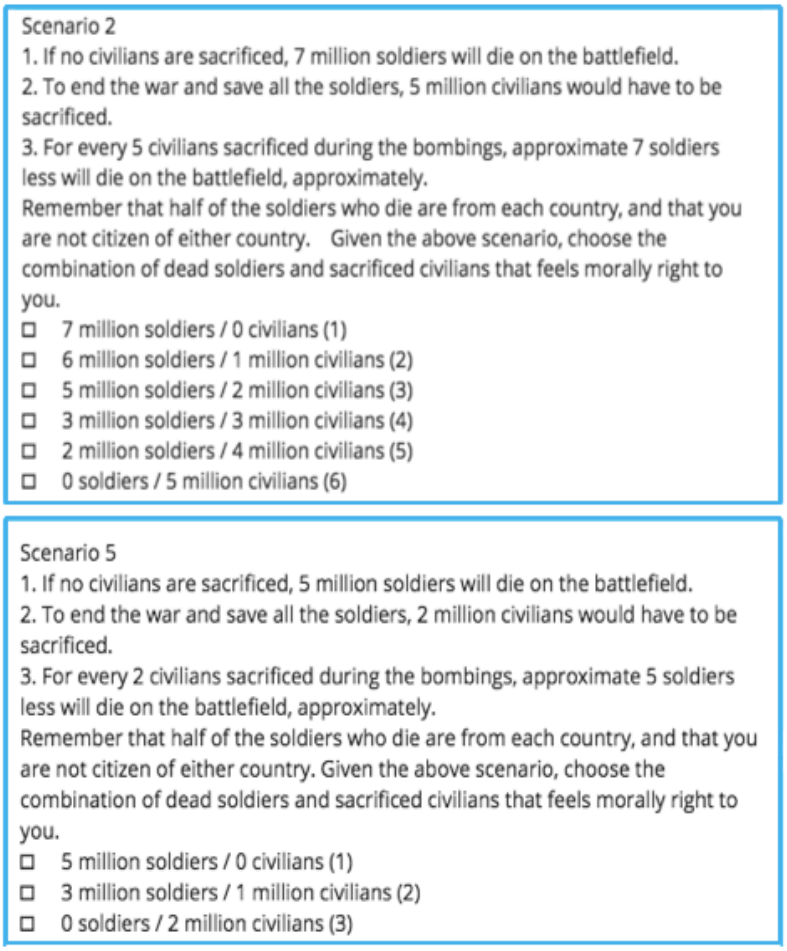


Figure 1: **screenshot of two scenarios**

The box shows two scenarios from the questionnaire

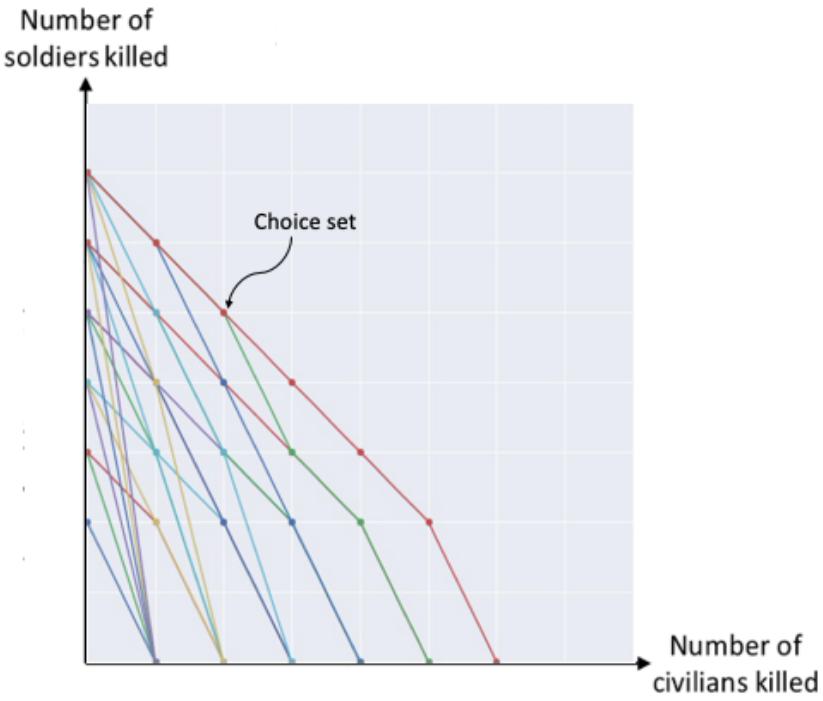


Figure 2: **All choice set with different combination of option for 21 scenarios.**

The colors line represents the material constraints of the 21 scenarios. Each line has only one color and represent one scenario. Each point in the line represents a different outcome: A combination of dead soldiers and dead civilians. The subject must choose one point in the line as the morally right combination of dead people. The slope of the line represents the number of soldiers that would be saved per each civilian that is sacrificed. The intercept of the line is the number of soldiers that would be saved if no civilian is sacrificed.

There are three versions of the questionnaire (Figure 3). Each version has the same 21 scenarios but different frames. (show Figure 2). The frames describe the motivations of soldiers and civilians:

1. All unwilling: The war was initiated by the rulers of country B, against the will of the civilian population. The soldiers of both countries where forced to join the army against their will, and are desperate to return to their families.
2. Willing civilians: The war was initiated by the rulers of country B, with the support of the civilian population. The soldiers of both countries where forced to join the army against their will, and are desperate to return to their families.

3. Willing soldiers: The war was initiated by the rulers of country B, against the will of the civilian population. The soldiers of both countries volunteered, and are willing to fight for their country.

(a)

All unwilling

Two foreign countries, A and B, have been at war for several years (you are not a citizen of either of these two countries). The war was initiated by the rulers of country B, against the will of the civilian population. The war has been bloody: Millions have died during the conflict, which so far had been deadlocked. Recently, the military equilibrium has broken, and it is now certain that Country A will win the war sooner or later.
The question is how, when, and at what cost.
Country A has two strategies available. Country A could use one, the other, or a combination of both.
The first strategy is to attack the opposing army with conventional weapons, preventing civilian casualties almost completely. If Country A applies this strategy, the war will continue for some time (perhaps years). The delay in the end of the war will cause the deaths of a great number of soldiers of both sides. Of the soldiers that die, about half will be from country A and half from country B. Nearly all are young soldiers who where forced to join the army against their will, and are desperate to return to their families.
The second strategy available to Country A is to bomb cities of Country B, killing civilians (who opposed the war from since the beginning) and almost no soldiers. This strategy would demoralize Country B and force it to surrender quickly. The war would end soon.
There is a third approach. Country A could bring the war to an end by using both strategies, resulting in the deaths of some civilians and some soldiers. The more civilians are sacrificed (killed) during the bombings, the sooner Country B will surrender, and the fewer soldiers will die on the battlefield.

