

Why do agents make suboptimal economic decisions?

An fMRI experimental analysis of loss aversion

By: Miroslav Kljajic

(4462496)

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Supervisors:

Professor Rose Anne Devlin (Economics)

Professor Andra Smith (Psychology)

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Abstract

Economists have long observed an asymmetry in the behaviour of individuals facing gains and losses. Loss aversion has an impact on many economic decisions, including those to do with the educational system (Fryer et al, 2012), social security benefits (Shu & Payne (2013), the stock market (Barberis & Huang, 2001) and the real estate market (Genesove & Mayer, 2001). This paper examines why people are loss averse and why it is that agents make choices that do not appear to be optimal in the utility maximization sphere. This paper hypothesizes that loss aversion is related to activity or the absence of activity in decision making regions of the brain. The paper also examines how market distractions play a role in decision making. In this study participants were placed in an MRI scanner and performed an fMRI task. This paper provides conclusive evidence to support our hypotheses that loss aversion is related to activity or absence of activity in decision making regions of the brain. Additionally we found evidence that market distractions lead to suboptimal decision making that is related to activity in brain regions other than those responsible for decision making. Visual regions of the brain are not associated with decision making and those regions of interest were the only regions that were activated during the visual presentation of a distracting stimulus. In this part of the experiment, the decision making part of the brain was not active. In the analysis of market distraction, it is evident that everyday distractions, in addition to loss aversion, deters optimal economic decision making and thus further bounds agent rationality.

1. Introduction

Economists have long observed an asymmetry in the behaviour of individuals facing gains and losses. Prospect theory, as developed by Tversky & Kahneman (1991), provides a useful framework for understanding better this sort of behaviour. The prospect theory of loss aversion states that losses have a more profound impact on preferences than gains (Tversky & Kahneman, 1991). Agents have a stronger preference for avoiding losses as opposed to acquiring gains.

This paper looks at the economics of decision making, particularly loss aversion, by replicating a rational agent's environment in a laboratory setting where the agent's objective is to maximize utility and minimize costs. In particular, an experiment was designed in order to measure participants' reactions both when they were given a chance to earn money and when facing the prospect of losing money. Reactions were measured using an *f* MRI (functional magnetic resonance imaging) tests.

Studies have concluded that loss aversion is indeed a puzzling phenomenon because agent who are loss averse exhibit both risk averse and risk seeking behaviour to avoid potential losses in current wealth (Kahneman & Tversky 1979, 1991; Genesove & Mayer, 2001; Fielding & Stracca, 2007; Peters, 2012). Economists understand that loss aversion may have an impact on many economic decisions, including those to do with the educational system (Fryer et al, 2012), social security benefits (Shu & Payne (2013), the stock market (Barberis & Huang, 2001) and the real estate market (Genesove & Mayer, 2001). Psychologists have spent a considerable amount of time trying to understand the physiology of decision making. On the experimental side, the literature shows that the amygdala is responsible for memory, decision making and emotional

processes and the prefrontal cortex is responsible for executive functioning of the brain including decision making, and these two brain regions play an important role in loss aversion (Tom et al., 2007; Martino, Camerer, & Adolphs, 2010; Canessa et al., 2013; Sokol-Hessner, Camerer, & Phelps 2013). The prefrontal cortex has strong connections with the amygdala that controls emotional processing (Amunts et al., 2005). As a result, these two regions are responsible for many aspects of the impact of emotions on decision making and agent rationality. The amygdala is the area of the brain primarily responsible for both the decision making and emotional processing (Amunts et al., 2005).

This paper examines why people are loss averse and why it is that agents make choices that do not appear to be optimal in the utility maximization sphere. This paper hypothesizes that loss aversion is related to activity or the absence of activity in decision making regions of the brain. The uniqueness of our research is the design of the experiment. Previous research on loss aversion using an fMRI allowed the participants to choose between different gambles (Tom et al., 2007; Martino, Camerer, & Adolphs 2010; Gächter, Johnson, & Herrmann 2010). In our experiment, the participants play an actual game of decision making with increasing levels of intensity levels from low fear (fear of loss) to high fear (snake photo). The experiment also entails a higher level of uncertainty than previous research. The uncertainty in the experiment stems from the participants not knowing the worth of object representing losses and gains in the game, even though they had the opportunity to ask before the start of the experiment. This was done to see if the participants would ask the right questions to better inform themselves about the task and increase their chances of making best economic decisions possible during the decision making game.

In addition, the paper predicts that “market distractions” lead to suboptimal decision making that is related to activity or inactivity in brain regions not associated with decision making. Market distractions related to economic decision making have been rarely studied in the past. The few studies that have looked at how market distractions influence decision making on an individual level have examined the impact of oversaturation of information on information recall (Héroux, Laroch, & McGown, 1988), the impact of computer related interruptions on decision making (Speier, Vessey, & Valacich, 2003) and gender differences in response to emotional distraction (Jordan, Dolcos, Denkova, & Dolcos, 2013), using an fMRI. However, studies focusing on market distraction on top of decision making using an fMRI method have not been completed and thus our experiment tries to answer questions in that particular area of research. Additionally, in our experiment, a stimulus that is intended to distract the participant follows a decision making game with potential gains and losses. Thus, the uniqueness of our study is that we get to observe the immediate effect of a distraction on decision making abilities because the distracting stimulus is introduced while the participant is playing the second round of the decision making game. The purpose of the experiment is to better inform the impact of distractions on the decision making capabilities of a supposed rational agent. “Market distractions” will be defined as factors that deter the agent from collecting information that is essential to making a rational, and most optimal, economic decision. For an example, a market distraction could be bad news unrelated to the market that hinder the agent’s ability to gather the essential information necessary to reach an optimal economic decision.

In this study participants were placed in an MRI scanner and performed an fMRI task with three conditions in a maze: the green condition where they could only earn money (catch a yellow circle), the purple condition where they could earn money but also lose current wealth (be

caught by a red triangle), and orange condition where a picture of a snake would flash in addition to purple level conditions to distract the agent from performing their task. The participants were tested for general anxiety but also for snake phobias. Those with regular levels of anxiety but high fear of snakes were selected for this study.

The uniqueness of this study is the use of the Psychophysiological Interaction (PPI) fMRI brain imaging technique that measures not only the activity of certain brain regions, but also the dependence of a certain brain region to another in order to directly observe positive or negative dependence. In relation to previous studies on loss aversion, PPI has not been used before to measure brain activity for economic decision making studies focusing on loss aversion. In addition we include a step beyond loss aversion, an appearance of a snake, to measure brain activity when an agent is distracted from the decision making environment.

2. Literature Review

Due to this experiment having roots in psychology and economics, the literature reviewed will present both the psychological and economical aspects of loss aversion. That is, the design of the experiment is psychological but the inferences of the experiment may have great implications on economic theory, which is why both relevant psychology and economics literature will be reviewed.

