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CULTURAL NEUROSCIENCE: AN APPROACH TO THE NEUROBIOLOGICAL BASES OF THE ETHNOGRAPHIC BEHAVIOUR WITH EEG AND GAME THEORY:

THE CASE OF IRELAND AND PORTUGAL

Dissertation for the

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Abbreviations

CG – Centipede Game

CN – Cultural Neuroscience

EEG – Electroencephalography

ERP – Event-Related Potential

FRN- Feedback Related Negativity

GT – Game Theory

IPEAS – Irish-Portuguese Enculturation / Acculturation Survey

MFN- Medial Frontal Negativity

MoCA – Montreal Cognitive Assessment

PGG – Public Goods Game

RPS – Rock-Paper-Scissors

UG – Ultimatum Game

VD- Volunteer's Dilemma

Abstract:

Over the past decade, *Cultural Neuroscience* has helped to characterize how culture shapes the brain by disclosing intercultural differences in behaviour and brain responses. In this study, we investigated how culture can shape brain function during a luck-based game, the Rock-Paper-Scissors game (RPS), and an economic-based game, the Ultimatum game (UG), given that the perception of the outcome and free-riders (i.e., individuals that take advantage of a situation, for their own profit, but with losses for others), may vary across cultures, at a neurobiological level.

Therefore, a sample of 30 Latin (M_{age} = 25.53; SD =7.61) and 30 Anglo-Saxon participants (M_{age} =24.80; SD = 7.35) played the original format of RPS game and of the UG, while their electrical brain activity was recorded using a 32-channel electroencephalogram (EEG). We examined three feedback-locked event-related potentials (ERPs) that play a crucial role in post-outcome processing: the Feedback Related Negativity (FRN) and the P3 in the RPS and the Medial Frontal Negativity (MFN) in the UG. We also analysed a fourth ERP for neural processing of faces in the UG: the N170. In addition, participants played three other games (the Centipede Game, Public Goods Game and Volunteer's Dilemma), in order to understand how their economic behaviours (in a volunteer and cooperation/free-riding level) are affected by their culture.

No significant behavioural performance differences were observed between the two cultures in all the five tasks ($p>0.05$). However, our results showed that groups significantly differed in amplitude of both FRN and P3, revealing that culture may significantly influence the processing of feedback. Interestingly, we did not find a main effect of condition, since gains, losses and draws elicited similar amplitudes for both FRN and P3. Considering the functional significance of both components, this result may be explained by the fact that participants played a luck-based game, in which the expectations and the arousing level of each result were similar. Our results also showed that the perception of free-riders with the N170 and of the level of fairness with the MFN were not significantly different. However, Irish participants tended to be more sensitive to unfair opponents and unfair offers than Portuguese participants, revealing that Portuguese participants tend to make lower offers and keep more money for themselves, when compared to Irish participants.

This study showed that under the same cognitive task, the two cultures performed differently at a neurobiological level, suggesting that the cultural settings might play a crucial role in brain functions.

Resumo:

Durante a última década, a Neurociência Cultural ajudou a desvendar como a cultura influencia e molda o cérebro, revelando que existem diferenças interculturais não só a nível comportamental, como também a nível da atividade cerebral. Neste estudo, investigamos como a cultura pode influenciar a função cerebral durante um jogo baseado em sorte, o jogo do Pedra-Papel-Tesoura, e um jogo baseado em decisões económicas, o jogo do Ultimato, dado que a perceção do resultado final e da presença de oportunistas, respetivamente, pode variar entre culturas diferentes, nomeadamente a nível neurobiológico.

Para esse efeito, uma amostra de 30 participantes latinos (M_{idade}= 25,53; DP = 7,61) e 30 anglo-saxões (M_{idade}= 24,80; DP = 7,35) jogaram o formato original dos jogos Pedra-Papel-Tesoura e Ultimato, enquanto a atividade elétrica do cérebro foi registrada usando um eletroencefalograma (EEG) de 32 canais. Examinamos três potenciais relacionados com eventos associados ao processamento do *feedback*: A Negatividade Relacionada ao *Feedback* (NRF) e o P3 no RPS e a Negatividade Médio-Frontal (NMF) no UG. Também analisamos um quarto componente associado ao processamento de faces no UG: o N170. Para além disso, os participantes jogaram três outros jogos (o Jogo da Centopeia, o Jogo dos Bens Públicos e o Dilema do Voluntário), de forma a percebermos como é que os seus comportamentos económicos (altruísmo e cooperação / oportunismo, num contexto social) são afetados pela sua cultura.

Não foram observadas diferenças significativas no desempenho comportamental entre as duas culturas, para cada um dos cinco jogos ($p > 0,05$). No entanto, os nossos resultados mostraram que os grupos diferiram significativamente em amplitude para o FRN e P3, revelando que a cultura pode influenciar significativamente o processamento de *feedback*. Curiosamente, não encontramos um efeito significativo entre as diferentes condições, uma vez que ganhos, perdas e empates originaram amplitudes semelhantes para FRN e P3. Considerando o significado funcional de ambos os componentes, esse resultado pode ser explicado pelo fato dos participantes terem jogado um jogo baseado na sorte, no qual as expectativas e o nível de excitação de cada resultado foram semelhantes.

Os nossos resultados também revelaram que a perceção de oportunistas, com o N170, e do nível de justiça, com o MFN, não foram significativamente diferentes. Contudo, os irlandeses mostraram maior sensibilidade aos oponentes oportunistas a às ofertas injustas do que os portugueses, revelando que os portugueses tendem a fazer

ofertas mais baixas e a manter mais dinheiro para si próprios, quando comparados com os irlandeses.

Este estudo demonstrou que sob a mesma tarefa cognitiva, as duas culturas tiveram um desempenho diferente a um nível neurobiológico, revelando que as características típicas de cada meio cultural desempenham um papel crucial nas funções cerebrais.

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Outline

This dissertation is divided into four different chapters:

○ Chapter I includes relevant information regarding the understanding of Cultural Neuroscience (CN) and of Game Theory (GT), in order to introduce the importance of cooperation and free-riding within a culture. The purpose of this chapter is to approach these two concepts as a way to achieve the proposed goals.

○ Chapter II explains how these concepts are approached and which methodologies and equipment were used to solve the main question of this research study, i.e., to know if there were differences between the Irish and Portuguese culture or not.

○ Chapter III presents the results obtained from the work developed in Portugal and Ireland.

○ Finally, Chapter IV reports the results discussion, main conclusions, as well as future studies that may not only contribute to the Cultural Neuroscience field, but also to the Economical field.

Chapter I

1.1. Thesis Overview

In a previous behavioural-based study (Lopes, 2014), which compared the Finnish and the Portuguese cultures, the authors used selected games from Game Theory (GT) to compare the two cultures and they observed that the Portuguese sample tended to withhold the punishment of free-riders, commonly called opportunists, although both the Portuguese and Finnish recognised the misconduct. Hence, Game Theory may provide a suitable framework to study cultures, bringing out the characteristic culturally rooted behaviours. Despite the results, the study did not include any neuroscientific technique. However, GT's games have been used while recording the brain signals, revealing the neural bases of the economic-based decisions (Chung, Yun, & Jeong, 2015; de Quervain et al., 2004; Lee, 2008; Polezzi et al., 2008; Pulford, Krockow, Colman, & Lawrence, 2016; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). Besides, several studies, that have been conducted in the last decade, demonstrated that neuroscience can measure cultural differences (Chiao et al., 2009; Han et al., 2013; Losin, Dapretto, & Iacoboni, 2010; Park, 2013; Roepstorff, 2013; Tieu & Konnert, 2015), naming this new neuroscientific field *Cultural Neuroscience*.

In spite of Ireland and Portugal being similar in genetic aspects and being both European countries within the European Union, they differ in certain cultural features, such as education, social norms and economy. For instance, both countries faced an economic crisis in 2010 and 2011, respectively, and although they both exited the bailout programme, their economic performance trajectory is different, suggesting they addressed the crisis problem differently.

Therefore, studying people from these two countries using games from GT combined with a neuroimaging technique, such as the electroencephalography (EEG), will be interesting to disclosure the differences between these two cultures and to characterize their behaviour according to their brain responses.

This research study was conducted with the aim of studying cooperation and free-riding among native Portuguese and Irish individuals, while seeking for differences within the brain.

In order to do so, the experiment was divided in two different stages. The first one was conducted in the Psychology Lab of the Psychology Programme of the School of Nursing and Human Sciences at Dublin City University, in Ireland, and the second one, was conducted in the laboratory of Neuropsychophysiology of the University of Porto, in Portugal. A total of 66 individuals from each country were selected for the purpose of this study (cf. Appendix XVI for more information on the participants selected/dismissed from the study).

1.2. Research question and aims

Research question

The research question presided over identifying and understanding how Portuguese and Irish individuals might differ on a cooperation and/or free-riding level, i.e., how constructs such as trust, altruism, altruistic punishment, and social sanctions, when culturally rooted, help the group dealing with and surpassing hard times and how brain signals reflect upon these processes.

Main and specific aims

The main goal of this research study was to understand how culture shapes brain functions, especially when applied to luck and economic-based behavioural contexts.

On a deeper level, this research study's specific aim was to understand how the perception of a certain stimulus affects brain function, as well as how it was processed during luck and economic-based decisions, in order to see if the differences observed on a neurobiological level are linked to cultural differences (and vice versa).

Thus, the objectives for this research study were:

1. To understand how the Event-Related Potential components are processed by our two samples.
2. To neurally characterise specific facets of cultural behaviour using games from Game Theory.

Expectations

Considering that the techniques and procedures used to study how mental functions are shaped within a culture are not only available, but have been extensively used over the years, it is expected that the outcomes of this research study will increase our understanding of economic behaviour (e.g., on how to construct the paradigms to

study free-riding and cooperation, within a culture). It will also allow us to interpret and create new strategies used by each country, in order to overcome economic crisis.

Regarding the results of this study, we anticipate significant behavioural differences across the two cultures considering that both Portugal and Ireland exited their bailouts differently. At a neurobiological level, we also expect to find differences that are influenced by the cultural settings of each of these countries.

1.3. Introductory Background: Aims and Complexities of Cultural Neuroscience

Cultural Neuroscience is an interdisciplinary field that aims to investigate human brain function and how its functioning is shaped by ethnographic phenomena. Furthermore, it also aims to explore how neural mechanisms may (or may not) contribute to the rise of divergent cultures around the world (Han et al., 2013).

According to cultural psychology (Mateo et al., 2012; Chiao et al., 2009), the differences observed among cultures are due to the way each individual has acquired the beliefs and values from their indigenous culture. On the other hand, social neuroscience is used to investigate humans' social behaviours and the brain mechanisms that trigger such actions.

Cultural Neuroscience fuses both these scientific areas, studying how the cultural environment influences each individual brain, and how brains socialise with other brains, developing collectively concerted norms of conduct, which drive each one's behaviour.

Several studies have now been conducted in the past few years to unravel how culture modulates neural mechanisms underlying human cognitive and affective processes (Chiao et al., 2009; Han et al., 2013; Losin, Dapretto, & Iacoboni, 2010; Park, 2013; Roepstorff, 2013). Most of these studies, however, have been emphasising the genetic approach, i.e., how genetic variance, in close linkage with the natural environment, has been favouring certain specific collective behaviours, coupled with the detriment of other behaviours, within an adaptive frame (Chiao, Cheon, Pornpattananangkul, Mrazek, & Blizinsky, 2013). Genetic-based Darwinian evolutionary processes may have been happening also within socio-cultural settings, besides the ecological ones, both playing active roles in gene selection.

It is well known that a large portion of the human brain takes approximately 20 years to mature (Gogtay et al., 2004). During that time, it is influenced by environmental experiences, both ecological and socio-cultural, and therefore, undergoes several

structural and functional changes as a response, a process known as neuroplasticity: “Culture is an all-encompassing variable with which the brain is heavily saturated from birth.” (Park, 2013, p. 58).

It is also important to acknowledge that Cultural Neuroscience is a new scientific subfield in neuroscience and thus, it still needs to answer many questions. For instance, it is unclear why some neurobiological mechanisms seem to be more sensitive to the environment and experiences than others. Moreover, it would be interesting to explore cultural values with group differences in the human brain and observe the connection between them.

Park (2013), a Cultural Neuroscience pioneer, raised four issues regarding studies that focus on studying cultures at a neuroscientific level.

The first issue is that that while genetics (“nature”) has an indubitable role in shaping brain’s structure and function, “(…) some cultural differences in neural function are exclusively a result of ‘nurture’, that is, cultural experiences, and that the brains of culturally diverse individuals are largely the same” (Park, 2013, p. 58).

As we know, the environment, such as culture values, plays a key role in the way each person becomes as a human being, but more than that, it also affects our genes and brain’s responses. The capacity for humans to adjust and change due to social experiences, shows how important this neuroscientific field is and how it is crucial to study in more detail the plasticity of the human brain, especially across cultures.

Therefore, even though the human brain may be genetically built, according to several findings, a large amount of neural differences arises after being contacted to social experiences, i.e., cultures shape brains.

Nevertheless, cultures have so many dimensions (diet, education, health caring, etc.) that it is difficult to relate the observed brain variations to a specific cause. Hence, one may expect that cultural studies are rather difficult to control. Despite this, Losin et al. (2010) propose eight guidelines, which are addressed in the next Chapter II.

The second issue is related to the hardwiring / soft wiring in the brain: do differences between cultures depend on genetically hardwired circuits, or are dissimilar results of the same processes but with other variables sets? Hardwired circuits mean that a certain range of outputs is empowered with limited influence of the inputs. Such architecture is difficult to change and little prone to outside modulations, e.g. the modulation of the prefrontal cortex or the anterior cingulate cortex (Cisek & Kalaska,

2010; Grabenhorst & Rolls, 2011; Marques dos Santos & Moutinho, 2015; Paus, 2001). The other way, the “soft” one, is that processes are much the same across humans and they would yield different behavioural results depending on the incoming cultural variables (and others). In this case, the influence of cultures would be mainly modulatory, but always prone to circumstantial adaptations, i.e., very difficult to control. However, cultural neuroscientific studies have not sufficiently addressed this issue yet, which means that the real imprints engraved by cultures in the brains are unknown and all hypotheses are open.

This third issue relates to how deep the imprints left by cultures in the brains are, even structural imprints. Considering that there are several studies (Chiao & Ambady 2007; Maguire et al. 2000), that demonstrate how the brain, after some practice, can change its own shape (e.g., training in juggling or being a taxi driver for long increase the volume of specific areas of the brain), it would be interesting to do the same for cross-cultural studies, i.e., seek for volumetric changes promoted by cultural aspects.

Finally, the last issue raised by Park (2013) is the need to replicate studies across several examples of cultures and refrain overgeneralisations. Because samples are usually small, so they are the effects, and jumping to general conclusions should be cautious, even more due to the dimensional complexity that cultures encompass. This observation is relevant, since it will give more consistency, credibility and benchmarks that can be used for future studies in this field (cf. Guidelines for cultural neuroscience studies, in Chapter II).

1.4. **What is *culture*?**

Cultural Neuroscience is a multidisciplinary field that aims to find relations between brain functioning and cultural behaviour (Han et al., 2013). But, what is in fact *culture*? How can it be defined?

There is a set of definitions that varies across different research fields. For instance, anthropologists refer to it as a full range of meanings (e.g., set of traditions, beliefs and values) that are passed down from one generation to the next one (Han et al., 2013). Moreover, the social psychologists would define it as a set of social rules and social institutions, more specifically ideas, values, beliefs and behaviour (Han et al., 2013).

The meaning of culture often leads to confusion and then different definitions, since it is often mistaken and overlapped by other concepts, such as *nationality*, *race*

and/or *language*. For instance, we can share a place of origin, a country, being of the same nationality, however, that does not mean we share the same beliefs, values or practices (*culture*). Normally, it would be intuitive to think that both *language* and *race* would be correlated to *nationality*, however, this is not applicable if someone immigrated to another country.

Therefore, as a way to avoid using different terms or definitions for culture, most Cultural Neuroscience studies (Chiao et al., 2009; Han et al., 2013; Losin et al., 2010) agreed to use the term *culture* associated with sharing the same beliefs, specific cognitive processes, values, knowledges and/or practices.

1.5. **Introducing Game Theory**

Game Theory (GT) offers a methodology that allows to study conflict (e.g. free-riding) and cooperation in decision-making processes (Alencar & Yamamoto, 2008), being widely used in several fields such as Economy, Political Sciences, Psychology and Biology (Myerson, 1991).

Within the Biological field, for example, several studies were conducted to analyse human behaviour in decision-making processes (Chung, Yun, & Jeong, 2015; de Quervain et al., 2004; Lee, 2008; Polezzi et al., 2008; Pulford, Krockow, Colman, & Lawrence, 2016; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). On the other hand, GT also found application for the interpretation of a wide class of social interactions (Henrich et al., 2001; Henrich et al., 2006; Lee, 2008; Lopes, 2014) and since this study will compare two different countries together, it will be interesting to see how cooperation, trust, fairness and coordination work between people from within each culture. Hence, cooperation and free-riding will be promoted, to measure behavioural and neural differences between both cultures.

In Economics, the so called “free-rider problem” occurs when a common or shared public good is taken inadvertently by some members of a group, as a way to gain some personal advantages (Baumol, 1952). Besides, if the individuals belonging to the group or culture see that there are other members that may free-ride, then they will tend to reduce their contributions towards the group due to those who are being opportunistic (Ruël et al., 2003).

In Lopes (2014), the researchers decided to study Finnish and Portuguese people using games from Game Theory and they found out that even though both Finnish and Portuguese people saw free-riding as a misconduct, whenever they had the chance to

pay to punish, Portuguese avoided to enter with costs that would punish free-riders, unlike the Finnish, proving that social norms and social sanction might be perceived differently across cultures, hence proving that Game Theory is a useful tool to study (dis)similarities between cultures.

Other studies found that it is possible to measure cultural differences using neuroscientific techniques (Chiao et al., 2009; Han et al., 2013; Losin, Dapretto, & Iacoboni, 2010; Park, 2013; Roepstorff, 2013; Tieu & Konnert, 2015). As far as we know, the idea of conjoining Cultural Neuroscience *with* Game Theory, in order to investigate the electrophysiological correlates of luck-based and economic responses between two European cultures and explore how the environment can influence these decision-making processes, is an idea yet to be explored. Therefore, considering the scope of our research (i.e., to study cooperation / free-riding and luck-based decisions), we anticipate similar behavioural responses as the ones obtained in Lopes, et al. 2014, at least regarding the Portuguese sample.

Considering the neurophysiological approach, knowing that previous studies proved that culture has a strong influence on brain functions, we predict that there will be differences, as the perception of an outcome and even the recognition of a free-rider varies across cultures (e.g. a more competitive culture *vs.* a less competitive culture or a culture that is more sensitive to the level of fairness of an offer *vs.* a culture that is less sensitive to the level of fairness of an offer, respectively).

1.6. **Criteria to select the games and justification of their choice**

This research intends to use Game Theory (GT) as a tool to study cultures. However, there is a large set of different games in GT and therefore, not every game is suitable to study cultural differences and more specifically cooperation *vs*. free-riding. For this purpose, a set of 33 different games have been analysed in Wikipedia (cf. Annex I) considering different criteria (e.g. how many strategies per player there are; Nash equilibrium -when the strategies chosen by both players are the best decision for them-; if it is a sequential/simultaneous and zero/non-zero-sum game with perfect/imperfect information; and finally, what they measure) that would then suit the main purpose of this study.

Lopes (2014) also used several games from GT, in order to study social norms, trust and economic behaviour, cooperative and competitive behaviour and costly punishment (Fehr & Fischbacher, 2004b; Fischbacher, Gächter, & Fehr, 2001; Gächter et al., 2004 Tu & Bulte, 2010; Cameron et al., 2013; Henrich et al., 2006a) between

Portuguese and Finnish people. Regarding their findings, Lopes and colleagues observed that Finnish tended to trust and take more risk-based decisions investing more money than the Portuguese sample. Portuguese were also more prone to compete than Finnish and finally, even though both cultures acknowledged when there was a misconduct, the Portuguese sample tended to refrain the punishment of free-riders, commonly called opportunists.

These results also revealed very helpful when selecting the games that are more suitable to compare and study Portuguese and Irish people, on a cooperative / free-ride level and in order to measure (behaviourally and neurally) the putative differences between these two cultures.

Thus, the following selected games from GT will be used:

○ Rock-Paper-Scissors (RPS)

Rock – Paper – Scissors is based on pure luck mostly, rather than on a wise strategy or economic wisdom. The purpose of this game is to control possible differences between the devices and acquisition environments in Ireland and Portugal in order to assess that both data sets are comparable, i.e., the behavioural responses are expected to be similar or equivalent between the two countries, given that luck is not influenced by culture, while the perception of the outcome (win, draw or lose) may vary across environments. We therefore anticipate no behavioural and neurobiological differences across cultures (as there is no “wisdom” attached when making the choice between the three options available, i.e., Rock, Paper or Scissors); even though, we suspect that at a neurobiological level, the perception of winning and/or losing may be stronger and/or more significant in one of the cultures (e.g., a more competitive one).

In each run, two players at the same time choose one among rock, paper, or scissors. Besides draws, rock wins scissors, scissors win paper, and paper wins rock. However, participants will be previously informed that this will be the only game, in which they will be playing with a computer and not a person. The rationale is to collect data free from social interactions as much as possible, , in order to control possible differences between the devices and acquisition environments in Ireland and Portugal. Because it is mostly luck and we assume that luck is not influenced by the nurturing culture, the behavioural responses and possibly the brain activity is expected to be equivalent between the two sites. Otherwise, the devices and/or the acquisition environment may be influencing the collection of the data.

○ Ultimatum game (UG)

The Ultimatum game is used to study fairness. There is plenty of neurobiological evidence which show that, in unfair situations, specific Regions Of Interest (ROIs) of the brain are activated (Sanfey et al., 2003; Xiao and Houser, 2005; Knoch et al., 2006). Those regions are the anterior cingulate cortex (ACC), the insula and the dorsolateral prefrontal cortex (DLPFC). These brain regions participate in solving conflicts between the wish to win something and the aversion of being treated unfairly.

Two players participate in the UG. These two players interact to decide how to divide a sum of money that is given to them. While the first player makes an offer on how to split the amount of money, the second player will either accept or reject the offer. If the second player rejects the proposal made by the first player, then none of them will receive anything (Barr et al., 2009). The game is normally played once so that reciprocation does not become an issue. However, because the EEG signal is weak and would not differentiate from noise in one shot trials, the participating participant will be in the place of the receiver and playing with multiple and different proposers, one at a time.

Rationally thinking, one would expect that all proposals would be accepted, even the unfair ones. However, there is a paradox:

- The receiver (i.e., the participant in this study) has the opportunity to reject the unfair offers. In this case neither the participant, nor the proposer receive money, i.e., while even 1 cent would be better than nothing and rationally the receiver would accept every offer distinct from 0, previous experiences (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003) have been showing that receivers use to reject offers lower than 20%, punishing unfair offers with a cost for him/her. The offers are manipulated but balanced across all participants.

The choice of this game instead of the Dictator Game, as in Lopes (2014), was due to the fact that the UG allows to prompt free-riding behaviours, so that each participant is able to choose between fair and unfair actions and decide whether they want to punish their opponent by rejecting an offer.

○ Centipede Game (CG)

The Centipede Game is an example of a coordination game, being for that reason suitable to study cooperation and competition in dynamic interactions. Like the Prisoner's Dilemma, this game battles between common and self-interest. However, unlike this, the

CG allows the player to move sequentially, knowing the decision of the other player. This provides a good model of “everyday relationships” that Prisoner’s dilemma does not offer (Pulford et al., 2016). According to Pulford et al., 2016, “The Centipede game is an ideal tool for studying the motivational bases of reciprocal cooperation, because it is a dynamic game that presents players with greater scope for expressing cooperative/competitive, selfish/altruistic, trusting/distrustful, and individualistic/collective motives than other dyadic games” (pp. 1 - 2). Therefore, it will be interesting to include this game in this research study.

In the Centipede Game, two players pass each other a pot. The pot has an initial amount of money and every time the pot passes from one player to the other the amount of money increases by an established quantity. Each player in each turn makes the decision: or takes all the amount in the pot for him/herself, or just passes the pot to the other player giving to the other the possibility of keeping with everything (McKelvey & Palfrey, 1992; Rosenthal, 1981). This game is here played in three runs: in one, cooperation will be promoted, in another one, the opposite player firstly will cooperate and then will start keeping with all the amount for him/her precociously, and finally, the opponent will take the selfish decision just from the beginning. The participant will be playing with a fake opponent all the time, and during the debriefing this misapprehension will be dismounted, so the participant does not leave the study having been deceived.

○ Public Goods Game (PGG)

Previous studies have found that, after repeated interactions, the levels of cooperation tend to decrease and the called “free-riders” or “defectors” start to appear after a few sessions, i.e., the Public Goods Game proves to be useful if the goal is to investigate cooperation and free-riding in humans and to observe the evolution of the participants’ behaviour (Alencar & Yamamoto, 2008; Chung et al., 2008). The social interpretation of the results emphasises the group cohesion and cultural norms to explain the prosocial (i.e., a behaviour that promotes social acceptance and friendship) outcomes of the public goods.

The Public Goods Game is a game that involves at least three players that have to secretly choose how many of their own tokens (money usually) they want to put into a public pot that is shared amongst them. After the players bets, the tokens inside of the pot are multiplied by a factor (greater than 1) and this "public good" payoff is evenly divided among players. Each participant will also keep the tokens they did not contribute to (Croson, 2007; Fehr & Fischbacher, 2004; Fischbacher, Gächter, & Fehr, 2001). It can

be played in one iteration, but it is more interesting if there is repeated play (the players have the opportunity to adjust their offers to the other players and search for free-riders that do not invest but get the payoffs). Here, it is played in three runs, each run between the participant and four other players. In the first run the fake players will promote cooperation (participate intensively with tokens) maximizing the earnings of the group, in the second run one of the fake players will suddenly adopt a free-riding posture by the middle of the run, and in the third run one of the fake players will be free-riding since the beginning. Again, during the debriefing the participant will be informed about the manipulation of the fake players.

○ Volunteer's Dilemma (VD)

The Volunteer's Dilemma mimics a perfect "real-life" interaction of free-riding, that is, in this game, players have either to volunteer, either to avoid paying a certain amount of money. If they defect, they become free-riders, also called as opportunists, since they take advantage on other people's losses.

The Volunteer's Dilemma, in its original form, encompasses scenarios that trap the participant in a dilemma: if s/he volunteers, s/he will have some cost and the group will have some benefit; if s/he does not volunteers then, someone else would have to volunteer in order for the group to get the benefit; otherwise, all the elements of the group will suffer some sort of punishment (Diekmann, 1985; Goeree, Holt, & Smith, 2017). One of these scenarios is: due to a failure, electricity has gone in the neighbourhood; everyone knows that if somebody gives a phone call, the failure will be repaired, and electricity will return again; the phone call, however, has a cost and its cost is to be assumed by the caller; the participant has to make a decision: either s/he volunteers and assumes the cost, or waits that somebody else makes the call; in this case, s/he benefits from the public good at no cost.

1.7. Addressing Game Theory with Neuroscience

One of the first pioneers in this field, Nalini Ambady (PhD) found that, even under the same stimulus, some people might activate their brain regions differently (Chiao & Ambady, 2007; Chiao et al., 2008). For instance, the study conducted between Japanese and Americans using silhouettes of bodies in submissive or dominant postures showed that Japanese responded better to the submissive postures than Americans, who responded better in response to dominant silhouettes. Thus, this study allowed the researchers to see cultural differences at the same time they were studying the brain's

circuitry (reward circuitry, in the brain's limbic system) using event-related potentials (ERP) and functional magnetic resonance imaging (fMRI).

Moreover, Denise Park proposed that cultures may perceive the world differently and that those are seen in the brain (Park & Huang, 2012). Therefore, using Chinese versus Americans tested with fMRI, she found that under *congruent environment* (e.g. giraffe on a savanna) *versus incongruent environment* (e.g. giraffe on a football field), Chinese were more sensitive to the background than Americans, which sustains previous findings, i.e., that Chinese come from a collectivist culture, where the context of things is valued, while Americans come from an individual culture were the context seems to not "affect" them, as opposite to detail. These findings were associated with different activations in the Ventral Visual Cortex (VVC) which is connected with perceptual processing.

These two pioneer investigations are perfect examples of how this field needs to be deeply explored, since it demonstrated that the same cognitive task was performed differently across cultures at a neurobiological level. For instance, they might explain the reason why some cultures appear to be more skilled than others, but more importantly they show that the cultural influence may play a very keen role on the neuroplasticity of brain functions.

Now, with these discoveries, combined with the findings obtained in Lopes (2014) and other studies that were used to analyse human behaviour in decision-making processes (Chung, Yun, & Jeong, 2015; de Quervain et al., 2004; Lee, 2008; Polezzi et al., 2008; Pulford, Krockow, Colman, & Lawrence, 2016; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003), we might be able to create new constructs and paradigms that will be more suitable to distinguish cultural facets (more specifically, of the economic behaviour) that may play a crucial role in each country.

According to another pioneer of Cultural Neuroscience, John Gabrieli, "everyone uses the same attention machinery for more difficult cognitive tasks, but they are trained to use it in different ways, and it's the culture that does the training" (retrieved from http://news.mit.edu/2008/psychology-0111).

Park also said that "Understanding cultural differences in the mind is really important as the world globalizes" and that "There can be a lot of breakdowns in communication" (both retrieved from https://www.nytimes.com/2008/03/04/health/04iht-6sncult.1.10695876.html).

1.7.1 The use of the Electroencephalography technique

For this research, we decided to use Electroencephalography as the neuroimaging technique and Game Theory as the tool to assess how Portugal and Ireland behave during luck and economic-based decisions.

The reason for using EEG is because it is a non-invasive technique; it allows to record and amplify electrical voltage currents across the scalp and to plot this over time (offering a better temporal resolution of the neural electrical activity when compared with other neuroimaging techniques, such as the fMRI and PET, for example); it offers little discomfort for the participants (plus, the meal restrictions of MRI techniques do not apply to EEG testing) and has a relatively low cost when compared to fMRI, for instance (Luck, 2014).

EEG-recorded Event-related potential (ERP) analysis is one of the most used methods in cognitive neuroscience to non-invasively examine the neural correlates of information processing (Nidal & Malik, 2015).

The ERPs waveforms are embedded in the EEG signal and can be extracted by event-locking the EEG signal to a stimulus or feedback event, and averaging this across trials (Luck, 2014). These averaged waveforms across trials are then averaged across participants, in order to obtain a Grand Average ERP waveform that reveals the temporal changes in the equivalent current dipole, and that is plotted in microvolts (μV), over time (ms).

ERPs components are useful for determining the millisecond-to-millisecond stages of information is processing in the brain, proving to be an excellent tool of temporal resolution for many sensory, perceptual and cognitive processes (Nunez & Srinivasan, 2006; Woodman, 2010). These components can present a positive or negative voltage deflection that are labelled with P and N, respectively, followed by a numerical indication of the order or time (in milliseconds) of the peak in the waveform sequence (e.g. N1/N100, P1/P100, N2/N200, etc.) (Woodman, 2010).