(b)

Willing Civilians

The war was initiated by the rulers of country B, with the support of the civilian population... ...killing civilians (who supported the war from the beginning)

(c)

Willing Soldiers

The war was initiated by country B, against the will of the civilian population... Nearly all are young soldiers who volunteered, and are willing to fight for their country

Figure 3: **Three versions of the dilemma**

The box presents the text of the dilemma in the three questionnaires, as presented to the subjects. Each subject responded two consecutive questionnaires: (a) and (b), or (a) and (c). Each questionnaire consisted of 21 scenarios. The color blue represents the motivations of soldiers and the color yellow the motivations of civilians.

Procedure

Each subject completed two versions of the questionnaire: one with the all-willing frame and one with a different frame (willing soldiers or willing civilians). N = 845 subjects completed the willing-civilians version and N = 901 subjects completed the willing-soldiers version. We randomized the order of the questionnaires, so about half of the subjects responded the all-willing version first. We also scrambled the questions in each questionnaire, showing them in different orders to different subjects.

After completing the questionnaires, the subjects took a test to show that they were paying attention and understood the instructions. Finally, we collected demographic data.

Analyzes

Measuring moral inconsistency in the sense of GARP

To make choosing easier to the subject, we used discrete sets of alternative outcomes. These sets approximate linear feasibility constraints (analogous to what economists call budget constraints). The discretization of the feasibility constraints is inconsequential for our purposes: the logic of GARP is the same in the linear and discrete cases. For simplicity, the following explanation assumes linearity. For example: Consider a given scenario. Denote the subjects chosen outcome as (x^*, y^*), where $x^* \geq 0$ is the number of surviving soldiers and $y^* \geq 0$ is the number of surviving civilians. The subject's choice must satisfy a feasibility constraint given by $x + Ky = N$, where $K > 1$ is the number of soldiers saved for each civilian killed, and $N > 0$ is the number of soldiers at risk of death. (show Figure 4). The values of K and N change from scenario to scenario, which means that each time the subject faces a different feasibility constraint.

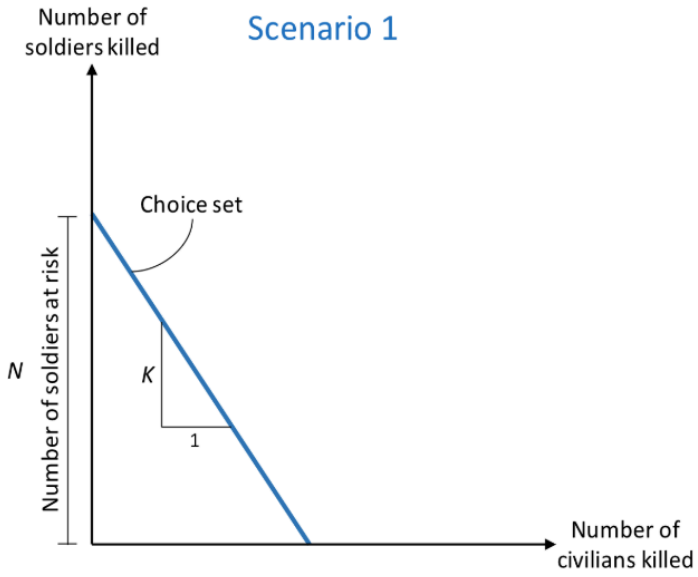


Figure 4: **The Carpet-Bombing dilemma.**

The blue line represents the material constraints of the scenario. Each point in the line represents a different outcome: A combination of dead soldiers and dead civilians. The subjects choose different combinations of values of N and K.

By choosing (x*, y*), the subject directly reveals that he weakly prefers (x*, y*), to all outcomes that satisfy the current feasibility constraint. Formally, the subject directly reveals that (x*, y*), $\succcurlyeq$ (x, y) for all (x;y) such that x+Ky = N, where $\succcurlyeq$ denotes the weak preference relation. If the subject weakly prefers (x*, y*), to (x, y), he is either indifferent between both outcomes, or strictly prefers (x*, y*), to (x, y). If the subject is indifferent between both outcomes, he might choose one or the other when both are feasible. If the subject strictly prefers (x*, y*), to (x, y), he will never choose (x; y) when (x*, y*), is also feasible. We assume that the subject strictly prefers any given outcome (x_1, y_1) to Pareto inferior outcomes in which less soldiers or less civilians survive. Formally, (x_1, y_1) $\succ$ (x_2, y_2) if $x_1 \geq x_2$, $y_1 \geq y_2$, and $x_1 + y_1 > x_2 + y_2$.

It can be proved that, by choosing (x*, y*) the subject directly reveals that he strictly prefers that outcome to all outcomes that lie below the current feasibility constraint (Varian, 1992). Formally, (x*, y*), (x, y) for all (x, y) such that x + Ky < N. Preferences between outcomes can be indirectly revealed through sequences of choices. For example, in one scenario the subject directly revealed that (x_1, y_1) $\succ$ (x_2, y_2). In another scenario, he directly revealed that (x_2, y_2) $\succcurlyeq$ (x_3, y_3). Therefore, he indirectly revealed that (x_1, y_1) $\succ$ (x_3, y_3). Chains of any length are possible: (x_1, y_1) $\succ$ (x_2, y_2) $\succcurlyeq \cdots \succcurlyeq$ (x_n, y_n) implies that (x_1, y_1) $\succ$ (x_n, y_n). GARP states that a rational subject will exhibit consistent preferences: If he reveals that (x_1, y_1) $\succ$ (x_2, y_2), he will never indirectly reveal that (x_2, y_2) $\succcurlyeq$ (x_1, y_1). A subject that reveals both (x_1, y_1) $\succ$ (x_2, y_2) and (x_2, y_2) $\succcurlyeq$ (x_1, y_1) commits a violation to GARP.

By making a sequence of choices, the subject constructs a network of outcomes, interconnected by preference relations. For this reason, the effect of one inconsistent choice can ripple through the network, and the subject can simultaneously commit many GARP violations. The total number of GARP violations that a subject commit while answering the questionnaire is an indicator of his “moral inconsistency”.

Measuring moral coherence

A subject can make different judgments in the same scenario if the motivations of soldiers or civilians change. A subject makes a “morally incoherent judgment” if he responds counterintuitively to a change in motivations. There are two types of morally incoherent judgments:

1. The subject judges that more soldiers must die if they are unwilling rather than willing to fight for their country.

2. The subject judges that more civilians of country B must die if they opposed rather than support the war.

The total number of morally incoherent judgements done by a subject while answering the questionnaire is an indicator of his moral incoherence.

6.4 Results and discussions

To test whether people make rational (GARP-respecting) moral tradeoffs, we created a moral dilemma about warfare—a domain relevant throughout human evolutionary history in which moral values often conflict (e.g., don't harm innocent people vs. save the most lives). The story explains that it has recently become clear that Country A will win the war, which was started by Country B; the question is how and at what cost. In all versions, bombing cities will kill civilians, but save the most lives by ending the war quickly. Conventional warfare will kill the most people—all combatants—but save civilians. The number of soldiers saved per civilian sacrificed (the "effectiveness" of bombing civilians) The subject, an impartial third-party, makes decisions about 21 scenarios per condition.