2.1 Theoretical Foundations of Loss Aversion in Economics

Behavioural economics has the opportunity to become a dominant paradigm in rational choice theory (Thaler, 1980; Laibson, 1998; Camerer, Loewenstein, & Rabin, 2004). However, some authors view behavioural economics as a complement rather than a substitute to traditional economic theory (Levine, 2012). Behavioural economists look at “rational” choice but they do

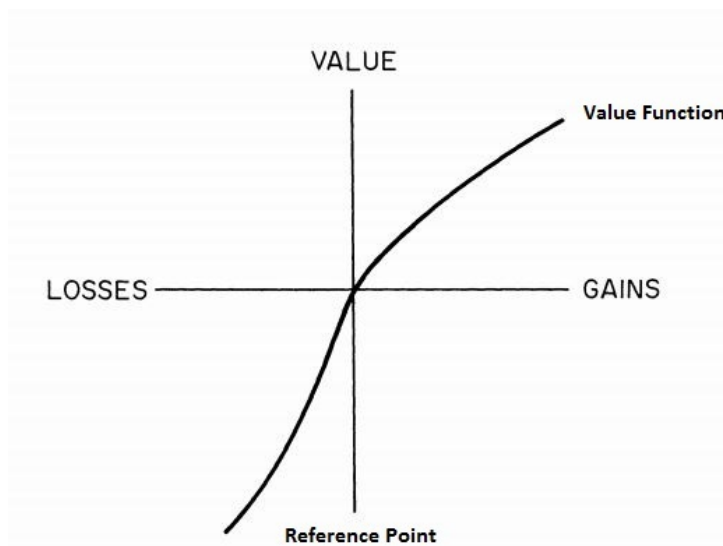
not assume agents are always rational. Rational choice is defined as wanting more utility rather than less and therefore the agents act in their own best interest (Durlauf & Blume, 2008). Agents make errors in decision making. Errors are not rational because the agent is not maximizing utility. Advocates of Prospect theory hold the view that economic rationality is violated and that decision making agents are consistently flawed (Beckman, 2011).

In economics, expected utility theory is the dominant paradigm in terms of decision making models that entail uncertainty. Decision making under uncertainty is described as a choices between different gambles (Schoemaker, 1982). Expected utility theory states that agents assign subjective values to gambles (Schoemaker, 1982). The amount of value an agent places on a gamble provides insight about the agent's expectations about the outcome of that particular gamble.

Prospect theory is an alternative model to the expected utility theory. Prospect theory describes decision making in two stages (Kahneman & Tversky, 1979). Editing is the first stage where people use heuristics, which are mental shortcuts, to solve a problem using a certain mechanism that is unique to a certain agent. This mechanism means that an agent will ignore many aspects of a problem and focus on a certain method of solving it.

During the editing stage the agent sets a reference point (see Figure 1) (Kahneman & Tversky, 1979). Reference point is a set of outcomes the agent places equivalent value to. Any gamble outcomes above the reference point are considered gains. Any gamble outcomes below the reference point are considered to be losses. The value function is not symmetrical because losses hurt more than gains. Thus the losses portion of the value function is steeper than the gains portion.

Figure 1: Prospect Theory – Editing Stage (Tversky & Kahneman, 1991, p. 1040)



The second stage of prospect theory is evaluation (Kahneman & Tversky, 1979). In this stage the agents calculate utilities based on their probabilities and potential outcomes. Agents choose options that give them the highest utility.

Both prospect theory and expected utility theory are descriptive models about decision making under risk (Wakker, 2010). Expected utility theory is concerned with absolute wealth rather than relative wealth, which is emphasized in prospect theory as relativity towards the reference point (Barberis, Huang, & Santos, 2001). Relative wealth is the wealth in prospect theory relative to the reference point, which does not exist in expected utility theory. The notion of relative wealth and the existence of a reference point are instrumental in explaining loss aversion.

Economists tend to assume that the consumer is generally risk averse (Rabin, 2000). That is to say that the rational agent prefers a payoff with complete certainty over an uncertain payoff, or gamble. Thus, risk aversion is defined as the unwillingness to accept a fair gamble in favour of a certain outcomes even if the gamble has a higher payoff than the certain payoff alternative. In expected utility theory, an agent is risk averse if and only if the agent's utility function is concave.

Loss aversion can also be explained through willingness to accept (WTA) and willingness to pay (WTP) (Coursey, Hovis, & Schulze, 1987; Brown & Gregory, 1999; (Horowitz & McConnell, 2002). If the agent who is making a purchase views the purchase of a commodity as a loss, the agent will not want to buy that commodity, this is the WTP. If an agent is reluctant to sell a good, the agent will not want to accept money for a good. Loss aversion is the different between WTA and WTP, where agents who own a good are much less likely to sell it than the probability to buy a good. Thus, under loss aversion, willingness to accept significantly overpowers the willingness to buy as the agent does not want to let go of current wealth. Thus, the agent is loss averse.

In a study by Allais (1953), the agents do not necessarily behave according to the predictions of the expected utility theory. In the study the agents tend not to consistently choose the option that provides them with highest utility. While participants in the study did not consistently choose the higher expected utility, they consistently chose smaller probability of losing, implying that agent's aversion to losses impaired their judgement to choose the highest expected utility. This phenomenon is referred to as the Allais paradox.

The original prospect theory has been advanced into a cumulative prospect theory by the same authors (Tversky & Kahneman, 1992). The original approach failed to rank gambles. The cumulative prospect theory uses the rank dependence from expected utility theory in order to be able to rank gambles and thus advance the original prospect theory. One thing both prospect theories share have in common is that the agent continuous to be loss averse. Loss aversion seems to hold no matter of transformation applied to the prospect theory or the cumulative prospect theory (Abdellaoui, Bleichrodt, & L'Haridon, 2008).

Schmidt, Starmer, & Sugden (2008) have built upon both the original prospect theory (Kahneman & Tversky, 1979) and cumulative prospect theory (Tversky & Kahneman, 1992) by relaxing the certainty assumption of a reference point and allows for the existence of uncertainty. In addition, the theory utilizes the rank dependence from the cumulative prospect theory, where the gambles are ranked depending on their decision weights. They argue that the first two major developments of prospect theory are limited due to their assumption that the reference points are certain. If an agent is in a possession of a lottery ticket as wealth, and intends to either sell or exchange the lottery ticket, the agent may not behave as predicted by the original prospect theory. The new version of the prospect theory is able to take into account the uncertainty of the lottery ticket. Results show that willingness to accept (WTA) continues to overpower willingness to pay (WTP), therefore loss aversion tends to hold even when the value of the reference point is uncertain.

2.2 Empirical Evidence of Loss Aversion in Economics

The previous articles built the foundation and the early theoretical models of loss aversion. The next few articles will review the empirical evidence of the impact of loss aversion

on everyday life including education, insurance, retirement and the housing market and thus will highlight the importance of loss aversion in economics.

A study by Campos-Vazquez & Cuijty (2014) conducted a prospect theory experiment at Mexico University to study the role of emotions on loss and risk aversion. They separated the participants into groups. Each group was given a piece of information that elicited a certain emotion. They find that on average, anger decreases the aversion to loss by one half. In addition, sadness increased risk aversion relative to acquisition of gain seeking. This paper is an important contribution to cumulative prospect theory because it links the impact of emotions to cumulative prospective theory, including risk aversion and loss aversion.

In a field experiment by Fryer et al (2012) the researchers investigate if loss aversion can be used to promote student achievement by offering incentives to teachers at the beginning of the semester rather than at the end. One set of teachers received the bonus at the end of the semester, the other set of teachers receive the bonus at the beginning of the semesters. The set of teachers who receive a bonus at the beginning of the semester are told that they can keep the bonus if the students' scores in their classroom are sufficiently high on mathematical exams. If the scores are not high enough, the teacher must return the bonus at the end of the semester.

Researchers find that due to the power of loss aversion, the math scores of students whose teachers receive bonus at the beginning of the semester increase by an amount equal to increasing the quality of the teacher by one standard deviation. Thus the authors conclude it is predominantly the power of loss aversion that incentivizes the teacher's effort and thus promotes an increase in quality of education. In this case, the reference point is the bonus pay to the

teacher. Depending on where the reference point is placed will determine how the teacher will treat the bonus, as something that can only be gained or something that has a potential to be lost.