1.8. Cultural settings between Ireland and Portugal: Economic Review

Both countries faced an economic crisis in 2010 and 2011, respectively, and although they both exited the bailout programme, their economic performance trajectory is different, suggesting they addressed the crisis problem differently.

For Portugal, “economic success came after relinquishing the austerity straitjacket imposed by the EU and International Monetary Fund between 2011 and 2014. Public sector wages and pensions have been restored to pre-crisis levels, but the government is likely to face future conflict with the EU, as Brussels seeks action to reduce Portugal’s debts”, while “Ireland’s exchequer remains highly dependent on a few large companies, leaving the economy in a vulnerable position” (retrieved from https://www.theguardian.com/business/2017/sep/16/weakest-eurozone-portugal-ireland-spain-italy).

In 2010, Ireland faced an economic crisis and had to ask for help to the European Financial Stability Facility (EFSF) and the International Monetary Fund (IMF). “The country received an emergency loan of 68 billion euros. Many banks were nationalized. The government introduced austerity measures and reorganized public finances. The salaries of officials and social benefits were cut, and taxes increased. Today, Ireland is regarded as a model of success in overcoming a financial crisis using austerity measures. In 2014, economic growth amounted to 5 percent — a record for the entire European Union. Today, Ireland’s GDP has almost reached pre-crisis levels” (retrieved from https://sputniknews.com/europe/201507051024235988/).

On the other hand, in 2011, Portugal received a loan from “the Eurozone countries and became the third recipient of financial assistance from the European stabilization funds. The European Central Bank (ECB) and the IMF allocated 78 billion euros to support Portugal. In return, Lisbon lowered the salaries of state employees, cut social benefits and increased taxes” (retrieved from https://sputniknews.com/europe/201507051024235988/).

Even though it was not well received by the Portuguese residents, the economy grew almost 0.9% for the first time. “The government is promising to continue reforms, but the situation is complicated due to demographic challenges, particularly, the aging population. Portugal ranks last in Western Europe in terms of welfare indicators” (retrieved from https://sputniknews.com/europe/201507051024235988/).

According to Deutsche Welle, Ireland and Portugal were two of the three countries that were able to overcome the economic crisis, avoiding bankruptcy. None of this would have been possible without the help of the EU countries and funding programs.

Chapter II

Methods

2.1. Guidelines for cultural neuroscience studies

Before playing the games, a photo of the participant is taken, and s/he is informed that similar photos were taken from the other participants and that the decisions that each one makes will figure next to the photo on the screen. Although the photo is discarded, this procedure is to induce a context of reality (Hewig et al., 2011), so the participant believes that s/he is playing against other humans and not with the computer, nor start imagining that the counterparts' decisions are in fact previously manipulated, except for the Rock – Paper – Scissors game. Also, all participants play the Ultimatum Game twice: once as a proposer when only the behavioural data is recorded, not the EEG signals; and once as a receiver, here recording both the behavioural decisions and the EEG, as further detailed. The reason for such a procedure is the same, i.e., to induce a context of reality for the participants so they believe that are playing against other humans.

The participants were also given a set of instructions (cf. Appendix XII and XIII for the English and Portuguese version, respectively), as well as the opportunity to practise before the experiment started, to get familiar with the games' procedure. The order of the games was randomised across participants (cf. Appendix XIV), except for the Rock-Paper-Scissors, which was always played first.

However, due to the difficulty of describing what culture is and what elements should be involved in that definition, it is fundamental to follow certain rules or guidelines as to "trim the edges" and obtain more accurate and, mainly, interpretable results as possible. Losin et al. (2010) summarised eight guidelines, which divided into three major groups. This research plenty adhered to these guidelines.

Table 2.1 – Guidelines and definitions for cultural neuroscience studies, based on the ones proposed by Losin et al. (2010).

Related to	***Guidelines***	***Meaning***	***Measure(s) used***
Selection of cultures	1. Define and measure culture	The same definition needs to be used for all the elements of the study in order to ensure conceptual consistency.	Measure of enculturation *versus* acculturation were used, creating for that purpose, an instrument to assess the level of these bidimensional definitions for each of the countries (cf. Appendixes VIII and IX, i.e., IPEAS, available in the English and Portuguese version).
	2. *Unpackage* culture	It is related with the psychological constructs that define one specific culture, which should be identified; such constructs should be the base of separation of cultures and therefore, should be used to select cultural groups; even more, these constructs must be measured in each participant.	These constructs and measures are presented in IPEAS and also in the games used, being a perfect example of how different the level of competition / cooperation / freeriding across different cultures can be, while playing the same game.

	3. Replicate cultures containing cultural elements of interest	The authors suggest using three different cultures, at least, as a term of comparison; further, the effects should be replicated in other cultures, so causal relations can be established.	This study was based by a previous study conducted by Lopes et al. (2014), using Finnish and Portuguese people as a term of comparison, while observing their performance on similar economic games.
Participant-specific elements of cultural groups selected	4. Match or measure onset/amount of cultural experience	The age of the participant at the onset of the cultural experience and the duration of the cultural experience of the participant is related to neural plasticity and therefore, have impact in cultural neuroscience studies; because these variables are of paramount importance in these studies, both should be measured in the cohorts, and even matched.	Only participants aged between 18-50 years old were used for this study (M_{age} = 25.53; SD =7.62 for the Portuguese study and M_{age} =24.80; SD = 7.35 for the Irish study). Besides, the games used for this research study were identical.
	5. Consider the effects of regional genetic variation	Genetic heritage and culture are often confounded; in order to separate each contribution to cross-cultural neural	Based on the fact our study addresses Portuguese and Irish native people, this recommendation will not be fulfilled as we

		differences it is recommended that a third group, this one containing shared genetic heritage, but different cultural experience; for instance, if A and B are two distinct cultural groups with dissimilar genetic heritage, a third group, e.g. Elements of B that changed to the culture of A, should be included.	are not including immigrants in this research.
	6. Match groups	Besides the cultural constructs, the other factors must match among cohorts.	A set of criteria (inclusion and exclusion) were used in order to refine and screen the collected sample. For instances, all participants that had a MoCA score below 26 were dismissed from the study.
The features of the experimental stimuli used	7. Equate stimuli	Stimuli should be equated among the cultural groups under study; however, equating is not being the same, and some adaptations / compensations should be introduced in order to reach an ideal balance.	In order to ensure that during the analysis all conditions would be equally balanced, we decided to introduce the *Purchase Power Parity* (also known as PPP) as an indicator of the cost of living and income of each country, so that we would introduce a real value into the final stake offered to participants during the

		Ultimatum Game, for instance (e.g., Big Mac Index).
8. Equate performance	Similarly, the performance among the cultural groups should be balanced, so its effects, which supposedly are not culturally grounded, are discounted.	The games were identical in their structure and duration (except for the language and photos of *fake* opponents).

Losin et al. (2010) firmly believe that Cultural Neuroscience is not only additive, since it can bring a lot of tools to understand how the neuroplasticity of the human brain co-varies across different cultures, but also that it is synergistic, since some of the findings may be different from those made so far in this field.

2.2. Experimental Protocols

2.2.1. Rock-Paper-Scissors (RPS)

The original format of the game is maintained, differing only on the basis that it is played against a computer instead of a person. Therefore, each player chooses among rock, paper or scissors and depending on the computer's choice, they may win, draw or lose (the payoff matrix figures in Table 2.2).

Each participant plays for 90 trials and, most importantly, all participants are informed that they are playing against a computer, which will generate its own random choices.

The rationale for using this game is to collect data free from social interactions as much as possible, given that luck is not influenced by culture, but mostly to ensure that the collected data from the two sites is equivalent and does not introduce noise in the EEG signal.

Table 2.2 – Payoff matrix of the game in which two players must choose simultaneously between three different options (Rock, Paper or Scissors).

Computer / *Player 1*	***Rock***	***Paper***	***Scissors***
Rock	0,0	-1,1	1, -1
Paper	1, -1	0,0	-1, 1
Scissors	-1, 1	1, -1	0,0

The detailed sequence in each trial is (cf. Figure 2.1):

1. the participant chooses among rock, paper or scissors (slide 1);
2. a slide with the participant's response is displayed for 1.5 seconds (slide 2);
3. then, the computer's response is displayed for 1.5 seconds (slide 3);
4. after that, a slide that shows the result for 1 second (slide 4);
5. follows a fixation cross for 1.5 seconds (slide 5);
6. end of the trial.

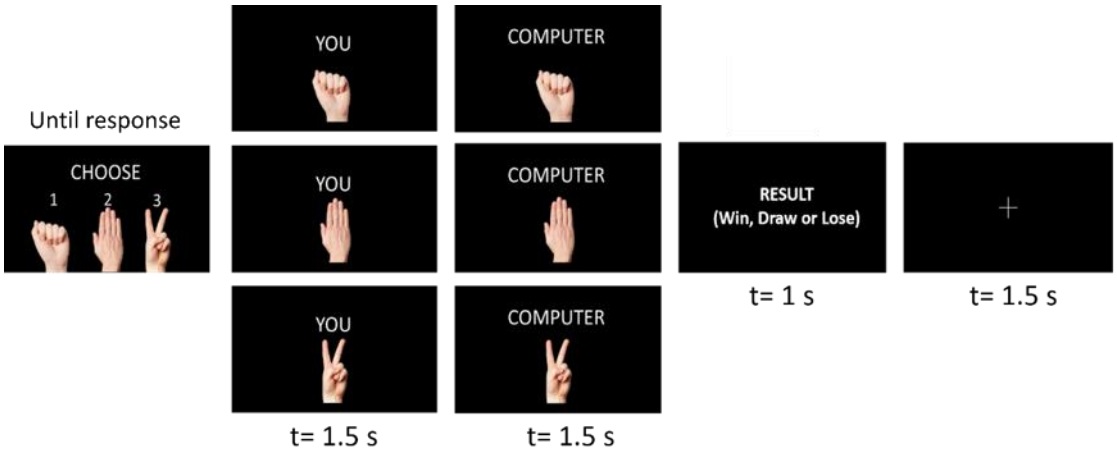

Figure 2.1 – Example of an individual trial with the three different options available (i.e., 1 for rock, 2 for paper and 3 for scissors), as well as the computer's response (which is randomised across trials) and the outcome from both choices (i.e., win/draw/lose).

2.2.2. Ultimatum Game (UG)

The participation of the individual in the Ultimatum Game is split in two parts: firstly, s/he decides as proposer (no EEG recording), and then s/he decides as receiver (with EEG recording). Again, the original structure of the game was maintained (Hewig et al., 2011; Polezzi et al., 2008; Qu et al., 2013; Crockett et al, 2008; Civai et al., 2010).

In this game, the amount of money may be an issue, because of the difference in the cost of living in the two countries. Thus, the *Purchasing Power Parity,* also known as PPP, was used as a benchmark indicator, as it takes into account the cost of living and income of each country, being widely used by macroeconomists to help them to estimate the global productivity and growth of each country.

One reference used with PPP is the BigMac price (retrieved from www.economist.com/content/big-mac-index), which costs 3.2 € in Portugal and 4.1 € in Ireland. Considering that in this game participants are able to offer at least half of the value they receive, to their opponent, the value for the final stake in the Portuguese case was 12 € maximum (in which, half would correspond to two BigMacs). In order to have a more accurate proportion for the final stake in the Irish version of this game, the PPP had to be addressed as an indicator.

The PPP is measured according to the national US currency (*dollar*), corresponding to:

a) 0.6 / 1 (*) dollar for Portugal;

b) 0.8 / 1 (*) dollar for Ireland;

c) Dividing the two rates in a) and b):
   0.8 / 0.6 = **1.3**

d) Dividing the two BigMac prices:
   4.1 € / 3.2 € = **1.3**

(*) These values were retrieved from https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm for the year of 2017.

The option here is to use two BigMacs as the initial lump of money, i.e., 12 € in Portugal, and 16 € in Ireland.

12€ ----------0,6 ***x***----------0,8 ***x* = 16€**	OR	12€ ----------3,20€ *y*----------4,10€ ***y* = 15, 375€ ≈ 16€**

Also, the proposer is able to share 50% of his/her amount of money, at most. This means that in Portugal the maximum amount to be sent to the receiver is 6 €, and in Ireland is 8€:

- a proposer and a receiver play against each other;
- the proposer has an initial amount of money;
- the proposer decides how to divide the amount of money between the two players;
- the receiver player can either accept or reject the proposal,
- if the receiver rejects the offer, then neither player wins money; if the receiver accepts the offer, then the money is split according to the proposal (Barr et al., 2009).

The detailed sequence in each trial, when the participant plays as **proposer**, is:

1. the first slide just shows the photo of the opponent;
2. in the second slide, the proponent must decide the amount to be shared among 1, 2, 3, 4, 5, or 6 € (Portugal), pressing the respective key or 1, 2, 3, 4, 5, 6, 7, or 8 € (Ireland);
3. end of the trial; this trial is played 20 times.

The detailed sequence in each trial, when the participant plays as **receiver**, is:

1. according to Table 2.3 there are six different offer possibilities; the first slide shows the one elected for the trial; a circle proportionally divided depicts the amount offered by the proposer (and the corresponding amount in euros); each part of the division is depicted with different colours: blue for the part that the participant receives if accepts the proposal, and red for the proposer;
2. the participant either accepts or rejects the proposal made by pressing two different keys on the keyboard;
3. a feedback slide of each round is displayed at the end of each trial showing the players payoff (Vieira et.al, 2014);
4. each offer is repeated 20 times, resulting on a total of 120 trials, plus 6 and 12 trials (behavioural only), where the participant has to classify **each offer** and **each proposer** who made the offer as *very unfair* to *very fair*, respectively (on a scale from 1 to 5, 1 being *very unfair* and 5 *very fair*);
5. offers are classified as unfair if the value is 1 € / 2 €, as mid-value if the offer is 4 € / 5 €, and as fair if the offer is 7 € / 8 € (case of Ireland); and as unfair if the value is 1 € / 2 €, as mid-value if the offer is 3 € / 4 €, and finally, fair if the offer is 5 € /6 € (case of Portugal);
6. The receiver (our participant) has the opportunity to reject offers made;
7. The offers were manipulated but balanced across all participants;
8. Every time the participant won, s/he collected points for him/herself, because previously s/he was informed that there is a real prize in the end for the three participants than make more points. This incentive is important, so the participant do not punish at no cost, which would be irrelevant.

Table 2.3 - Different splits of money and respective payoff between the proposer (computer, player A) and the receiver (participant, player B) in the UG.

If Player A gives	***Player A receives***	***Player A's payoff***	***Player B's payoff***
		CASE OF IRELAND	
€ 1	€ 15	€ 13	€ 1
€ 2	€ 14	€ 12	€ 2
€ 4	€ 12	€ 11	€ 4
€ 5	€ 11	€ 10	€ 5
€ 7	€ 9	€ 9	€ 7
€ 8	€ 8	€ 8	€ 8

	CASE OF PORTUGAL		
€ 1	€ 11	€ 11	€ 1
€ 2	€ 10	€ 10	€ 2
€ 3	€ 9	€ 9	€ 3
€ 4	€ 8	€ 8	€ 4
€ 5	€ 7	€ 7	€ 5
€ 6	€ 6	€ 6	€ 6

The detailed sequence in each trial is (cf. Figure 2.2):

i) Each trial started with the photo of the proposer for 1.5 seconds;

ii) Presentation of a colour circle showing the proposal made by the proposer (in red) to the participant (in blue) for 1.5 seconds;

iii) The participant gives his/her answer, after seeing the proposal;

iv) A slide showing the answer is displayed during 1 second;

v) A fixation cross was displayed within 1 second;

vi) End of the trial.

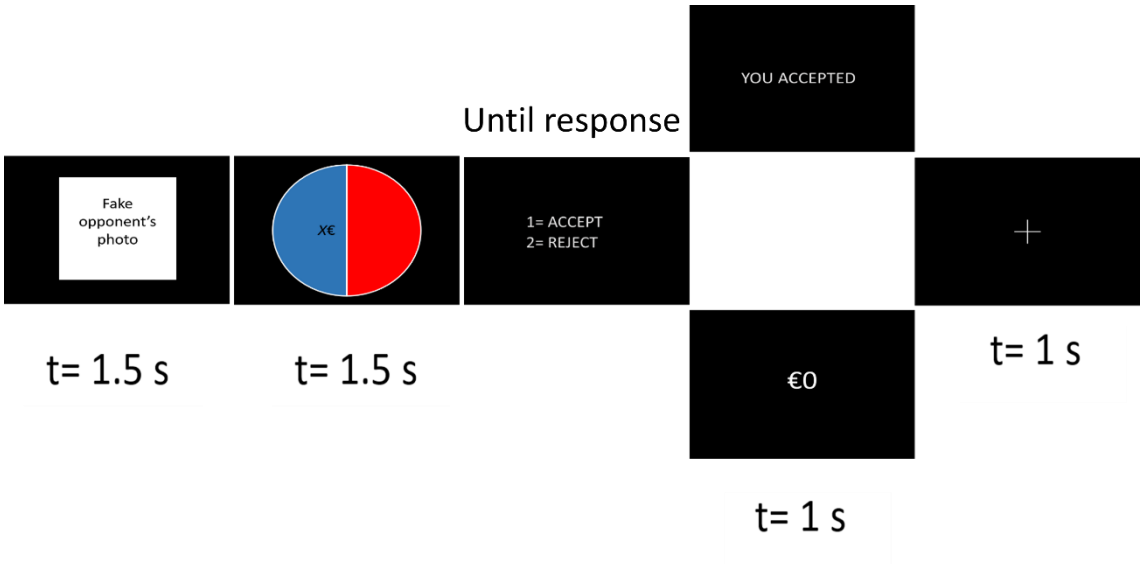

Figure 2.2 – Example of an individual trial in the UG. It starts the photo of the *fake* opponent and then with a colour circle showing the proposal made by the proposer (in red) to the participant (in blue). After the participant chooses to accept or reject the offer, a slide showing the answer appears on the screen.

2.2.3. Centipede Game (CG)

This game is played according to Aumann's version (McKelvey & Palfrey, 1992):

- the participants play against a *fake* opponent in every round, although they are told the opposite at the beginning of the experiment (there is a photo of the fictitious player showing up on the screen, even though all the moves are programmed by a computer);
- the game begins with one of the players passing a pot with a certain value inside;
- the initial pot has an initial amount of 1 € and every time the pot pass from one player to the other, the amount of money increases by another 1 € (cf. Table 2.4);
- in each turn, each player makes the decision: takes the amount from the pot for him/herself, or just passes the pot to the other player, now with increasing value, giving to the other the possibility of keeping the larger amount;
- this sequence (trial) is played in nine rounds, each encompassing 10 trials, in which they were organised in three different groups, i.e., cooperative, midriding and freeriding groups:
- During three rounds (in a total of 30 trials), cooperation is promoted, i.e., the opponent gives back the pot;
- in another three rounds (also in a total of 30 trials), the opposite player firstly cooperates, and then starts to keep the bigger pot for him/her precociously (in the 5th trial, the opponent starts to freeride instead of cooperating);
- finally, the opponent takes the selfish decision from the beginning for three rounds as well (again, with 30 trials overall).
- the order of these nine rounds types is randomised across the participants.

Table 2.4 – Payoff matrix in the Centipede Game. The person that takes the pot, receives the amount.

Number of the trial	***Value inside of the pot***
1	**1** €
2	**2** €
3	**3** €
4	**4** €
5	**5** €
6	**6** €
7	**7** €

8	**8 €**
9	**9 €**
10	**10 €**

The detailed sequence in each trial is (cf. Figure 2.3):

1. each trial starts with one pot and the payoff according to Table 2.4 (slide 1);
2. then, the participant chooses either to pass the pot, or to take the amount to him/herself by pressing the correspondent key (slide 2);
3. after the decision, a fixation cross is displayed on the screen for 1.5 seconds (slide 3);
4. the next pot is presented for 1.5 seconds with the respective value inside (i.e., if the participant took the amount from the pot on the previous trial, then the value starts with 1 € again on the next one. If the participant passes the pot, the value rises by another euro, in accordance to the amount that was presented in the last trial).
5. A photo of the *fake* opponent is displayed for 2 seconds showing his/her move (slide 4);
6. another fixation cross is displayed for 1.5 seconds (slide 6);
7. end of the trial.

Figure 2.3 – Sequence of three trials between the participant and the opponent.

2.2.4. Public Goods Game (PGG)

This game is played according to the standard condition in Chung et al. (2015), which is the condition that maximises freeriding. In this condition, there is no payback if at least two players do not cooperate with the group, i.e., if the group fails, no one receives the money (i.e., the ones who cooperated), while the free riders receive 5 €. Then:

- the participant and four other fictitious players make the playing pool;

- each player has two types of tokens: 5 € and 0 €;
- secretly, each player chooses which token to put into a public pot (see Table 2.5);
- if at least three players invest with the 5 € token, the sum of the tokens in this pot is multiplied by a factor (greater than 1) and this "public good" payoff is evenly divided among players; each participant also keeps the tokens they did not contribute (Croson, 2007; Fehr & Fischbacher, 2004; Fischbacher et al., 2001);
- if more than two players invest the 0 € token, those that invest the 5 € token lose their investment;
- it is played in nine rounds; each round has three different playing pools;
- each round consists of 10 trials;
    - in one round, the fictitious players promote cooperation, participating intensively with tokens and maximizing the earnings of the group;
    - in another round, one of the fictitious players suddenly adopts a freeriding posture by the 5th trial, by investing nothing in the public pot;
    - in the remaining round, at least two of the fictitious players freerides since the beginning;

Table 2.5 – Payoff matrix using the CondS in the PGG according to Chung et al. (2015).

	Success	***Failure***
Cooperation	10€	0€
Freeriding	15€	5€

The detailed sequence in each trial is (cf. Figure 2.4):

1. the participant chooses one token by pressing the respective key: 5 € or 0 € (slide 1);
2. a slide showing the result of the group is displayed for 3 seconds (slide 2);
3. after the group's decision, a fixation cross is displayed on the screen for 1 second (slide 3);
4. a fourth slide showing the final amount won by the participant is displayed on the screen for 1.5 seconds. In the example below, if the participant was cooperative towards the group, s/he wins 10 €; if the participant does not contribute towards the group, i.e., if the participant freerides, then s/he wins 15 €;
5. another fixation cross is displayed for 1 seconds (slide 5);

6. a final slide showing the group's result. In the example from Figure 4, if the participant cooperates, then everyone wins the same amount (10 €), if the participant freerides, then s/he wins 15 €, while the other four players only receive 10 € (slide 6);
7. end of the trial.

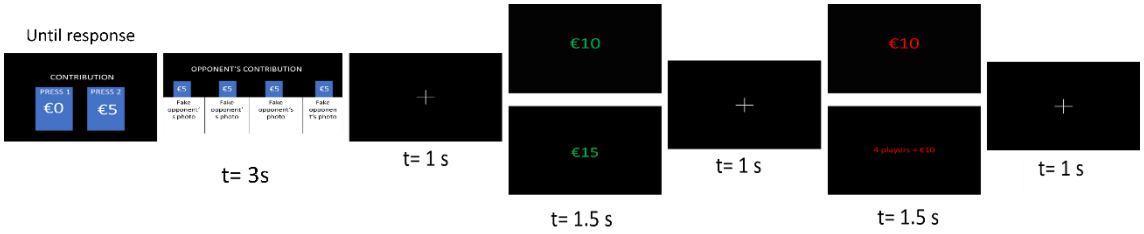

Figure 2.4 – Example of an individual trial from the cooperative round. In this type of round, the group is intensively cooperating, so that the outcome will only be affected by the participant decisions.

2.2.5. Volunteer's Dilemma (VD)

- A typical scenario in the Volunteer's Dilemma is (Diekmann, 1985; Goeree, Holt, & Smith, 2017): due to a failure, electricity has gone in the neighbourhood; everyone knows that if somebody gives a phone call the failure will be repaired, and electricity will return again; the phone call, however, has a cost and its cost is to be assumed by the caller.
- The participant has to make a decision: or volunteers and assumes the cost or waits that somebody else makes the call. If s/he does not assume the cost and someone else does, then s/he benefits from the public good at no cost. This manipulation is made, in order to assess the "opportunistic immobility" either in small groups, and in larger, i.e., inducing selfish decisions.

For this study, the original construct of the game (Diekmann, 1985) was mimicked and adapted to an economic scenario (Goeree, Holt, & Smith, 2017), in which:

- Each participant must make (covertly) the decision: to choose 1 cent or to choose €1.
- If at least one player chooses 1 cent (volunteers and assumes the cost), then everyone gets the amount chosen, otherwise, no one gets anything.
- The game has a total of 65 trials.

Table 2.6 - Payoff matrix between the participants and the players in the VD.

Participant *versus* Players	***If the participant volunteers (gives 1 cent)***	***If the participant does not volunteer (keeps 1€)***
If at least one player volunteers	1,1	1,0
If no players volunteer	1,0	0,0

The detailed sequence in each trial is (cf. Figure 2.5):

1. Each trial started with a decision between €1 and 1 cent in which the participant must choose either to give 1 cent or to keep the money to him/herself by pressing the correspondent key;
2. A slide showing the result of the group is displayed for 3 seconds;
3. The outcome is displayed on the third slide for 2 seconds. If at least one player, including the participant, volunteers with 1 cent towards the group, then everyone keeps the amount they initially chose. If no one does that, i.e., if no one volunteers and everyone wants to keep 1 € for themselves, then no one wins;
4. A fixation cross is displayed on the screen for 1 second;
5. End of the trial.

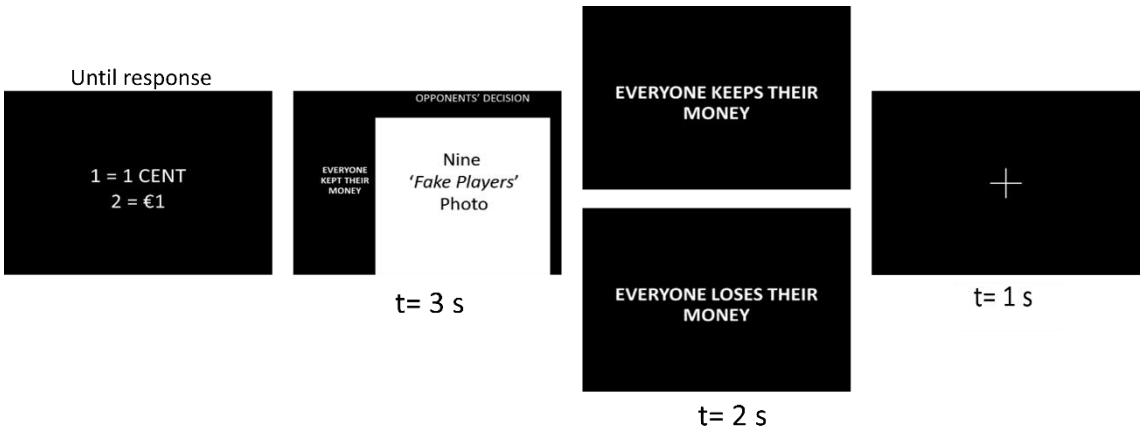

Figure 2.5 – Example of an individual trial.

2.3. EEG apparatus

This research took into account the recommendations and limits mentioned in Gilmore (1994) and Light et al. (2010) concerning the EEG acquisitions best practices and safety.

The experiments were conducted in the Neuropsychology Laboratory, Faculty of Psychology and Education Sciences, University of Porto, Portugal (see, Figure 2.6), and in the Psychology EEG Laboratory of the School of Nursing and Human Sciences, Faculty of Science and Health, Dublin City University, Ireland (see, Figures 2.7 and 2.8). The two EEG devices were not totally equivalent, even though they had both 32 active electrodes (10/20 system), covering the whole scalp (see, Figure 2.9), however, the acquisitions parameters (described in more detail in section 2.5. Data acquisition) were matched as closely as possible.

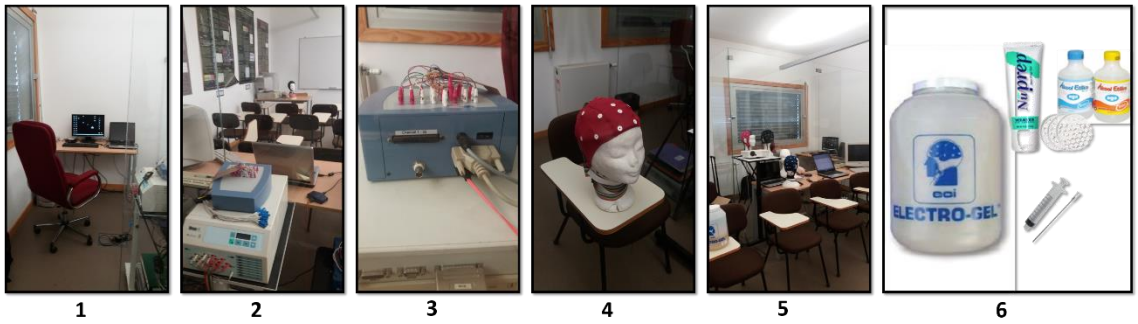

Figure 2.6- Setup of the Neuropsychology Lab at the Faculty of Psychology and Education Sciences, University of Porto. **1-** Room for the participant. **2,3-** Amplifier. **4-** EEG cap (Note: EEG cap references (ANT system) used: 211091, 211092 and 211093. All uni-size Ag/AgCl caps). **5-** Recording room. **6-** Electroconductive gel (left), Nuprep gel for scrubbing (upper left), alcohol, cotton pads and syringes with blunt tip (bottom right).

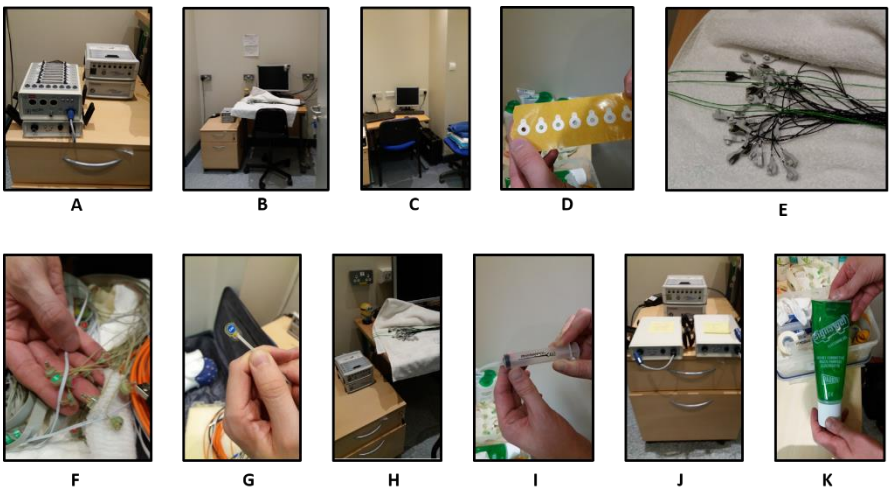

Figure 2.7- Setup of the EEG Lab at the Psychology Department at the SNHS at DCU. **A-** Battery and amplifier from Maynooth (left) and battery and amplifier from DCU (right). **B-** Electrically sheltered room for the participants. **C-** Recording room. **D-** Electrode washers. **E, F, G, H-** Electrodes. **I-** Syringes. **J-** Two batteries from Maynooth University. **K-** Electrode gel.