For each scenario, the subject could choose from a menu of options (from 2 to 7). Every scenario included the two extreme options: (i) sacrifice only civilians to save the most lives in total (utilitarian) and (ii) sacrifice no civilians and lose the maximum number of lives, all soldiers (deontic). But 19 of the 21 scenarios provided intermediate options as well, in which the subject could choose to sacrifice some (but not all) civilians to save a larger number of soldiers. Intermediate options are rarely included in research on moral dilemmas, but they are necessary to discover whether people make negotiable tradeoffs between conflicting moral values. Because we are interested in the rationality of moral intuitions (not the ability to reason deliberatively from a philosophical principle), subjects were asked to choose the option "you *feel* is moral right, which may or may not be the same as what you think is morally right."

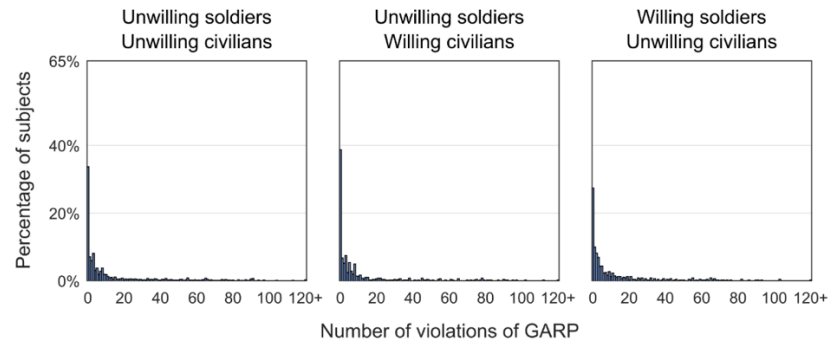
To test for moral coherence, we varied a parameter known to be morally relevant: whether actions were taken willingly or unwillingly [xx arb]. This created three conditions.

1. *Unwilling soldiers, Unwilling civilians*: The soldiers were drafted and are desperate to return to their families; the civilians did not want the war.
2. *Willing soldiers, Unwilling civilians*: Same as (1), except the soldiers volunteered to fight for their country
3. *Unwilling soldiers, Willing civilians:* Same as (1), except the civilians wanted the war and encouraged it.

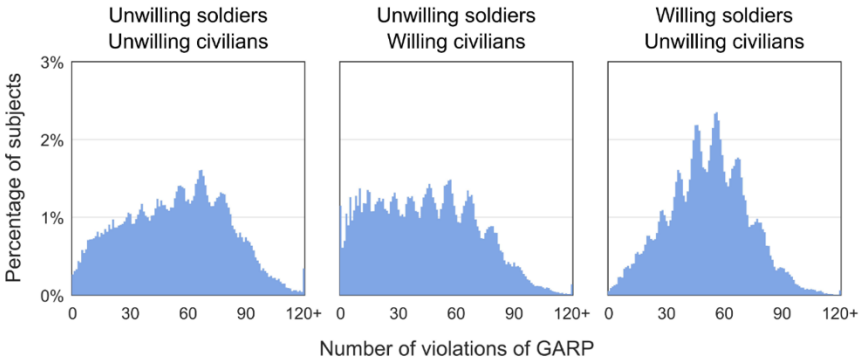
All 1746 subjects provided judgments for the baseline condition in which everyone was unwilling to participate in this war. To see whether answers shift with willingness, they also provided judgments for one other condition: either willing soldiers (n = 845)

or willing civilians (n = 901). Assignment was random, and order of conditions was counter-balanced across subjects. Moral coherence implies that, when all else is equal, subjects will choose to sacrifice more willing than unwilling soldiers, and more willing than unwilling civilians.

Figure 5(a) shows the distribution of the number of GARP violations in three different conditions. The average GARP violation is 7.4 and the average GARP violations of subjects that make mixed or Intermediate moral intuitions is 11.9. Theoretically, a subject can make up to 180 violations to GARP, and a subject who choses randomly would make an average of 82 violations. We boot-strapped simulations, this gives a measure of the number of violations that would be expected from random choice, while incorporating information about subjects' actual choices, rather than just the possible alternatives. The result shows that the subjects commit an average of 50 of violations, approx. (figure 5(b)).
So, for all, the subjects appear to be highly consistent. This criterion of consistency inspired by rational choice theory is key to verify a design inspired by natural selection and begin to characterize this system or cognitive program. Since warfare is an evolutionarily relevant domain of social interaction, we expected the subjects to be highly consisted in the sense of GARP. The results of the experiment strongly supported our prediction.



(a)



(b)

Figure 5: **GARP Violations: Most Subjects are very consistent**.

The subjects were very consistent in the sense of GARP(a), as compared to bootstrapped simulations, which commit an average of 50 of violations, aprox. (b)

We wanted to know whether they responded to relevant variables influence moral judgments (such as motivations) in a consistent way. Figure 6(a) shows that everything else being equal, subjects said that less civilians should be killed if the soldiers are volunteers instead of drafted. They also said that more civilians should be killed if the civilians are bellicose instead of peaceable. This result revealed which motivations are relevant to moral intuitions. These results support the hypothesis that subjects are motivated by deontic norms that encourage help and discourage harm, both norms conditioned on the merits of the potential recipients of help or harm.

It is important to note this result independent on the material constraints of the scenario and on the motivations of civilian and soldiers. The most subjects chose intermediate solutions to the dilemma —64%—. These were not "trembling hand" mistakes by people applying a deontic or utilitarian principle: the mean number of intermediate options chosen was 8 of 19, with a uniform distribution across the range (see Figure 6).

They said that some but not all civilians should be killed to save some but not all soldiers. Even though the mind is replete with conflict between different domains, people are able to be morally compromised and able to "negotiable", that is, the mental machinery weighs the different moral considerations to produce all-things-considered moral intuitions. In this sense, Greene and colleagues (2001) work on the dichotomy still falls short of providing an adequate and consistent picture of the psychological mechanisms underlying evaluations and verdicts in dilemma scenarios.

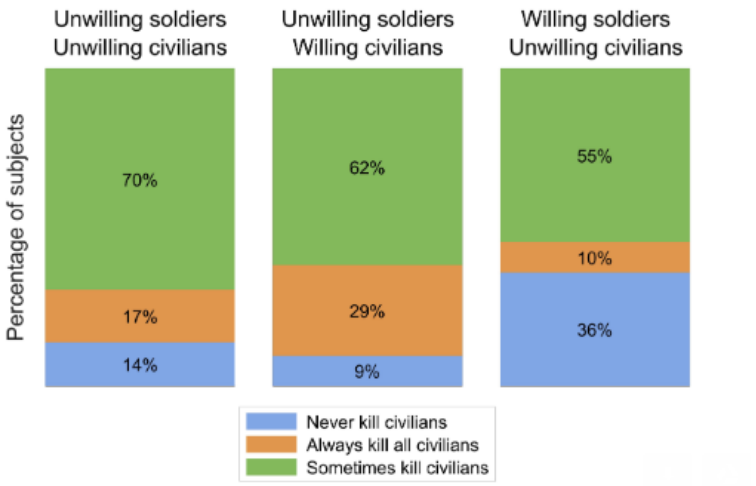


Figure 6: **The distribution of moral judgement types in each condition.**

The subjects biased their judgements toward "utilitarianism" (saying that more civilians should be sacrificed) or the subjects biased their judgements toward "deontology" (saying less civilians should be sacrificed) or the subjects biased their judgements in intermediate options.