Shu & Payne (2013), attempt to explain how retirees make the decision to claim Social Security benefits early. Social Security Benefit is the largest source of income for Americans and delaying the claim on this income causes the income to grow due to inflation and low interest rate. However, most Americans tend to start claiming social security benefits as soon as they retire from the labour force. One of the reasons proposed by the researchers is that those who are more loss averse tend to claim early as they do not want to risk losing the money they have accumulated over the working years. The researchers indeed find that those people who score high on a loss aversion questionnaire tend to claim Social Security Benefits four months earlier on average than those who score low on the questionnaire.

The researchers further claim that some would come to a conclusion that the retirees are risk averse rather than loss averse. However, if the retirees were risk averse they would want to delay claiming, as larger future benefits minimize the disadvantage of a possible risk by claiming benefits in the future rather than now. The authors imply that risk aversion would be the wrong utility to use when describing decision making whether to claim benefits now or later.

Tovar (2009) studies the effect of loss aversion on trade policy. They modeled their study after Tversky & Kahneman (1992) theory of cumulative prospect theory. They measured loss aversion by using the level of protectionism in that sector to be equivalent to exhibiting loss aversion. They find that those trade sectors with the highest decrease in profitability are the sectors who exhibit the highest levels of loss aversion.

Loss aversion also plays a major role in the stock market (Barberis & Huang, 2001). The stock market has two forms of wealth: the individual stocks and the stock portfolio. A stock portfolio has many individual stocks which tend to offset the volatility of one another and therefore are more balanced (and less risky) than individual stocks. The authors find that because the stock owner is generally loss averse, he or she will charge a smaller rate of return on portfolio as the losses are offset by stocks that are performing better. If the stock owner is holding individual stocks, he may be charging a higher rate of return for holding the stocks because the chances of complete loss are much higher and individual stocks are much riskier. Thus this paper implies that most stockholders tend to be loss averse. In the context of prospect theory, individual stocks are narrowly defined because agents prefer mental shortcuts (heuristics) such as a certain mechanism of making a decision. Thus they will be more sensitive towards individual stocks, as it is easier to mentally account for one stock rather than a stock portfolio with a multitude of stocks. As authors conclude, loss aversion (sensitivity to loss) is indeed higher for individual stocks.

Genesove & Mayer (2001) show that seller behaviour in the residential real estate market is partially determined by loss aversion. Researchers used data from boom-bust cycles in downtown Boston from 1990 to 1997. They find that during peaks of business cycles, houses tend to be sold at or above the asking price of the seller. However, if the economy is in a recession, that is, in a business cycle bust, the asking price increases much higher than the original purchasing price. The reason for this asking price increase is because sellers are loss averse and are significantly increasing their asking price to avoid losses relative to the original purchasing price. Owners who are highly averse to losses will set a higher asking price to mitigate the chances of loss, which in absence of high probability of loss, would be much lower.

Thus, loss aversion during an economic recession tends to place upward pressure on the prices and sellers who are loss averse tend to actually sell their homes on the market for a higher transaction price. The original purchase price is the reference point and the asking price for a sale can be a source of wealth gain or loss, depending on market conditions.

2.2 Loss Aversion in Experimental Psychology

The distinctiveness of our research as compared to the studies outlined below is our experiment design. We incorporated both PPI analysis (measures not only the activity of certain brain regions, but also the dependence of a certain brain region to another in order to directly observe positive or negative dependence) and an additional stimulus to see how agents react to economic decision making while being distracted.

Tom et al., (2007) examined the brain areas that played a part in loss aversion using an fMRI. Participants had to decide between a 50/50 gamble of gaining or losing a monetary value. The participants were instructed to either accept or reject the gambles. As the probability of gains increased, midbrain dopaminergic regions of the brain showed significant activity. As the probability of losses increased, the same regions showed decreasing activity. Loss aversion in individuals was also correlated with activity in the ventral striatum and prefrontal cortex.

In a study by Martino, Camerer, & Adolphs (2010), two individuals who had amygdala damage were instructed to perform numerous experimental economics tasks. The amygdala is area of the brain primarily responsible for decision making, emotional reactions and memory processing (Amunts et al., 2005). Some of the tasks required the participants to play a monetary gamble with potential gains and losses. The two individuals showed expected behaviour in ability to analyze changes in expected value and risk. The individuals showed significant

reduction in loss aversion as compared to that of the control group. The authors conclude that the amygdala plays a significant role in generating loss aversion in monetary outcomes in individuals by hindering actions of the individual which tend to have a negative monetary outcome on the individuals decision making, which is controlled by the prefrontal cortex.

Gächter, Johnson, & Herrmann (2010) compare loss aversion in risky and non-risky scenarios to distinguish between these two circumstances and try to measure the impact of risk on loss aversion. The risky portion of the experiment is a simple lottery game with 360 participants. The riskless portion is a willingness to accept (WTA) relative to willingness to purchase (WTP) gap that is found to be indicative of loss aversion, known as the endowment effect (Kahneman, Knetsch, & Thaler, 1990). The WTA and WTP are both induced on each participant. The authors find strong positive correlation in both riskless and risky choices and loss aversion. They also find that loss aversion is positively correlated with age, income and wealth and negatively correlated with education.

Chib, De Martino, Shimojo, & O'doherty (2012) examined performance based pay incentives. They used fMRI to analyze neural processes with a performance based mechanism incentivized with money. As the incentives were increased, the participants tended to perform better. However, as the incentives were increased drastically, the participants tend to do worse in their incentive-based performance task. Additionally, activity in the striatal region of the brain tends to deactivate as the incentives are perceived to be too high. Striatal deactivation is correlated with loss aversion behaviour. The authors propose that as incentives increase people tend to perform increasingly better and view the incentive as a potential gain. However, at some point the incentives are overwhelming relative to the work required to perform the task and avoid failure, and thus the participants begin focusing on avoiding losses. Overall, very high monetary

incentives could result in poor behaviour such as loss aversion rather than an increase in task performance.

In an fMRI study by Canessa et al., (2013) participants were given equivalent chance of gaining or losing money while their brain activity was measured. They found that the posterior insula and the amygdala showed significant activity when the magnitudes of potential losses were increased. Loss aversion was shown to be correlated with both the limbic regions of the brain and also in the volume of the gray matter in the amygdala-thalamus-striatum network. This network produces avoidance behaviour, which is negatively correlated with monetary performance.

Sokol-Hessner, Camerer, & Phelps (2013) investigated using fMRI how and if in any part emotions played in financial decision making. They found that loss aversion is correlated with the activity in the amygdala region of the brain. There is also a correlation between decreasing inactivity of the amygdala response to losses and successful regulations of loss aversion. Overall, the authors imply that the emotional parts of the brain and the decision making parts, tend to work together and overlap in activity despite the fact that the two tasks seem to be divergent in nature. Thus emotional regulations cannot be ignored in decision making activities when assessing choices and their corresponding value.

In summary, the prospect theory of loss version states that agents have a strong preference for avoiding losses rather than acquiring gains. Three generations of prospect theory continue to confirm the existence of the resilient phenomenon that is loss aversion. Economic literature agrees that loss aversion does impact the market environment including the education system, the social security benefits market, the stock market and the real estate market. On the

experimental side, the literature shows that the amygdala and prefrontal cortex play a role in loss aversion. The dorsolateral prefrontal cortex contains many decision making regions of the brain and has important connections with the amygdala. The design of this experiment adds value to the literature of loss aversion as it studies loss aversion in a laboratory environment resembling that of a decision making market, where it isolates loss aversion to solely study its impact. In addition, the design goes a step further and adds stimuli to the experiment design to analyze how unrelated stimuli (market distractions) impact economic decision making.