Figure 2.8- EEG caps from Maynooth University (Ag/AgCl caps) (from **L** to **O**, differing in size, i.e., from LARGE/MEDIUM, LARGE to SMALL, respectively(*)) and from DCU (**P**).

(*) Head circumference electro-cap International, Inc. Eaton, Ohio 45320 USA (Biosemi):

Large Size (blue cap): 58-62 cm

Large / medium (purple and red cap): 56-60 cm

Medium / small (yellow and red cap): 52-56 cm

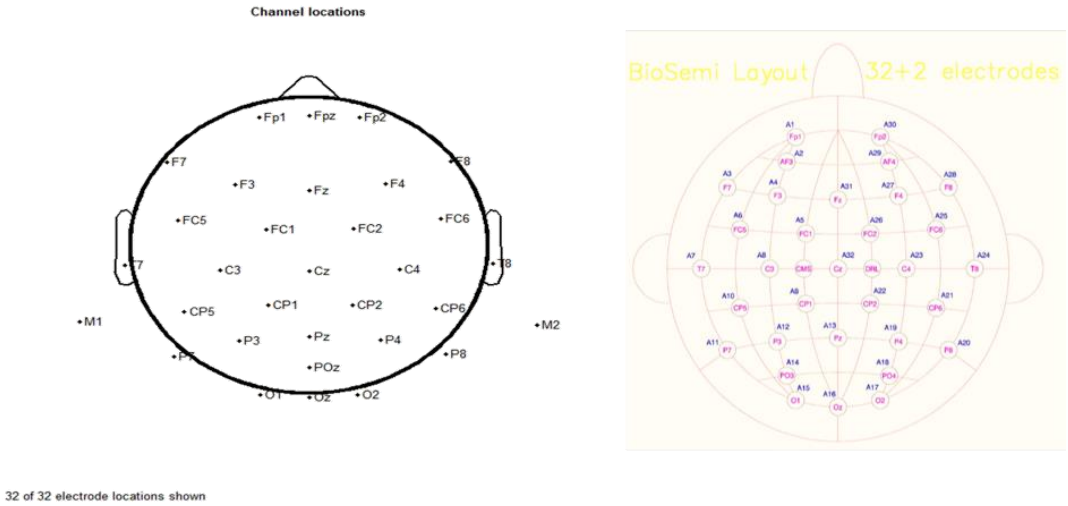

Figure 2.9 - Schematic positioning of electrodes in the 32-channel EEG used in Porto (right) and in Dublin (left). The images were retrieved directly through the EEGLab

software (left) and https://www.biosemi.com/pics/cap_32_layout_medium.jpg (right), respectively.

Thus, to solve this issue, four electrodes had to be eliminated from both caps. M1, M2, Fpz, POz were eliminated from the Portuguese EEG cap and AF3, AF4, PO3, PO4 from the Irish one (see, Figure 2.10). Moreover, an elp. file, used to read head coordinates of each electrodes, was created, so that the conditions during the analysis would be the same on both sites.

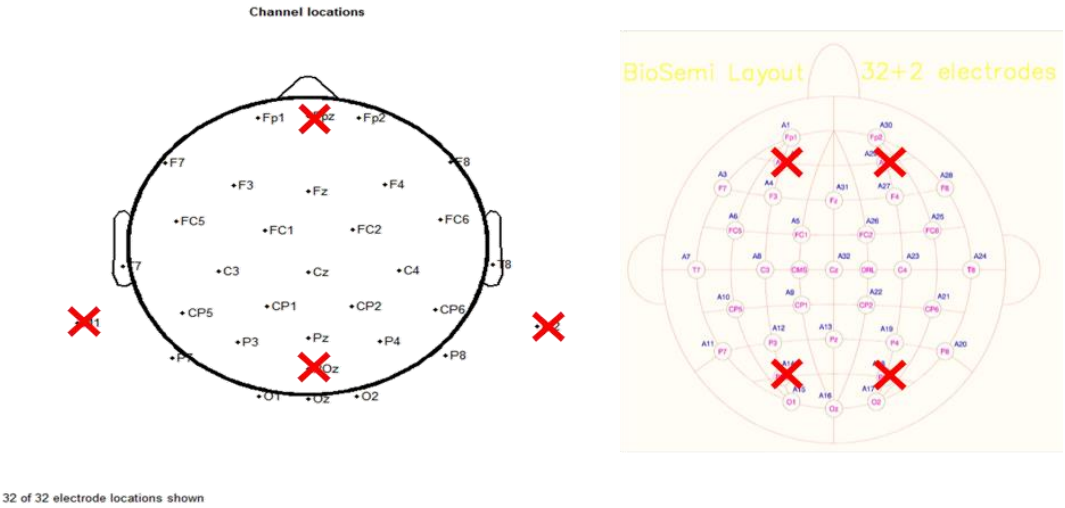

Figure 2.10 – Electrodes eliminated from the Portuguese EEG cap (right) and from the Irish one (left).

2.4. Participant Recruitment and Ethical Approval

After having received approval by the Ethics Committees from Ireland and Portugal (cf. Appendix II and III, respectively) a total of 35 participants from Portugal (17 males and 18 females) and 31 participants from Ireland (13 males and 18 females) were recruited (for further information on the participants that were dismissed with the justification for the dismissal, please, cf. Appendix XVI), in order to account with the enculturation / acculturation instrument (cf. Appendixes VIII and IX, i.e., IPEAS) screening, or technical difficulties during the EEG acquisition. Also, in order to screen participants that may suffer from mild cognitive impairment, the Montreal Cognitive Assessment (MoCA) (https://www.mocatest.org/splash/), version 7.1, was also applied, as well as the Handedness Questionnaire (cf. Appendixes IV and V). If participants did not meet the inclusion and exclusion criteria or failed the right handedness test / IPEAS / MoCA, they were dismissed before the study would take place (cf. Appendix XVI).

The recruitment was through emails sent by a neutral person of the research study, as well as posters in strategic places around the University campuses and other

public places. Also, posts on social media were used, in order to disseminate the call for participation.

The participants were selected according to a list of several inclusion / exclusion criteria that helped in screening the participants of this study. Therefore, the inclusion criteria were:

- aged between 18 and 50 years old;
- English as first language (in Ireland) / Portuguese as the first language (in Portugal);
- Irish natives in Ireland (and Portuguese natives in Portugal) and must been living in full term in the country of origin (i.e., travel abroad only for short terms, e.g., on vacation);
- right handed.

Moreover, the exclusion criteria were:

- personal history or diagnosis of neurologic or psychiatric disorders;
- taking medication that influence or change the behaviour;
- recent excessive consumption of alcohol;
- consumption of drugs at a pace that could disturb behaviour;
- pregnancy or breast-feeding;
- any sort of lesion in the scalp;
- actual or future student of any of the researchers.

Recently published studies using EEG and games from the GT recruited between 20 and 26 participants (Chung et al., 2015; Qu, Wang, & Huang, 2013; Wu, Leliveld, & Zhou, 2011). Hence, this research includes two cohorts, one representing the Irish culture and the other one representing the Portuguese culture, of similar size.

The participants were paid for their time (15 € in a gift card). Also, in order to prompt participants to compete in the games, the three participants that earned more points in the games received an extra 30 € prize (in a gift card, too). This is to induce a context of reality in the participants, so they believe they are competing against other participants.

Therefore, each session with the participants began with the confirmation of the inclusion criteria and a small brief about the study's requirement (cf. Appendixes VI and VII with the Informed Consent, X and XI with the Plain Language Statement), as well as the collection of sociodemographic and neurocognitive information (cf. Table 2.7).

Table 2.7 – Sociodemographic information and means (and standard deviations) of neurocognitive measures [(*)].

Measure [(*)]	***Portuguese (group 1)***	***Irish (group 2)***	***Group comparison***	
			t	*p*
N	30	30	-	-
Gender (n male / n female)	15/15	13/17	-	-
Age	25.5 (7.61)	23.9 (6.83)	0.856	.395
MoCA	27.9 (1.19)	28.3 (1.49)	-0.907	.368
HQ	95.5 (9.13)	93.0 (9.52)	1.038	.304
IPEAS (regarding the questions involving the native culture)	89.6 (7.18)	88.3 (9.85)	0.599	.552
IPEAS (regarding the questions involving another culture)	4.3 (6.78)	5.3 (7.76)	-0.531	.597

[(*)] Measures were obtained after performing an independent- measures- t- test for each factor, while using the IBM SPSS© (version 24).

2.4.1. MoCA, The Montreal Cognitive Assessment

This test is commonly used to screen participants that may suffer from mild cognitive impairment (https://www.mocatest.org/splash/), available in the English and Portuguese version).

It consists of a one-page test that lasts approximately thirty minutes, depending on the participant, and that assesses different cognitive domains, such as:

1. executive functions (alternating trail making) and visuoconstructional skills (drawing a cube and a clock);
2. language (naming the animals that are on the pictures; sentence repetition; verbal fluency);
3. memory (remembering a list of five words at the end of the test);
4. attention (forward and backward digit span; vigilance; serial subtraction);
5. orientation (asking the participant to name the date, place and city where the test is taking place).

It is quoted from 0 to 30 points, 26 being considered as normal.

All participants that got a score underneath this value, were dismissed from the study (cf. Appendix XVI).

2.4.2. Handedness Questionnaire (HQ)

The test uses a percentage scale that helps to determine the dominance of a person's hand (cf. Appendix IV and V, available in the English and Portuguese version, respectively).

It consists of a small survey, in which participants are asked different daily tasks, and they have to choose the hand they use to perform the specific task.

All participants with a percentage below 65% were dismissed from this study, since the test was performed by the participant's self-evaluation and not by an observation of the participant performing the tasks (cf. Appendix XVI).

2.4.3. IPEAS, Irish-Portuguese Enculturation / Acculturation Survey

The IPEAS (cf. Appendix VIII and IX, available in the English and Portuguese version, respectively) is an adapted version based on the Vancouver Index of Acculturation (VIA) (Tieu & Konnert, 2014) and the Enculturation Scale for Filipino Americans (ESFA) (Prado & Church, 2010).

VIA uses a bidimensional measure by evaluating both the enculturation and acculturation dimensions as two distinct constructs, enabling to understand how people adapt to new traditions, values, language, etc., by assessing how their *heritage* culture (no matter if it belongs to the culture that the person was born or raised, or if it is from the family's background) has been affected.

On the other hand, ESFA uses measures of enculturation by creating a scale to analyse three general dimensions, such as *Connection with Homeland*, *Interpersonal Norms, and Conservatism* (Prado & Church, 2010). The idea is to differentiate the concepts as two different dimensions, in order to obtain a more accurate measurement on how the Filipino Americans had retained and/or learned values, beliefs, traditions, etc., from their *heritage* culture.

Therefore, for this study, a total of 20 questions addressing cultural aspects of each country (10 questions per country) was created to assess the enculturation and/or

acculturation level of the participants (cf. Appendix XVI, for further details on the score obtained by each participant).

2.5. Data acquisition

The recording session involved about 15-20 minutes for electrode application, followed by the introduction to the instructions (cf. Appendix XII and XIII, available in the English and Portuguese version, respectively) and practise blocks of each game, which took about 30-40 minutes overall. Participants were implicated in the acquisition session for about 1 hour. Frequent breaks were interspersed during the experiment (e.g. between the games), to ensure minor or no discomfort of the participants.

The electrodes were prepared and checked before the experiment started as to make sure impedance values were < 5 kΩ sampling. The setup of the external electrodes (i.e., EX1, EX2, EX3 and EX4) was made according to the BioSemi ActiveView software (see Figure 2.11). Cz was used as the reference electrode during the recording session in Ireland, whereas the mastoids were used as the reference electrodes during the recording session in Portugal. However, for the analysis purposes, we decided to set the reference electrode to Cz. Regarding the recording software, the sampling rate= 1024 Hz; Low Cutoff Filter = Fixed TC1 Sec (0,16 Hz); High Cutoff Filter = High Cutoff 15Hz. Moreover, the epochs for the ERPs analysis (using BESA software, described below) were from 200 to 800ms, time-locked to the feedback onset.

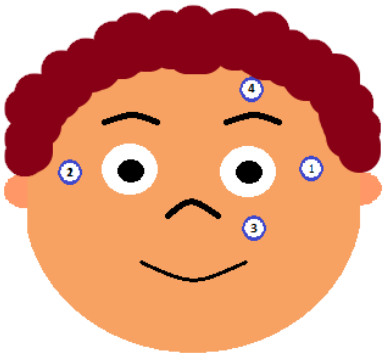

Figure 2.11 - Schematic positioning of the external electrodes.

As measures of quality, the activity of all the electrodes and all channels was systematically checked in order to ensure that they were working properly, i.e., electrodes that produced flat line signals, or showed a lot of activity, while the participant

was resting, were considered as a bad electrode / channel (see, Appendix XVIII). If there were still bad channels remaining, more electrode gel was applied and scrubbing to minimize impedances (the last step was only performed for the Portuguese participants, as for the Irish EEG caps no skin preparation was required since high electrode impedance can be tolerated). Further, every participant was told to avoid eye blinks, and tensing muscles in their forehead or jaw, as this would introduce noise into the EEG data. After all the electrode signals looked acceptable, the recording session began.

At the end of each EEG collection, the removal and cleaning of the caps and electrodes was performed. Furthermore, the participants were debriefed from the study they just participated in and were told that they had played with *fake* opponents during the entire experiment.

Finally, the participants were paid for their time, with a gift card worth 15 €. The three participants that obtained most points received a bonus of 30 € (also, in a gift card). As explained in section 2.4, this was introduced to avoid deception from the participants' perspective, but also to prompt them to assume an active posture while playing the games, by giving them a context of reality, so they believed they were playing against other participants.

2.5.1. Triggers

Triggers are timing markers used to delimit an event of interest that occurs at a certain stage of the task, being sent from the parallel port to the EEG apparatus.

Each game was triggered differently (cf. Appendix XV).

Therefore, for the RPS, the outcome was initially triggered (Win, Draw, Lose); however, we also decided to trigger the previous slide, i.e., where the computer's choice is displayed, since at this stage, participants already knew the outcome before the next slide would figure on the screen (see, Figure 2.12)

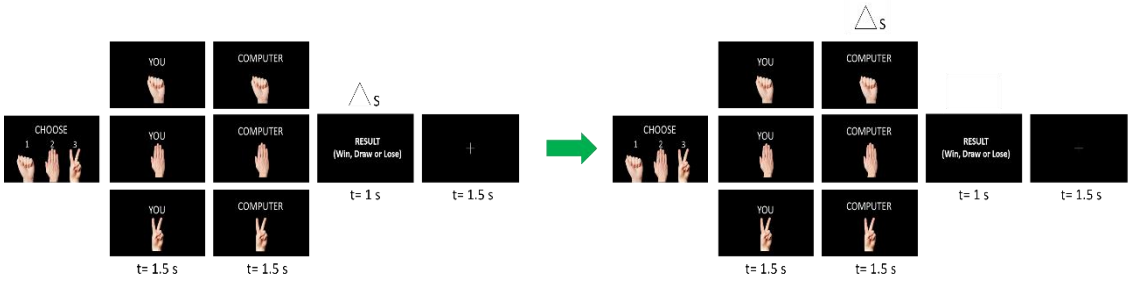

Figure 2.12 – Onset for the outcome (left) and for the computer's choice (right).

For the UG, the face of the *fake* participant was triggered, since the intention would be to see how the perception of freeriders affects brain function. The condition (level of fairness) of each offer was also triggered, in order to understand how people, react to fair/unfair offers (see, Figure 2.13).

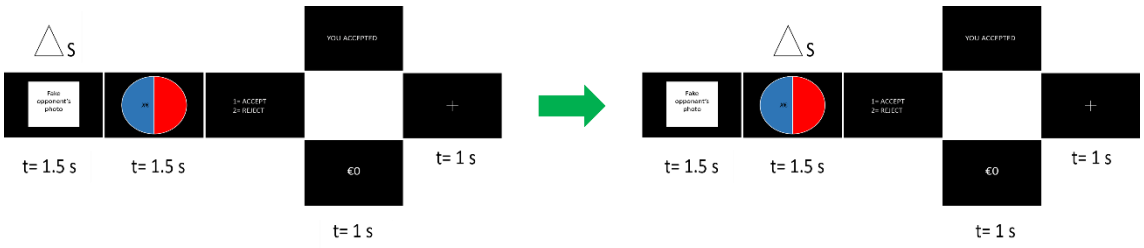

Figure 2.13 – Onset for the *fake* participants face (left) and for the offers made (right).

2.5.2. ERP Components

The Event-Related-Potentials are important components used to measure the earliest stages of information processing of the brain, to a certain event or stimuli within a millisecond precision, which can then be compared and/or linked to the behavioural responses from the same event or stimuli.

Unlike other techniques, this procedure is non-invasive, it has a high temporal resolution and it is affordable too. However, it requires a large number of time-locked experimental trials, in order to obtain a good averaged signal.

Regarding the ERPs analysed for this study, three feedback-locked event-related potentials (ERPs) that play a crucial role in outcome processing (Miltner et al., 1997; Martín, 2012; Holroyd and Coles, 2002; Donchin and Coles, 1988; Nieuwenhuis, 2011; Boksem & De Cremer, 2010; Campanhã, Minati, Fregni, & Boggio, 2011; Osinsky, Mussel, Öhrlein, & Hewig, 2013 Gehring & Willoughby, 2002), were examined:

- The Feedback Related Negativity (FRN) and the P3 in the RPS;
- The Medial Frontal Negativity (MFN) in the UG.

Besides, a fourth ERP for neural processing of faces (Kropotov, 2016; Ghuman et al. 2014) was analysed for the UG:

- The N170.

While the FRN appears to be sensitive to expectancy violations, the P3 appears to be sensitive to the arousing nature of the feedback, the MFN seems to be sensitive to unfairness and the N170 appears to be an important component for face recognition.

FRN (Feedback Related Negativity)

According to the reward prediction error hypothesis (Miltner et al., 1997), the FRN is consistently larger for negative than for positive feedbacks (for both monetary and non-monetary feedbacks) (Martín, 2012), being elicited in the frontal-central region (more precisely, in the anterior cingulate cortex, ACC) at approximately 200-300ms (with a negative deflection), after the feedback onset. Besides, it is also dependent on dopaminergic function, which in return also decreases when an outcome is worse than expected (Holroyd and Coles, 2002).

The FRN was measured at Fz, quantified as the mean amplitude in the time window of the 220-320ms for the onset placed on the result and for the computer's choice.

P300

Even though, the P300 has widespread sources, it is generated in the centroparietal region, being elicited at approximately 300 to 600 ms after the feedback onset and presenting a positive deflection (Martín, 2012).

According to the context-updating hypothesis (Donchin and Coles, 1988), the P300 catalogs the brain's activity underlying the revision of the current mental model of a certain task, after a stimulus. The mental model is maintained if the stimulus context is also preserved, and only sensory potentials are evoked. If a new stimulus is detected, the updating of the information in working memory will occur and the P300 will be elicited. Therefore, the outcomes associated with higher levels of arousal will generate larger P300 amplitudes, reflecting increased allocation of attention (Nieuwenhuis, 2011).

The P300 was measured at Pz, quantified as the mean amplitude in the time window of the 350-450ms.

MFN (Medial Frontal Negativity)

The MFN is associated with unfairness sensitivity being elicited by negative feedback (e.g. situations of loss of money *versus* gain of money) and is calculated by subtracting the ERP elicited by fair offers from the one elicited by unfair offers (Boksem & De Cremer, 2010; Campanhã, Minati, Fregni, & Boggio, 2011; Osinsky, Mussel,

Öhrlein, & Hewig, 2013). The MFN is normally elicited at approximately 300 ms after the offer onset, appearing to also be generated in the ACC (Gehring & Willoughby, 2002).

The MFN was measured at Fz, quantified as the mean amplitude in the time window of the 250-330ms for the Irish group and 200-280ms for the Portuguese group, after the offer onset.

N170

The N170 is associated with the encoding of faces, showing a right-hemisphere localization (Kropotov, 2016) displayed across the occipital-temporal-parietal regions. Ghuman and colleagues (2014) also found a correlation between the fusiform gyrus of the temporal cortex with face recognition, while using fMRI.The N170 is elicited at approximately 130 to 200ms after the onset of the stimulus presentation, presenting a stronger effect on the right side of the scalp (Ghuman et al. 2014; Kropotov, 2016).

The N170 was measured at P8, quantified as the mean amplitude in the time window of the 140-200ms for the Irish group and 120-180ms for the Portuguese group, ms after the offer onset.

Considering the scope of our research study, i.e., to understand how Portuguese and Irish people differ (behaviorally and neurobiologically) on a free-riding and/or cooperation level, we predict that free-riders will have a larger FRN for negative feedbacks (e.g., when they lose) than positive ones. Regarding the P300, we expect that free-riders will elicit a higher P300 when the level of arousal is high (in this case, when they are winning). Thirdly, for the MFN, we anticipate that free-riders will elicit a higher MFN in scenarios in which they are punished by their *fake* opponent. Finally, we estimate that participants will elicit a different N170 when they will be playing against a *fake* opponent that acts as a free-rider when compared with a *fake* opponent that acts as a cooperator.

2.5.3. E-Prime Software

E-Prime software offers a very easy and intuitive way to design and analyse behavioural paradigms and was used to program all six tasks.

The Neuropsychophysiology Laboratory at the University of Porto (Portugal) used the version 2.0.8.90, while the one used at Dublin City University (Ireland) is more recent, i.e., version 2.0.10.252. Even though, the versions were slightly different, this did not

affect the collection of the data. The games were identical in their structure and triggers, differing only in the language and set of photos (*) of the *fake* opponents.

(*) The photos were taken from random students (both in Ireland and in Portugal) that did not take part of the study and that gave full consent and approval to use them for the purpose of this study.

2.5.4. ASA Software (ANT System) and Biosemi ActiveView Software

ASA Software (ANT Neuro) offers a high flexibility for cognitive and clinical neuroscientific studies, being also compatible with several softwares of analysis such as BESA software.

It was used to record the brain activity of the Portuguese participants in the Neuropsychophysiology of Porto (Portugal).

The BioSemi ActiveTwo is only used for research purposes, being able to record brain signals.

This recording software was used in the Psychology Department (EGGLab) of DCU (Ireland).

The electrophysiological data acquired with the ActiveTwo is meant to be used within the framework of scientific research. The system is not intended for medical applications.

The system is not certified as a Medical Device as defined in EU directive 93/42/EEC, Article 1, Sec 2 (a) (European Union), or as defined in the Federal Food Drug & Cosmetic (FD&C) Act, Chapter II, Sec 201 (h) (USA).

2.5.5. BESA Software

BESA is widely used software for source analysis and dipole localization in EEG and MEG research. BESA Research has been developed based on 30 years' experience in human brain research by the team around Michael Scherg, University of Heidelberg, and Patrick Berg, University of Konstanz.

The version used for this research study was 5.3.1 February 2010. BESA Software is not a clinical product, not being adequate for diagnostic procedures.

2.6. Statistical Methods and Analysis

The results of both the behavioural and neurophysiological data were compared using the IBM SPSS© (version 24).

To detect the effects on the *feedback type* for the neurophysiological analysis, a 3x2x2 (i.e., 3 different conditions x 2 electrodes x 2 groups)repeated measures ANOVA was performed for the RPS and a 2x1x2 (i.e., 2 different conditions x 1 electrode x 2 groups) repeated measures ANOVA was performed for the UG, with *feedback type* and *electrode* as within-participants and *group* (Portuguese participants *versus* Irish participants) as between-participants' factor. The mean amplitude was chosen as the dependent variable for the ERP components.

For the RPS the *feedback type* had three factors/levels, i.e., win / draw / lose (if the feedback onset was set for the result) or rock/paper/scissors (if the feedback onset was set for the computer's choice), while for the UG the *feedback type* had only two factors/levels, i.e., fair / unfair (independently of the feedback onset being set for the *fake* participant's face or for the offer made).

Regarding the behavioural analysis, the choice rates (i.e., percentage of times the participant choses an option, in relation to the total number of trials) was calculated for each participant. Once again, to see the effects of the *choice type/offer type/proposer type* and reaction times, a repeated measures ANOVA was performed with the *choice type/offer type/proposer type* as the within-participants variable and *group* (Portuguese participants *versus* Irish participants) as the between-participants' factor.

The threshold established for all analysis to test statistical significance was set at $\alpha = .05$. Whenever violations of sphericity were detected, the Greenhouse-Geisser method was applied (Luck, 2005; Picton et al., 2000). Moreover, significant ANOVA main effects were quantified using Bonferroni-corrected post-hoc comparisons.

Chapter III

Results

3.1. Behavioural data

3.1.1. Rock-Paper-Scissors (RPS)

Regarding decision-making results, we did not find a main effect of *group*, $F(1, 58) = 1.00$, $p = .321$, $\eta^2p = .017$. However, we found a main effect of *choice type*, $F(2, 96) = 6.79$, $p = .003$, $\eta^2p = .105$, $\varepsilon = 0.870$, revealing that, in both groups, Rock was significantly more chosen than Paper ($p = .008$) and Scissors ($p = .027$). We did not find a significant choice*group interaction, $F(2, 116) = 0.571$, $p = .535$, $\eta^2p = .010$.

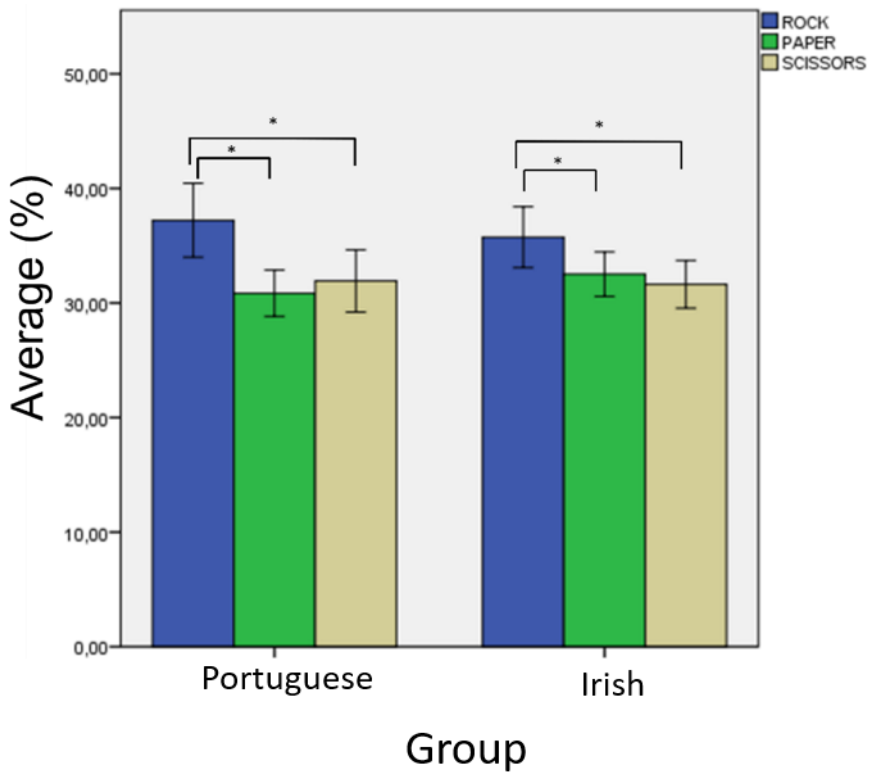

Figure 3.1 – Average rates (%) for the two groups (Portuguese sample on the left and Irish one on the right) in the *choice* made during the Rock-Paper-Scissors game. Error bars indicate 95% confidence intervals.

Concerning reaction times, we did not find a main effect of *group*, $F(1, 58) = 1.260$, $p = .266$, $\eta^2p = .021$. We also did not find a main effect of *choice type*, $F(2, 89) =$

1.281, p = .277, η^2p = .022, ε= 0.800 and of choice*group interaction, $F(2, 116) = 0.300$, p = .741, η^2p = .005.

3.1.2. Ultimatum Game (UG) and Proposer

Regarding decision-making results for the UG, we did not find a main effect of *group*, $F(1, 58) = 1.00$, p = .321, η^2p = .017. However, we found a main effect of *choice type*, $F(2, 123) = 54.095$, p = .001, η^2p = .483, ε= 0.425, revealing that, in both groups, Fair Accept (i.e., when participants accept a fair offer) > Unfair Reject (i.e., when participants reject an unfair offer) > Mid Accept (i.e., when participants accept a mid-offer) > Mid Reject (i.e., when participants reject a mid-offer) > Unfair Accept Reject (i.e., when participants accept an unfair offer) > Fair Reject (i.e., when participants reject a fair offer).

We did not find a significant choice*group interaction, $F(2, 123) = 1.454$, p = .237, η^2p = .024.

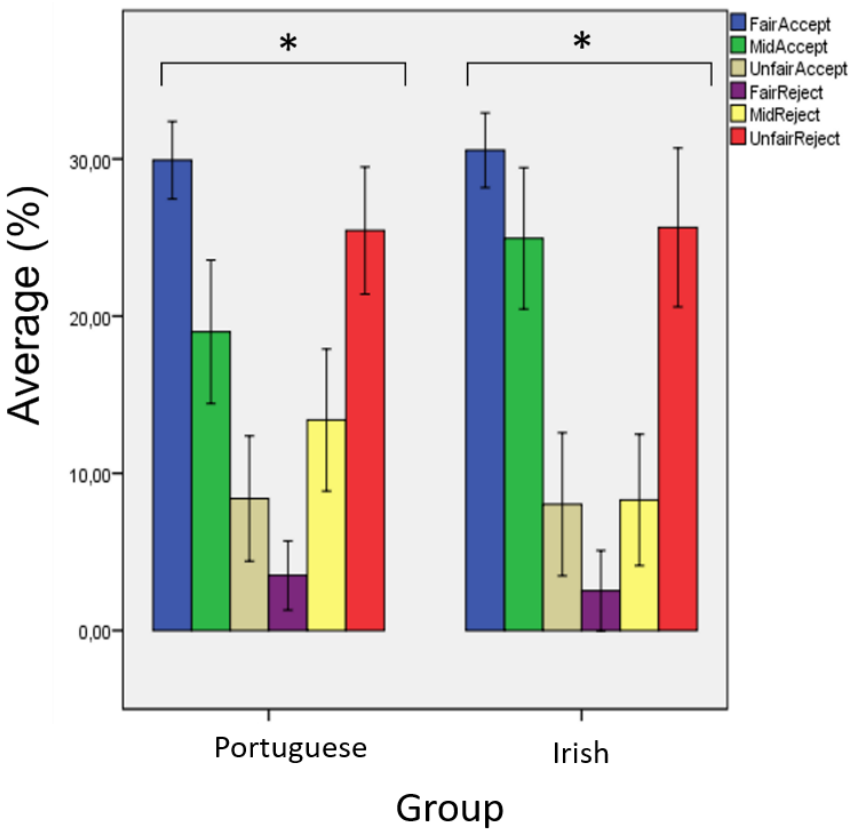

Figure 3.2 – Average rates (%) for the two groups (Portuguese sample on the left and Irish one on the right) in the *choice* made during the Ultimatum Game. Error bars indicate 95% confidence intervals.