For another, the study how each cognitive system represents its particular domain of social interaction, what proprietary concepts it uses, its inference systems, motivations, emotions, sentiments and decision rules. It is necessary to explore the internal computations that create these moral motivations and for this the modification in the motivation to kill the soldiers and civilians in the dilemma is important, because this modification represent the moral considerations or moral sentiments can be changed and it is hoped that under a logic of an evolved architecture of the human mind, independent the wide range of moral considerations exists rationality in the moral intuition. To verify this we analyzed the coherence of the individuals in each treatment where two different conditions (baseline (unwilling people) + willing civillians or volunter soldiers), that is to say, it was analyzed if the change of motivation of soldiers and civilians affected the tradeoffs in at least one condition, so we measured coherence among subjects who made tradeoffs in at least one condition. In general, the subjects were very “consistent” in the sense of coherence.

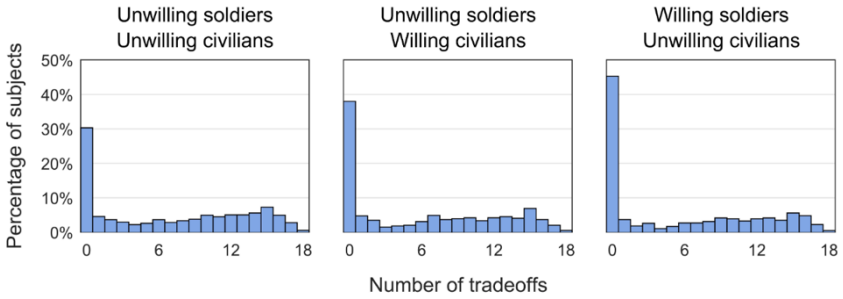


Figure 7: **Coherence violations.**

Coherence is violated when a subject chooses to sacrifice more unwilling than willing people. Consequently, the trade-off numbers were counted in that direction. Moral coherence was high (number of tradeoffs close to zero). Although each subject had 21 opportunities to violate coherence, 55% (willing soldiers) and 68% (willing civilians) of them had no violations whatsoever.

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CHAPTER 3:
Creating a new method to see the functionality of jealousy: Evocation of jealousy in romantic couples through a third-party interaction

SUMARY

If we consider that natural selection produced sex differences in the design of adaptations designed to solve the problems surrounding reproduction, then the design of human jealousy must also be triggered by distinct evoking acts that are specific challenges for women and men in their exclusive reproductive bond. Then following an evolutionary perspective, jealousy would be directed to drive away interlopers who could potentially threaten the bond with the romantic partner. To explore this possibility, we use as a methodological innovation an economic game for the evocation of jealousy.

By means of a dictator game protocol, we induce jealousy, showing men and women that their imagined or real heterosexual partner allocates money to or receives money from an opposite sex third party that they recently met (experimental condition). We did three analyses: In the first we played the traditional dictator game, but in a hypothetical format, in a sample of 163 men and 135 women through MTurk™, in the second we improved the rules of the dictator game transforming it into an "interpersonal dictator game" with a sample of 80 men and 71 women through MTurk™, and the third analysis was bringing to real lab experience the interpersonal dictator with a sample of 56 heterosexual couples that participated simultaneously on a laboratory setting. Our results show that the interpersonal dictator protocol exerted the expected evocation of jealousy for both sexes. We discuss the implications of this method to support the adaptive function of sex-differences in jealousy, and sex-differences in the treatments and possible alternative modifications to improve the similarity of the game to actual jealousy evocation.

7.1 Introduction

In general terms, jealousy has been defined as a complex emotion (Buunk, 1997), as it evokes multiple emotions such as anger, sadness and fear, and is also very similar to a flight stress response (Buss 2013a; Fernandez & Palestini 2010). In general, there is an extensive bibliography of variables associated with jealousy, among them we find sex-differences, attachment style, cross-cultural influences, romantic love, self-esteem, features of the rival, among others. One of the most studied variables are sex differences in jealousy, where men are more susceptible to sexual jealousy and women are more vulnerable to emotional jealousy, and this difference is maintained in multiple cultures (Buss, 2018; Edlund & Sagarin, 2012).

All these studies have contributed to describe the emotion of jealousy and its relationships with personal and cultural variables that is how we know that it is activated by a real or perceived threat to the relationship in a given context but its functionality is not well known, we only have theories that support certain relationships between variables. Sex differences in jealousy are supported by theories such as evolutionary and social cognitive (Buss et al., 1992; Harris, 2003). A functional hypothesis cannot be investigated with the present methodologies until now, since the methodologies are mostly of forced choice (Bendixen et al., 2015; Sagarin et al., 2012) and consequently intuitive measures are not obtained (Harmon-Jones et al., 2009). In general, sex differences corresponding to continuous measures of jealousy have typically been less robust than forced choice in the literature. For example, Bendixen's (2015) work reports that parental reversal was an important variable for sex difference in reporting jealousy, but not the difference in type of infidelity. In addition, people do not self-report negative and complex emotions in social terms (Lopatosvka and Arapakis, 2011) and this may affect the ecological validity of the research (Harris et al., 2002). The perception, use, understanding of emotion states is important for compression of a guide to a person's relationship with their environment and how these affect decisions making and responses to a behavior (Damasio, 1994). Effective emotion management is also critical for adequate social functioning, as this ability allows one to express socially appropriate emotions and behave in socially acceptable ways (Lopes et al., 2004; Iris, 2009)). For example, it is thought that individuals high in social desirability may be less willing and/or capable of reporting negative emotional states (Paulhus & Reid, 1991; Welte & Russell, 1993).Therefore, on an experimental level, the ideal is to achieve a jealousy response that is close to a real response, which counts on ecological validity, but having in mind avoiding the risk of damaging the relationship of the subjects under study, and that is what the present work tries to highlight.

In view of an evolutionary perspective natural selection produced sex differences in the cognitive systems responsible for solving the problems surrounding a relationship of cooperation for survival and reproduction (Buss, 2013). This view presents two implications: first is jealousy appears as an emotion designed to protect pair-bonding, and secondly is that this emotion is activated differently for men and women, since their adaptive challenges in the Pleistocene were different (Buss, 2013; Dillon, 2013; Dijkstra, 2002; Hart, 2017, Fernandez, 2017).