3. Methodology

3.1 General fMRI Overview

The fMRI is a machine that measures neural activity as a participant is performing a task of interest (Ogawa, 1990). It works by detecting changes in the blood flow that occur due to the oxygenation of the blood. Strong neural activity requires higher levels of oxygen which makes the blood flow significantly faster from one region of the brain to another thus the brain is Blood Oxygen Level Dependant (BOLD). The MRI technique can be used to map the brain's activity that will show which parts of the brain are linked with a specific mental process. Thus, the neural activity associated with a task that an fMRI participant is subjected to can be mapped out based on blood flow in certain regions of the brain.

In addition to identifying brain regions activation during an experiment, another major advantage of using functional imaging is to observe the interactions between brain areas (O'reilly et al., 2012). Networks of brain regions can be activated together and this allows for the researcher not only to see the localization of activations but also the interactions between different areas of the brain that is of interest to the researcher (Stephan, 2004; Friston, 2011;

Smith et al., 2012). Thus, using fMRI, we can both observe the functional localization of regions of interest (ROI), as well as the functional interactions between the regions of interest.

There are two distinct advantages of using an fMRI for experimental research (Ogawa, 1990). First, it is non-invasive and there is no risk of radiation to the participant unlike the CT (fluids are inserted into the body and involves radiation) and PET (non-invasive but involves ionizing radiation) scans. Second, it has excellent spatial resolution, thus it is very efficient at detecting blood flow activity within 2 mm in the brain. Thus, an fMRI has advantages to both the participant and the researcher carrying out the experiment.

3.2 Participants

The principal investigator of this study was Professor Andra Smith who carried out the experiment from September of 2012 to January of 2013. The primary purpose of the study was to investigate the physiological correlates of decision making, loss aversion and “market distractions” in an agent. In order to retain the feel of a real market environment, it is essential that participants believe that a human is responsible for their perceived loss of wealth. In actuality, a programmed algorithm was pitted against our participants to ensure that each participant experiences the same degree of challenge.

Ethics approval was obtained from the Université du Québec en Outaouais (UQO) and from the University of Ottawa. A poster was placed on various University of Ottawa campus boards to attract potential participants. The poster invited participants to take part in a study of the brain functions involved in a simple multiplayer computer game where researchers would be investigating two effects of interest: 1) the influence of viewing pictures of wild animals on the accuracy of performance during a multiplayer game; and, 2) the effects of a threat of monetary

loss during the game. In order to maintain the deception that participants could lose money during the task, the study advertised a potential compensation of \$50. However, all participants received the full \$50 at the conclusion of the experiment.

Twenty participants (10 females and 10 males) were chosen out of 47 who initially expressed interest in the study. We chose the participants who were MRI compatible, scored low on the State-Trait Anxiety Inventory for Adults (STAI) to ensure that no generalized anxiety disorder is present prior to entering the next phase of the study. We also chose participants if they scored high but below the threshold of pathology on the Snake Questionnaire (SNAQ) for the picture of the snake to have a reasonable distracting effect on the participant. Participants ranged from 18 and 25 years of age. Twenty participants in an fMRI study are sufficient for acceptable power of the results (Herwig et al., 2011). Each participant was MRI compatible with no metal, no pacemaker, no claustrophobia, able to see the screen without glasses (or had contacts) and without physical injury to restrict lying down for approximately one hour. Participants were not included if they reported previous head injuries, neurologic disease or mental health issues (all assessed by an in person interview).

3.3 Questionnaires

During recruitment, the Snake Questionnaire (SNAQ; Klorman et al., 1974) was used to assess fear of snakes. This measure comprises 30 true-or-false items querying fear and indifference related to various snake-related situations (e.g. I avoid going to parks or on camping trips because there may be snakes about.). Participants scoring within the low-to-moderate range were retained in order to ensure that a fear response would be elicited during the presentation of

snake images in the fMRI task. As previously mentioned, the snake represents a market distraction that deters the agent from making the most optimal economic decision.

The State Trait Anxiety Inventory (Spielberger & Gorsuch, 1983) was also administered, both before and after the scanning session, to assess pre- and post-experiment anxiety. This self-report questionnaire consists of one scale measuring trait anxiety (STAI-T) and another scale capturing state anxiety (STAI-S). The STAI-T consists of 20 items that assess how respondents feel in general whereas the STAI-S contains 20 items assessing how participants presently feel. Increases in scores on the STAI-S scale are commensurate with elevated psychological stress and physical danger.

Upon completing the experiment and both versions of the STAI, participants were informed of the deception used in the study and administered a debriefing questionnaire. The aim of this questionnaire was to assess participant perception during the fMRI tasks. The questionnaire included questions on whether participants believed they would lose a portion of their compensation during the task and whether they believed they were playing against another human and not a computer-controlled artificial intelligence.

3.4 fMRI Scanning

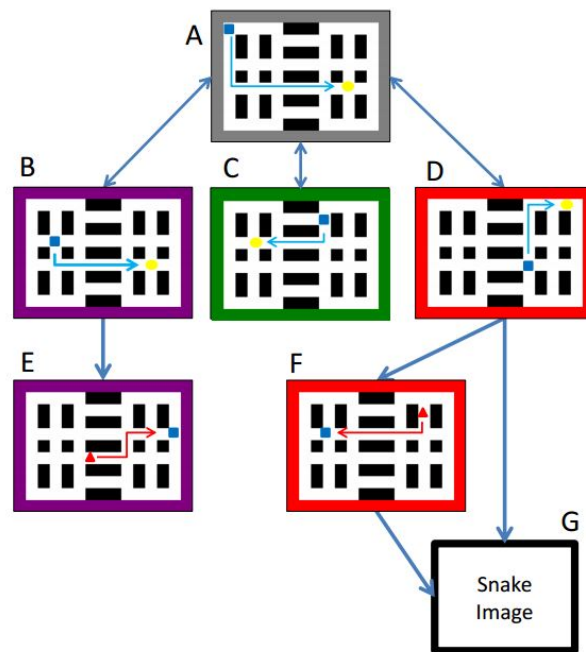
All brain imaging was performed on a 1.5 Tesla Siemens Magnetom Symphony MR scanner. Participants, lying on their back with their head secured in a standard head holder, were instructed to stay as still as possible while in the scanner. A gradient echo localizer was acquired and used to prescribe a subsequent 3D FLASH (Fast Low Angle Shot, a spoiled gradient sequence) (TR/TE 22/9.2ms, flip angle 30°, field of view (FOV) 256x256 mm scan). Whole brain echo planar fMRI, based on the blood oxygen level dependent (BOLD) effect, was

performed using a gradient echo pulse sequence (TR/TE 3000/40ms, flip angle 90°, FOV 250x187.5mm, 64x64 matrix, slice thickness 5mm, 27 axial slices, bandwidth 2430 Hz per pixel).

3.5 fMRI Maze Task

The task was adapted from Mobbs et al., (2009) and programmed using E-Prime 2.0 (Psychology Software Tools, Inc; www.pstnet.com). Participants navigated a blue square through a 9 x 13 maze that consisted of paths (white squares) and walls (black squares; see Fig. 2).