Concerning reaction times, we did not find a main effect of *group*, $F(1, 58) = .072$, $p = .790$, $\eta^2p = .001$. We also did not find a main effect of *choice type*, $F(3, 188) = 2.017$, $p = .108$, $\eta^2p = .034$, $\varepsilon = 0.647$ and of choice*group interaction, $F(3, 188) = 0.662$, $p = .587$, $\eta^2p = .011$.

After the 120 trials, a set of 6 and 12 trials (behavioural only) was displayed, in which the participant had to classify **each offer** and **each proposer** who made the offer as *very unfair* to *very fair*, respectively (on a scale from 1 to 5, 1 being *very unfair* and 5 *very fair*). Regarding the results for the classification on the offers made during the game, we did not find a main effect of *group,* $F(1,58) = 1.294$, $p = .260$, $\eta^2p = .022$. However, we found a main effect of *offer type* ($p = .001$), revealing that, in both groups, Fair Offers received a higher classification, following the Mid Offers and then the Unfair Offers, respectively (cf. Figure 3.3). There was no significant group*offer type interaction ($p>0.05$).

Concerning reaction times, we found a main effect of *group* $F(1,58) = 9.449$, $p = .003$, $\eta^2p = .140$, showing that Portuguese had faster responses while classifying the offers made, when compared with Irish. However, the results were statistically non-significant showing no main effect on *offer type* and offer type*group interaction ($p>.05$).

Regarding the results for the classification on each proposer, who made the offers during the game, we did not find a main effect of *group* and of group*proposer type interaction *($p<0.05$).* However, we found a main effect of *proposer type* ($p = .001$), revealing that, in both groups, the proposers associated with fair offers (Fair Faces) received a higher classification, following the by the ones who were offering mid offer (Mid Faces) and then the ones who made unfair offers (Unfair Faces), respectively (cf. Figure 3.3).

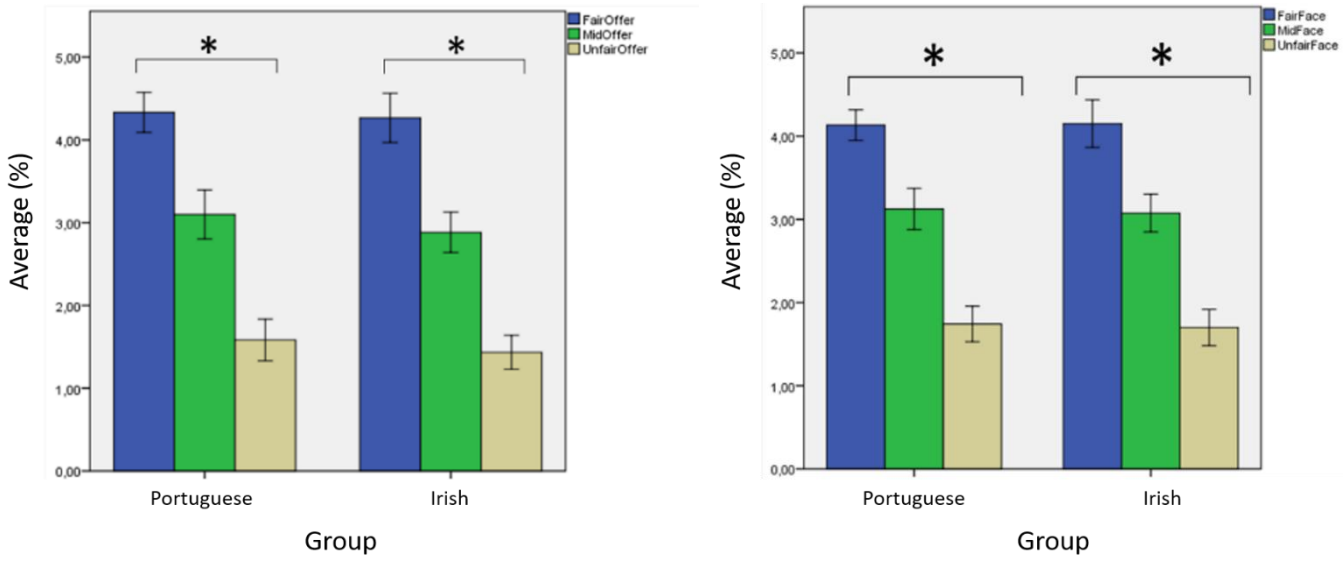

Figure 3.3 – Average rates (%) for the two groups (Portuguese sample on the left and Irish one on the right on each of the two graphs) in the classification made for the *offer type* (on the left graph) and the *proposer type* (on the right graph), during 18 trials after playing the Ultimatum Game. Error bars indicate 95% confidence intervals.

Concerning reaction times, the results were statistically non-significant showing no main effect on *group* and proposer type*group interaction (p>.05). However, we found a main effect of *proposer type*, $F(2,116) = 7.579$, $p = .001$, $\eta^2p = .116$, revealing that, the Portuguese had faster responses while classifying the proposers who made the offers, when compared with the Irish group.

Regarding the Proposer, we found a main effect on the *offer type* made between *groups*, $F(1, 58) = 4.131$, $p = .047$, in which the Irish group made higher offers to the opponent (cf. Figure 3.4).

Concerning reaction times, we did not find a main effect of *group*, $F(1, 58) = .187$, $p = .667$..

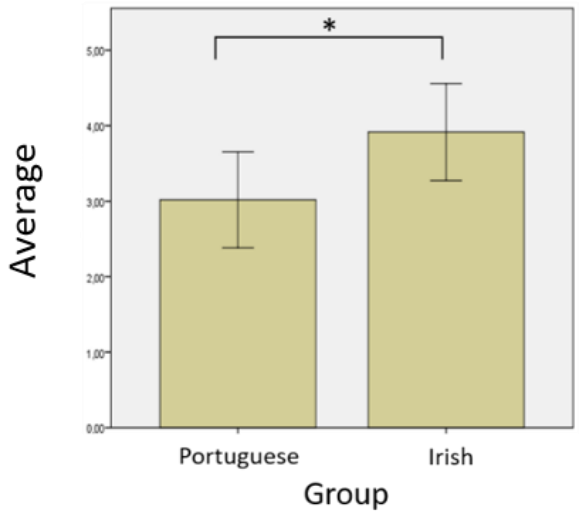

Figure 3.4 – Average rates for the two groups (Portuguese sample on the left and Irish one on the right) during the Proposer. Error bars indicate 95% confidence intervals.

3.1.3. Centipede Game (CG)

Regarding the decision-making results for the CG, we did not find a main effect of *group*, $F(1, 58) = 1.00$, $p = .321$, $\eta^2p = .017$. However, we found a main effect of *choice type*, $F(5, 290) = 48.96$, $p = .001$, $\eta^2p = .458$, $\varepsilon = 0.352$, revealing that, in both groups, **Pass Mid** (i.e., when the participant is passing the pot, while the opponents are being cooperative for half of the game and opportunistic during the other half) was significantly more chosen than **Pass Coop** (i.e., when the participant is passing the pot, while the

opponents are being cooperative), **Take Free** (i.e., when the participant is taking the pot, while the opponents are being opportunistic), **Pass Free** (i.e., when the participant is passing the pot, while the opponents are being opportunistic), **Take Coop** (i.e., when the participant is taking the pot, while the opponents are being cooperative) and **Take Mid** (i.e., when the participant is taking the pot, while the opponents are being cooperative for half of the game and opportunistic during the other half). From the interaction between each *choice type*, p=.001, except for the ones between Pass Free and Take Coop (p=.054); Pass Coop and Take Free (p=.035) and finally, between Pass Free and Take Free (p= 1.000) (the last one is statistically non-significant).

We did not find a significant choice type*group interaction, $F(5, 290) = 0.206$, $p = .960$, $\eta^2p = .004$.

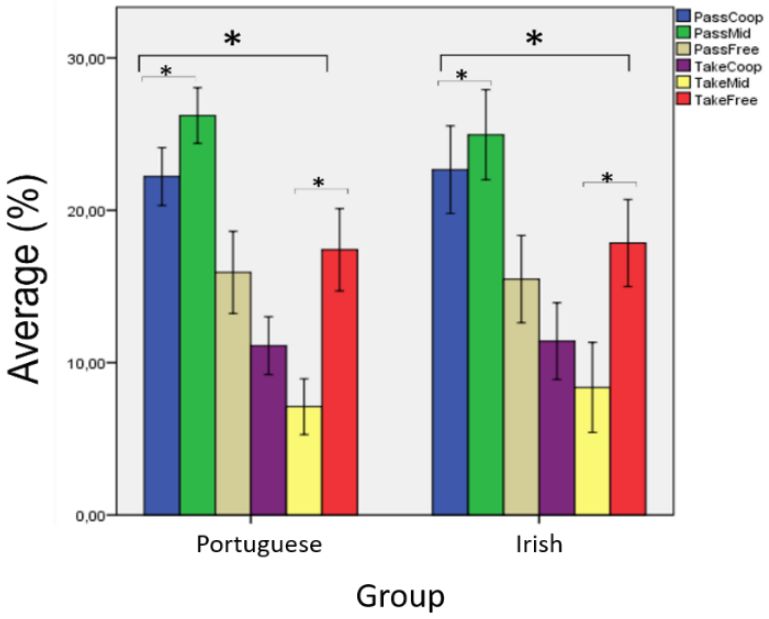

Figure 3.5 – Average rates (%) for the two groups (Portuguese sample on the left and Irish one on the right) during the Centipede Game. Error bars indicate 95% confidence intervals.

Concerning reaction times, we did not find a main effect of *group*, $F(1, 58) = 1.533$, $p = .221$, $\eta^2p = .026$. We also did not find a main effect of *choice type*, $F(2, 116) = 2.253$, $p = .110$, $\eta^2p = .037$, $\varepsilon = 0.399$ and of choice*group interaction, $F(2, 116) = 0.962$, $p = .385$, $\eta^2p = .016$.

3.1.4. Public Goods Game (PGG)

Regarding the decision-making results for the PGG, we did not find a main effect of *group*, $F(1, 58) = 0.900$, $p = .347$, $\eta^2p = .016$. However, we found a main effect of *choice type*, $F(2, 89) = 46.34$, $p = .001$, $\eta^2p = .448$, $\varepsilon = 0.311$, revealing that, in both

groups, **Success Coop** (i.e., in which the participant is giving €5 to the public pot and the group is also contributing to it) > **Failure Free** (i.e., in which the participant is not contributing to the public pot and at least two members are not giving money to the group) > **Success Free** (i.e., in which the participant is not contributing to the group, while the opponents do so) > **Failure Coop** (i.e., in which the participant is giving €5 to the public pot and at least two members are not giving money to the group). From the interaction between each *choice type*, *p*=.001, except for the ones between Success Coop and Success Free; Success Coop and Failure Free; Success Free and Failure Free (*p*= 1.000) were statistically non-significant (p=1.000).

We did not find a significant choice type*group interaction, $F(5, 285) = 0.658$, $p = .655$, $\eta^2p = .011$.

Concerning reaction times, we did not find a main effect of *group*, $F(1, 58) = 2.361$, $p = .130$, $\eta^2p = .039$. We also did not find a main effect of *choice type*, $F(3, 159) = 2.609$, $p = .112$, $\eta^2p = .043$, $\varepsilon = 0.548$ and of choice*group interaction, $F(3, 159) = 1.748$, $p = .124$, $\eta^2p = .029$.

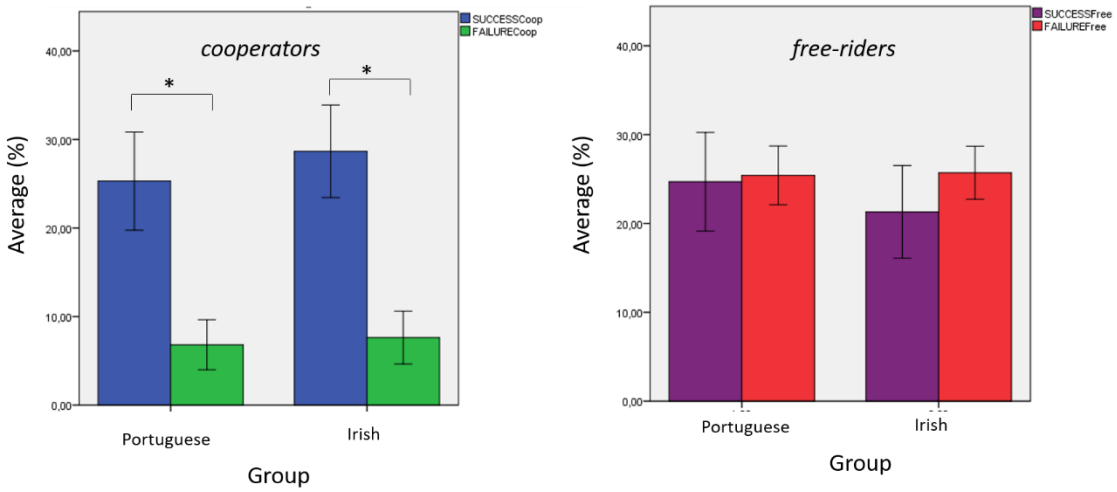

Figure 3.6 – Average rates (%) for the two groups (the first graph corresponding to the cooperators and the left graph corresponding to the free-riders) during the Public Goods Game. Error bars indicate 95% confidence intervals.

3.1.5. Volunteer's Dilemma (VD)

Regarding the decision-making results for the VD, we did not find a main effect of *group*, $F(1, 58) = 1.00$, $p = .321$, $\eta^2p = .017$. However, we found a main effect of *choice type*, $F(1, 59) = 30.45$, $p = .001$, $\eta^2p = .344$, $\varepsilon = 0.513$, revealing that, in both groups, Passing (i.e., volunteering towards the group) was significantly more chosen than Taking

(i.e., keeping one euro for himself/herself) (p = .001). We did not find a significant choice type*group interaction, $F(2, 116) = 0.589$, p = .557, η^2p = .010.

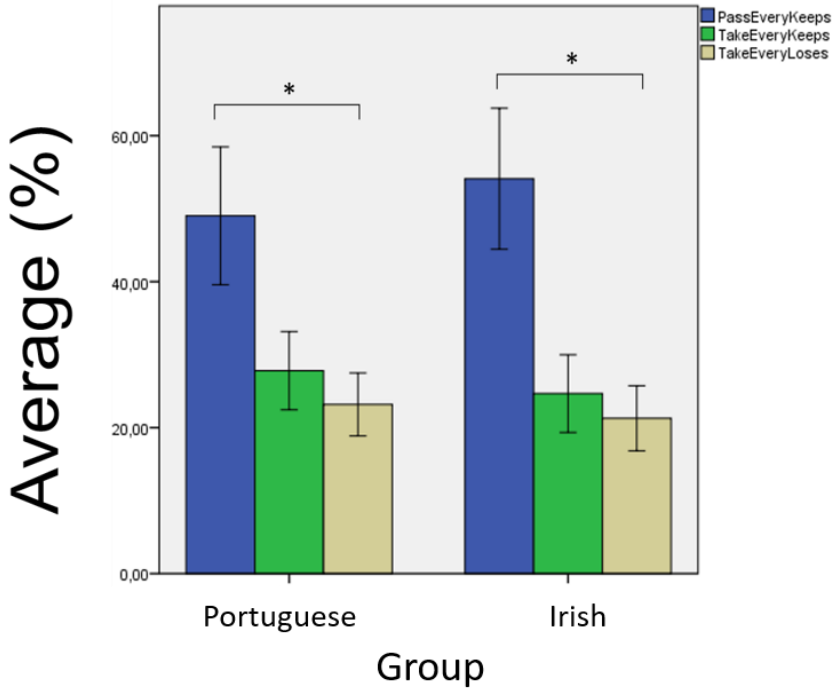

Figure 3.7 – Average rates (%) for the two groups (Portuguese sample on the left and Irish one on the right) during the Volunteer's Dilemma. Error bars indicate 95% confidence intervals.

Concerning the results of the reaction times, we did not find a main effect of *group*, $F(1, 59) = 3.328$, p = .073, η^2p = .054. However, we found a main effect of *choice type*, $F(2, 116) = 3.759$, p = .026, η^2p = .061, ε= 0.941, revealing that Portuguese were faster in their responses, especially when they chose to free-ride.

We did not find a significant choice type*group interaction, $F(2, 116) = 0.254$, p = .776, η^2p = .004.

3.2. EEG data

3.2.1. Rock-Paper-Scissors (RPS)

a) Results for the onset for the outcome:

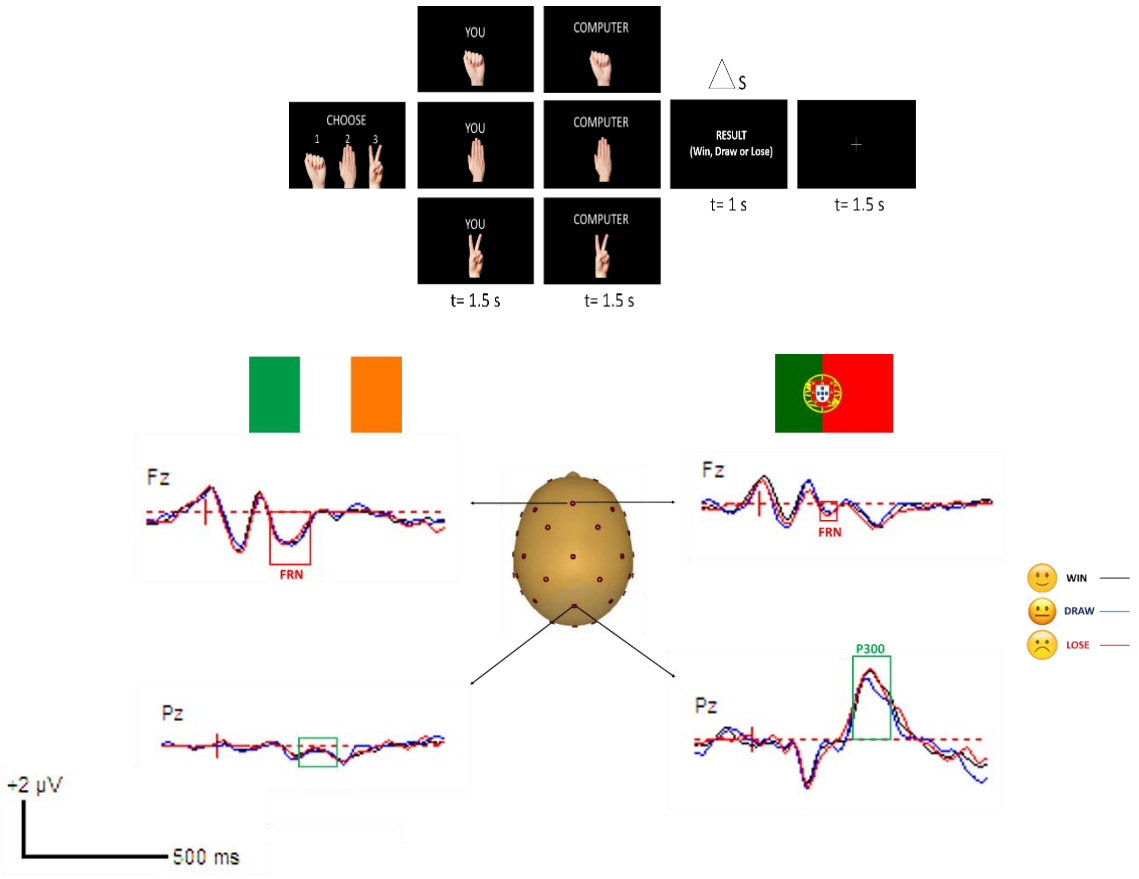

Figure 3.8 – Onset for the outcome (upper image). Grand-averages of the FRN and P300 for the Irish (left) and Portuguese group (right) (bottom image). The FRN was measured at Fz, quantified as the mean amplitude in the time window of the 220-320ms. The P3 was measured at Pz, quantified as the mean amplitude in the time window of the 350-450ms (bottom). **Note: These results were presented on the poster board number F015 at FENS Forum this July 2018, in Berlin (cf. Appendix XIX).**

● At Fz, we found a main effect of *group*, $F(1,55)=8.287$, $p=.006$, $\eta^2p = .131$, revealing that the FRN amplitude was more negative for Irish ($M= -0.726$, $SD=0.160$) than for the Portuguese group ($M= -0.081$, $SD= 0.157$). However, we did not find a significant main effect of *feedback type,* $F(2,95)=1.630$, $p=.204$, $\eta^2p = .029$, nor group* feedback type interaction, $F(2,95)=.388$, $p=. 683$, $\eta^2p = .006$.

● At Pz, we found a main effect of *group*, $F(1,55)=25.45$, $p<.001$, $\eta^2p = .316$, revealing that the P3 amplitude was larger for Portuguese ($M=1.94$, $SD=0.337$) than in the Irish group ($M= -0.49$, $SD=0.343$). However, we did not find a significant main effect of *feedback type,* $F(2,110)=0.857$, $p=.427$, $\eta^2p = .015$, nor of group* feedback type interaction, $F(2,110)= 1.636$, $p=.199$, $\eta^2p = .029$.

b) Results for the onset for the computer's choice:

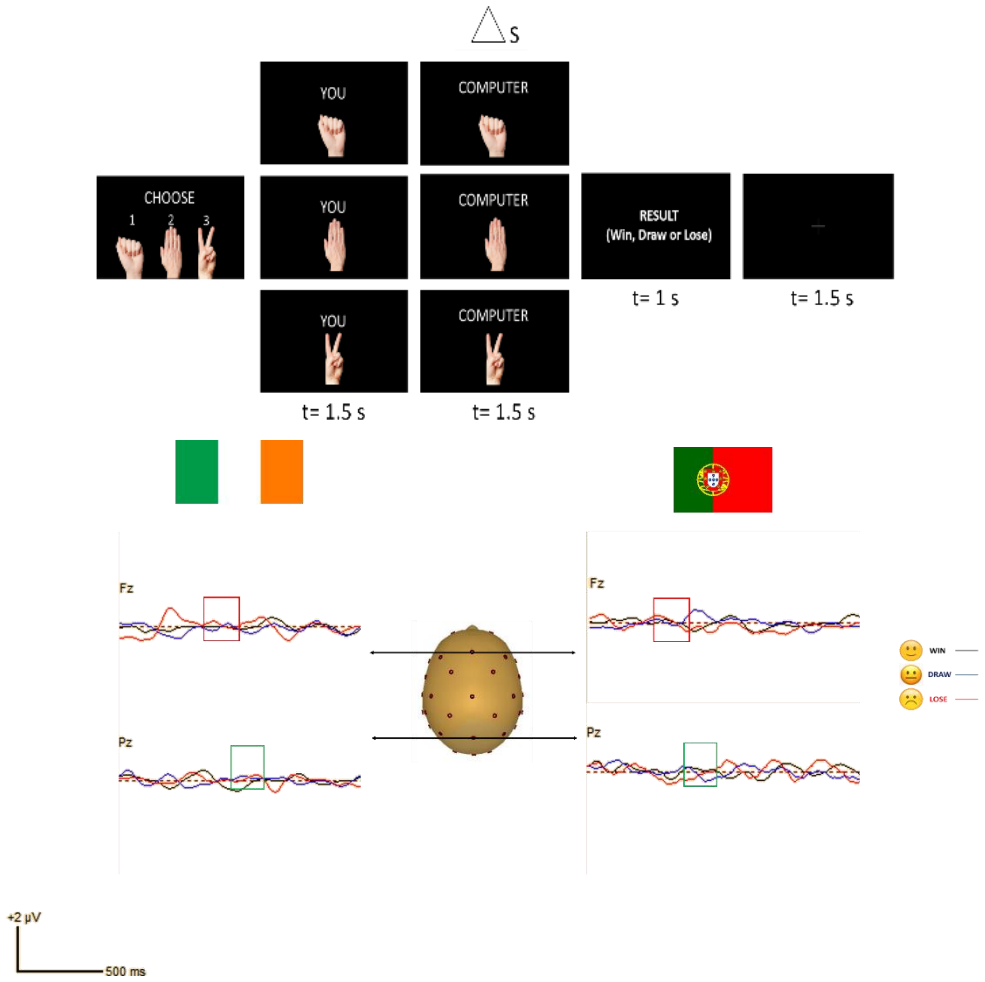

Figure 3.9 – Onset for the computer's choice (upper image). No ERP component was found for both the Irish and Portuguese group (bottom image).

The results for this onset were inconclusive, as the data was very noisy and no ERP components was found (cf. Figure 3.9). This might have been due to the fact that participants did not anticipate the outcome at this stage and were expecting the slide with the final result instead (in order to know if they won/drew/lost), not paying too much attention to the computer's choice slide.

3.2.2. Ultimatum Game (UG)

a) Results for the onset for the *fake* opponents' picture:

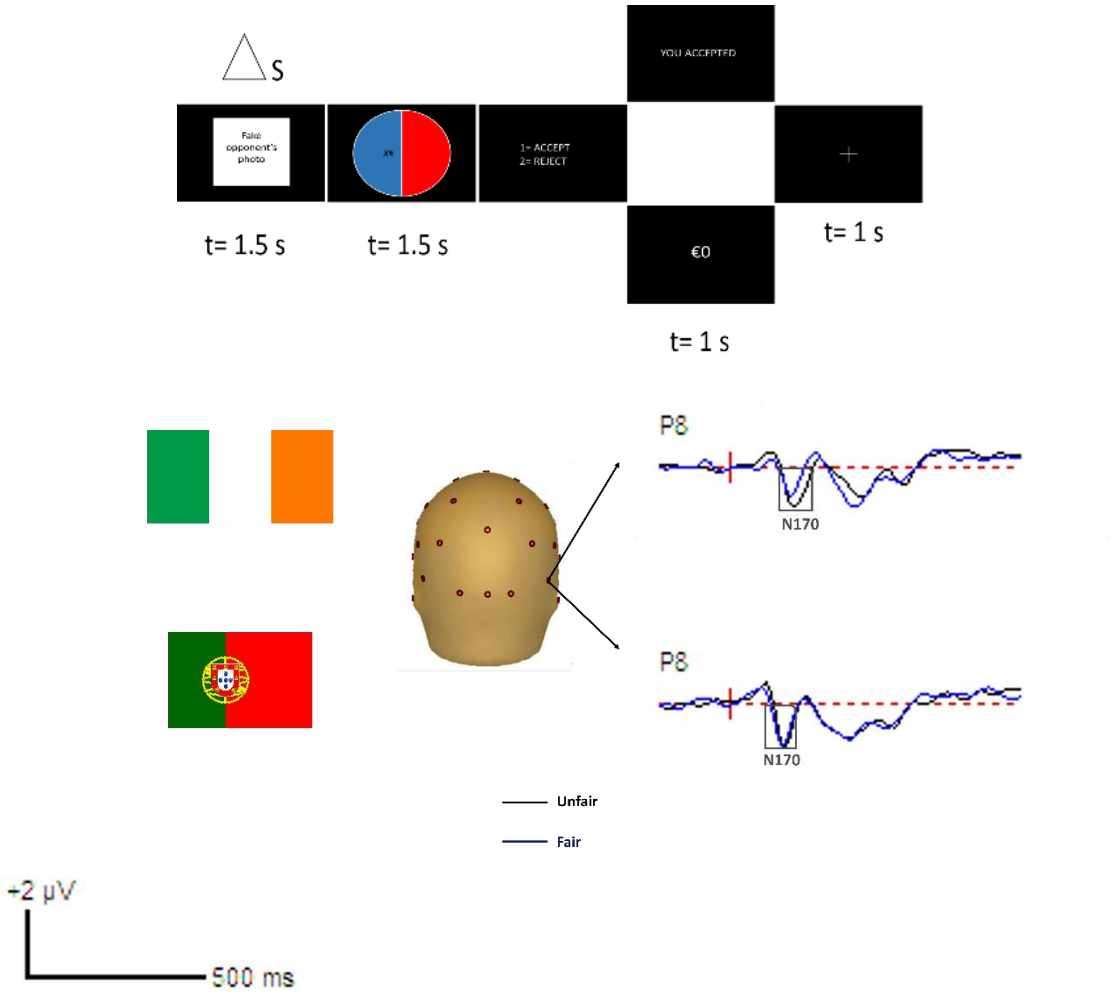

Figure 3.10 – Onset for the *fake* opponent's picture (upper image). Grand-averages of the N170 for the Irish (upper right) and Portuguese group (bottom right) (bottom image). The N170 was measured at P8, quantified as the mean amplitude in the time window of the 140-200ms for the Irish group and 120-180ms for the Portuguese group.

● Regarding the first time window in P8 (i.e., between 140-200ms), we did not find a main effect of *group*, $F(1,48)=.482$, $p=.491$, $\eta^2p = .010$. However, we observed that the N170 amplitude was more negative for Irish (M_{unfair}=-0.9167, SD_{unfair}=1.22536; M_{fair}=-0.4538, SD_{fair}=1.12780) than for the Portuguese group (M_{unfair}=-0.5116, SD_{unfair}=1.29295; M_{fair}=-0.3864, SD_{fair}=1.45849). However, we did find a significant main effect of *feedback type,* $F(1,48)=5.148$, $p=.028$, $\eta^2p = .097$, revealing that the *fake* opponents who made unfair offers had a more negative impact on the participants' component amplitudes.

We did not find a group* feedback type interaction, $F(1,48)=1.697$, $p=.199$, $\eta^2p = .034$.

● Regarding the second time window at P8 (i.e., between 120-180ms), we did not find a main effect of *group*, $F(1,48)=0.990$, $p=.325$, $\eta^2p = .020$. However, we observed that the N170 amplitude was more negative for Portuguese (M_{unfair}=-0.7696, SD_{unfair}=1.26429; M_{fair}=-0.7395, SD_{fair}=1.2880) than for the Irish group (M_{unfair}=-0.5941, SD_{unfair}=0.96481; M_{fair}=-0.3475, SD_{fair}=0.87996). We did not find significant a main effect of *feedback type,* $F(1,48)=0.987$, $p=.325$, $\eta^2p = .020$, nor group* feedback type interaction, $F(1,48)=.603$, $p=. 441$, $\eta^2p = .012$.

● For the latency, we found a main effect of *group*, $F(1,49)=46.403$, $p=.001$, $\eta^2p = .486$, revealing that the N170 peak happened earlier for Portuguese for unfair offers (M_{unfair}=134.94 SD_{unfair}=22.23; M_{fair}=131.52, SD_{fair}=21.21) than for the Irish group (M_{unfair}=169.95, SD_{unfair}=22.23; M_{fair}=161.42, SD_{fair}=13.21). We also found a significant main effect of *feedback type,* $F(1,49)=7.242$, $p=.010$, $\eta^2p = .129$.