Consequently, these implications come from the evolutionary challenge of mate retention, So why should protect the mating bond? The answer is for the benefits of pair bonding (Conroy-Beam, Goetz, & Buss; 2015). If we consider that Relationships are a dynamic process in which social contracts are produced for social exchange. In this contract, each member of the couple pushes the other to a reciprocity of benefits that allow them to fulfill their common reproductive goals (Conroy-Beam, Goetz, & Buss; 2015; Cosmides & Tooby, 2013). So, if we want to maintain the benefits of a long-term mating, from an evolutionary point of view, suspecting the probability of losing them is less costly than losing them (Buss and Haselton, 2005a; Foster et al., 2014 Schmitt & Buss, 200). Hence, natural selection molded the cognitive bias to dissuade possible betrayal from a partner and increase the protection of the mating bond (Buss, 2018). Despite this, there are functionally documented works regarding jealousy that support other hypotheses where this emotion is activated when bonding is disrupted or when trust is lost or exist exacerbated personal insecurity (Mathes, 1992; Chin et al., 2017; Rodriguez et al., 2015). Contrary to this we will explore that jealousy would be directed to keep away individuals perceived as rivals that potentially threaten the bond with the partner. Therefore, this study aims at investigate the experimental induction of jealousy by presenting a social rival scenario.

The first effort was to establish some considerations to create a method to evoke jealousy. Among these we find the already mentioned sex differences in jealousy inspired by the fact that the adaptations are different according to the restrictions or adaptive problems of each sex. As a consequence, the jealousy situation is different for each sex. Another important point is the way to measure this emotion, since we must be super careful with Self-reports, because many people lie about being a negative and complex emotion, then it is difficult to in terms of behavior. In addition to this we must consider that all the mentioned methods have helped the description of jealousy but to study functionality we need a method that ensures an evocation of jealousy to compare it with other variables like trust. The last factor we must consider to evoke jealousy is that we must visualize that the benefits of a cooperative relationship can be measured in resources, but in romantic relationships sexual selection operates and there are sexual asymmetries in this allocation of resources

explained by the theory of parental investment (Trivers, 1972). Specifically, there is a large female investment in nutrient-rich eggs, internal female fertilization, internal gestation of 9 months and postpartum lactation which implies that women have higher biological-reproductive costs and this implies an implicit contract related to the exclusive allocation of resources by men for the upbringing of their children (Buss, 2013; Fernandez, 2017). Under this same line of work, it has been seen that the difference in parental investment can predict the variations that exist in populations in the response to jealousy, where greater parental investment is associated with a response of jealousy (Scelza et al., 2019a).

In economic terms, Becker explained why people maximized their utility when investing resources in a child or maintaining these resources in a marriage (Becker, 1973, 1974, 1976, 1999). Inspired by these works and with the theory of evolutionary psychology, it has been proposed that romantic relationships can be seen as a game of public good where, in evolutionary terms, the public good or invested resource increases the individual utility of the couple's members and this utility is fitness where the invested resources can be seen as benefits delivered by the couple's cooperation (Buss, 2003; Conroy-Beam et al., 2015) In turn, these benefits, are visualized as the resources of the couples is greater than resources of individuals (Kaplan and Lancaster 2003; Conroy-Beam et al., 2015;). In this context, measuring fitness in an economic way is difficult, because men and women can also invest resources and make profits outside the couple's relationship. Specifically, both partners may reduce the investment or disproportionately consume the benefits. For example, a member of the couple may be using food resources and at the same time investing in alternative partners. (Haselton et al., 2005). Also, many times the division of labor for sex is different and, in many cases, does not give an expected cooperation, although the results may be efficient (Ellison et al., 2003; Gurven et al, 2009). In other words, if the benefits a couple shares are their offspring, these benefits cease to be personal and the investment may be different to ensure descendants, but considering the long term that investment will increase the fitness of each member of the couple. (Kaplan et al., 2001; Conroy-Beam et al., 2015)

The approach of the game of public good with mating is important to understand that long-term relationships are dynamic processes of cooperation where resources are invested in time to achieve benefits that are translated into fitness and that in this process can change the incentives, the partners and the context of this cooperation. But, in methodological terms, in a public good game identifying the freerides is a process that occurs in time and is where punishment is a mechanism that can be considered altruistic to maintain cooperation that benefits all members who play. (Frank, 2010; Fischbacher et al., 2006; Fehr, 2002; Gachter et al., 2010) In addition, if we think in terms of retention of benefits, identifying where and how freerides

resources are diverted is difficult to establish, as we ignore their preferences and would add variables that we cannot control and generate noise. And the level of investment is not always linked to a freerider, because relationships have welfare compensation that is independent of the magnitude of the actual investment (Sell, Tooby, & Cosmides, 2009). On the other hand, in resource distribution experiments, men invest according to the priorities of loyalty, social obligations and the presence of other possible male investors (Scelza et al., 2019b) so we cannot say that when you invest less you are acting as a freerider, because you may have other motivations

Having all the factors discussed above clear, and considering the reproductive restrictions may have led to a co-evolution of psychological characteristics that are preferred by the opposite sex. we tested the evolutionary perspective, Specifically, the hypotheses are different for both sexes: **i) if female jealousy is evoked by male investment in another woman, then, the female members of the dyad are expected to report greater jealousy over the investment of men in another woman ii) if male jealousy is triggered by a third party investment in his female partner, then men are expected to report greater jealousy over the investment of another man in their female partner**.

7.1.1 Dictator game

To test these hypotheses, we will approach jealousy in a different way, through economic games. The use of game theory allows us to test evolutionary hypotheses in order to know which cognitive adaptations underlie behavior with decision making to face ancestral problems (Cosmides, 1989). The dictator has been used in studies to analyze different behaviors according to social distance. Specifically, when partners have greater anonymity dictators allocate less money compared to lesser anonymity (Charness and Gneezy, 2008). Moreover, thanks to this approach we know that the closeness of a social partner increases cooperation (Freitag and Bauer, 2016; Hackman et al., 2016). Consequently, if we think of reproductive relationships in terms of cooperation, individuals can take advantage of all the benefits inherent in a relationship of mutualism and/or reciprocity (Conroy Beam et al., 2015; Sutcliffe et al., 2011).

To evaluate these hypotheses without elaborating an imaginary context we will use economic games, because they are based on a weighting of oneself and of the other person, but not of the intruder. We will use modifications the dictator games: In the dictator game, the first player, "the dictator", determines how to split an endowment (such as a cash prize) between themself and the second player. the recipient has no influence over the outcome of the game (Hoffman, McCabe, Shachat, & Smith, 1994). The idea is that the members of the couple play the role of assignor/receiver in the dictator's game with a third of the opposite sex, and that the dictator has the opportunity to assign money to the partner or rival.