Figure 2

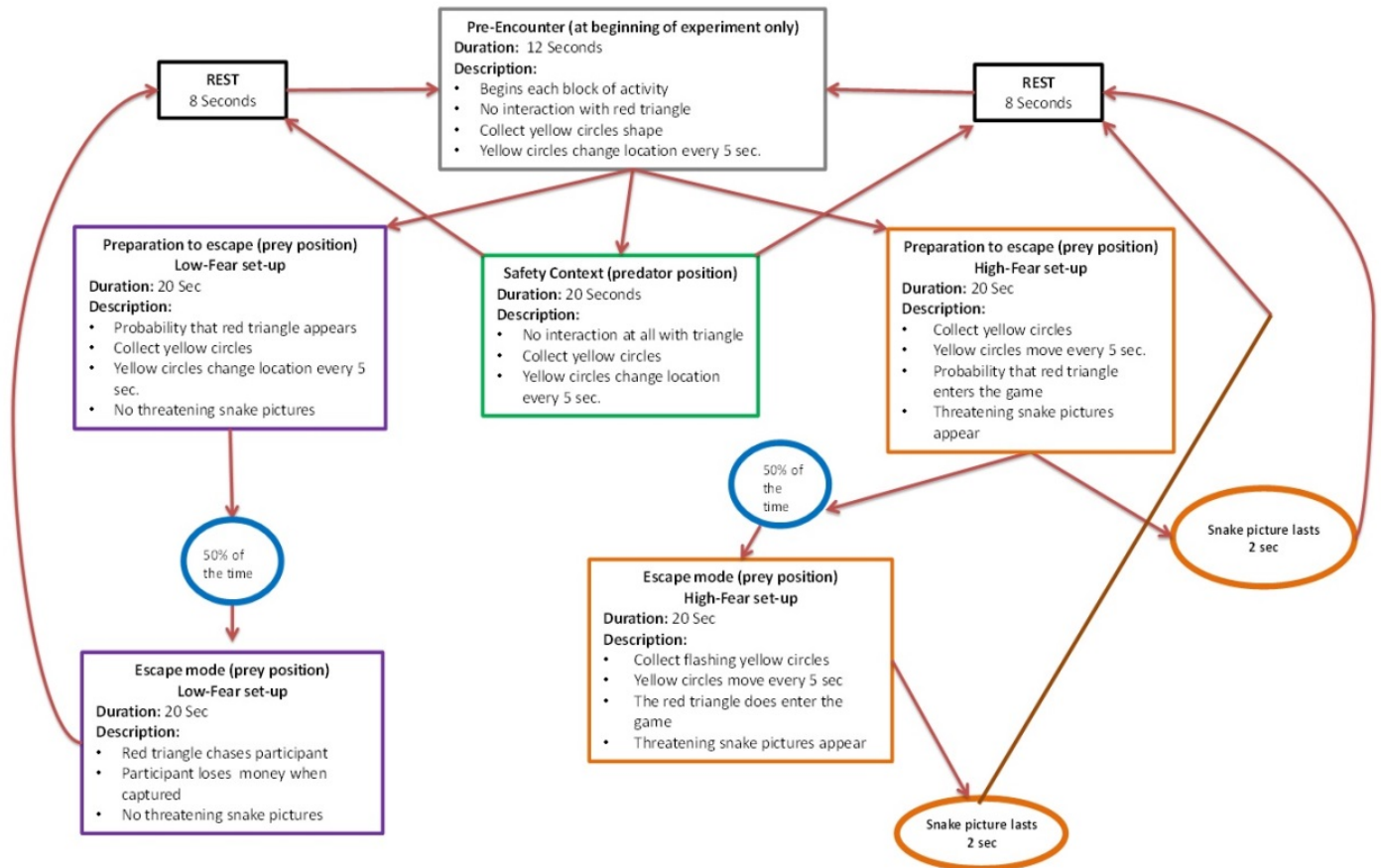


Every trial began with an 8-second neutral condition (NC) in which participants were instructed to collect as many yellow circles as possible. One yellow circle appeared at a time and moved to a random path-location upon capture or every five seconds, if uncollected. The location changing

behaviour of yellow circles remained the same across all conditions in which participants were instructed to capture them. During NC, the border of the maze was colored gray to indicate that there was no threat of encountering the predator.

Next, participants were presented with one of three possible 21-second collection conditions as illustrated in figure 3. Collection conditions were indicated by their associated border color: the no-fear collection condition (NFC) was green (8 blocks), the low-fear collection condition (LFC) was purple (16 blocks), and the high-fear collection condition (HFC) was orange (16 blocks). During each collection condition, participants were instructed to collect yellow circles, with each circle capture representing an undisclosed gain in compensation. Half of the LFC and HFC blocks were preceded by a predator encounter condition in which the border color of the preceding context was retained. Predator encounter conditions were identified by the removal of yellow circles and the presence of a red triangle (i.e. the predator). Low-fear predator conditions (LFP) were presented only after LFC and high-fear predator encounter conditions (HFP) followed HFC. During both LFP and HFP, participants were to elude the pursuing predator.

Figure 3 – Maze Task Design



Prior to the task, participants were reminded that they would be challenged by a human-controlled sprite (i.e. red triangle/predator) during LFP and HFP; however, in reality, the opponent was computer-controlled and had been programmed using a breadth-first search algorithm to mimic a human search strategy. The algorithm detected the shortest path from the triangle to location of the participant-controlled sprite and navigated towards the sprite until capture. Upon capture, the predator would disappear and spawn in a random location after 2000ms. Participants were informed that each capture by the opponent would result in a loss of their compensation by an undisclosed amount of money. When a block terminated in either HFC

or HFP, a snake image selected from the IAPS database (Lang, Bradley, & Cuthbert, 2008) was presented on-screen for 2000ms. At the end of each block, a feedback screen alerted participants whether they had lost or gained money during the trial.

4. Data Analysis

4.1 Image Processing

Statistical Parametric Mapping 8 (SPM8) was used to post-process the fMRI data and to perform the statistical analyses specific to these data. The functional whole images (574 images for each participant) were realigned to correct for motion by employing the procedure of Friston (1995). Images were then spatially normalized to match the echo planar imaging (EPI) template provided in SPM8. Images were then smoothed with a 10mm full-width at half-maximum Gaussian filter given the slice thickness of 5mm.

First level analyses were performed for each participant using these images representing the multiple task conditions. HFP – LFP processing was isolated by subtracting the averaged LFP from the averaged HFP images (condition labelled as “HFP – LFP”), creating one image per participant. Additional contrasts were also computed at the first level: “LFP – NFC”, “HFP-NFC”, and all subsequent comparisons. These processed within-subject images were then entered into a group analysis that provided an average image for the group of 20 participants. Whole brain and region of interest (ROI) investigations were performed. The ROIs included the hippocampus, amygdala, hypothalamus, insula and dorsolateral prefrontal cortex.

4.2 Psychophysiological Interaction Analysis (PPI)

One approach to analyzing fMRI data is through functional connectivity analysis. Functional connectivity analysis measures the dependence between different brain regions, including when the brain is in the resting state (Biswal, Yetkin, Haughton, & Hyde, 1995). The most relevant technique to measure functional connectivity analysis is the Psychophysiological Interaction (PPI) method, if the experiment is task based. PPI analysis measures task-based increases and decreases in brain activity between different regions of interest (Friston et al., 1997).

PPI models the relationship between brain regions in relation to the experiment setup, which in this experiment is the maze task. PPI investigates changes in correlation between brain regions of interest (ROI) when an experiment is performed. Seed-based analysis of PPI regresses, or rather linearly correlates, the changes in brain regions of interest (ROI) with respect to time (in milliseconds). A seed region is a group of voxels in an ROI (Margulies et al., 2007). If the seed region activity correlates with activity in another region of the brain it is said to be positively or negatively related to that region. Voxels have 3 dimensional coordinates to map out the exact area of that specific region of the brain and in this study were 2x2x2 mm. In this paper, Montreal Neurological Institute (MNI) coordinates were used to identify various regions of interest and seed regions. PPI was performed on the HFP - LFP contrast and seeds were bilateral including the amygdala ($x,y,z = 24 -2 -20$ and $-24 -2 -20$), hypothalamus ($x,y,z = 8 -2 -7$ and $-8 -2 -7$), dorsolateral prefrontal cortex ($x,y,z = 32 42 18$ and $-32 42 18$). Bilateral seeds indicate that both right and left sides of the regions of interest in the brain were analyzed. In addition, the precuneus or superior occipital region was included as a seed region as this was the most

significantly activated region when comparing the HFP - LFP conditions. The coordinates of this right sided seed were $x,y,z = 28 -68 34$.