However, we did not find a group* feedback type interaction, $F(1,49)=1.324$, $p=. 255$, $\eta^2p = .026$.

Since we found a main effect of *feedback type,* we decided to perform a paired t-test, to see if there was a significant difference between the fair and unfair conditions in each group. Thus, we only found a main effect on the Irish group (p=0.014), while for the Portuguese group the difference was non-significant (p>0.05).

Moreover, we decided to perform an independent t-test, in order to see if there were significant differences between the two *feedback type*.

Therefore, we found that while the latency for unfair offers was significant (p=0.034), the one for fair offers was marginally significant (p=0.076).

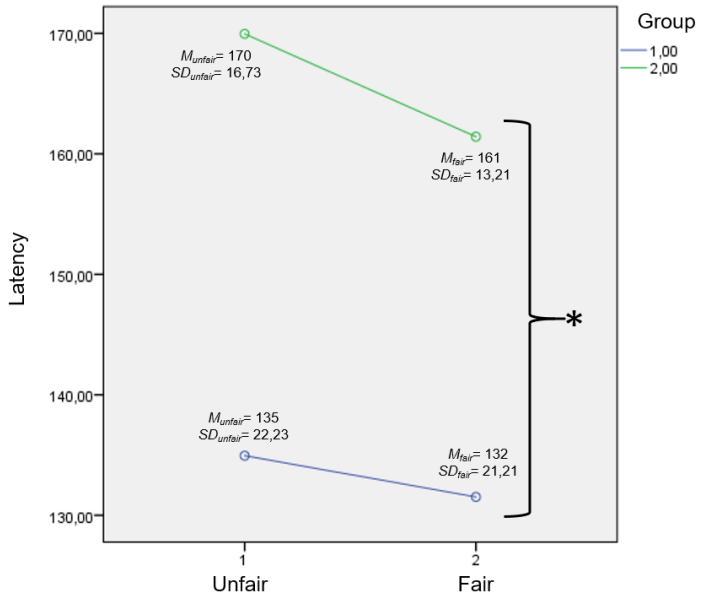

Figure 3.11 – Latencies for the N170 in the two groups (1 for the Portuguese group and 2 for the Irish) for each *feedback type* (i.e., unfair and fair conditions).

b) Results for the onset for the offer made by the *fake* opponent:

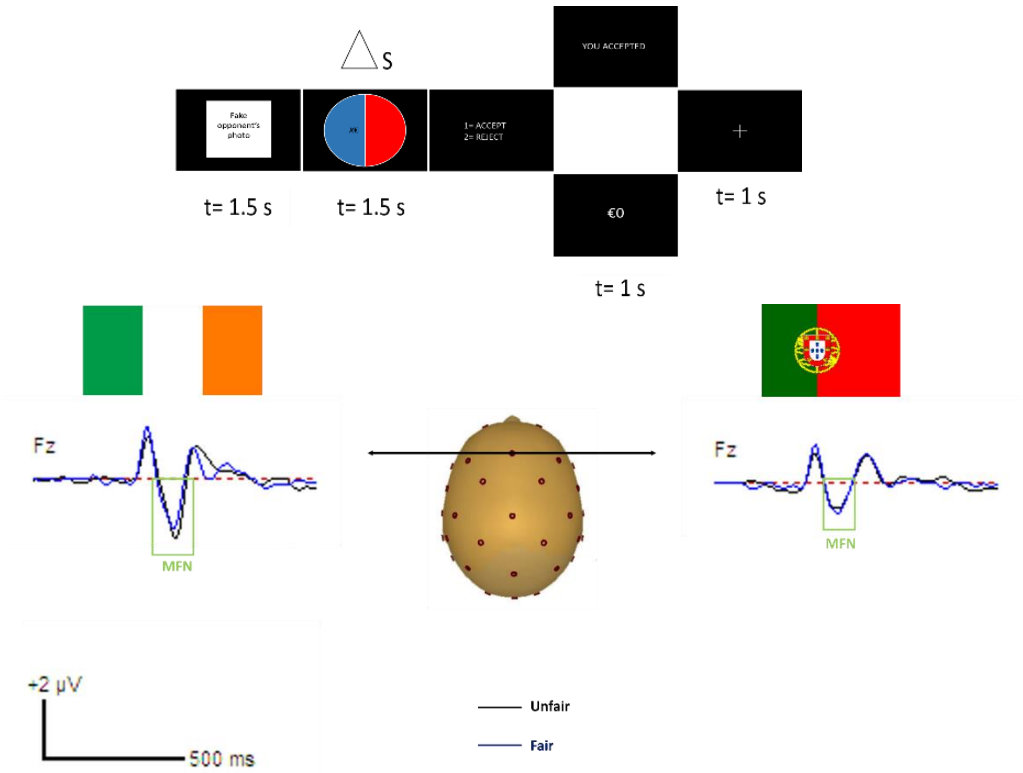

Figure 3.12 – Onset for the offers made (upper image). Grand-averages of the MFN for the Irish (bottom left) and Portuguese group (bottom right). The MFN was measured at Fz, quantified as the mean amplitude in the time window of the 250-330ms for the Irish group and 200-280ms for the Portuguese group.

● Regarding the first time window in Fz (i.e., between 250-330ms), we found a main effect of *group*, $F(1,49)=31.290$, $p=.001$, $\eta^2p = .390$, revealing that the MFN amplitude was more negative for Irish (M_{unfair}=-1.2779, SD_{unfair}=0.91046; M_{fair}=-1.1785, SD_{fair}=1.16931) than for the Portuguese group (M_{unfair}=0.0430, SD_{unfair}=0.67914; M_{fair}=0.0917, SD_{fair}=0.69323). However, we did not find significant main effect of *feedback type,* $F(1,49)=0.740$, $p=.394$, $\eta^2p = .015$, nor group* feedback type interaction, $F(1,49)=.087$, $p=. 770$, $\eta^2p = .002$.

● Regarding the second time window in Fz (i.e., between 200-280ms), we found a main effect of *group*, $F(1,49)=17.625$, $p=.001$, $\eta^2p = .265$, revealing that the MFN amplitude was more negative for Portuguese (M_{unfair}=-0.6941, SD_{unfair}=0.57514; M_{fair}= -

0.7593, SD_{fair}=0.73319) than for the Irish group (M_{unfair}= 0.2486, SD_{unfair}= 0.90346; M_{fair}= 0.449, SD_{fair}=0.93724). However, we did not find significant main effect of *feedback type,* $F(1,49)=2.596$, p=.114, η^2p = .050, nor group* feedback type interaction, $F(1,49)=.736$, p=. 395, η^2p = .015.

● For the latency, we found a main effect of *group*, $F(1,49)=97.004$, p=.001, η^2p = .664, revealing that the MFN peak happened earlier for Portuguese for unfair offers (M_{unfair}=231.71 SD_{unfair}=29.90; M_{fair}=227.84, SD_{fair}=29.20) than for the Irish group (M_{unfair}=304.46, SD_{unfair}=27.43; M_{fair}=302.26, SD_{fair}=26.43). However, we did not find a significant main effect of *feedback type, F*(1,49)=1.308, p=.258, η^2p = .026.

We also did not find a group* feedback type interaction, $F(1,49)=0.101$, p=. 753, η^2p = .002.

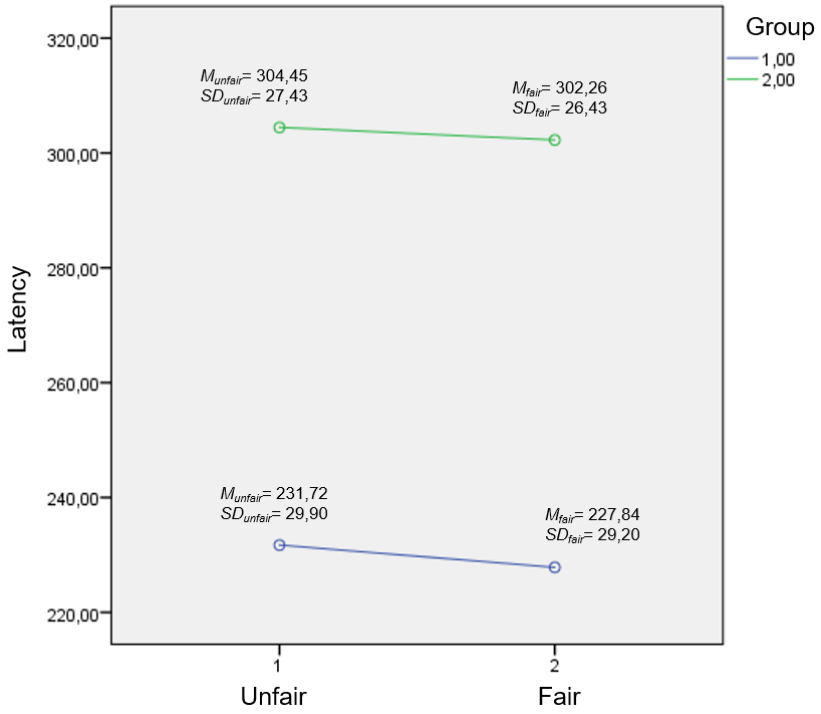

Figure 3.13 – Latencies for the MFN in the two groups (1 for the Portuguese group and 2 for the Irish group) for each *feedback type* (i.e., unfair and fair conditions).

Chapter IV

Discussion

4.1. Behavioural data

Our results for the Rock-Paper-Scissors matched our initial predictions, i.e., no significant differences were observed between the two samples groups. This was an important achievement, as this game was initially introduced as the baseline game, i.e., to assess the balance between both of the samples (for example, the EEG equipment and the acquisition's environments are as balanced as possible between Ireland and Portugal). We also found that regarding the *choice type,* Rock was the predominant choice when compared to the other two options, suggesting that Rock might be perceived as a stronger 'winning-symbol' when compared with paper and/or scissors.

In the Ultimatum Game, no significant differences were found. Both groups tended to choose accepting fairer offers and rejecting unfair ones, in order to seek a higher score and punish the proposer who made unfair offers, respectively. This pattern has been present in previous behavioural studies that were also using a population sample from an *industrialized* country, which in most cases were students (Hewig et al., 2011; Henrich et al., 2001; Henrich et al.2006). When offers were below 20%, receivers would punish the unfair proposal with a cost from him/herself by rejecting the offer made. Moreover, in this present study, when it came to classify the proposals made, no differences were observed, as both groups gave a higher classification to the fair *fake* opponents than the unfair *fake* opponents. This suggests that participants were able to equally recognise the unfair *fake* opponents who behaved as free-riders during the game, by giving them a lower classification when compared to the fair *fake* opponents. However, the Portuguese sample showed faster responses in classifying the offers made and also the proposers who made such offers, when compared to the Irish sample, which can suggest that Portuguese participants were more likely to make impulsive decisions. Nevertheless, when the roles were inverted (i.e., participant would play as a proposer, instead of a receiver), Portuguese people tended to withhold the offers, so they could keep more money for themselves, while Irish tended to be more generous in their offers.

Interestingly, within both the Centipede Game and Public Goods Game, participants tended to be more cooperative, when surrounded by a single / group of *fake* opponents, respectively, avoiding misbehaviour in front of their *fake* opponents and risk being considered a free-rider. However, once a few *fake* opponents switched their behaviour, participants tended to readjust their strategy by starting to take advantage of others, in this case, by taking the majority of the profits for themselves (i.e., instead of contributing with money, they would withhold it for their own benefit). We also observed that cooperators in the Public Goods Game changed their strategy after a *failure* and a *success*. Where participants failed, they would switch to a safer strategy and avoid taking risks by investing money into the shared pot, whereas after a *success* they tended to play randomly and in some cases take more risk, by investing their money into the group.

On the other hand, free-riders did not change their behaviour independently of a *success* or *failure* scenario, showing no significant behavioural differences between the two countries. This finding is in accordance to Chung and colleagues (2015), revealing that the CondS (also known as, the Standard Condition) is ideal to study free-riders, since this condition offers an equal amount of money regardless of the choices made by each individual if the group succeeds, thus making it "easier" to take risks by not investing into the group and acting as a free-rider.

Regarding the Volunteer's Dilemma, both groups chose to cooperate towards the group rather than choosing to take risks, by not investing their money and consequently, ended up losing their money, if no one volunteered. This result was not found in our initial predictions, i.e., according to Goeree and colleagues (2017), the chances of having no volunteers in a larger group is very high, since the expectation of at least one-person volunteering towards the group is equally as high. This suggest that when a sample is composed of younger-adults (in this present study, we used majoritarily students), the tendency of taking higher risk decreases. Therefore, it would be interesting to investigate if this pattern persists in future studies, using different age groups, as performed by Fernandes et. al (2018).

Our findings also match the previous ones made by Lopes (2014), i.e., even though Portuguese people saw free-riding as misconduct, whenever they had the chance to pay to punish, they avoided to enter with costs that would punish free-riders, unlike the Finnish, proving that social norms and social sanctions might be differently perceived across cultures, thus proving that Game Theory is a useful tool to study (dis)similarities between cultures.

Alongside this, Lopes (2014) also observed that the Finnish tended to trust and take more risk-based decisions, by investing more money than the Portuguese sample. Portuguese were also more prone to compete than Finnish. The same was observed between the Portuguese and Irish samples.

Our study suggests that the Portuguese sample's economic strategies are intrinsically related to the cultural influences, since they seem to have a similar pattern of behaviour when competing against other cultures. It would be interesting to compare both Finnish and Irish people and then combine all three cultures in a separate study, so we could unravel and establish which strategies are used by each culture, in order to increase their own profits, respectively.

This behaviour might also be explained by the current economic situation and the value of money in each country. For instance, in terms of salary income, Portuguese people need to work twice as much in order to obtain the minimal wage of Ireland and four times as much, in order to reach the level of the Finnish lifestyle. So, it might be easier for an Irish or Finnish person to invest their money to punish misconducts, while Portuguese people might prefer to save the money for themselves. Besides, the samples used in this study represent a newer generation that are known as "low-investors", which can also be explained by the lack of significance in some of the results obtained.

4.2. EEG data

Each trial of the Rock-Paper-Scissors comprised a decision stage followed by a feedback stage, during which the outcome was shown. Subjects could win, lose or draw. We examined two feedback-locked event-related potentials (ERPs) that play a crucial role in the feedback processing: the Feedback Related Negativity (FRN) and the P3 (Miltner et al., 1997; Martín, 2012; Holroyd and Coles, 2002; Donchin and Coles, 1988; Nieuwenhuis, 2011). The FRN is generated in the anterior cingulate cortex and, according to the reward prediction error hypothesis (Miltner et al., 1997), it is consistently larger for negative than for positive feedbacks (Martín, 2012). According to the reinforcement-learning theory, this increased amplitude elicited by negative outcomes results from a decreasing in the dopaminergic activity after events that are worse than expected, which allows the adaptation of the motor system control according to the feedback contingencies (Holroyd and Coles, 2002). The P3 has widespread sources and, according to the context-updating hypothesis (Donchin and Coles, 1988), it indexes the brain activity underlying the revision of a mental model of a task induced by a stimulus. If a stimulus delivers information that is inconsistent with

the mental model, it will be updated and the P3 amplitude will be proportional to the amount of cognitive resources employed during the updating. Outcomes associated with higher levels of arousal or task-relevance elicit larger P3 amplitudes, reflecting increased allocation of attention (Nieuwenhuis, 2011). Thus, while the FRN appears to be sensitive to expectancy violations, the P3 appears to be sensitive to the arousing nature of the feedback.

Our results for the Rock-Paper-Scissors game showed that groups significantly differed in amplitude of both FRN and P3, revelling that culture may significantly influence the processing of feedback.

Interestingly, we did not find a main effect of condition, since gains, losses and draws elicited similar amplitudes for both FRN and P3. Considering the functional significance of both components, this result may be explained by the fact that participants played a luck-based game, in which the expectations and the arousing level of each result were similar. However, this result did not meet our initial prediction, since this game was introduced as the baseline game, in order to establish an equilibrium between the two sites. Therefore, it can be speculated that the cultural settings may play a crucial role in the way feedback is processed.

Regarding the N170 in the Ultimatum Game, we found that the Portuguese sample had the component happening earlier for both conditions (faster for fair than unfair conditions). The N170 latency happened earlier in the right hemisphere, which is in accordance with previous findings (Blau et al., 2007).

Interestingly, we found that the difference of the *feedback type* (i.e., unfair/fair) was significant, revealing that the *fake* opponents who made unfair offers had a more negative impact on the participants of the study.

This suggests that the N170 is a crucial ERP component for face processing (Blau et al., 2007; Ghuman et al., 2014; Kropotov, 2016) and that it is sensitive to the faces of the *fake* opponents who might have played a negative role throughout the game (i.e., participants learned to recognize the faces that were associated with free-riders *versus* cooperators).

The MFN amplitude differed between groups, which is not in accordance with the lack of differences found in fairness ratings. This evidence suggests that the Irish group would have a higher unfairness sensibility, indexed by a higher MFN amplitude.

However, the correlation between the MFN amplitude and the difference between fairness ratings given to unfair and fair offers were non-significant. This lack of correlation leads us to hypothesize that MFN component can be modulated by the magnitude of the stakes (which were higher in unfair than in fair conditions), rather than by the unfairness of the offers. Regarding the latency, we also found that the MFN for the Portuguese group happened earlier.

Moreover, according to our results, the behavioral differences found between groups may underlie different economic preferences, rather than unfairness sensitivity.

Also, the lack of empathy in our paradigm may also influence the decision-making in social contexts.

Future studies and alternative interpretations must be considered to confirm whether this pattern of neural responses to unfairness is similar or not.

4.3. Project limitations

There are several limitations associated to this research study. For instance, even though the EEG technique has a high temporal resolution (in milliseconds), its spatial resolution is quite low, which means that the recorded signal may include a high number of individualities that will have to be taken into account during the interpretation of the activated regions of the brain during each of the games.

Second of all, there is another limitation associated with the design of the games, which is they are commonly played in one shot, i.e., only one time, in order to avoid the participants to learn what the best strategy is and then change their behaviours accordingly. Thus, it becomes very challenging to create paradigms that fit the features of the EEG, since, to obtain a good signal, we need to have several trials of the same conditions/stimuli (approximately 30 trials).

Thirdly, the fact that it is a cultural study. Therefore, even though creating the same conditions of study across countries is crucial, it can be very difficult to get. For example, the setup of the recording rooms was different (i.e., DCU had an electrical shielded room for participants that was separated from the recording room, while in Porto, the recording room was only separated by a see-through glass from the space where the participants were). Besides, even though we used a 32-channel EEG, the layout of the caps was not equivalent in four different electrodes. However, all of this was taken into consideration and solved, so that during our analysis, we could discard external factors as the origin of the differences observed.

Finally, another important limitation of this research study was that our samples were not representative enough of the Portuguese and Irish cultures, i.e., it would have been interesting to have a sample with different ages and backgrounds (e.g. the study conducted by Fernandes et. al., 2018, where they examined age-related differences in behavioural responses to risk in neural correlates of feedback processing).

4.4. Future research

This research study was inspired by Lopes et al, 2014 and a lot of their suggestions for future improvement were taken into account for this study, such as bringing some reality to the context of the games participants were playing (e.g., taking a picture of each participant at the beginning of each session) and using a neuroimaging technique to obtain new measures that would help creating new constructs and theories that could then be used to predict economic-based behaviours.

Regarding future studies, it would be interesting and potentially significant for social studies, to combine other neuroimaging techniques (e.g., fMRI) and see how freeriders can emotionally affect decision-making processes. Besides, it would be easier to create paradigms for this purpose, as they would be played in only one shot.

Another suggestion would be to use more than one participant during the same session, in order to create a real interaction with participants. That could be achieved by generating a setting that would lodge more than one EEG at the same time.

Finally, it is important to replicate cultural studies using similar cultures, in order to eradicate the idea that the differences observed are due to genetical factors.

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Appendixes

I- List of games from Game Theory

(https://en.wikipedia.org/wiki/List_of_games_in_game_theory , accessed the first time on the 8th January 2017)

Game	Number of Players	Strategies per player	Number of Nash equilibrium	Sequential game	Perfect information	Zero sum	Notes
Battle of the sexes	2	2	2	No	No	No	It is similar to the Coordination game
Blotto games	2	variable	variable	No	No	Yes	This type of game is normally used as a metaphor for electoral competition or in auction theory
Cake cutting	*N*, usually 2	infinite	variable	Yes	Yes	Yes	It is used to study fair offers
Centipede game	2	variable	1	Yes	Yes	No	Like the Prisoner's dilemma, this game represents a conflict between self-interest and mutual benefit
Chicken (aka hawk-dove)	2	2	2	No	No	No	This game is commonly called as an 'anti-coordination game', in which it is mutually beneficial for the players to play different strategies
Coordination game	*N*	variable	>2	No	No	No	It is used in social sciences and economics to study competition and cooperation
Cournot game	2	infinite	1	No	No	No	It is normally used to study an industry structure in which companies compete on the amount of output they will produce
Deadlock	2	2	1	No	No	No	The best decision is dominant and beneficial and there are no conflicts between players to achieve a better strategy

Dictator game	2	infinite	1	N/A	N/A	Yes	This type of game is normally used to study altruistic behaviour
Diner's dilemma	*N*	2	1	No	No	No	Similar to Prisoner's dilemma, however instead of two players, there is *N* players
Dollar auction	2	2	0	Yes	Yes	No	Players in this game are compelled to make irrational choices based on a set of apparently rational choices
El Farol bar	*N*	2	variable	No	No	No	*N* players with two different strategies chosen at the same time
Game without a value	2	infinite	0	No	No	Yes	Both players play a perfect strategy (that is, knowing each other's objectives)
Guess 2/3 of the average	*N*	infinite	1	No	No	Maybe*	This type of game illustrates the difference between perfect rationality and the common knowledge of that rationality
Kuhn poker	2	27 & 64	0	Yes	No	Yes	Simpler version of a poker game that uses three cards (King, Queen and Jack)
Matching pennies	2	2	0	No	No	Yes	This is a "random" game based on winning or losing the guess
Minority game	*N*	2	variable	No	No	No	This game is a variant of the El Farol bar game, in which the players who stay on the minority side, win the game
Nash bargaining game	2	infinite	infinite	No	No	No	It is used to study the effects of risk aversion
Peace War game	*N*	variable	>2	Yes	No	No	This game was invented to study cooperation and aggression
Pirate game	*N*	infinite	infinite	Yes	Yes	No	This game is a version of the Ultimatum game
Princess and monster game	2	infinite	0	No	No	Yes	This game is an example of a pursuit-evasion game
Prisoner's dilemma	2	2	1	No	No	No	This game is used as a model for social cooperation
Public goods	*N*	infinite	1	No	No	No	It is similar to the Prisoner's dilemma and is used to study prosociality
Rock, paper, scissors	2	3	0	No	No	Yes	"Random" game in which it is impossible to gain an advantage
Screening game	*N*	variable	variable	Yes	No	No	This is a game where complete honesty is not optimal for one of the players, leading to several strategies by the exchange of ideas

Signaling game	*N*	variable	variable	Yes	No	No	This game describes situations in which only one of the players knows about a secret information, while the other one does not
Stag hunt	2	2	2	No	No	No	It is used to describe a conflict between safety and social cooperation
Traveler's dilemma	2	N >> 1	1	No	No	No	The players try to maximize their own profit, without considering the other player's payoff
Truel	3	1-3	infinite	Yes	Yes	No	"Duel" of three participants, in which they fight for survival
Trust game	2	infinite	1	Yes	Yes	No	This is game is very similar to the Dictator game and it is used to study trust and trustworthiness
Ultimatum game	2	infinite	infinite	Yes	Yes	No	It is very similar to the Dictator game and used to study fairness
Volunteer's dilemma	*N*	2	2	No	No	No	*N* players must decide whether to make a "small sacrifice", in which all will gain from it, whether to freeride
War of attrition	2	2	0	No	No	No	This is a win or loss game (attack/defence)

*****If the payoff is split between players that make an optimal guess, then it is Sum-zero.

II- Ethical Approval from Ireland

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Dr Styliani Vlachou
School of Nursing and Human Sciences

Dr José Paulo Marques dos Santos
Faculty of Medicine/University of Porto

26th May 2017

REC Reference: **DCUREC/2017/092**

Proposal Title: **Cultural Neuroscience - An approach to the neurobiological bases of the ethnographic behaviour with EEG and Game Theory: The case of Ireland and Portugal**

Applicant(s): **Dr Styliani Vlachou, Dr José Paulo Marques dos Santos**

Dear Styliani, José:

Further to expedited review, the DCU Research Ethics Committee approves this research proposal.

Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Donal O' Gorman

Dr Dónal O'Gorman
Chairperson
DCU Research Ethics Committee

DCU
Research & Innovation

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III- Ethical Approval from Portugal

SÃO JOÃO

Parecer da Comissão de Ética para a Saúde do
Centro Hospitalar de São João / Faculdade de Medicina da Universidade do Porto

Título do Projecto: "Cultural Neuroscience: an approach to the neurobiological bases of the ethnographic behaviour with EEG and Game Theory - The case of Ireland and Portugal" / "Neurociência Cultural - uma abordagem para as bases neurobiológicas do comportamento etnográfico com EEG e a Teoria dos Jogos - O caso da Irlanda e de Portugal"

Nome da Investigadora Principal: Equipa liderada pelo Prof. José Paulo Marques dos Santos, da FMUP, que participa também como orientador da Drª Joana Raquel Lopes Farinha dos Santos Augusto, aluna do 2º ano do Mestrado em Neurobiologia da FMUP.

Onde decorre o Estudo: Estudo multicentrico internacional que na UP será desenvolvido no Departamento de Biologia Experimental da FMUP e no Laboratório de Neuropsicofisiologia da Faculdade de Psicologia e Ciências da Educação.

Objectivos do Estudo: Esta investigação visa usar eletroencefalografia (EEG) assim como jogos da "Teoria dos Jogos" de forma a mapear as redes corticais e entender como o comportamento humano difere entre as culturas, neste caso entre duas culturas em específico: Irlanda e Portugal. Como tal, os objectivos para este projecto de pesquisa são:
1- Mapear as redes cerebrais com EEG;
2 - Compreender o que são microestados no EEG e como se relacionam com o comportamento humano (função);
3 – Caracterizar tendo por base aspectos neurobiológicos e aspectos específicos do comportamento cultural usando quatro jogos da Teoria dos Jogos:
3.1 - Jogo do Ditador (Dictator Game) para estudar o altruísmo;
3.2 - Dilema do Prisioneiro (Prisoner's Dilemma) para estudar a cooperação;
3.3 - Jogo do Ultimato (Ultimatum Game) para estudar a justiça;
3.4 - Jogo de Punição por Terceiros (Third-Party Punishment) para estudar a sanção social e egoismo.

Concepção e Pertinência do estudo: Para o efeito, serão recrutados voluntários saudáveis (n=60), 30 em Portugal e 30 na Irlanda, de entre estudantes da UP com idades entre os 18 e os 30 anos. A hipótese de estudo que se coloca é que existem diferenças nas redes cerebrais entre irlandeses e portugueses e que essas diferenças são mapeáveis através dos métodos que irão ser utilizados.

Benefício/risco: Não há benefícios para os participantes, excepto a de terem a oportunidade de participar num estudo que utiliza uma técnica de neuroimagem e jogar jogos que estão relacionados com processos de decisão, permitindo, dessa forma, compreender os mecanismos inerentes do comportamento humano em situações estratégicas sem que estas causem qualquer tipo de danos psicológicos.
Os potenciais riscos/incómodos para os participantes neste projecto podem ser devidos ao eventual desconforto associado à realização do EEG, dependendo do tipo de eléctrodos usados. Neste estudo utilizam-se eléctrodos com geles electrolíticos para penetrar no couro cabeludo, e não eléctrodos secos que seriam mais desconfortáveis. Mesmo assim, algumas pessoas podem sentir uma impressão ligeiramente desconfortável derivada da sensação húmida no couro cabeludo, cuja intensidade depende do grau de sensibilidade de cada um. Contudo, o objectivo é minimizar qualquer tipo de desconforto que o participante possa vir a sentir. Os jogos destinados a serem usados nesta investigação são recorrentes de jogos usados em Economia Comportamental para estudar a conduta humana no

momento de tomada de decisão. Não são jogos de azar e, neste projecto, nenhum dos participantes vai sofrer perda financeira. Para além disso, estes jogos não causam qualquer tipo de danos psicológicos. No entanto, se os participantes começarem a sentir algum tipo de desconforto, podem sempre desistir de continuar no estudo.

Confidencialidade dos dados: Os nomes serão convertidos em códigos, de modo a que os dados não possam ser directamente relacionados com o participante. O ficheiro informático que contém a ligação entre o código e o nome da pessoa será protegido por uma palavra-chave e apenas existirá em suporte de hardware e nunca em servidores, a fim de impedir o acesso aos dados. O(s) suporte (s) físico (s) (por exemplo, pendrive ou disco) só pode estar nas mãos dos investigadores associados a este projecto.
Poderá haver situações em que, por força da lei, exista a necessidade de divulgar resultados/dados e outras informações obtidas através deste estudo. Contudo, mesmo sob limitações legais, os dados individuais não serão identificáveis, uma vez que se trata de um estudo anónimo e este, por sua vez, recorre ao uso de códigos para cada um dos participantes. Quanto ao arquivo que estabelece a ligação entre o nome do participante e o respectivo código, este só será fornecido mediante a aceitação prévia dada pela Comissão de Ética.

Respeito pela liberdade e autonomia do sujeito de ensaio: Está prevista a obtenção do consentimento informado que é acompanhada de uma folha de informação para os participantes esclarecedora sobre a natureza do estudo e que contempla todas as questões éticas relevantes.

***Curriculum* do investigador**: Adequado à investigação.

Data previsível da conclusão do estudo: Julho de 2017

Conclusão: Proponho um parecer favorável à realização deste projecto de investigação.

Porto, 9 de Dezembro de 2016

O Relator, Prof. Doutor Manuel Pestana

7. **SEGURO**

a. *Este estudo/projecto de investigação prevê intervenção clínica que implique a existência de um seguro para os participantes?*

SIM ☐ (Se sim, junte, por favor, cópia da Apólice de Seguro respectiva)

NÃO ☒

NÃO APLICÁVEL ☐

8. **TERMO DE RESPONSABILIDADE**

Eu, ***Joana Raquel Lopes Farinha dos Santos Augusto*** , abaixo-assinado, na qualidade de Investigador Principal, declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (com as emendas de Tóquio 1975, Veneza 1983, Hong-Kong 1989, Somerset West 1996 e Edimburgo 2000) e da Organização Mundial da Saúde, no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo no decurso do actual internamento ou da mesma consulta.