7.2 Methods

7.2.1 The game protocol

We use two modified dictator games with an opposite sex third party (one for men and one for women). The idea was that each member of the couple performed the role of allocator and role of the recipient and then the outcome of these games was informed to the partner (jealousy evoking mechanism). In general, each treatment consists of three conditions which are modified versions of the economic game. The dictator allocates or receives money from the partner or an opposite sex person and in turn on each condition there is an outcome of the game and a self-report. In the female case represents a situation in which their male partner allocates resources to another female and the male case represents a situation in which his female partner receives resources from another male. The control scenario it's the opposite to the experimental case for sex and the neutral scenario is a general situation where the members of the couple are not recipients or allocators in the game. (see Figure 1 for an illustration of the jealousy evoking protocol, with the conditions depicted by sex).

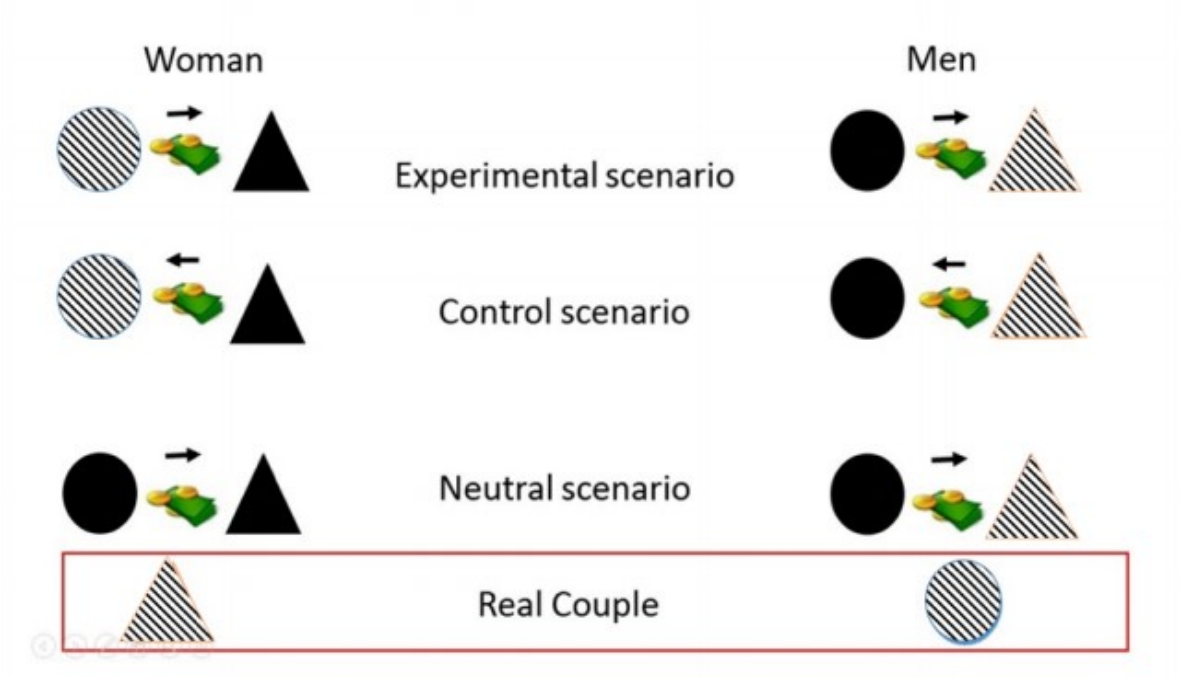

Figure 1: **Jealousy evoking protocol.**

The red box shows the real couple or singles participants it was indicated that they imagined a romantic partner. The triangle is the woman and the circle is the man. Another “woman” as recipient and allocator are the manipulation for the evocation of jealousy for the female member of the dyad, while for the male partner the manipulation is another “man” giving to, or receiving money from their partner. In black are the individuals who play as rivals for the distribution of money.

In addition, we modified the instructions of the games in such a way that the movement of resources according to each exclusive hypothesis for each sex was the one that evoked jealousy and not imaginary history. Then we piloted the protocol, we make four modifications to the instructions of the game. The first three modifications went from maximizing to neutralizing the impact of the situation of jealousy in the game. Specifically, initially, participants were asked to imagine that their partner had an emotional and physical connection; secondly, an interesting conversation; and finally, only a conversation with the rival of the opposite sex that were playing. The last modification changes the rules the dictator game where the dictator no longer decides whether to distribute between herself and another person (the partner or other persona), but now he decides between his partner and another person, transforming it into a "*Interpersonal dictator game"* (Barbato et al., 2018). This game was made on the MTurk™ online platform for individuals, for singles participants it was indicated that they imagined a romantic partner with different people in four MTurks™ for the four modifications (Figure 2). Each participant experienced the three condition theyns and indicated immediately how jealous the situation would make them. Finally, the interpersonal dictator game was repeated, but this time with real couples that came to the lab, where couples played simultaneously and they believed they were playing online with a third party first, and then with their partner, to test the ecological validity of the method.

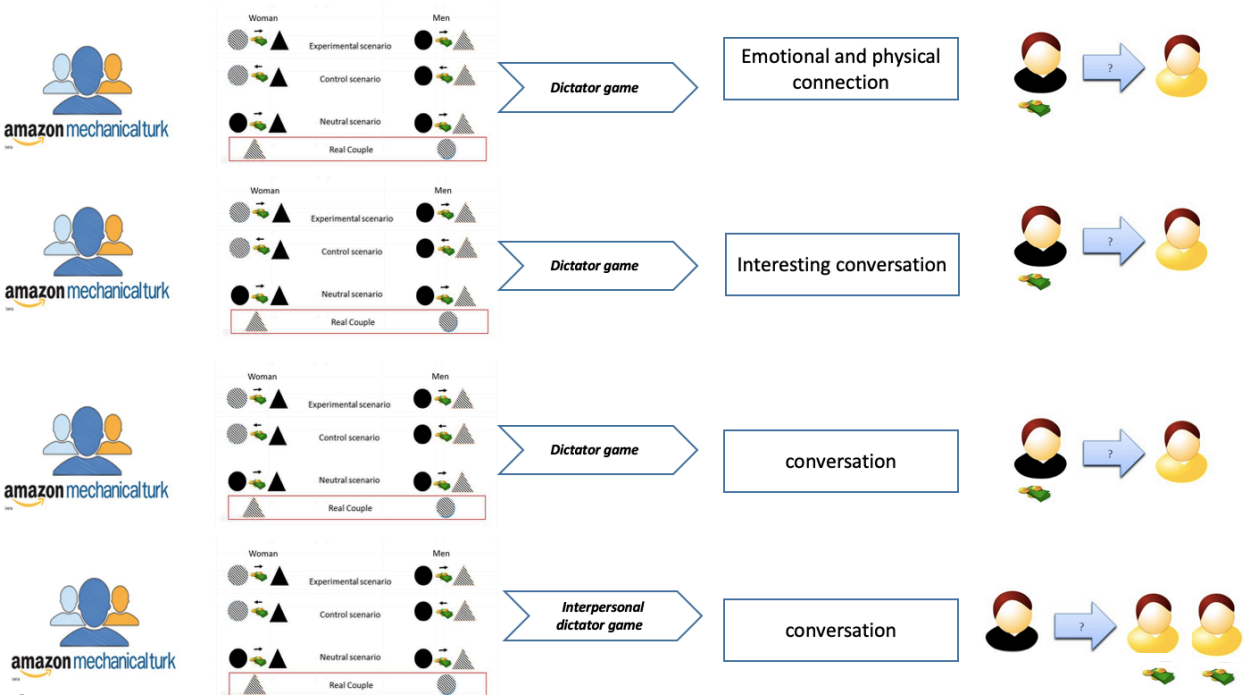

Figure 2: Jealousy evoking protocol with four modifications.