To investigate the extensive relationship between decision-making (high-fear, prey condition) and ROI (regions of interest) activations, we used the PPI method, a multiple regression technique that allows the investigation of the functional coupling between regions in relation to the experimental setup (O'reilly et al., 2012). Consequently, for each ROI (those significantly activated in the HFP minus LFP contrast) we extracted the first eigenvariate time series (changes in fMRI image activity across time in milliseconds) from each participant using the Volume of Interest tool in SPM. The PPI regressor was calculated as the element-by-element product of the ROI time series and a vector coding for the effect of task (HFP minus LFP condition). This interaction term was then entered as a regressor of interest in a first level model together with the ROI time series and the vector coding for the task effect. Ultimately, model contrasts were generated to test the effects of positive and negative PPIs. Here, we set the threshold level for statistical significance at $p < 0.001$ (uncorrected). For all types of analyses, we considered extent thresholds of 20 contiguous voxels. Thus at least 20 contiguous voxels represent a single cluster.

In order to explore the dependencies between brain regions, the analysis has to be done in four parts (Ashburner, 2013). Firstly, a standard general linear modelling (GLM) analysis is carried out using Restricted Maximum Likelihood (ReML) in order to identify the seed regions (e.g.: the amygdala) of the brain. This is the within-subject level of the analysis. Secondly, from the seed region, we extract the BOLD (Blood Oxygen Level Dependent) signal which is then used to, thirdly, form the PPI interaction term. Fourthly, we performed a GLM analysis this time including the PPI interaction term in order to draw the desired inferences on a population

(Ashburner, 2013). This later part is also a within-subject analysis. In its simplest form, the true GLM model used in the within-subject analysis takes the following form:

$$Y_{it} = X\beta_i + \epsilon_{it} \quad (1)$$

Where Y_{it} is a vector containing the BOLD signal at time 't' for voxel 'i' in either the low fear or high fear stage of the experiment. The design matrix X is given by the experiment. In our experiment, the X variables are Green Condition, Purple Condition (Low Fear) and Orange Condition (High Fear). Apart from the constant vector, the first two components of the matrix components are the time series of other cyclical and countercyclical voxels BOLD signals. In technical terms, these are time series reflecting the main effect of the task and the main effect of the stimulus type. The third component is the interaction term between the main task effect and main stimulus effect. This variable is the psycho-physiological interaction which is of interest in this study. Other variables include the hemodynamic response of the voxel and multiple confounding variables such as realignment parameters. β_i is a vector of coefficients and ϵ_{it} is the error term which is assumed to be independently, identically and normally distributed.

It should be noted that the estimated coefficients reflect correlations not causal relationships. This arises as a result of the design of fMRI equipment. Indeed, while the fMRI is able to measure blood flow levels in each of the brain's voxel, it is impossible to infer from which regions of the brain this flow comes from. As such, only correlations can be inferred from an fMRI analysis and not causation linkages. The coefficients p-values for their part are of interest. That statistic actually informs us to whether or not the higher than normal blood flow levels observed in the brain, measured by the T score, are associated with the PPI. As mentioned above, PPI models the relationship between brain regions in relation to the experiment setup, which in this experiment is a maze task. The T score reported is the difference between the average score

for one image and the baseline (resting state) of that image. The T score reports region of interest (ROI) activation higher than the resting state (Clare, 1997). If the p value is significant ($p < 0.05$ for example), we can conclude that the activation in a certain brain region is higher or lower than the resting state at a 5% confidence level.

5. Results

5.1 fMRI Results

To demonstrate that the maze task was activating anticipated regions of the brain, comparisons of both the high and low fear predator blocks were compared with the safety or neutral (Green) condition. As expected both of these conditions revealed significantly more activation than the control condition in bilateral visual cortices, pre-motor and motor cortices, superior parietal regions and subcortical regions, including the hippocampus and amygdala.

Table 1. Regions of the brain with significantly different activation for the High Fear Predator – Low Fear Predator contrast.

Brain Region	Definition/Association	MNI coordinates	T score	p value	Cluster size
<u>High Fear Predator > Low Fear Predator</u>	Vision (Amunts et al., 2005)	28 -68 34	3.60	0.05 **	194
L Superior Occipital Gyrus		40 -42 52	3.29	0.05 *	>2000
R Supramarginal Gyrus		30 -62 40	3.24	0.05 *	>2000
R Angular Gyrus					
<u>High Fear Predator < Low Fear Predator</u>	Visual Memories Processing visual stimuli. (Smith & Kosslyn,	-46 12 -40	5.08	0.000 **	1020
L Temporal Pole					

R Temporal Pole	2007)	40 16 -40	4.87	0.01 **	265
L Superior Medial Frontal Gyrus	Self-Awareness (Goldberg, Harel, & Malach, 2006)	-8 52 48	4.91	0.000 **	1202
Anterior Cingulate	Cognitive Functions Decision Making Impulse Control Emotion (Decety, 2004)	2 44 -18	4.35	0.001 **	500
L Amygdala	Memory Decision Making Emotion (Fear) (Amunts et al., 2005)	-22 -8 -22	4.15	0.000 **	1020
R Amygdala		22 -2 -24	3.63	0.037	98

** corrected at $p=0.001$

* corrected at $p=0.05$

In summary, the comparison that provided more information on the nature of the prey condition was the high fear predator – low fear predator (HFP – LFP) contrast. This comparison showed significantly more activity during the snake trials in posterior brain regions and less activity in more frontal areas compared to the low fear predator condition. More specifically, there was significantly more activity in the left superior occipital gyrus, the supramarginal and angular gyri (Table 1). There were also regions that were significantly less active during the high fear predator condition compared with the low fear predator condition. These included more frontal regions: bilateral temporal pole, superior medial frontal gyrus, the anterior cingulate, and bilateral amygdala (Table 1).

5.2 PPI Results

Based on the results of the above analysis, bilateral amygdala and the right superior occipital gyrus were chosen as seed regions for the PPI analysis as these were the activated regions and therefore the surrounding areas are chosen as regions of interest to identify possible relationships between the seeds and regions of interest (ROI). Those results above the threshold of resting state and significance are reported to minimize clutter.

Table 2. Significant results with activity from the PPI analysis for seed regions including both positive and negative connectivity regions.

Seed Region	Brain Region	Definition/Association	MNI coordinates	T score	p value	Cluster size
HFP<LFP L Amygdala Positive (p=0.005 FWE corrected)	L Inferior Frontal Gyrus	Risk Aversion (Christopoulos et al., 2009)	-56 14 0	4.88	0.05	428
HFP<LFP R Amygdala Positive (p=0.005 FWE corrected)	R Inferior/Middle Frontal Gyrus (B46)	Risk Aversion (Christopoulos et al., 2009)	54 30 24	6.12	0.034	578
	L Middle Temporal Gyrus	Recognition of faces Word meaning (Acheson & Hagoort, 2013)	-60 -4 -16	4.42	0.003	939
	L Supplementary Motor Area	Movement (Luppino, Matelli, Camarda, Gallese, & Rizzolatti, 1991)	-8 18 54	4.10	0.002	959

HFP>LFP R Superior Occipital Gyrus Positive (p=0.05 FWE corrected)	L Superior Occipital Gyrus	Vision (Amunts et al., 2005)	-24 -66 24	4.95	0.021	4042
	L Superior Frontal Gyrus		-22 -6 58	4.16	0.03	3768
	L Superior Parietal Lobule		-16 -66 60	4.19	0.03	3768

In summary, positive blood flow dependency (as blood flow increases in one brain regions, blood flow also increases in another region) of the left amygdala was observed in the left inferior frontal gyrus (Figure 3 in Appendix) and for the right amygdala in the right inferior/middle frontal gyrus, the left middle temporal gyrus, the supplementary motor area and the right precentral gyrus. Correspondingly, positive blood flow dependency with the left superior occipital gyrus was observed in the homologous contralateral region, the left superior frontal gyrus and the left superior parietal lobule (Figure 4 in Appendix).