Porto, 07 / 11 / 2016

Joana Augusto

O Investigador Principal

PARECER DA COMISSÃO DE ÉTICA PARA A SAÚDE DO CENTRO HOSPITALAR DE S. JOÃO

emitido na reunião plenária da CES de 09 Novembro 2016

A Comissão de Ética para a Saúde APROVA por unanimidade o parecer do Relator, pelo que nada tem a opor à realização deste projecto de investigação.

IV- Handedness Questionnaire (English version)

EDINBURGH HANDEDNESS INVENTORY
(retrieved from http://www.brainmapping.org/shared/Edinburgh.php)

Handedness Questionnaire

Instructions

For each of the activities below, please indicate:

Which hand you prefer for that activity?
Do you ever use the other hand for the activity?

Which hand do you prefer to use when:		no pref		Do you ever use the other hand?
Writing:	Left ○	○	○ Right	☐ Yes
Drawing:	Left ○	○	○ Right	☐ Yes
Throwing:	Left ○	○	○ Right	☐ Yes
Using Scissors:	Left ○	○	○ Right	☐ Yes
Using a Toothbrush:	Left ○	○	○ Right	☐ Yes
Using a Knife (without a fork):	Left ○	○	○ Right	☐ Yes
Using a Spoon:	Left ○	○	○ Right	☐ Yes
Using a broom (upper hand):	Left ○	○	○ Right	☐ Yes
Striking a Match:	Left ○	○	○ Right	☐ Yes
Opening a Box (holding the lid):	Left ○	○	○ Right	☐ Yes
items below are not on the standard inventory:				
Holding a Computer Mouse:	Left ○	○	○ Right	☐ Yes
Using a Key to Unlock a Door:	Left ○	○	○ Right	☐ Yes
Holding a Hammer:	Left ○	○	○ Right	☐ Yes
Holding a Brush or Comb:	Left ○	○	○ Right	☐ Yes
Holding a Cup while Drinking	Left ○	○	○ Right	☐ Yes

V- Handedness Questionnaire (Portuguese version)

EDINBURGH HANDEDNESS INVENTORY

(retrieved from http://www.brainmapping.org/shared/Edinburgh.php)

Teste de Lateralidade de Edimburgo

Instruções

Para cada uma das actividades indicadas, por favor indica:

Qual é a mão que mais utilizas para esta actividade?
Alguma vez usas a outra mão para a actividade referida?

Qual é a mão que preferes usar quando:		Sem Preferência		Aguma vez usas a outra mão?
Escreves:	Esquerda		Direita	SIM
Desenhas:	Esquerda		Direita	SIM
Atiras um objecto:	Esquerda		Direita	SIM
Usas uma tesoura:	Esquerda		Direita	SIM
Usas uma escova de dentes:	Esquerda		Direita	SIM
Usas uma faca (sem um garfo):	Esquerda		Direita	SIM
Usas uma colher:	Esquerda		Direita	SIM
Pegas numa vassoura:	Esquerda		Direita	SIM
Acendes um fósforo:	Esquerda		Direita	SIM
Abres uma caixa e seguras na tampa ao mesmo tempo:	Esquerda		Direita	SIM
os seguintes items não estão no inventário padrão:				
Usas um rato de computador:	Esquerda		Direita	SIM
Usas uma chave para abrir uma porta:	Esquerda		Direita	SIM
Seguras num martelo:	Esquerda		Direita	SIM
Seguras numa escova ou num pente:	Esquerda		Direita	SIM
Seguras num copo enquanto bebes:	Esquerda		Direita	SIM

VI- IC- Informed Consent (English version)

Informed Consent Form

Cultural Neuroscience - An approach to the neurobiological bases of the ethnographic behaviour with EEG and Game Theory: The case of Ireland and Portugal

Supervisor: Dr. Styliani Vlachou (stella.vlachou@dcu.ie)
School of Nursing and Human Sciences, Faculty of Science and Health, DCU

Supervisor: Dr. José Paulo Marques dos Santos (jmarquessantos@med.up.pt)
Faculty of Medicine, University of Porto, Portugal

Researcher Dr. Richard Roche (Richard.Roche@nuim.ie)
Department of Psychology, Maynooth University

Researcher: Joana Augusto, MSc Neurobiology student (up201506951@med.up.pt)
Faculty of Medicine, University of Porto, Portugal

This study is for the master's thesis project of Joana Augusto who is in the second year of her MSc on Neurobiology, being supervised by Dr. Styliana Vlachou and by Dr. José Paulo Marques dos Santos.

The main aim of the research is to understand how two cultures, the Irish and the Portuguese, deal differently with the financial crisis and hostile economic environments. For such purpose, subjects from the two countries are asked to perform economic games while the activity of their brains is registered with electroencephalography (EEG).

I confirm that (if you confirm, please circle Yes or No):

My age is between 18 and 50 years old	Yes	No
English or Irish is my first language	Yes	No
I was born and always lived in Ireland (except on holidays)	Yes	No
I did not have in the past any sort of neurologic or psychiatric disorders	Yes	No
I am not consuming alcohol excessively	Yes	No
I do not consume drugs	Yes	No
I am not pregnant, nor breast-feeding	Yes	No
I do not have any sort of lesions in my head	Yes	No
Any of the researchers is / will be teaching me	Yes	No
In the past three months I took the following medication:		
	None	
I have read the Plain Language Statement (or had it read to me)	Yes	No
I understand the information provided	Yes	No
I have had an opportunity to ask questions and discuss this study	Yes	No
I have received satisfactory answers to all my questions	Yes	No
I am aware that my brain activity will be recorded with EEG	Yes	No

All data collected in this study is anonymised. This means that data is labelled with a code and there is not a direct connection from the data collected (brain and responses) to your name or contacts. Only the researchers above may know the connection. The anonymous data, only, will be preserved. Even so, there may be situations where, by law, there is the need to disclose results/data and other information from this study. Even under legal limitations, individual data won't be identifiable as this is an anonymous study and codes for individual participants will be used. However, once there will be a file that connect both names and codes, this will only be provided upon prior acceptance by the Ethics Committee.

Circle your decision, please:

I authorise / I do not authorise that the anonymous data is made available in public computer servers for scientific purposes only, may be shared with other genuine researchers, and may be re-used in further scientific studies.

I hereby agree to participate in the study named above and acknowledge I can voluntarily withdraw from the study without penalty and without giving a reason at any time. I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project.

Signature: _____ Date: _____

Name (block capitals): _____

VII- IC- Informed Consent (Portuguese version)

DECLARAÇÃO DE CONSENTIMENTO

Considerando a "Declaração de Helsínquia" da Associação Médica Mundial (Helsínquia 1964; Tóquio 1975; Veneza 1983; Hong Kong 1989; Somerset West 1996 e Edimburgo 2000)

Designação do Estudo:

"Neurociência Cultural: uma abordagem para as bases neurobiológicas do comportamento etnográfico com EEG e a Teoria dos Jogos: O caso da Irlanda e de Portugal"

Eu, abaixo-assinado,_____(nome completo), compreendi a explicação que me foi fornecida acerca da investigação que se tenciona realizar, bem como do estudo em que serei incluído. Foi-me dada oportunidade de fazer as perguntas que julguei necessárias, e de todas obtive resposta satisfatória.
Tomei conhecimento de que, de acordo com as recomendações da Declaração de Helsínquia, a informação ou explicação que me foi prestada versou os objectivos, os métodos, os benefícios previstos, os riscos potenciais e o eventual desconforto. Além disso, foi-me afirmado que tenho o direito de recusar a todo o tempo a minha participação no estudo, sem que isso possa ter como efeito qualquer prejuízo na assistência que me é prestada.
Por isso, consinto que me seja aplicado o método e os inquéritos propostos pelo investigador.

Data: ____ / _____ / 20___

Assinatura do voluntário são: _____

O Investigador responsável:

Nome:

Assinatura:

VIII- IPEAS – Irish-Portuguese Enculturation / Acculturation Survey (English version)

Subject's code _____

Irish-Portuguese Enculturation / Acculturation Survey (IPEAS)

Please circle Yes or No for each question:

Were you born in Ireland?	Yes	No
Is your parents' nationality and relatives at home Irish?	Yes	No
Have you always lived in Ireland? (except on holidays)	Yes	No
Have you done all your schooling in Ireland?	Yes	No
Is the language you speak at home Irish or English?	Yes	No
How long was the longest season outside Ireland?		

To the best of your knowledge, please answer to the following questions. Leave it in blank if you don't know.

Question	Answer
What does the green or the orange colour represent in the Irish flag?	Green: Revolution, the shamrock, and the Irish catholic nationalists Orange: William III and the northern Irish protestants
What does the red colour represent in the Portuguese flag?	The blood in the battlefield
What did Brian O'Driscoll?	Rugby
What did Eusebio?	Football
What does "craic" represent to you?	Fun and music
What does "fado" represent to you?	Melancholic music
Name a traditional meal in Ireland.	Irish stew, coddle, bacon and cabbage, …
Name a traditional meal in Portugal.	Cod fish, sardines, Portuguese stew
In what region Irish is the main language?	Gaeltacht
Name the main Portuguese dialect.	Mirandês
What is the first verse of the Irish anthem's chorus?	Soldiers are we
What is the first verse of the Portuguese anthem's chorus?	Às armas, às armas (Get the arms, get the arms)
Name the third biggest city in Ireland.	Galway
Name the third biggest city in Portugal.	Coimbra
Which are the two most popular traditional sports in Ireland?	Gaelic football & hurling
In which two traditional sports Portugal is European champion?	Football & Quad (rink) hockey
What happens in Ireland on March 17th?	St. Patrick's day
What happens in Portugal in April 25th?	Revolution of the carnations
When in a pub (Irish), where do you go to order?	To the bar
When in a café (Portuguese), where do you go to order?	To a table

IX- IPEAS – Irish-Portuguese Enculturation / Acculturation Survey (Portuguese version)

Código do Sujeito _____

Questionário do nível de Enculturação/Aculturação dos Portugueses

Responde SIM ou NÃO a cada questão:

Nasceste em Portugal?	SIM	NÃO
A nacionalidade dos teus pais/outros membros familiares é portuguesa?	SIM	NÃO
Sempre viveste em Portugal? (excluindo períodos de férias)	SIM	NÃO
Completaste a tua escolaridade em Portugal?	SIM	NÃO
A tua língua oficial é o português?	SIM	NÃO
Qual foi o teu período mais longo fora de Portugal?		

De forma a testar o teu conhecimento, por favor responde às seguintes questões.
Deixa as que não souberes em branco.

Questão	Resposta
O que é que a cor verde ou laranja representa na bandeira irlandesa?	Verde: Revolução, o trevo, e os nacionalistas católicos irlandeses Laranja: William III e os protestantes da Irlanda do Norte
O que é que a cor vermelha representa na bandeira portuguesa?	Sangue derramado no campo de batalha
O que fez Brian O'Driscoll?	Rugby
O que fez Eusébio?	Futebol
O que é que "craic" representa para ti?	Diversão e música
O que é que "fado" representa para ti?	Música melancólica
Menciona um prato tradicional irlandês	Guisado irlandês, *coddle*, bacon e repolho, etc.
Menciona um prato tradicional português	Bacalhau, sardinhas, cozido à portuguesa
Em que região o irlandês é a língua oficial?	Gaeltacht
Nomeia o principal dialecto português	Mirandês
Qual é o primeiro verso do refrão do hino nacional irlandês?	Soldiers are we
Qual é o primeiro verso do hino nacional português?	Às armas, às armas
Nomeia a terceira maior cidade da Irlanda	Galway
Nomeia a terceira maior cidade de Portugal	Coimbra
Quais são os dois desportos tradicionais mais populares na Irlanda?	Futebol gaélico e *hurling*
Quais são os dois desportos tradicionais nos quais Portugal é campeão europeu?	Futebol e hóquei em patins
O que acontece na Irlanda no dia 17 de março?	St. Patrick's day / Dia de São Patrício
O que acontece em Portugal no dia 25 de abril?	Revolução dos cravos
Onde se costuma fazer o pedido quando estamos num pub irlandês?	Ao balcão
Onde se costuma fazer o pedido quando estamos num café português?	Fica-se à espera na mesa

X- PLS – Plain Language Statement (Irish version)

Cultural Neuroscience - An approach to the neurobiological bases of the ethnographic behaviour with EEG and Game Theory: The case of Ireland and Portugal

Supervisor: Dr. Styliani Vlachou (stella.vlachou@dcu.ie)
School of Nursing and Human Sciences, Faculty of Science and Health, DCU

Supervisor: Dr. José Paulo Marques dos Santos (jmarquessantos@med.up.pt)
Faculty of Medicine, University of Porto, Portugal

Researcher Dr. Richard Roche (Richard.Roche@nuim.ie)
Department of Psychology, Maynooth University

Researcher: Joana Augusto, MSc Neurobiology student (up201506951@med.up.pt)
Faculty of Medicine, University of Porto, Portugal

This study has received ethical approval from the Dublin City University Research Ethics Committee.

You were invited to participate in a scientific study which is part of Ms. Joana Augusto MSc thesis. This invitation is for the participation in the data collection in Ireland only. Before you agree to take part in the study, it is important you understand the reasoning behind this study. Please read the following information carefully and discuss it with others if you feel appropriate. If you require additional information, or would like to ask any questions, please contact Ms. Joana Augusto.

Brief Description

The study aims to compare how Irish and Portuguese people behave during economic-based decision-making. Either your responses will be considered, and your brain activity will also be registered with electroencephalography (EEG) in order to understand the biological (brain) bases of such decision-making.

What we expect from you

Firstly, we will ask you to fill a questionnaire which aims to measure how much you are involved in the Irish culture. Then, you will be asked to perform five games. These games involve decisions about how you split sums of money or profits from a business. You will be competing with other participants for a prize for the three best players. During the games you will wearing an EEG cap to register your brain activity. We expect that the experiment takes around 2 ½ hours of your time in a single session.

Potential risks

This study does not involve high risks. There will not be financial risks, that is, either your time spent will be compensated, and you will compete for a prize. Therefore, there will never be money losses for you.

EEG is an innocuous technique. The cap that you will be wearing just measures the product of your brain activity. There is anything from the outside that may interfere with your brain. Wearing the cap, however, is not comfortable. Because human hair interferes with the registration of the brain signals, we use a gel to improve the measurement. Nevertheless, most people support well this discomfort. Also, your forehead and behind your ears will be cleaned using alcohol pads before wearing the cap to improve contact with the skin. After the recording session, the gel used is removed from the hair, which is easily done using some paper roll and alcohol.

In any case, if you feel continued discomfort after completion of the study, you may use the DCU Counselling Service (http://www.dcu.ie/counselling/index.shtml; for out of hours support please use the following link http://www4.dcu.ie/counselling/afterhours/index.shtml%23).

Benefits and incentives

Besides the possibility of the best three participants getting the prize (30 € in a gift card, each prize), there is not more benefits for you. Although it is not a benefit, those who participate in the study are compensated for their time with 15 € in a gift card.

XI- PLS – Plain Language Statement (Portuguese version)

INFORMAÇÃO PARA O VOLUNTÁRIO SOBRE O ESTUDO DE INVESTIGAÇÃO
"Neurociência Cultural: uma abordagem para as bases neurobiológicas do comportamento etnográfico com EEG e a Teoria dos Jogos: O caso da Irlanda e de Portugal"

Foi convidado para participar num estudo de investigação. Antes de se decidir, é importante para si perceber porque é que a investigação está a ser realizada e o que irá envolver. Por favor leia este folheto informativo cuidadosamente e tire as suas dúvidas se alguma coisa não estiver clara ou se desejar mais esclarecimentos.

QUAIS SÃO OS OBJETIVOS DO ESTUDO?

Esta investigação vai usar eletroencefalografia (EEG) assim como jogos da Teoria dos Jogos de forma a entender como o comportamento humano difere entre duas culturas, neste caso entre a Irlandesa e a Portuguesa, procurando as respetivas bases neuronais.

QUEM ESTÁ A ORGANIZAR O ESTUDO?

Este estudo está a ser organizado pelo Departamento de Biologia Experimental da Faculdade de Medicina da Universidade do Porto, em parceria com o Laboratório de Neuropsicofisiologia da Faculdade de Psicologia e Ciências da Educação da Universidade do Porto contando com a colaboração do Laboratório de Psicologia da Universidade de Dublin City e Maynooth University, na Irlanda.

SERÁ QUE EU TENHO QUE PARTICIPAR?

Cabe a si decidir se pretende participar ou não neste estudo de investigação. Se decidir participar, após a leitura deste folheto e de eventuais esclarecimentos que necessite ser-lhe-á dada uma folha de consentimento informado para assinar. Se decidir participar, é livre de a qualquer momento desistir sem para isso necessitar de dar qualquer explicação.

O QUE ME ACONTECERÁ SE EU PARTICIPAR NO ESTUDO?

Na parte inicial do estudo, irá ser submetido a dois questionários. O primeiro, tem por objetivo medir o seu grau de adaptação dentro da sua cultura de origem (ou seja, vai servir para testar o seu nível de enculturação), tendo por nome: "Questionário do Nível de Enculturação/Aculturação dos Irlandeses e Portugueses". O segundo, tem por objetivo medir a sua lateralidade, isto é, saber qual é a sua preferência, no uso das mãos, durante tarefas do quotidiano. Este último tem por nome: "Lateralidade de Edimburgo".

Estes dois questionários têm uma duração aproximada de 20 minutos.

Para além disso, irá realizar um teste (em inglês, *Montreal Cognitive Assessment, MoCA)* de forma a avaliar a sua capacidade cognitiva. Este teste tem uma duração aproximada de 15 minutos e envolve a realização de tarefas simples.

Este estudo envolve a realização de uma eletroencefalografia (EEG) enquanto estiver a jogar cinco jogos diferentes.

O EEG é uma técnica não-invasiva, que mede os campos elétricos resultantes da atividade do cérebro. Esta é medida com elétrodos colocados na superfície do couro cabeludo. O procedimento de inserção do elétrodo na touca é indolor (embora possa, ocasionalmente, dar origem a uma ligeira sensação de desconforto). A sua testa e mastoides serão limpos usando algodão embebidos em álcool antes dos elétrodos serem aplicados na touca, de forma a melhorar o contato com a pele.

Após as aquisições de EEG estarem concluídas, o gel será removido do cabelo utilizando papel de cozinha.

O processo de montagem leva cerca de 20-30 minutos, seguindo-se a experiência com cerca de 45 a 60 minutos. Há pausas entre cada jogo.

No final da experiência, irá receber um cartão de oferta no valor de 15 €. Pode ainda receber um cartão de oferta, no valor de 30 €, se fizer parte dos três jogadores que obtiverem pontuação mais elevada.

QUAIS SÃO AS RESTRIÇÕES À PARTICIPAÇÃO?

É necessário que cumpra com todos os requisitos seguintes:
- ter idade entre 18 e 50 anos;
- ter o Português como língua nativa;
- ter nascido em Portugal e ter sempre vivido em Portugal (i.e. apenas com saídas para o estrangeiro curtas, por exemplo em férias);

- ser destro/a;
- não ter histórico de diagnóstico de desordens neurológicas ou psiquiátricas;
- não estar a tomar medicação que possa influenciar o comportamento;
- não consumir álcool em excesso;
- não consumir drogas;
- não estar grávida nem em período de amamentação;
- não ter qualquer tipo de lesão na cabeça;
- não ser actual ou futuro estudante de qualquer dos investigadores.

QUAIS SÃO OS BENEFÍCIOS DA PARTICIPAÇÃO NO ESTUDO?

Os três primeiros classificados no conjunto dos jogos receberão, cada um/a; um prémio de 30 € (em cartão de oferta) e não haverá qualquer outro tipo de benefícios para os participantes. Apesar de não ser um benefício, todos os particpantes que completem o estudo serão compensados pelo seu tempo dispendido com 15 € em cartão de oferta.

QUAIS SÃO AS POSSÍVEIS DESVANTAGENS DA PARTICIPAÇÃO NO ESTUDO?

As desvantagens acabam por estar essencialmente associadas ao potencial desconforto que possa vir a sentir, por exemplo, no processo de montagem do equipamento (colocação da touca, elétrodos, gel, etc.). No entanto, faremos todos os esforços possíveis para minimizar e até se possível eliminar qualquer desconforto que possa vir a sentir. Recordamos-lhe que a sua participação é voluntária e que pode desistir de participar neste estudo se achar por bem fazê-lo.

O QUE ACONTECERÁ AOS RESULTADOS DESTE ESTUDO?

O anonimato dos participantes será preservado.

Os dados serão anonimizados e preservados, podendo ser compartilhados com outros cientistas genuínos, ou editores de revistas científicas. Poderão inclusivamente, vir a ser usados em futuros estudos científicos.

Caso esteja interessado, poderá contactar posteriormente os investigadores para saber os resultados deste estudo.

CONTACTOS DOS INVESTIGADORES:

Doutor José Paulo Marques dos Santos, Faculdade de Medicina da Universidade do Porto
E-mail: jmarquessantos@med.up.pt
Tel.: 912757264

Joana Raquel Augusto, aluna do 2º ano de Mestrado em Neurobiologia, da Faculdade de Medicina da Universidade do Porto
E-mail: up201506951@med.up.pt
Tel.: 912794947

CONTACTOS DA CES (COMISSÃO DE ÉTICA PARA A SAÚDE):

E-mail: comissao.etica@chsj.min-saude.pt

XII- Games instructions (English version)

A) PROCEDURE FOR EACH EEG SESSION:

- Give the PLS to the participant to read;
- Give the IC to read and sign;
- Do the IPEAS survey;
- Do the Handedness Questionnaire;
- MoCA (Reading the instructions in English);
- Take a photo of the participant;
- Practice blocks of each game reading all the instructions to them;
- EEG setup;
- EEG session.

B) <u>INSTRUCTIONS OF THE GAMES</u>:

Rock-Paper-Scissors

- What must be said to the participant:

"This game will be the only one that you will play against the computer. The computer will generate its response randomly. All victories will then be added to the total points accumulated during your performance in all five games you play. You will have to choose one of the three options available then, depending on the computer's choice, you can WIN, DRAW or LOSE".

Centipede game

- What must be said to the participant:

"This game has several rounds; each round has a total of 10 trials. You will play against one participant per round. You will start with a pot containing €1 that you will pass or take, depending on your decision. The same way you cannot guess your opponent's choice, s/he cannot do the same. Therefore, every time you decide to pass the pot, the value will rise by another euro so, one of you can end up with €10, if you continuously decide to pass the pot until the end of the round. If you decide to take the money before the round finishes, then you will accumulate the points that were inside of the pot. Once one of you decide to take the pot, and if the round has still not finished, the pot will start with the initial amount in the next trial, i.e., €1."

Ultimatum game

- What must be said to the participant:

"In this game, you will receive different proposals. Your opponent received €16 and had to decide how to divide this amount with you. The maximum s/he can give you is €8. All you must do is decide either if you want to accept the offer or reject it. If you accept, you will accumulate points. If you reject, you won't accumulate points. At the end, you will have to

classify each offer and then the people who made the offer, on a scale from 1 to 5, 1 being "very unfair" and 5 being "very fair"".

Volunteer's dilemma

- What must be said to the participant:

"In this game, you will be playing against 9 players. You will have to decide if you want to contribute to the group with 1 cent or keep €1 for yourself. You will only see their decision, once you have made yours. If at least one player contributes with 1cent, then everyone will keep and accumulate what they decided to contribute to the group. If the 10 of you won't give 1 cent, then everyone will lose their points on that trial."

Public Goods game

- What must be said to the participant:

"In this game, you will be playing against the same four players across 10 trials. You will have to decide which contribution you wish to make to the group, knowing that it will enter to a public pot that you all share.

Therefore, you have two cards. One worth €0 and the other worth €5. If you decide to contribute to the public pot with €5, and supposing that the other four players decided to do the same, then you will have €25 at the end. This amount is doubled and then divided equally between each of you. In this case, you will end up earning €10. However, if at least two of the five players don't contribute to the group with €5, then those who did contribute will lose their money and won't accumulate points, while those who didn't will keep their card worth €5.

During this task, you will only see the group's contribution after you made your choice and then you'll see a slide showing what you received – in green- and what the group received – in red -."

XIII- Games instructions (Portuguese version)

A) PARA CADA RECOLHA DE EEG, ESTE SERÁ O PROCEDIMENTO:

- Assinar dois Consentimentos Informados com o nome do participante (um para o investigador e outro para o voluntário);

- MoCA (Carina Fernandes);

- Teste de lateralidade;

- IPEAS;

- Antes de começar com os jogos, irei pedir uma foto ao participante, com a justificação de que será usada nos jogos para os participantes seguintes (caso do Proposer);

- Montagem do EEG, apontando sempre a referência da touca que está a ser usada;

- Avisar o participante para relaxar os músculos, evitar piscar muito os olhos e usar sempre a mão dominante quando estiver a responder com o comando.

B) <u>INSTRUÇÕES DOS JOGOS</u>:

Papel-Pedra-Tesoura

- O que dizer ao participante:

"Este jogo, será o único que irá ser jogado com as respostas do computador. Todas as vitórias serão somadas e contabilizadas como pontos para cada participante do estudo. Terá de escolher uma das três opções (i.e., pedra, papel ou tesoura), podendo vir a perder, ganhar ou empatar, consoante a jogada escolhida por si e, de seguida, pelo computador.

Assim sendo, Pedra > Tesoura; Papel > Pedra; Tesoura > Papel"

Jogo da Centopeia

- O que dizer ao participante:

"Este jogo tem várias jogadas, sendo que, em cada ronda, irá jogar com um adversário diferente. Irá ter de decidir se quer passar um pote com dinheiro lá dentro ou ficar com o montante para si. Cada decisão tem influência não só na sua pontuação final, como também irá influenciar a dos jogadores com quem irá jogar".

Jogo do Ultimato

- O que dizer ao participante:

"Neste jogo, vai receber propostas de dinheiro. O seu adversário, recebeu 12 euros e terá de decidir como deve dividir esse montante consigo. O máximo que você pode receber é 6 euros. Pelo que, neste jogo, o/ senhor/a terá de decidir se aceita a proposta ou se rejeita a proposta. Se rejeitar, nenhum de vocês recebe o dinheiro. Se aceitar, acumulam pontos equivalente à oferta feita".

Jogo do dilema do Voluntário

- O que dizer ao participante:

"Neste jogo, vai estar a jogar com 9 jogadores. Terá de escolher se quer contribuir para o grupo com 1 cêntimo ou ficar com 1€ para si. Só irá ver a decisão dos membros do grupo, após o/a senhor/a fazer a sua escolha. Basta haver pelo menos 1 jogador a contribuir com 1 cêntimo para cada um manter o seu dinheiro (e assim, acumular pontos). Caso contrario, isto é, se ninguém contribuir, então todos perdem o seu dinheiro e ninguém ganha pontos".

Jogo dos Bens Públicos

- O que dizer ao participante:

"Neste jogo, irá jogar com cinco jogadores, sendo que terá de escolher um de dois cartões: 0€ ou 5€, para contribuir no pote público. No final, consoante a contribuição de cada jogador, o montante disponível no pote duplica e é repartido equitativamente pelos restantes jogadores. Contudo, se pelo menos dois jogadores, dos cinco, não contribuir com os 5€, então, os que contribuíram perdem o seu dinheiro e os dois que não contribuíram ficam com o seu dinheiro, ou seja, 5€."

XIV- Games order

Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6
RPS	RPS	RPS	RPS	RPS	RPS
UG	UG	UG	UG	UG	UG
CG	CG	PGG	PGG	VD	VD
PGG	VD	CG	VD	PGG	CG
VD	PGG	VD	CG	CG	PGG
Participant 7	**Participant 8**	**Participant 9**	**Participant 10**	**Participant 11**	**Participant 12**
RPS	RPS	RPS	RPS	RPS	RPS
CG	CG	CG	CG	CG	CG
UG	UG	PGG	PGG	VD	VD
PGG	VD	UG	VD	PGG	UG
VD	PGG	VD	UG	UG	PGG
Participant 13	**Participant 14**	**Participant 15**	**Participant 16**	**Participant 17**	**Participant 18**
RPS	RPS	RPS	RPS	RPS	RPS
PGG	PGG	PGG	PGG	PGG	PGG
UG	UG	CG	CG	VD	VD
CG	VD	UG	VD	CG	UG
VD	CG	VD	UG	UG	CG
Participant 19	**Participant 20**	**Participant 21**	**Participant 22**	**Participant 23**	**Participant 24**
RPS	RPS	RPS	RPS	RPS	RPS
VD	VD	VD	VD	VD	VD
UG	UG	CG	CG	PGG	PGG
CG	PGG	UG	PGG	CG	UG
PGG	CG	PGG	UG	UG	CG
Participant 25	**Participant 26**	**Participant 27**	**Participant 28**	**Participant 29**	**Participant 30**
RPS	RPS	RPS	RPS	RPS	RPS
UG	UG	UG	UG	UG	UG
CG	CG	PGG	PGG	VD	VD
PGG	VD	CG	VD	PGG	CG
VD	PGG	VD	CG	CG	PGG

XV- Triggers

1) **Rock-Paper-Scissors (90 trials overall):**

CHOICE:

Rock: 1 – 222 – 2 – **RED**
Paper: 2 – 444 – 4 – **ORANGE**
Scissors: 3 – 888- 8 –**YELLOW**

RESULT:

Win: 16- **GREEN**

Draw: 32 – **BLUE**

Lose: 64 – **PURPLE**

2) **Ultimatum Game (120 trials overall):**

CHOICE:

Accept.bmp – 99 – 68 – **ORANGE** + **PURPLE**
Rejection – 100 – 72 – **PURPLE** + **YELLOW**

*If subjects press 1, then they accepted the offer made by the proposer. Otherwise, by pressing 2, they reject it and therefore, no one receives any money.