In this figure we can see the protocol with the four modifications of the dictator's game instructions, where different MTurk™ participants underwent these modifications. In each modification the participants experienced the three conditions that are different for each sex.

7.2.2 Participants

Three statistical analyses were performed with a total of 561 subjects, one for 298 (163 men and 135 women) MTurk™ subjects who played dictator games, one for 151 (80 men and 71 women) MTurk™ subjects who played interpersonal dictator games and one for 56 (112 subjects) real couples who played interpersonal dictator games. Each dyad came to the laboratory, where they separately but simultaneously participated in the interpersonal dictator game in exchange for an approximately $7.5 USD incentive, implemented through the Qualtrics TM platform.

We measured the jealousy response under three experimental conditions. In addition, with the interpersonal game dictator we covaried relevant factors such as personal trust, general trust and reactive jealousy. Specifically, three mixed ANOVA were performed. Each mixed ANOVA was used to test the effect of the game conditions (within subject's variable) and sex of the participant (between subject's variable) on the reported jealousy after participating on each game.

7.2.3Procedure

All participants followed the same protocol in this order: accept an informed consent online or signed in paper and pencil, completed demographic information, played a pre-game and we asked for scales of personal trust, general trust and jealousy to control that these variables do not explain our results of jealousy in the game The pre-game consisted of a one shot dictator game where the participant is the dictator and allocates a specific amount of money between his partner and another person. The pregame is made so that the participant intuitively and ecologically understands what a dictator game is like and can follow the conditions presented later.

Then participants were introduced to the games through and ONLINE platform (games are different by sex, three conditions of the dictator/interpersonal game), followed by a subjective evaluation of the amount of jealousy the game evoked. The experiment was programed in a Qualtrics ™ plantform and carried out by MTurk™ (Figure 2) and the fourth modification (Interpersonal dictator game), was carried out with real couple son the laboratory.

7.3 Results and discussion

Dictator game:

In this analysis are the three Mturk that use the dictator game (see figure 2). The data were submitted to descriptive analysis (see table 1) and mixed ANOVA were performed with a total of 561 subjects, one for 298 (163 men and 135 women) MTurk™. The dictator game results from the mixed ANOVA yielded a significantly effect of interpersonal dictator game condition on jealousy ($F_{2, 296}$= 61.02; p <.000; η^2= 0.172; 1-p= 1) and main effect of sex (F1,296= 5,32; p <.022), but the post-hoc Tukey test showed the experimental and control condition where significantly different from the neutral condition, but they did not differ among them (see Table 2). If the game evoke jealousy what one would expect is that there would be a significant effect of the conditions, but caused by all the differences of all conditions, since there is only one difference with the neutral only indicates that there is a weighting of an important person vs an unknown.

	Jealousy (Mean/SD)		
Sex	Experimental	Control	Neutral
Male	2,36/1,688	2,26/1,728	1,47/1,521
Female	2,92/1,732	2,61/1,741	1,61/1,693

Table 1: Descriptive analysis. We observed three conditions with the means in jealously in a scale with 5 points in the dictator game.

					95% Confidence Interval	
(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	,205	,091	,077	-,015	,424
	3	1,100	,117	,000	,820	1,381
2	1	-,205	,091	,077	-,424	,015
	3	,896	,107	,000	,637	1,154
3	1	-1,100	,117	,000	-1,1381	-,820
	2	-,896	,107	,000	-1,154	-,637

*. The mean difference is significant at the .05 level.

Table 2: Test de Tukey. Comparisons by specific conditions in dictador game. (1) = Experimental; (2) = Control and (3) = Neutral.

Interpersonal Dictador game

In the case of the interpersonal dictator game, 151 (80 men and 71 women) MTurk™ subjects who played. The results from the mixed ANOVA show a significantly effect of interpersonal dictator game on jealousy ($F_{2,\ 151}$= 39,194; p <.000; η^2= 0.208; 1-p= 1) and a main effect of sex (F2,296= 8,153; p <.000). The post-hoc Tukey test showed something similar with the previous case in the dictator game where there is a significant difference effect with the two conditions with the neutral condition, but the difference is that in this case the descriptive statistics analysis (see table 3) takes us on a good path, since there is greater difference between the experimental and control condition in women (see figure 3 and *Table 4*). In addition, variables that could affect the results described above were controlled. The co-variables that were controlled were scales of personnel trust, general trust and jealousy scale. Specifically, for personal trust ($F_{2,\ 296}$= 2,190; p = 0.11; η^2= 0.15), General trust ($F_{2,\ 296}$= 5,967; p = 0.003; η^2= 0.39) and reactive jealously ($F_{2,\ 296}$= 6,857; p = 0.10; η^2= 0.04). The co-variables that show significance affect results when they go to extremes. For example, in the case of reactive jealousy these explain when in the conditions the subjects report more than 4 on a scale of 1-5. In other words, high levels of jealousy under these conditions will react intensely and may boost the results. In general, this result is very important, because it adds evidence to evolved sex differences in jealousy using an interpersonal dictator game in comparation with the dictator game, since the distribution of resources with a third party resulted relevant for the evocation of jealousy. In addition, there is a significant main effect of sex, suggesting that the evolutionary derived hypothesis (experimental condition) evokes more jealousy than the control and neutral condition in women compared to men (see figure 3)

	Jealousy (Mean/SD)		
Sex	Experimental	Control	Neutral
Male	2,23/1,684	2,74/1,659	1,15/1,450
Female	3,30/1,752	2,39/1,855	1,68/1,911

Table 3: Descriptive analysis. We observed three conditions with the means in jealously in a scale with 5 points in the interpersonal dictador game.

					95% Confidence Interval	
(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	,194	,152	,609	-,174	,563
	3	1,347	,165	,000	,948	1,747
2	1	-,194	,152	,609	-,563	,174
	3	1,153	,176	,000	,728	1,578
3	1	-1,347	,165	,000	-1,747	-,948
	2	-1,153	,176	,000	-1,578	-,728

*. The mean difference is significant at the .05 level.