Our research aligns with previous literature in terms of the amygdala activation in the decision making task where loss aversion is expected to occur, in addition to the frontal gyrus that is association with risk aversion. Unique to our experiment is the deactivation of decision making areas of the brain under high fear condition and sole activation of the visual regions of the brain.

6. Discussion

From the fMRI results, it is the decision making areas of the brain (bilateral temporal pole, superior medial frontal gyrus, the anterior cingulate, and bilateral amygdala) that are not significantly active in the high fear condition. In the high fear setup, the participant is less likely

to care about losses and gains and more likely to just want to avoid the picture of the snake. In the high fear set up, the visual region of the brain is activated (left superior occipital gyrus, right supramarginal gyrus and right angular gyrus), implying that the participants are mostly concerned about the appearance of a snake picture rather than making decisions of whether to try to catch the yellow circles (acquire gains) or avoid the red triangle (loss aversion).

Thus support is found for the market distraction hypothesis: Market distractions lead to suboptimal decision making that is related to activity or inactivity in brain regions not associated with decision making. Visual regions of the brain are not associated with decision making and those regions of interest were the only region activated during the high fear condition. The parts of the brain involved in decision making are shut off and dominated by visual parts of the brain, which in this case is seeing the snake. The snake can be understood as a market distraction that takes the agent away from the task at hand, which is to make a calculated decision, and focuses the agent on some stimuli that distracts and prevents the agent from making an optimal economic decision.

However, decision making areas of the brain are active in the low fear setup, demonstrating that some level of decision making is occurring. During the low fear setup, the participant is more likely to try to gain yellow circles and avoid the red triangle (loss aversion) than in the high fear set up. Thus the agent is more likely to be a calculating agent in low fear but that is not to say the agent is perfectly rational. In the PPI analysis we see that the amygdala BOLD signal is higher than it is under normal circumstances while in the decision making regions of the brain (the dorsolateral prefrontal cortex) the BOLD signal is lower than it is under normal circumstances. Thus, the agent is trying to avoid losses more than he is trying to maximize profits.

As the amygdala is associated with fear and negative emotional response and the participants must avoid the red triangle (loss aversion) in the low fear scenario, it can be concluded that loss aversion is associated with fear because the amygdala is activated in the low fear condition where agents choose to avoid losses. This result confirms the results of Martino, Camerer, & Adolphs (2010). The level of fear causes the decision making areas of the brain to stop working as the amygdala dominates the functionality of the brain during the task where the possibility of loss is introduced. Our hypothesis that loss aversion is correlated with activity or absence of activity in decision making regions of the brain hold true because amygdala is a significantly active region of the brain and is part of the decision making, however other decision making parts of the brains are below the resting state. Therefore, loss aversion can be explained by the dominance of the amygdala, a center for emotions and decision making, and absence of activity (blood flow) of other decision making regions of the brain in relation to the resting state. In simple terms, emotions overpower rational decision making. This result has also been found by Sokol-Hessner, Camerer, & Phelps (2013), Canessa et al., (2013), Camerer, & Adolphs (2010).

Of note, some participants disclosed during the debriefing session that they realized the red triangle was actually controlled by a computer rather than by a human – so that they knew they could never win, but kept playing and lived up to the challenge of trying not to be caught by this red triangle.

As mentioned in methods, it was not disclosed to the participants how much money they would earn if they were to catch the yellow circle and how much money they would lose if they were to be caught by the red triangle. The participants should normally have asked ahead of time how much catching a yellow circle would earn, and how much money would be lost if they were

caught by the red triangle. The basic idea behind any economic decision making strategy is to maximize consumption and minimize costs (utility optimization). It would thus have been expected that the participants would want to have the above-mentioned information in order to fully benefit from the experiment (maximize reward).

If, for example, catching one yellow circle was to earn a participant \$50, but being caught was to cost her/him 1 cent, we would expect her/him to try to catch as many yellow circles as possible and somehow not care so much about being caught by a red triangle (we did not initially tell the participants this red triangle was controlled by a computer so that they readily assumed it was controlled by one of the researchers). However, none of the 20 participants that were chosen for this study asked the question ahead of the game, that is: “how much value is associated with the catch and be caught scenarios?”

In other words, the participants entered into the fMRI scan with asymmetry of information. It was important to give the participants an opportunity to ask questions before the experiment about the game they were about to play, to see how actively the participants would inform themselves to make the best economic decisions while playing the game. Out of the 20 participants, only two mentioned in the debriefing period that it would have been nice to know what the value of each yellow circle and red triangle catches were. Yet, this information was crucial ahead of the game in order for them to make sound economic decisions.

Evidently, even before performing the fMRI maze task, participants were generally not asking all the right questions. That is to say they did not take the additional steps to maximize their utility and did not ask questions to better inform themselves about indicators such as worth of triangles and circles that would lead to personal utility maximization. Possible explanation for

this is that generally agents don't ask the right questions or any questions at all, to better inform themselves. Agents perhaps assume that imperfect information is actually perfect information. The findings in this paper support the evidence found in the literature (Tom et al., 2007; Martino, Camerer, & Adolphs, 2010; Canessa et al., 2013; Sokol-Hessner, Camerer, & Phelps 2013).

There is a strong relationship between the activity of amygdala and inclination to avoid losses. The amygdala has conflicting mechanisms of processing both emotions and decision making. From the results and the literature, the emotional response gets the better of the agent. Unique to this paper, market distractions, additional stimuli introduced in the market environment replicated in the experiment, deter the agent from making rational decisions. The agent is completely distracted by the stimuli. Market distraction analysis goes a step further from the literature to explain why agents are not always rational, beyond loss aversion. The research explains how everyday economic decision making is deterred by constant interruptions in the real work market environment.

7. Conclusion

This paper provides evidence to support our hypothesis that loss aversion is correlated with activity or absence of activity in decision making regions of the brain. We have shown that agents do their best to avoid losses. The decision making regions of the brain (prefrontal cortex) and amygdala are significantly active during that stage. An active amygdala implies emotional response linked to preference to avoid losses as opposed to the more rational utility maximization. This lack of rationality is amplified by the fact that the agents did not ask appropriate questions prior to the experiment. The incomplete information further leads to irrational decision making and thus suboptimal outcomes. The results of this experiment confirm the existence of loss aversion studied through three generations of prospect theory.

In the high fear set up, we predicted that market distractions lead to suboptimal decision making correlated with activity or inactivity in brain regions not associated with decision making. The snake experiment was conclusive to that end. The snake, a distraction, activated the visual regions of the brain but also shut down both the decision making regions and the amygdala. Thus, any economic decisions that could take place would not be optimal.

On an aggregate level every suboptimal decision made lowers economic efficiency and perhaps leads to market failure as the allocation of goods and services by irrational agents are not allocated efficiently due to individual suboptimal decisions. From the literature, loss aversion plays a significant role in disrupting the efficiency of the market. In addition, loss aversion can be used as a tool for better economic outcomes. From both the literature and the experiment we have seen that if the agents are better informed about the impact of loss aversion, we cannot stop its effect on the agent but we can manipulate it to work in the favour of the market. In the market for education for example, manipulation of loss aversion significantly improved the quality of teaching. In the analysis of market distraction, it is evident that everyday distractions, in addition to loss aversion, deters optimal economic decision making and thus further bounds agent rationality.