RESULT:

CASE OF IRELAND:

Men:

15/1 – 2- **RED**

14/2 – 4 - **ORANGE**

13/3 – 8 - **YELLOW**

11/5 – 16 - **GREEN**

9/7 – 32 - **BLUE**

8/8 – 64 -**PURPLE**

Women:

15/1 – 222- 6 – **RED** + **ORANGE**

14/2 – 333 - 10 - **YELLOW** + **RED**

13/3 – 444 - 12 - **ORANGE** + **YELLOW**

11/4 – 555 – 14 - **RED** + **ORANGE** + **YELLOW**

9/7 – 666 – 18 – **GREEN** + **RED**

8/8 – 777 – 20 - **GREEN** + **ORANGE**

3) **Centipede game (90 trials overall):**

CHOICE:
1 – Pass.bmp – 22 – 2 - **RED**
2 – Take.bmp – 33 – 4 –**ORANGE**

OPPONENTS:

Opassboy1.bmp – 44 – 8 – **YELLOW**
Opassgirl1.bmp–77 – 16 - **GREEN**
Otakegirl1.bmp – 777 – 18 - **GREEN** + **RED**
Otakeboy2.bmp – 555 – 64 - **PURPLE**
Opassboy2.bmp – 55 – 32 - **BLUE**
Opassboy3.bmp – 66 – 36 – **BLUE** + **RED**
Otakeboy3.bmp – 666 – 20 - **GREEN** + **ORANGE**
Otakegirl2.bmp – 888 – 68 – **PURPLE** + **ORANGE**
Opassgirl3.bmp – 99 – 38 – **BLUE** + **RED** + **ORANGE**
Opassgirl4.bmp – 11 – 40 – **BLUE** + **YELLOW**
Otakegirl4.bmp– 111 – 22 - **GREEN** + **RED** + **ORANGE**
Otakeboy4.bmp – 222 – 72 - **PURPLE** + **YELLOW**

4) **Public Goods game (90 trials overall):**

CHOICE (group 1: cooperation): Success.bmp (33) – 4 – **ORANGE**

Success1.bmp (34) – 38 – **BLUE** + **ORANGE** +**RED**

Successfreeriding.bmp (22) – 2 – **RED**

Successfreeriding1.bmp (23) – 36 - **BLUE** + **ORANGE**

CHOICE (group 2: midriding): Successfreeriding2.bmp (55) – 16 – **GREEN**

Successfreeriding21.bmp (56) – 40 – **BLUE** + **YELLOW**

Failure.bmp (44) – 8 – **YELLOW**

Failure1.bmp (45) – 42 - **BLUE** + **YELLOW** + **RED**

CHOICE (group 3: freeriding): Failure2.bmp (77) – 64 – **PURPLE**

Failure21.bmp (78) – 20 – **GREEN** + **ORANGE**

Failure3.bmp (66) – 32 – **BLUE**

Failure31.bmp (67) – 18 - **GREEN** + **RED**

*If subjects press 1, they are not contributing to the public pot;

* If subjects press 2, they contribute to the public pot with €5.

OPPONENTS CHOICE:

Cooperation.bmp (88) – 72 – **YELLOW** + **PURPLE** (every opponent contributed to the public pot)

Midriding.bmp (99) – 14 – **RED** + **ORANGE** + **YELLOW**

Midridinggirl.bmp (100) – 10 - **RED** + **YELLOW**

Freeriding.bmp (222) – 12 – **ORANGE** + **YELLOW**

4) **Volunteer's dilemma (65 trials overall):**

CHOICE:
"1" – 16 - **GREEN**

"2" – 32 - **BLUE**

*If subjects press 1, then they are contributing towards the group benefit. Otherwise, s/he keeps 1 euro for themselves.

RESULT:

Everyonekeeps.bmp – 22 – 2 - **RED**

Everyonekeeps1.bmp – 33 – 4 - **ORANGE**

Everyoneloses.bmp – 44 – 8 – **YELLOW**

XVI- Final results and scores of each participant

Portuguese Participant	Gender	Age	Profession	MoCA score	Handedness results (%)	IPEAS results	EEG cap reference (ANT system)	Notes	Final score of the five games
1	M	22	Student	29	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	He spent one week abroad (holidays)	1050,91
2	F	35	Student	27,5	100	10/10 (for the Portuguese questions) 1/10 (for the Irish questions)	211091	She wears glasses She travelled on holidays for three months	746,35
3	M	44	Manager	26	90	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	He spent one month abroad (holidays)	725,41
4	F	45	Clinical Analysis Technician	29	100	9/10 (for the Portuguese questions) 1/10 (for the Irish questions)	211092	She wears glasses She spent three months away with her parents as a baby (she was	690,78

								less than 1-year old)	
5	F	31	Clients assistant	28	80	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	She has never left the country	1009,53
6	F	44	Call centre	26	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	She spent three months abroad (holidays)	898,61
7	M	22	Student	29	100	9/10 (for the Portuguese questions) 2/10 (for the Irish questions)	211092	He wears glasses He spent one week and a half abroad (holidays)	769,9
8	M	19	Student	27	80	10/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	He spent three weeks abroad (holidays)	722,46
9	F	24	Student	29	100	10/10 (for the Portuguese questions)	211092	She spent four months abroad (ERASMUS)	697,49

						1/10 (for the Irish questions)			
10	M	22	Student	29	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	He spent two weeks abroad (holidays)	861,82
11	M	18	Student	28	100	9/10 (for the Portuguese questions) 1/10 (for the Irish questions)	211093	He spent two weeks abroad (holidays)	857,68
12	M	21	Student	30	100	9/10 (for the Portuguese questions) 1/10 (for the Irish questions)	211092	He spent one week abroad (holidays)	728,64
13	F	25	Student	29	100	10/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	She spent one month abroad (holidays)	931,64
14	F	22	Student	30	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	She spent ten days abroad (holidays)	933,6

15	M	20	Student	29	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	He spent two weeks abroad (holidays)	958,69
16	M	27	Security Assistant	26,5	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	He spent one week abroad (holidays)	817,64
17	M	27	Shopkeeper	26	90	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	He spent two weeks abroad (holidays)	991,55
18	M	30	Researcher	28	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	He spent two weeks abroad (holidays)	908,8
19	M	19	Student	28	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	He spent one week abroad (holidays)	952,62
20	F	25	Psychologist	26	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	She spent six months abroad (ERASMUS)	1034,9

21	F	23	Student	28	90	10/10 (for the Portuguese questions) 1/10 (for the Irish questions)	211091	She spent one month abroad (holidays)	986,36
22	F	23	Student	28	90	10/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	She spent five days abroad (holidays)	953,74
23	M	19	Student	28	100	10/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	He spent one week abroad (holidays)	842,73
24	M	21	Student	28	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	He spent a few hours in Spain	1047,79
25	M	18	Student	26	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211091	He spent one week abroad (holidays)	1018,88

26	F	31	Researcher	29	100	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	She spent three months abroad (ERASMUS)	785,78
27	F	25	Event hostess	28	65	8/10 (for the Portuguese questions) 2/10 (for the Irish questions)	211091	She spent three weeks abroad (holidays)	951,97
28	F	23	Student	29	100	9/10 (for the Portuguese questions) 2/10 (for the Irish questions)	211092	She spent five months abroad (ERAMUS)	892,55
29	F	23	Psychologist	28,5	90	9/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211093	She spent three months abroad (ERASMUS)	790,79
30	F	18	Student	27	100	8/10 (for the Portuguese questions) 0/10 (for the Irish questions)	211092	She spent three days abroad (holidays)	833,66
Irish Participants	**Gender**	**Age**	**Profession**	**MoCA score**	**Handedness results (%)**	**IPEAS results**	**EEG cap reference (BioSemi) (*)**	**Notes**	**Final score of the five games**

31	M	46	Lecturer in DCU	28	80	2/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large	He wears glasses He spent four months abroad (holidays)	810,61
32	M	34	Lecturer in DCU	28	100	2/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Medium/small	He wears glasses He spent two months abroad (holidays)	806,76
33	M	31	Researcher	30	80	1/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	He wears glasses He spent two months abroad (PhD program)	849,39
34	M	36	Chaplain	30	80	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large	He spent three months abroad (holidays)	878,59
35	M	20	Student	27	100	0/10 (for the Portuguese questions)	Large	He spent three weeks abroad (holidays)	936,96

						9/10 (for the Irish questions)			
36	M	31	Post-doc researcher	30	100	1/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	He spent three months abroad (holidays)	760,55
37	F	22	Worker in the Science Gallery	28	100	1/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Medium/small	She spent two years in England as a baby	1028,52
38	F	29	Student	27	80	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Medium/small	She spent two weeks abroad (holidays)	814,69
39	F	20	Student	26	80	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	She spent two weeks abroad (holidays)	949,61
40	F	19	Student	28	100	0/10 (for the Portuguese questions) 7/10 (for the Irish questions)	Large/medium	She spent two weeks abroad (holidays)	786,49

41	M	20	Student	30	100	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large	He spent one month abroad (holidays)	841,69
42	M	36	Researcher	30	100	3/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large	He spent ten months abroad (training course)	1397,94
43	F	21	Student	30	100	1/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Large/medium	She spent three months abroad (holidays)	960,74
44	F	20	Student	30	100	0/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Medium/small	She spent six weeks abroad (holidays)	880,44
45	F	22	Student	29	80	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	She spent three months abroad (holidays)	742,6
46	F	20	Student	28	100	0/10 (for the Portuguese questions)	Medium/small	She spent two months abroad (holidays)	944,35

						8/10 (for the Irish questions)			
47	F	20	Student	30	100	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Medium/small	She spent two weeks abroad (holidays)	884,79
48	F	21	Student	29	80	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	She spent three weeks abroad (holidays)	847,79
49	F	19	Student	27	100	1/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large/medium	She spent three months abroad (holidays)	916,62
50	F	21	Student	25	80	0/10 (for the Portuguese questions) 10/10 (for the Irish questions)	Large	She spent two weeks abroad (holidays)	947,53
51	F	18	Student	29	100	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Medium/small	She spent six weeks abroad (holidays)	874,61
52	F	22	Student	28	100	0/10 (for the Portuguese questions)	Medium/small	She spent three months	946,48

						8/10 (for the Irish questions)		abroad (holidays)	
53	M	28	PhD student	30	100	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large/medium	He spent nine months abroad (training course)	833,43
54	M	19	Student	29	100	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large/medium	He spent one month abroad (holidays)	898,36
55	M	19	Student	26	100	0/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large	He spent one month abroad	834,89
56	F	24	Student	28	100	1/10 (for the Portuguese questions) 9/10 (for the Irish questions)	Large/medium	She spent two weeks abroad (holidays)	953,91
57	M	22	Student	27	80	1/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Large	He spent one year abroad (ERASMUS)	796,81

58	M	20	Student	27	80	1/10 (for the Portuguese questions) 7/10 (for the Irish questions)	Large/medium	He spent three months abroad (holidays)	671,69
59	F	20	Student	29	90	0/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Large/medium	She spent one month abroad (holidays)	623,57
60	F	18	Student	26	100	1/10 (for the Portuguese questions) 7/10 (for the Irish questions)	Large/medium	She spent two weeks abroad (holidays)	975,83

Portuguese participants that were dismissed

	Gender	**Age**	**Profession**	**MoCA score**	**Handedness results (%)**	**IPEAS results**	**EEG cap reference (ANT system)**	**Notes**	**Justification for dismissal**
	F	24	Unemployed	23	-	-	-	MoCA <26	Inclusion criteria were not fulfilled. In this case, the MoCA final result was <26.
	F	27	Student	24	90	-	-	MoCA <26	Inclusion criteria were

									not fulfilled. In this case, the MoCA final result was <26.
	M	21	Student	25	100	-	-	MoCA <26	Inclusion criteria were not fulfilled. In this case, the MoCA final result was <26.
	M	21	Student	25	100	-	-	MoCA <26	Inclusion criteria were not fulfilled. In this case, the MoCA final result was <26.
	F	23	Student	23	100	-	-	MoCA <26	Inclusion criteria were not fulfilled. In this case, the MoCA final result was <26.
Irish participants that were dismissed									
	Gender	**Age**	**Profession**	**MoCA score**	**Handedness results (%)**	**IPEAS results**	**EEG cap reference (BioSemi) (*)**	**Justification for dismissal**	

	F	41	Student	28	100	1/10 (for the Portuguese questions) 8/10 (for the Irish questions)	Medium/Small	The participant did not fulfil all the criteria of inclusion. In this case, the participant suffered from epilepsy and persisted towards participation in the study, even though she was informed of her ineligibility.

(*) Head circumference electro-cap International, Inc. Eaton, Ohio 45320 USA (Biosemi):

Large Size (blue cap): 58-62 cm

Large / medium (purple and red cap): 56-60 cm

Medium / small (yellow and red cap): 52-56 cm

XVII- Behavioural Results (%) and Reaction Times (in milliseconds) of the Portuguese and Irish Participants

1) Rock-Paper-Scissors (this game had total of 90 trials). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results (%) and Reaction Times (RT) (in milliseconds)

PARTICIPANT	ROCK (%)	RT (*)	PAPER (%)	RT (*)	SCISSORS (%)	RT (*)	WIN (%)	DRAW (%)	LOSE (%)
1	41,11	399,00	35,56	379,50	23,33	380,10	47,78	33,33	18,89
2	40,00	1592,00	30,00	1170,00	30,00	1386,90	31,11	34,44	34,44
3	26,67	1958,00	30,00	1684,00	43,33	1783,10	37,78	27,78	34,44
4	32,22	1009,00	33,33	904,60	34,44	950,48	41,11	36,67	22,22
5	40,00	1026,00	18,89	958,00	41,11	1304,70	27,78	38,89	33,33
6	37,78	932,00	22,22	723,70	40,00	625,36	32,22	34,44	33,33
7	42,22	1069,00	26,67	672,60	31,11	1307,50	35,56	31,11	33,33
8	46,67	667,00	26,67	2156,00	26,67	1886,00	43,33	40,00	16,67
9	34,44	1755,00	26,67	1260,00	38,89	1655,10	31,11	38,89	30,00
10	34,44	810,00	31,11	426,90	34,44	441,29	21,11	34,44	44,44
11	31,11	1899,00	30,00	2157,00	38,89	2144,40	33,33	24,44	42,22
12	38,89	1009,00	28,89	752,70	32,22	782,34	41,11	24,44	34,44
13	33,33	788,00	34,44	716,50	32,22	745,55	41,11	33,33	25,56
14	34,44	969,00	31,11	1052,00	34,44	825,40	28,89	35,56	35,56
15	41,11	1421,00	31,11	932,90	27,78	1352,20	46,67	26,67	26,67
16	57,78	871,00	23,33	807,80	18,89	1009,20	33,33	31,11	35,56
17	35,56	648,00	28,89	720,20	35,56	478,59	47,78	31,11	21,11

18	33,33	3321,00	41,11	3375,00	25,56	3896,50	43,33	25,56	31,11
19	33,33	722,00	31,11	741,60	35,56	868,56	38,89	31,11	30,00
20	37,78	882,00	30,00	894,90	32,22	601,83	37,78	25,56	36,67
21	36,67	4469,00	44,44	3810,00	18,89	785,76	43,33	22,22	34,44
22	34,44	1342,00	34,44	1628,00	31,11	1623,00	55,56	25,56	18,89
23	28,89	1957,00	36,67	1439,00	34,44	1739,40	43,33	28,89	27,78
24	35,56	3125,00	32,22	3590,00	32,22	3242,70	54,44	31,11	14,44
25	35,56	2110,00	33,33	1825,00	31,11	1806,10	61,11	20,00	18,89
26	27,78	572,00	34,44	428,80	37,78	552,97	26,67	33,33	40,00
27	70,00	745,00	21,11	538,70	8,89	237,25	34,44	26,67	38,89
28	31,11	801,00	34,44	881,20	34,44	898,26	31,11	37,78	31,11
29	33,33	893,00	30,00	488,40	36,67	649,45	37,78	34,44	27,78
30	31,11	1190,00	33,33	914,20	35,56	1604,90	41,11	35,56	23,33
31	30,00	2228,70	38,89	1434,00	31,11	1451,90	31,11	35,56	33,33
32	35,56	1378,70	30,00	1520,00	34,44	923,42	33,33	32,22	34,44
33	68,89	590,31	17,78	968,80	13,33	802,00	36,67	34,44	28,89
34	35,56	1520,60	31,11	1661,00	33,33	1354,40	43,33	31,11	25,56
35	36,67	1724,30	30,00	2011,00	33,33	2332,80	50,00	26,67	23,33
36	31,11	444,36	21,11	472,60	47,78	619,60	33,33	30,00	36,67
37	34,44	456,39	32,22	406,70	33,33	401,40	50,00	32,22	17,78
38	35,56	2279,00	33,33	2031,00	31,11	1944,70	33,33	32,22	34,44
39	37,78	412,44	32,22	518,70	30,00	487,04	26,67	28,89	44,44
40	41,11	484,65	27,78	440,20	31,11	395,70	37,78	28,89	33,33
41	35,56	1763,90	34,44	2035,00	30,00	1299,20	31,11	38,89	30,00

42	35,56	547,38	31,11	553,30	33,33	625,80	42,22	33,33	24,44
43	34,44	539,61	37,78	675,70	27,78	673,00	28,89	35,56	35,56
44	38,89	596,51	32,22	563,10	28,89	859,46	36,67	36,67	26,67
45	30,00	2259,10	34,44	1532,00	35,56	2013,50	46,67	28,89	24,44
46	35,56	305,25	37,78	330,30	26,67	360,42	44,44	25,56	30,00
47	36,67	1121,70	28,89	878,00	34,44	1057,10	34,44	22,22	43,33
48	33,33	645,00	34,44	759,30	32,22	661,58	37,78	26,67	35,56
49	37,78	445,73	31,11	578,30	31,11	445,86	22,22	25,56	52,22
50	27,78	792,64	35,56	949,70	36,67	762,09	37,78	33,33	28,89
51	35,56	2039,20	36,67	1987,00	27,78	1254,40	36,67	38,89	24,44
52	28,89	1126,40	42,22	1398,00	28,89	1748,50	36,67	26,67	36,67
53	37,78	703,22	25,56	909,40	33,33	706,47	32,22	27,78	40,00
54	31,11	2173,40	35,56	2451,00	33,33	1970,20	37,78	33,33	28,89
55	30,00	2363,60	37,78	1793,00	32,22	1810,40	45,56	31,11	23,33
56	32,22	590,03	27,78	614,30	40,00	466,92	32,22	30,00	37,78
57	34,44	560,00	38,89	415,30	26,67	333,00	33,33	32,22	34,44
58	41,11	688,51	34,44	750,40	24,44	566,95	30,00	40,00	30,00
59	36,67	1471,70	31,11	1425,00	32,22	1182,90	48,89	37,78	13,33
60	32,22	1253,00	33,33	1328,00	34,44	1410,30	37,78	23,33	38,89

*Reaction Time to the stimulus (in milliseconds)

Notes:

ROCK represents the number of times the participant chose the option 1 on the computer screen.

PAPER represents the number of times the participant chose the option 2 on the computer screen.

SCISSORS represent the number of times the participant chose the option 3 on the computer screen.

WIN represents the number of times the participant won against the computer.

DRAW represents the number of times the participant drawn against the computer.

LOSE represents the number of times the participant lost against the computer.

2) Ultimatum Game (this game had total of 120 trials). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results (%) and Reaction Times (RT) (in milliseconds)

PARTICIPANT	FAIR ACCEPT (%)	RT (*)	MID ACCEPT (%)	RT (*)	UNFAIR ACCEPT (%)	RT (*)	FAIR REJECT (%)	RT (*)	MID REJECT (%)	RT (*)	UNFAIR REJECT (%)	RT (*)
1	35,00	354,91	3,33	629,00	,00	,00	,00	,00	30,83	333,70	30,83	355,79
2	28,33	848,00	13,33	993,30	,83	4122,00	,00	,00	20,83	1004,13	36,67	1033,87
3	27,50	1903,60	2,50	2184,00	8,33	1318,00	7,50	1837,40	30,83	1274,00	23,33	1024,90
4	30,00	1224,50	20,00	1085,17	18,33	1189,63	,00	,00	1,67	876,00	19,17	2038,60
5	15,83	1358,26	30,00	896,67	20,83	1062,00	15,00	1277,94	5,00	2070,67	13,33	828,81
6	30,00	586,47	37,50	686,07	6,67	895,10	,00	,00	4,17	890,00	21,67	694,50
7	15,83	1072,60	24,17	919,00	3,33	1806,00	17,50	684,81	6,67	1026,00	32,50	546,82
8	27,50	419,58	18,33	422,00	,83	4213,00	7,50	373,00	14,17	450,06	31,67	359,95
9	14,17	717,65	,00	,00	,00	,00	21,67	791,23	29,17	638,00	35,00	557,76
10	27,50	606,73	,00	,00	,00	,00	,83	4300,00	34,17	1047,00	37,50	1088,30
11	27,50	498,18	1,67	563,00	,00	,00	3,33	419,50	30,00	685,50	37,50	687,38
12	30,00	618,00	20,83	710,50	,83	574,00	1,67	2265,00	12,50	479,00	34,17	430,00
13	31,67	620,26	31,67	836,32	,83	601,00	1,67	715,00	1,67	1924,50	32,50	641,33
14	20,83	912,08	19,17	1238,00	15,00	1287,00	12,50	576,40	8,33	868,50	24,17	795,21
15	35,83	545,72	25,00	1035,07	,83	984,00	,00	,00	9,17	632,40	29,17	540,00
16	32,50	1157,89	34,17	821,95	33,33	1181,00	,00	,00	,00	,00	,00	,00
17	28,33	493,00	30,83	461,86	23,33	715,39	,83	1266,00	,83	544,00	15,83	353,16
18	32,50	868,93	31,67	718,47	30,83	609,50	1,67	838,50	1,67	343,50	1,67	859,00
19	35,00	446,67	27,50	518,52	11,67	747,93	,00	,00	,83	592,00	25,00	750,30
20	30,00	355,33	22,50	528,00	2,50	906,70	,00	,00	20,83	763,80	24,17	557,17
21	37,50	912,02	30,00	805,50	30,00	720,80	,00	,00	,00	,00	2,50	1344,00
22	33,33	565,65	16,67	1335,00	,00	,00	,00	,00	18,33	523,27	31,67	572,61

23	35,83	372,26	33,33	368,00	,83	1273,00	,00	,00	,00	,00	30,00	534,28
24	38,33	1069,74	,00	,00	,00	,00	,00	,00	29,17	1259,00	32,50	935,10
25	37,50	883,82	,00	,00	,00	,00	5,00	1133,33	27,50	1176,24	30,00	678,47
26	27,50	782,21	23,33	647,43	14,17	773,94	7,50	897,00	11,67	688,20	15,83	494,16
27	25,00	657,73	23,33	730,00	18,33	762,80	,83	246,00	8,33	374,10	24,17	463,45
28	30,00	880,11	15,00	905,00	,00	,00	,00	,00	10,83	1159,00	44,17	1043,80
29	38,33	823,00	30,00	1076,00	10,00	1149,00	,00	,00	,00	,00	21,67	527,00
30	38,33	505,13	4,17	464,00	,00	,00	,00	,00	32,50	484,50	25,00	318,80
31	35,83	1231,20	26,67	1577,25	5,00	1634,67	,00	,00	1,67	1560,00	30,83	1656,60
32	33,33	731,93	31,67	470,45	4,17	760,80	,00	,00	,83	672,00	30,00	773,56
33	35,83	915,93	33,33	927,17	,83	528,00	,00	,00	8,33	1046,00	21,67	1030,00
34	32,50	944,48	35,00	852,62	,00	,00	,00	,00	1,67	3921,00	30,83	976,95
35	26,67	383,88	,00	,00	,00	,00	,00	,00	35,00	696,40	38,33	409,63
36	36,67	348,43	20,83	432,56	,00	,00	,00	,00	8,33	504,50	34,17	364,95
37	27,50	541,09	22,50	692,55	3,33	483,25	,00	,00	11,67	647,70	35,00	590,78
38	41,67	904,42	12,50	1123,80	,83	2185,00	,00	,00	15,00	1503,00	30,00	821,75
39	32,50	534,07	34,17	484,29	2,50	1844,33	,00	,00	,83	1553,00	30,00	439,53
40	32,50	567,76	34,17	584,70	,83	1430,00	,83	455,00	,00	,00	31,67	514,53
41	35,83	515,72	34,17	650,37	24,17	1010,59	,00	,00	,00	,00	5,83	2491,60
42	28,33	750,58	,00	,00	,83	799,00	,00	,00	35,83	978,50	35,00	806,26
43	34,17	644,17	37,50	1191,33	26,67	731,44	,00	,00	,83	1445,00	,83	2254,00
44	34,17	694,68	27,50	619,30	5,83	1161,57	1,67	701,50	5,00	1140,00	25,83	656,55
45	33,33	661,63	33,33	939,35	32,50	667,56	,83	576,00	,00	,00	,00	,00
46	34,17	514,95	33,33	687,77	31,67	492,15	,83	587,00	,00	,00	,00	,00
47	34,17	838,37	20,00	788,38	,00	,00	1,67	459,50	7,50	1268,00	36,67	1024,00
48	28,33	644,94	7,50	781,00	,83	627,00	,00	,00	25,83	963,42	37,50	1222,80
49	27,50	580,90	35,00	621,33	1,67	990,50	,83	3389,00	1,67	1294,00	33,33	742,70

50	28,33	509,44	37,50	689,56	,00	,00	,00	,00	,00	,00	34,17	620,10
51	31,67	755,11	31,67	606,50	36,67	654,71	,00	,00	,00	,00	,00	,00
52	30,83	852,22	30,00	1210,78	3,33	5896,75	5,00	1986,80	4,17	2622,00	26,67	644,78
53	22,50	1117,30	5,00	2787,00	,00	,00	11,67	3844,10	23,33	1829,00	37,50	796,33
54	28,33	348,74	30,83	599,67	1,67	336,00	,00	,00	,83	392,00	38,33	373,78
55	8,33	857,70	31,67	811,68	11,67	1083,57	30,83	787,70	2,50	3914,00	15,00	696,60
56	30,83	698,65	35,00	761,20	34,17	635,48	,00	,00	,00	,00	,00	,00
57	35,00	425,40	,00	,00	,00	,00	,83	385,00	30,83	565,70	33,33	544,88
58	30,00	671,16	31,67	642,84	,00	,00	,00	,00	,00	,00	38,33	673,02
59	15,83	876,47	16,67	916,10	11,67	1041,29	20,83	975,80	10,00	815,10	25,00	925,03
60	30,00	1085,90	19,17	962,35	,00	,00	,00	,00	17,50	1089,00	33,33	1095,30

*Reaction Time to the stimulus (in milliseconds)

Notes:

FAIR ACCEPT represents a case in which the participant accepted fair offers (case of Ireland 8:8 / 7:9; case of Portugal 6:6 /5:7);

MID ACCEPT represents a case in which the participant accepted midfair offers (case of Ireland 5:11 / 4:12; case of Portugal 4:8 / 3:9);

UNFAIR ACCEPT represents a case in which the participant accepted unfair offers (case of Ireland 2:14 / 1:15; case of Portugal 2:10 / 1:11);

FAIR REJECT represents a case in which the participant rejected fair offers (case of Ireland 8:8 / 7:9; case of Portugal 6:6 /5:7);

MID REJECT represents a case in which the participant rejected midfair offers (case of Ireland 5:11 / 4:12; case of Portugal 4:8 / 3:9);

UNFAIR REJECT represents a case in which the participant rejected unfair offers (case of Ireland 2:14 / 1:15; case of Portugal 2:10 / 1:11).

2.1) Behavioural data of the 60 participants (Portuguese participants from 1 to 30 and Irish participants from 31 to 60), during the final phase of the Ultimatum Game. This table considers the classification that each participant made on the *offers* that were proposed during the game as FAIR, MID or UNFAIR OFFER, as well as the *opponent* who made such proposal (in this case, as a FAIR, MID or UNFAIR FACE), on a scale from 1 to 5, 1 being *very unfair* and 5 being *very fair*.

PARTICIPANT	FAIR OFFER	RT (*)	MID OFFER	RT (*)	UNFAIR FAIR	RT (*)	FAIR FACE	RT (*)	MID FACE	RT (*)	UNFAIR FACE	RT (*)
1	4,5	766,5	2,5	2259	1.5	414	4	1369,5	2,25	1311	2,75	1157,5
2	3,5	7186	2,5	2332,5	1	2956,5	4,25	1186,5	3,25	2245	1,5	2875,5
3	3	2402	1,5	1750	1	4602,5	3,75	2820,5	2,75	2914	1,5	974
4	5	3668,5	3	1676	3	7173	3,5	3368,3	2,25	2628	1	2384,3
5	3	3319,5	3	2785	1,5	1860,5	4	4065,3	3,5	2146	2,5	2230,5
6	5	420	5	1591	1	5589	5	720,75	5	856,8	1	545
7	4	3035,5	4	2126	1,5	887,5	3,25	2252	3,5	2849	2	904
8	4	3040	2,5	2023,5	1	762,5	4	3191,8	2,5	3777	1,25	823,5
9	4	5088,5	2	1611	1,5	805	3,5	1509,3	2	1660	1,25	2133,8
10	4,5	1097	2	3085,5	1	318,5	4	2716	3,25	510,3	1,25	480,75
11	4,5	3042	3	1314	1,5	451	4,25	784,25	3,25	2113	1,5	373,5
12	4,5	2829	3,5	1247	3,5	1965,5	4,75	735	3	2198	1,75	530,5
13	4,5	2093	3,5	4930,5	1,5	601	4,5	1203	3,5	1700	1,5	242,25
14	4,5	2648,5	3	1109	1,5	762,5	4	678,25	3,5	772,5	2	429,25
15	4,5	872	4	4662,5	1	1010	4,75	1787,8	3,5	620,8	1	767,5
16	5	1881	4,5	1495	3,5	3661,5	3,5	1021,8	3,5	1657	3	405,25
17	5	3905,5	3	3240,5	1,5	1811,5	4,25	1906,5	3,25	1800	1,75	1530,8
18	5	2720,5	4	2306	1,5	1092,5	4,75	633,75	3,5	1007	1,75	1021
19	5	3389	3,5	715	1,5	3242	3,5	1745,5	3,5	1945	1,5	508,75
20	3,5	3824	3	803	1,5	204	4,5	1377	3	1222	1,75	638

21	5	1349	3	2968	1,5	1956,5	4	1438,3	3	625,3	2,5	409,5
22	4,5	2228	3,5	3231	1,5	1476,5	4	1053	3,5	2086	2	1964,8
23	5	643,5	3,5	1684,5	2	336	5	935,75	3,5	602,5	1,5	328,75
24	4,5	1165	1,5	3263,5	1,5	3860,5	4,5	1048,8	1,25	1585	1	846
25	4,5	3207	3,5	3502	1	487,5	4,5	662,5	2,25	3241	1,5	804
26	5	975,5	3	2890,5	2	6347	4	1190,3	3,5	2071	2,75	1233,3
27	3	1389,5	3	3901,5	1	912	4,5	1280,3	3,25	3299	1	532
28	3,5	4582	3	2031	1,5	2983,5	4,5	1270,8	3,25	1794	2	1830,8
29	4	4124,5	3,5	2441,5	1	1246	3,75	1002,5	3,25	1052	2,25	3232
30	4,5	684,5	2,5	2414	2	380	3,25	959	3,25	1217	2,25	1855,3
31	4	4704	3	7908,5	2	6491,5	4,25	3149,3	2,75	3917	2	1419
32	4	4594,5	3,5	2330,5	1,5	1053,5	5	795,5	4	2389	1	1317,3
33	4,5	3909	2,5	2042,5	1	695	4,5	1850	2,75	2565	1	429,25
34	4,5	3453	3,5	1936	1,5	634	4	2125,8	2,75	1554	1,5	1740,8
35	2,5	1004	2	4162	1	1744,5	3,75	1450	1,25	1655	1,5	1740,8
36	5	959,5	3,5	6810	1,5	2336	5	2113	3,5	2792	2	1714,3
37	4,5	3879,5	2,5	1082	1,5	592	4,5	984,75	2,5	1184	1,25	1113,8
38	4	1453	3	2808	1	3177,5	4,5	2942,5	3	2776	2	981,75
39	5	772	3,5	4252	1	637,5	4,5	500,75	3,25	1869	1,25	345
40	2	4050	3	2911,5	1	1416,5	4,5	748	3,25	738,3	2	1115,8
41	5	3449,5	3	8866,5	1	1492,5	5	1527,5	3,75	4636	1	1744
42	4,5	3941	2,5	2696,5	2	4660,5	4,5	1103	3	3368	1,25	912
43	3	4310,5	2	13707,5	1	924,5	2,25	1032	2	2610	1,5	1199,8
44	5	2575	2,5	1525,5	1	519	4,25	1105,3	3,5	1541	1,75	444,25
45	4,5	8737,5	3,5	774,5	1,5	10589,5	4,5	8667,8	3,5	2172	1,5	2446,8
46	5	599,5	3,5	3341	1,5	1252,5	3,75	736	3,25	378	2,5	2336,3
47	5	2193	3	2136,5	2,5	5121,5	4,5	1567	3	2461	1,5	2039

48	4,5	2539,5	2,5	6137	1	2690,5	4	2109,8	2,75	1677	1,5	2177,5
49	5	3847	3,5	3321	2	6009	4,5	2214,5	4	3037	1,5	1487,5
50	5	3791	3	6181,5	1	1869	3	2173,8	3,25	1911	3	2113,3
51	4	4891	2	3619	1	691	3,75	1583,5	3,5	1653	1,25	3163,3
52	4,5	487,5	3,5	1807,5	1,5	1689	4	1562,3	2,75	1351	3	736,5
53	3,5	3652	1	1225,5	2,5	6305	3,25	2187,5	2,25	938,8	1,25	428
54	4,5	2166	3	2369	1	3856	4,5	1603,3	3	1395	1	676,5
55	3,5	4945,5	2,5	2752	3	5233	2,25	2802,3	3,5	1555	2,75	2287,8
56	4,5	7437	4	2696	1	1182	4,75	445,75	4,25	1648	2,25	2552,3
57	3	2869,5	2	1022,5	1	349	2,75	1340,3	2,75	413,3	2,25	556,25
58	5	1397	3	4546,5	1,5	4526	5	1101,8	3,25	3477	1	1172
59	4,5	1578,5	3	660,5	2	4429,5	4,75	1267	3	781,5	1,75	896,75
60	4,5	2994,5	3,5	4284	1	2040,5	4,75	1218,3	3	2856	2	1349,5

*Reaction Time to the stimulus (in milliseconds)

2.2) Proposer (this task was only behavioural and consisted of 20 trials only). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results, considering that they had to choose how much they would be willing to offer to the opponent they were seeing on the screen.