Table 4: Test de Tukey: Comparisons by specific conditions in interpersonal dictator game (1) = Experimental; (2) = Control and (3) = Neutral

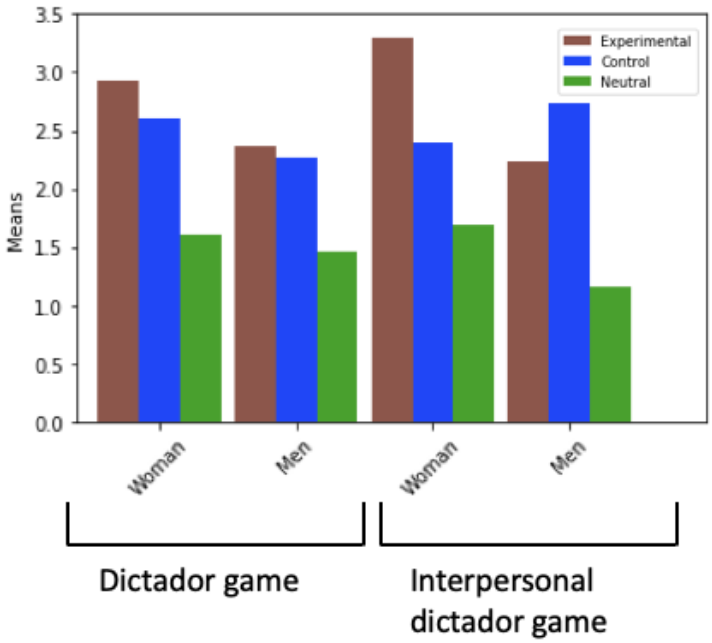

Figure 3: **Dictator game vs interpersonal game.** We observe the three game conditions per Dictator variant.

Interpersonal dictator game with real couples

We repeat the interpersonal dictator game with 56 real couples, in this case couples play at the same time and believe they are playing online with a third party. The results show a significant effect with a trend found in the results as Mturk. Specifically, the mixed ANOVA showed ($F_{2,112}$= 34.42; p <.000) a significant effect of the interpersonal dictator game condition and significant main effect of sex ($F_{2,218}$ = 8.55; p <.004) and the Tukey test showed all conditions where significantly different (p= < .05. See table 6). The effect of covariables is similar to that reported in the previous interpersonal dictator game where no covariables explain the results, but exist a potentiating effect of reactive jealousy: Personal trust ($F_{2, 218}$= 1,127 ; p = 0.326 ; η^2= 0.10), General trust ($F_{2, 218}$ = 0,191 ; p = 0,826; η^2= 0.003) and reactive jealously ($F_{2, 218}$ = 13,595 ; p <.000 ; η^2= 0.11). In general, the significant main effect of sex suggesting that the experimental condition (testing the evolutionary hypothesis) evokes more jealousy than the control and neutral condition in women compared to men (see Figure 4). Consequently, the interpersonal dictator game allowed to activate more reproductive jealousy in the experimental condition of distribution of specific resources by sex, compared to a control and a neutral condition, differentiated by sex.

If we consider that in a context of cooperation there are evolutionary limitations there are expectations about resources and the game emulates this, since each condition is presented to the person, we want to evoke jealousy and the expected result is asked of the participant and then the exaggerated result is exposed. therefore, in the interpersonal game of the dictator these expectations are modified to evoke jealousy. In other words, if the theoretical function of jealousy is to protect the loss of a valuable relationship with a rival (Buss, 2018; Bunk, 1997). This game allows you to emulate these conditions of cooperation to test this type of hypothesis. Specifically, for the case of women where a deviation of resources and commitment is similar to an emotional infidelity and fits our evolutionary hypothesis, since explicitly in the game the couple distributes the resources to another woman. In the case of men, despite being a different experimental condition, where another third party offers resources to his partner to evoke jealousy, this did not achieve the expected results and we believe it is because the evolutionary function of men jealousy is to avoid sexual infidelity from his long-term partner (Buss, 2015) and the game does not explicitly achieve this situation

It should be noted that a complementary informal record was added on personal impressions after the couples' participation in the game and which was marked by the women's reaction. Specifically, "Women expressing discomfort, nervousness

and tension with the results of the conditions of the game before debriefing. Literally one of them expressed: "the game put me in a tense situation" (Barbato et al., 2018). This allows us to conclude that the methodology allows us to make observations of the real behavior in a context of evolutionary cooperation without artifacting a story. Then we achieve an emotional response close to the real with an ecological validity that allows to evaluate a functional hypothesis, and also innovate with a method that solves problems common to the study of complex, but the method has a limitation, because the interpersonal dictador game achieves greater evocation in women (if it managed to evoke jealousy in men there should be no main effect in the analysis of mixed anova, as the experimental condition is already different in men). Since we are only manipulating jealousy that evokes the effect of resource allocation, but this is not what happens in men's restrictions that require sexual exclusivity. We aim to find a better treatment to similarly induce jealousy in men as well as in women with a sex-specific economic game situation that may be similar to sexual infidelity.

	Jealousy (Mean/SD)		
Sex	Experimental	Control	Neutral
Male	1,02/1,314	0,91/1,269	0,27/0,700
Female	1,93/1,463	1,21/1,358	0,68/1,114

Table 5: Descriptive analysis. We observed three conditions with the means in jealously in a scale with 5 points in the interpersonal dictator game with real couples.

					95% Confidence Interval	
(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	,411	,107	,001	,151	,671
	3	1,000	,131	,000	,682	1,318
2	1	-,411	,107	,001	-,671	-,151
	3	,589	,124	,000	,287	,892
3	1	-1,000	,131	,000	-1,318	-,682
	2	- ,589	,124	,000	-,892	-,287

*. The mean difference is significant at the .05 level.

Table 6: Test de Tukey: Comparisons by specific conditions in interpersonal dictator game with real couples. (1) = Experimental; (2) = Control and (3) = Neutral

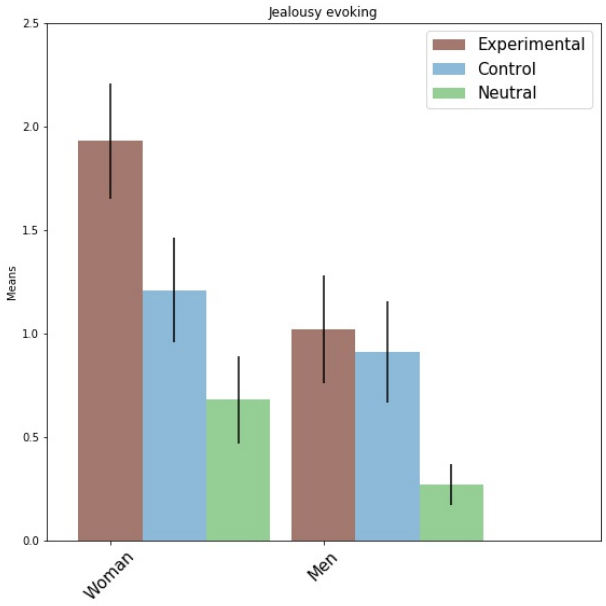

Figure 4: **interpersonal dictator game in real couples:**

Jealousy evoking protocol: for woman and men. We observed three conditions where the means are significantly different from each other as determined by a Tukey's test

7.4 References

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