8. Appendix

Figure 3. PPI positive functional connectivity between the left amygdala and the right prefrontal cortex (top image), the right amygdala and the left supplementary motor area (bottom left), right prefrontal cortex (bottom middle) and left middle temporal gyrus (bottom right).

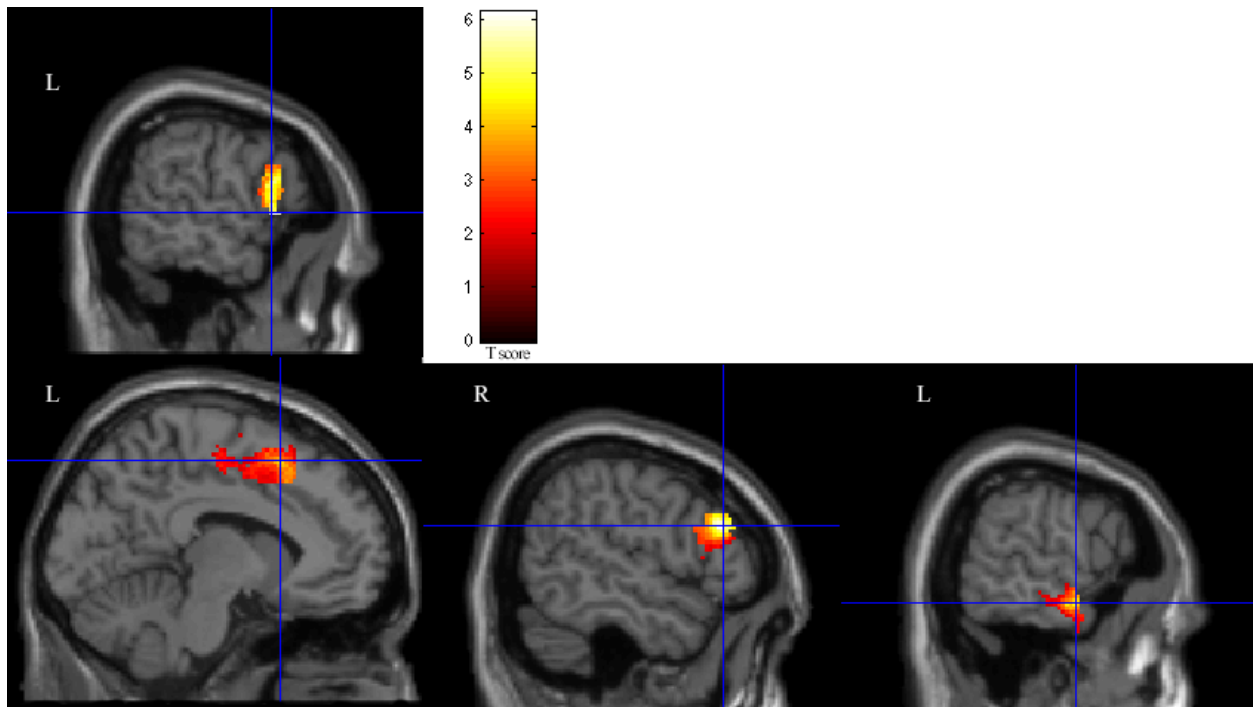
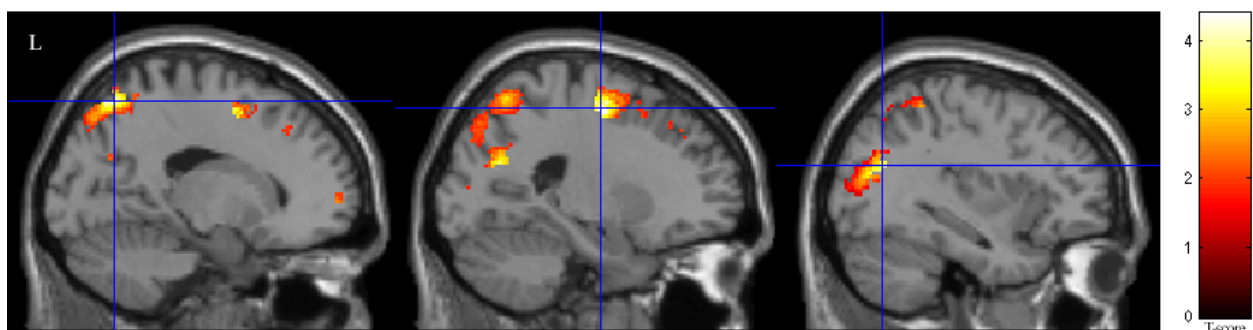


Figure 4. PPI positive functional connectivity between the right superior occipital gyrus and the left superior parietal lobule (left most image), the left superior frontal gyrus (middle image) and the left superior occipital gyrus (right most image).



8.1 Annex A – Poster for the experiment

Are you interested in participating in an *fMRI* study on the brain functions involved in a simple multiplayer computer game?

We will be investigating the effects of viewing pictures of wild animals on the accuracy of our participants' performance while they play a computer game with another player. We will also be investigating the effects of the risk of losing money while playing a game.

Q. What would I have to do?

You would undergo a pencil-and-paper screening test in the fall of 2012 to determine your reactions to wild animals (snakes).

If you are selected to participate, you will undergo *fMRI* (functional magnetic resonance imaging) in early 2013. *fMRI* is a harmless form of brain scan, taken while you are doing mental tasks in order to determine which areas of the brain were “activated” by the task. The scan will take place at St. Joseph MRI on one occasion. You will play a computerized game in which you will navigate a shape through a maze.

You may be paid up to \$50 for this study. You will also be provided with feedback about your test performance as well as a copy of your MRI scan, if you are interested.

Q. Am I eligible?

You are eligible for this study if:

- You are between the ages of 18 and 25 and are not claustrophobic
- You are fluent in English (This study will be conducted in English only)
- You are right handed with no recent tattoos or piercings you cannot remove

For more information, please call:
613-562-5800 ext. 1405

Or email:
uOttawa.fMRI.Study@gmail.com

You will be promptly contacted for a brief telephone screening for eligibility.
Thank you for your interest.

8.2 Annex B – Maze Task: Participant Instructions

Thank you for participating in this study.

The game has two modes, capture and evade. Throughout all modes you will be controlling a blue square.

You will mostly be playing the capture mode. In this mode, your goal is to capture as many yellow circles as possible. Only one circle will appear at a time and it will move to different locations once caught or after five seconds if you were unsuccessful. When you capture a yellow circle, you increase the amount of money you will receive from this study.

During evade mode, your goal will be to evade a red triangle being controlled by another person. When you are captured by the other person, you will lose part of the money awarded to you during capture mode.

This game has three levels. During the green level, you will see a green border surround the maze. This signals that you will be able to collect yellow circles uncontested by the other person.

During the purple level you will see a purple border surround the maze. This signals that you will have a fixed amount of time to collect yellow circles. Once this time has elapsed, there is a 50% chance that the game will enter evade mode. In evade mode, the other player will be controlling a red triangle. Your task will be to avoid the other player for the remainder of the level.

During the orange level you will see an orange border surround the maze. This signals that you will have a fixed amount of time to collect yellow circles. Once this time has elapsed, there is a 50% chance that the game will enter evade mode. The other player will again be controlling a red triangle. Your task will be to avoid the other player for the remainder of the level. At the end of the orange level, a picture of a wild snake will appear on the screen for a brief period.

The three levels will be presented to you in a random order. Before entering all levels, the game begins with a neutral level, as indicated by a grey-colored border surrounding the maze.

After each level you will have the opportunity to rest briefly. Upon completing the game, you will receive any money that you have won.

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