PARTICIPANT	PROPOSAL (*)	RT (**)
1	1,3	418,6
2	5,45	1771,65
3	1	3044,65
4	2,35	7127,2
5	3,75	1131,65
6	1,05	2655,6
7	1,6	1541,2
8	3,05	805,65
9	6	1219,65
10	1	1275,8
11	2,25	924,6
12	3,1	2106,1
13	4,45	1473,95
14	2,65	2281,8
15	2,05	1630,85
16	1,25	1416,4
17	1	667,45
18	1	2041,2
19	1,1	670,15
20	4,7	873,2632
21	2,6	1599,25
22	3,2	1483,8
23	3	1735,9

24	6	1105,3
25	1,8	1533,35
26	5,45	815
27	4,75	5184,25
28	3,75	1312,1
29	3,9	1802,8
30	6	538
31	3,5625	1660,8
32	5,9625	2388,4
33	4,5	3712,7
34	2,025	2459,4
35	2,1	2865,4
36	1,5	844,8
37	1,1625	2220,7
38	4,5	1450,2
39	1,575	1030,7
40	2,2875	6267
41	3,15	1430,35
42	5,3625	5797
43	3,7125	2883,2
44	2,625	1531,2
45	4,8	1127,7
46	6	2879,8
47	3	1099,1
48	3,1125	1575,2
49	5,2875	2531,3
50	2,925	1976

51	6	1408,05
52	6	1969,9
53	1,3125	2154,7
54	6	957,35
55	1,5	527,45
56	3,9375	1281,8
57	6	1121,7
58	6	706,68
59	6	1604,8
60	2,8125	1181,4

*****Proposal were made from 1€ to 6€ for the Portuguese study and from 1€ to 8€ for the Irish one, however for the statistical analysis, all values from the Irish participants were converted so that they would be within the same conditions with the ones obtained by the Portuguese participants.

For example,

If 6€ is the maximum that Portuguese participants could give, then by multiplying the value obtained from the offer made by the Irish participant and then dividing that amount per 8 (maximum in euros that the Irish participants could give), we will be able to get the right conversion:

6€ ——————————— ***x***

8€ ——————————— **4,75 (average of offers made by the Irish participant nº1)**

***x*= 3,5625**

**Reaction Time to the stimulus (in milliseconds)

3) Centipede Game (this game had total of 90 trials). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results (%) and Reaction Times (RT) (in milliseconds)

PARTICIPANT	PASS/COO (%)	RT (*)	PASS/MID (%)	RT (*)	PASS/FREE (%)	RT (*)	TAKE/COO (%)	RT (*)	TAKE/MID (%)	RT (*)	TAKE/FREE (%)	RT (*)
1	28,89	466,62	31,11	414,71	15,56	542,10	4,44	534,50	2,22	524,00	17,78	481,50
2	20,00	1352,78	28,89	1385,70	11,11	1924,00	13,33	747,17	4,44	1036,5	22,22	1577,10
3	11,11	7062,60	22,22	2178,40	17,78	1407,00	22,22	1643,80	11,11	1876,0	15,56	1250,43
4	20,00	1269,78	26,67	1547,90	13,33	1730,00	13,33	2053,83	6,67	1353,3	20,00	1552,78
5	26,67	1188,75	28,89	996,46	22,22	881,70	6,67	1507,00	4,44	1406,0	11,11	1081,80
6	13,33	1260,83	22,22	1298,00	20,00	926,60	20,00	1202,00	11,11	1315,6	13,33	881,17
7	22,22	468,90	24,44	651,73	13,33	515,30	11,11	585,60	8,89	476,00	20,00	416,11
8	20,00	1049,67	28,89	631,31	33,33	491,20	13,33	576,17	4,44	422,00	,00	,00
9	31,11	939,21	33,33	718,20	26,67	989,80	2,22	1010,00	,00	,00	6,67	2219,33
10	24,44	1283,09	28,89	1231,60	28,89	1499,00	8,89	760,50	4,44	1169,5	4,44	991,00
11	24,44	927,18	22,22	881,10	11,11	1585,00	8,89	978,00	11,11	1153,0	22,22	1092,50
12	26,67	875,50	28,89	892,85	17,78	977,00	6,67	716,67	4,44	514,50	15,56	596,71
13	26,67	717,42	33,33	803,67	15,56	1257,00	6,67	803,67	,00	,00	17,78	673,75
14	15,56	626,29	20,00	958,00	15,56	864,60	17,78	961,50	13,33	828,00	17,78	787,63
15	22,22	1108,60	28,89	621,85	15,56	1094,00	11,11	646,80	4,44	669,00	17,78	1329,00
16	26,67	1638,25	31,11	2658,00	31,11	1299,00	6,67	922,00	2,22	583,00	2,22	1632,00
17	28,89	530,08	28,89	822,08	15,56	241,00	4,44	478,50	4,44	363,00	17,78	301,75
18	17,78	1108,25	24,44	1118,70	6,67	1310,00	15,56	1536,00	8,89	1089,8	26,67	1203,08
19	24,44	1258,09	24,44	1206,80	11,11	1432,00	8,89	558,25	8,89	541,50	22,22	750,00
20	22,22	775,40	20,00	778,33	11,11	1669,00	11,11	551,80	13,33	533,83	22,22	478,40
21	17,78	1387,75	31,11	2516,60	13,33	951,00	15,56	939,86	2,22	565,00	20,00	2355,56
22	24,44	803,64	26,67	844,83	8,89	742,80	8,89	1423,50	6,67	915,67	24,44	458,27

23	22,22	450,70	26,67	582,00	13,33	435,30	11,11	515,80	6,67	813,67	20,00	454,67
24	17,78	1274,25	26,67	1203,80	11,11	1595,00	15,56	983,00	6,67	818,33	22,22	586,30
25	22,22	631,50	20,00	735,22	8,89	1164,00	11,11	672,80	13,33	405,33	24,44	471,73
26	22,22	1006,30	20,00	1202,60	13,33	538,50	11,11	1397,60	13,33	1021,20	20,00	585,56
27	22,22	731,20	26,67	588,33	15,56	806,70	11,11	1124,80	6,67	551,33	17,78	484,25
28	26,67	1589,50	31,11	1194,40	22,22	1775,00	6,67	1594,00	2,22	928,00	11,11	1761,20
29	26,67	600,17	28,89	758,38	17,78	573,90	6,67	876,00	4,44	347,50	15,56	424,00
30	11,11	489,20	11,11	544,40	,00	,00	22,22	441,40	22,22	404,10	33,33	531,40
31	22,22	2121,90	28,89	22007,0	8,89	9108,00	11,11	6391,00	4,44	1996,0	24,44	11614,0
32	28,89	16993,0	33,33	20358,0	31,11	13071,00	4,44	2781,00	,00	,00	2,22	530,00
33	26,67	824,50	31,11	943,93	20,00	648,10	6,67	757,66	2,22	619,00	13,33	845,17
34	22,22	853,00	24,44	1352,90	31,11	1030,00	11,11	642,20	8,89	2130,00	2,22	1142,00
35	8,89	721,00	,00	,00	2,22	3202,00	24,44	523,82	33,33	796,40	31,11	542,93
36	22,22	542,20	28,89	572,38	8,89	511,00	11,11	732,00	4,44	471,50	24,44	533,82
37	20,00	700,33	24,44	1038,60	17,78	555,90	13,33	689,33	8,89	497,25	15,56	589,28
38	22,22	1398,40	28,89	1798,10	28,89	1231,00	11,11	1413,20	4,44	1898,5	4,44	797,50
39	20,00	2082,44	26,67	466,66	15,56	761,60	13,33	752,33	6,67	742,33	17,78	552,25
40	24,44	625,27	24,44	701,63	22,22	578,60	8,89	863,50	8,89	835,00	11,11	854,20
41	20,00	5882,78	26,67	1756,80	17,78	8810,00	13,33	2785,67	6,67	4925,30	15,56	3916,29
42	11,11	648,80	22,22	538,60	17,78	688,30	22,22	1393,50	11,11	686,80	15,56	745,57
43	28,89	871,46	26,67	888,16	17,78	652,40	4,44	573,00	6,67	729,33	15,56	739,86
44	28,89	742,23	31,11	806,71	20,00	745,70	4,44	550,50	2,22	381,00	13,33	595,17
45	26,67	1262,00	26,67	759,58	11,11	666,20	6,67	950,00	6,67	712,00	22,22	922,20
46	24,44	623,00	28,89	634,69	11,11	524,00	8,89	467,25	4,44	574,50	22,22	339,80
47	26,67	937,25	22,22	1143,60	13,33	1286,00	6,67	687,30	11,11	690,00	20,00	623,67
48	42,22	1112,11	31,11	875,43	17,78	1428,00	13,33	1039,30	2,22	553,00	15,56	695,14
49	,00	,00	,00	,00	,00	,00	33,33	763,30	33,33	904,00	33,33	1232,40

50	26,67	1062,08	22,22	602,10	8,89	825,30	6,67	542,30	11,11	748,80	24,44	650,55
51	31,11	614,21	33,33	699,21	22,22	840,90	2,22	579,00	,00	,00	11,11	494,00
52	22,22	918,10	28,89	1645,00	22,22	3560,00	11,11	1010,40	4,44	1214,00	11,11	540,00
53	15,56	1536,70	15,56	711,57	8,89	604,50	17,78	1229,38	17,78	1240,40	24,44	1215,36
54	26,67	692,50	24,44	763,64	6,67	1015,00	6,67	668,30	8,89	689,00	26,67	698,58
55	24,44	568,09	24,44	790,64	15,56	784,10	8,89	701,50	8,89	591,25	17,78	630,50
56	26,67	702,50	24,44	650,00	6,67	533,70	6,67	650,30	8,89	396,25	26,67	634,67
57	22,22	539,10	26,67	407,00	15,56	407,10	11,11	383,40	6,67	393,30	17,78	521,37
58	13,33	1552,23	20,00	1120,70	11,11	648,60	20,00	623,00	13,33	745,67	22,22	1388,80
59	17,78	904,00	28,89	663,23	13,33	855,20	15,56	624,86	4,44	626,50	20,00	640,67
60	26,67	1066,83	33,33	725,93	20,00	1029,33	6,67	844,66	,00	,00	13,33	643,50

*Reaction Time to the stimulus (in milliseconds)

Notes:

PASS/COO represents a situation in which the participant is passing the pot, as well as their opponent;

PASS/MID represents a situation in which the participant is passing the pot, while the opponent is passing the pot for half of the round and the other half s/he is taking the money;

PASS/FREE represents a situation in which the participant is passing the pot, while the opponent is taking the money;

TAKE/COO represents a situation in which the participant is taking the pot, while the opponent is passing the money;

TAKE/MID represents a situation in which the participant is taking the pot, while the opponent is passing the pot for half of the round and the other half s/he is taking the money;

TAKE/FREE represents a situation in which the participant is taking the pot, as well as their opponent;

4) **Public Game (this game had total of 90 trials). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results (%) and Reaction Times (RT) (in milliseconds)**

PARTICIPANT	SUCCESS (COOPERATION) (%)	RT (*)	MIDFAIR (COOPERATION) (%)	RT (*)	FAILURE (COOPERATION) (%)	RT (*)
1	1,111111	581	1,111111	426	0	0
2	50	1376,47	16,66667	3060,6	3,333333	1182
3	38,88889	1059,94	11,11111	917,4	24,44444	986,45
4	50	1253,31	13,33333	1822,25	26,66667	1533,25
5	7,777778	706	5,555556	712,6	5,555556	777
6	25,55556	1294,04	7,777778	1423,14	8,888889	1101,25
7	47,77778	789,18	8,888889	1188,25	3,333333	1086,3
8	37,77778	577,29	8,888889	743,5	4,444444	600,5
9	24,44444	1018,59	15,55556	915,14	3,333333	1401,67
10	30	869,33	3,333333	1076,33	1,111111	550
11	32,22222	904,31	5,555556	1180,2	2,222222	1396,5
12	31,11111	1004,25	12,22222	844,45	10	627
13	20	1205,33	11,11111	1752,4	5,555556	883,8
14	14,44444	859,23	8,888889	743,87	5,555556	560
15	17,77778	1024,13	6,666667	1292	2,222222	593
16	31,11111	1245,61	14,44444	589,77	25,55556	630,56
17	22,22222	620,5	5,555556	688,8	2,222222	195,5
18	33,33333	1113,67	11,11111	2434,3	3,333333	1577,67
19	8,888889	667,37	14,44444	668,15	2,222222	947
20	4,444444	1290,75	0	0	1,111111	527
21	21,11111	663,42	13,33333	584,67	11,11111	578,2
22	10	1568,11	4,444444	1936,5	12,22222	750,27

23	47,77778	577,02	4,444444	893	3,333333	1432
24	1,111111	716	0	0	0	0
25	3,333333	1100,4	3,333333	467,67	1,111111	406
26	34,44444	651,87	10	895,67	17,77778	554,69
27	12,22222	1439,91	4,444444	1076	2,222222	771
28	30	896,93	13,33333	801,83	8,888889	1224
29	31,11111	942,36	5,555556	711,2	6,666667	663
30	38,88889	724,54	7,777778	492,29	0	815,33
31	45,55556	1649,46	6,666667	1976,67	6,666667	2405
32	38,88889	870,71	12,22222	1479,82	10	2897,8
33	38,88889	1970,37	14,44444	1139,77	4,444444	2036
34	27,77778	1574,24	10	852	18,88889	1439,82
35	15,55556	877,14	4,444444	1127	0	0
36	50	579,51	15,55556	650,43	3,333333	856
37	5,555556	1513,8	5,555556	1398,6	1,111111	592
38	31,11111	1621,89	10	1082,33	15,55556	1289,57
39	25,55556	860,61	2,222222	574,5	1,111111	960
40	17,77778	920,88	6,666667	829,17	10	554,22
41	24,44444	1332,45	10	2533,22	4,444444	871,5
42	6,666667	2411,17	5,555556	843,2	4,444444	864
43	40	969,56	8,888889	1090,25	4,444444	1215
44	50	684,29	16,66667	679,33	11,11111	804
45	27,77778	1433,64	14,44444	1302,23	3,333333	1469,33
46	27,77778	743,24	8,888889	440	16,66667	741,93
47	21,11111	1790,84	6,666667	1732	4,444444	1505
48	20	1200,61	12,22222	810,72	2,222222	931,25
49	12,22222	1265,73	8,888889	553,88	2,222222	1505,75

50	33,33333	891,73	12,22222	837,64	4,444444	1361,5
51	18,88889	1151,24	10	877,88	10	702,77
52	25,55556	2150,13	6,666667	1086,83	24,44444	2049,9
53	23,33333	1831,19	5,555556	1102,2	3,333333	1379,67
54	37,77778	664	11,11111	408,1	2,222222	766
55	21,11111	1101,89	1,111111	733	2,222222	562
56	50	874,13	14,44444	1359,54	4,444444	830,25
57	47,77778	675,02	15,55556	584,93	18,88889	471,82
58	50	806,6	16,66667	1487,06	33,33333	1222,13
59	12,22222	1127,91	1,111111	1048	4,444444	1088,75
60	15,55556	1373,93	7,777778	739	4,444444	1455

PARTICIPANT	SUCCESS (FREERIDE) (%)	RT (*)	MIDFAIR (FREERIDE) (%)	RT (*)	FAILURE (FREERIDE) (%)	RT (*)
1	48,88889	417,11	15,55556	342,71	33,33333	550,17
2	0	0	0	0	30	1541,6
3	11,11111	2904,22	5,555556	1127,4	8,888889	1920,625
4	0	0	3,333333	2747	6,666667	1228,67
5	42,22222	804,76	11,11111	701,3	27,77778	461,5
6	24,44444	1294,63	8,888889	1177,125	24,44444	1004,5
7	2,222222	2586,50	7,777778	1552,60	30	750,37
8	12,22222	594,63	7,777778	747,29	28,88889	477,35
9	25,55556	753,35	1,111111	525	30	771,56
10	20	969,61	13,33333	941,67	32,22222	949,9
11	17,77778	981,75	11,11111	971,70	31,11111	893,96

12	18,88889	852	4,444444	860,50	23,33333	714,09
13	30	866,56	5,555556	1187,8	27,77778	698,52
14	35,55556	996,91	7,777778	979,86	27,77778	728,08
15	32,22222	994,68	10	989,44	31,11111	549
16	18,88889	932,35	2,222222	587,5	7,777778	801,57
17	27,77778	507,76	11,11111	430,10	31,11111	489,71
18	16,66667	975,93	5,555556	992,8	30	1244,63
19	41,11111	713,65	2,222222	992,8	31,11111	756,57
20	45,55556	663,68	16,66667	861,07	32,22222	483,65
21	28,88889	576,62	3,333333	685	22,22222	437,45
22	40	791,44	12,22222	757,27	21,11111	894
23	2,222222	1069,5	12,22222	1182,82	30	611,04
24	48,88889	894,86	16,66667	648,07	33,33333	585,57
25	46,66667	811,53	13,33333	707,92	32,22222	712,03
26	15,55556	759,85	6,666667	760,5	15,55556	618,5
27	37,77778	1469,26	12,22222	1737,27	31,11111	1468,78
28	20	705,78	3,333333	1056	24,44444	1003,45
29	18,88889	1129,41	11,11111	860,5	26,66667	754,54
30	11,11111	506,5	8,888889	1010,5	0	474,56
31	4,444444	1553	10	2376,44	26,66667	2105,8
32	11,11111	2041	4,444444	1176	23,33333	1081,38
33	11,11111	813	2,222222	7314,5	28,88889	955,423
34	22,22222	1294,8	6,666667	916,83	14,44444	847,46
35	34,44444	552,65	12,22222	779,64	33,33333	459,367
36	0	0	1,111111	835	30	642,74
37	44,44444	717,92	11,11111	601,2	32,22222	873,9
38	18,88889	1411,47	6,666667	1707,5		1176,56
39	24,44444	691,63	14,44444	491,5	32,22222	511,24

40	31,11111	699,58	10	2949,33	23,33333	823,81
41	25,55556	1571,87	6,666667	1574,33	28,88889	749,07
42	43,33333	778,79	11,11111	799,5	28,88889	643,423
43	10	549,33	7,777778	885	28,88889	726,57
44	0	0	0	0	22,22222	682,55
45	22,22222	1578,75	2,222222	2366	30	858,56
46	22,22222	556,7	7,777778	532,14	16,66667	454
47	28,88889	1029	10	1634	28,88889	879,11
48	30	944,88	4,444444	625,25	31,11111	1041,73
49	37,77778	1067,62	7,777778	638,57	31,11111	1422
50	16,66667	669,13	4,444444	575,5	28,88889	595,23
51	31,11111	722,25	6,666667	879,83	23,33333	895,76
52	24,44444	911	10	1942	8,888889	1847,8
53	26,66667	1179,54	11,11111	1168,7	30	1294,4
54	12,22222	1232,18	5,555556	1284,2	31,11111	566,8
55	28,88889	719,85	15,55556	722,5	31,11111	643,7
56	0	0	2,222222	205,3	28,88889	688,346
57	2,222222	356	1,111111	361	14,44444	482,69
58	0	0	0	0	0	0
59	37,77778	610,94	15,55556	571,14	28,88889	717,42
60	34,44444	1132,74	8,888889	1357,88	28,88889	900,07

*Reaction Time to the stimulus (in milliseconds)

Notes:

SUCCESS (COOPERATION) represent a situation in which the participant is giving €5 to the public pot and the group is also contributing to it;

SUCCESS (FREERIDE) represent a situation in which the participant is not contributing to the group, while the opponents do so;

MIDFAIR (COOPERATION) represent a situation in which the participant is giving €5 or not to the public pot, while the group is contributing to it;

MIDFAIR (FREERIDE) represent a situation in which the participant is not contributing to the public pot and at least one member is not giving money to the group;

FAILURE (COOPERATION) represent a situation in which the participant is giving €5 to the public pot and at least two members are not giving money to the group;

FAILURE (FREERIDE) represent a situation in which the participant is not contributing to the public pot and at least two members are not giving money to the group.

5) **Volunteer's Dilemma (this game had total of 65 trials). Portuguese (from 1-30) and Irish (from 31-60) participants behavioural results (%) and Reaction Times (RT) (in milliseconds)**

PARTICIPANT	PASS/EVERYONE KEEPS (%)	RT (*)	TAKE/EVERYONEKEEPS (%)	RT (*)	TAKE/EVERYONELOSES (%)	RT (*)
1	13,85	441,67	47,69	649,26	38,46	394,44
2	100,00	1680,03	,00	,00	,00	,00
3	96,92	1020,37	1,54	946,00	1,54	497,00
4	33,85	1820,32	36,92	2021,63	29,23	1640,79
5	76,92	855,70	10,77	1102,29	12,31	1054,13
6	64,62	1005,86	18,46	1010,83	16,92	881,09
7	15,38	534,40	47,69	610,48	36,92	454,38
8	36,92	443,25	36,92	508,79	26,15	507,41
9	78,46	1065,09	13,85	1306,22	7,69	1450,40
10	27,69	902,83	36,92	1775,63	35,38	1444,96
11	49,23	672,94	23,08	860,80	27,69	664,44
12	55,38	746,61	18,46	1258,83	26,15	733,12
13	55,38	881,38	23,08	718,00	21,54	524,21
14	61,54	957,25	23,08	927,73	15,38	947,40
15	47,69	792,26	26,15	647,88	26,15	472,42
16	55,38	976,47	27,69	2723,30	16,92	960,27
17	69,23	451,09	16,92	704,82	13,85	598,44
18	30,77	1379,55	43,08	1206,64	26,15	1404,18
19	58,46	856,65	27,69	934,88	13,85	730,67
20	15,38	1116,60	46,15	1081,73	38,46	679,72
21	98,46	985,84	1,54	343,00	,00	,00

22	40,00	631,15	29,23	928,68	30,77	604,30
23	41,54	683,59	32,31	561,19	26,15	581,88
24	32,31	1260,43	33,85	1090,41	33,85	1446,46
25	18,46	879,92	50,77	785,27	30,77	856,55
26	33,85	1069,82	35,38	541,56	30,77	523,10
27	9,23	1027,17	49,23	792,00	41,54	914,59
28	69,23	1091,56	13,85	1005,33	16,92	1136,45
29	32,31	843,62	35,38	559,39	32,31	739,86
30	52,31	1289,38	26,15	636,76	21,54	401,78
31	60,00	1727,15	20,00	1213,85	20,00	1466,07
32	36,92	1943,04	32,31	1728,40	30,77	1879,80
33	93,85	699,97	3,08	662,00	3,08	1900,50
34	63,08	921,07	23,08	1335,73	13,85	1165,00
35	6,15	1125,75	52,31	734,12	41,54	565,37
36	69,23	764,40	18,46	854,92	12,31	560,63
37	73,85	672,02	13,85	803,56	12,31	1249,75
38	47,69	2064,52	26,15	2648,23	26,15	1859,60
39	60,00	985,85	20,00	802,40	20,00	616,31
40	47,69	673,06	27,69	603,44	24,62	584,68
41	23,08	2133,90	41,54	2216,30	35,38	1868,50
42	40,00	907,00	29,23	1047,42	30,77	654,75
43	86,15	724,77	7,69	1343,20	6,15	683,25
44	61,54	617,02	20,00	407,77	18,46	1398,20
45	100,00	1304,94	,00	,00	,00	,00
46	32,31	495,90	40,00	638,08	27,69	332,89
47	32,31	1035,50	36,92	1084,60	30,77	1257,40
48	58,46	1065,71	24,62	1173,43	16,92	921,54

49	72,31	597,64	10,77	2337,43	16,92	484,73
50	60,00	766,84	23,08	1567,46	16,92	832,82
51	80,00	747,04	7,69	711,00	13,85	858,63
52	87,69	827,84	6,15	485,50	6,15	866,75
53	98,46	1003,13	1,54	2574,00	,00	,00
54	16,92	332,55	44,62	685,86	38,46	616,32
55	13,85	932,44	47,69	1125,48	38,46	1022,72
56	29,23	1880,00	35,38	1441,56	35,38	1063,44
57	43,08	758,12	33,85	1092,30	23,08	833,73
58	66,15	1059,65	21,54	881,71	12,31	997,12
59	26,15	2361,76	40,00	1606,42	33,85	1549,59
60	36,92	1162,08	30,77	1252,95	32,31	1065,81

*Reaction Time to the stimulus (in milliseconds)

Notes:

PASS/EVERYONE KEEPS represents a situation in which the participant decided to contribute to the group;

TAKE/EVERYONEKEEPS represents a situation in which the participant decided to keep their money, while at least one opponent decided to contribute towards the group;

TAKE/EVERYONELOSES represents a situation in which the participant decided to keep their money, as well as all the members of the group.

XVIII- Channels eliminated and/or interpolated, and participants eliminated from the neurophysiological analysis

Rock-Paper Scissors Game

Participant Number	Electrode(s) eliminated and/or interpolated	Participant eliminated
16	EEG signal was very noisy, even after removing major artifacts	Participant 16 was only eliminated from the EEG analysis perspective
17	FC5, CP1 eliminated	
19	CP2 eliminated	
23	FC5 eliminated	
26	Cz, C3 interpolated	
32	O2 was broken, which affected the ribbon, and consequently the EEG signal	Participant 32 was only eliminated from the EEG analysis perspective
36	CP6 interpolated	
40	F7 interpolated	
42	F3 interpolated	
44	FP1 eliminated	
50	F8 eliminated	
52	EEG signal was very noisy, even after removing major artifacts	Participant 52 was only eliminated from the EEG analysis perspective
53	FC2, O2, F7 eliminated	
55	O2 eliminated T8, FC6 eliminated	
58	F7 eliminated	

PARTICIPANTS 16, 32 AND 52 WERE REMOVED FROM THE EEG ANALYSIS

Ultimatum Game

Participant Number	Electrode(s) eliminated and/or interpolated	Participant eliminated
2	FC2, F4, CP2 eliminated	
3	FP1, F3, FC1, FC5 eliminated	
4	O1, F3, FC1, FP1 eliminated	
5	FP1 eliminated	
6	FP1, CP2 eliminated	
8	FP1, FC1 eliminated	
10	FP1, FC2 eliminated	
11	FP1, F4, FC1 eliminated Cz, CP1, CP2, CP5 interpolated	
12	F4 eliminated	
13	CP6, O1 eliminated	
16	F7, CP1, T7 eliminated	
17	P4 eliminated	
18	FP1 eliminated	
20	FP1, CP2 eliminated	
22	F7, CP2 eliminated	
23	F4, FC2, FC5 eliminated	
24	FP1, F4, FC2, CP2 eliminated	
25	FP1, CP2 eliminated	
26	C3, Cz interpolated	
27	EEG signal was very noisy, even after removing major artifacts	Participant 27 was only eliminated from the EEG analysis perspective

28	EEG signal was very noisy, even after removing major artifacts	Participant 28 was only eliminated from the EEG analysis perspective
29	EEG signal was very noisy, even after removing major artifacts	Participant 29 was only eliminated from the EEG analysis perspective
30	EEG signal was very noisy, even after removing major artifacts	Participant 30 was only eliminated from the EEG analysis perspective
31	T8, F7, F4, F8 eliminated	
32	O2 was broken, which affected the ribbon, and consequently the EEG signal	Participant 32 was only eliminated from the EEG analysis perspective
33	CP6 eliminated	
34	O2, P4, P8 eliminated	
36	CP6, F7 eliminated	
37	F4, P8 eliminated	
38	F4, FP1, FP2, P4 eliminated	
39	F8 eliminated	
40	O2, F7 eliminated	
42	EEG signal was very noisy, even after removing major artifacts	Participant 42 was only eliminated from the EEG analysis perspective
43	O2 eliminated	
44	O2 eliminated	
45	F4, P8 eliminated	
46	P4, F8 eliminated	
47	FC6 eliminated	
48	EEG signal was very noisy, even after removing major artifacts	Participant 48 was only eliminated from the EEG analysis perspective
49	C4, F7, O2 eliminated	

50	EEG signal was very noisy, even after removing major artifacts	Participant 50 was only eliminated from the EEG analysis perspective
51	P8, O2, P4 eliminated	
52	P4, O2 eliminated	
53	O2 eliminated	
54	F4 eliminated	
55	O2, C4, T8 eliminated	
56	O2, F7, P8 eliminated	
57	CP5, P4 eliminated	
58	EEG signal was very noisy, even after removing major artifacts	Participant 58 was only eliminated from the EEG analysis perspective
60	F7 eliminated	

PARTICIPANTS 27,28, 29, 30, 32, 42, 48, 50 AND 58 WERE REMOVED FROM THE EEG ANALYSIS

XIX- Poster Presentation at FENS Forum, July 2018 in Belin