EMOTION REGULATION AND ITS INFLUENCE ON DECISION MAKING

Emotion regulation and decision making

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Abstract

One thing that may affect our decision making is emotions, and emotions are something we can regulate, this is referred to as emotion regulation. Therefore the aim of this thesis is to investigate to what extent the use of emotion regulation strategies can influence our decision making, and how this process plays out at the neural level. The findings within this thesis will suggest that the emotion regulation strategy reappraisal, compared to suppression, influences our decision making to some extent. At the neural level, findings within this thesis will indicate that neural changes may occur when individuals regulate their emotions in relation to making decisions. For instance, decreased activity within the striatum was associated with making less risky decisions when using the emotion regulation strategy reappraisal. On the other hand, the ventromedial prefrontal cortex may be important in mediating the neural systems of emotional states and working memory in order to enable decision making. This thesis will also cover some prominent theories of emotion and decision making. Emotion regulation, as well as strategies for emotion regulation, will be explained.

Keywords: emotion, emotion regulation, decision making, reappraisal
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1. Introduction

Imagine that you are sitting at home hungry, you have some healthy and already prepared food in your fridge, but you are craving for some fast food, such as pizza. You have two options. You may decide to control your cravings and eat the food that you already have, since you are trying to eat healthier, or, you may decide to give in to your craving. In either case, you need to make a decision to reach your goal, you may also need to regulate your emotions in relation to the two options.

As in the above example, our actions often lead to an outcome or reward, we have a goal or personal need that we want to accomplish by actively choosing how to reach our goal or attain our need (Gazzaniga, Ivry, & Mangun, 2009). In order to behave in a goal-oriented way, we need to be able to make decisions and decision making is seen as a cognitive process in which we use our cognitive control. Cognitive control, also known as executive function (Gazzaniga et al., 2009), can be defined as the cognitive processes that allow us to perform more complex tasks and aspects of behaviors (Miller & Cohen, 2001). In short, cognitive control enables us to use our goals, knowledge, and perceptions in order to bias the selection of our thoughts and actions among a variety of possibilities (Miller & Cohen, 2001). Furthermore, emotions can affect our decision making in different ways, such as when we consider and evaluate different options and their possible outcomes (Grecucci & Sanfey, 2014). One way that we may try to influence our emotions is by regulating them, this is referred to as emotion regulation (Gross, 2014) and can be seen as a form of cognitive control (Ochsner & Gross, 2005).

Thus, since emotions can affect our decision making, the aim of this thesis will be to investigate to what extent the use of emotion regulation strategies can influence our decision making, and how this process plays out at the neural level. In order to reach the aim, relevant
literature from the field of cognitive neuroscience, affective neuroscience and neuroeconomics will be reviewed.

This thesis will begin with a chapter concerning emotions, in which some prominent theories of emotions will be presented, in order to explain what emotions are and how they may be generated. The second chapter will concern decision making. In order to build an understanding of how we make decisions, some theories about decision making will be presented, with one section particularly covering the *somatic marker hypothesis* by Antonio Damasio with colleagues. Following this, there will be a chapter about emotion regulation, in which emotion regulation and its central features, along with some typical emotion regulation strategies, will be defined and discussed. Finally, there will be a discussion tying together decision making and emotion regulation, exploring to what extent we can influence our decision making by regulating our emotions. The thesis ends with some suggestions for future research.

2. Emotion

It was long thought that emotions are something subjective, thus conscious, which made it hard to study them with empirical methods. However, with the course of time, researchers came to realize that unconscious processes give rise to conscious emotions (Gazzaniga et al., 2009). These unconscious processes, which happen outside of our awareness, may be studied with methods from cognitive neuroscience or psychology (Gazzaniga et al., 2009). Particularly the subfield of cognitive neuroscience called *affective neuroscience* aims at understanding our brain functions in relation to emotional aspects (Purves et al., 2012). In short, emotions involve cognitive processes which may take place either within or outside our conscious awareness (Gross, 2014), which implies that emotions can be either conscious or unconscious to us.
Defining the concept of emotion has been somewhat difficult, and there is no generally accepted definition of emotion. However, it has generally been accepted within psychology that “emotion consist of three components: a physiological reaction to a stimulus, a behavioral response, and a feeling” (Gazzaniga et al., 2009, p. 427). For instance, most researchers differentiate emotion from feeling, claiming that an emotion per se is not a feeling, saying instead, that a feeling is what we subjectively experience from the emotion (Gross, 2014). Emotions are also said to be distinct from moods, in the way that emotions often have identifiable triggers or objects (Ochsner & Gross, 2005).

Present models of emotion suggest that emotions are valenced responses to internal mental representations and/or external stimuli (Ochsner & Gross, 2005). That relies on different neural systems and involve alterations across different response systems, such as behavioral, peripheral, physiological, and experiential (Ochsner & Gross, 2005). For clarification, valence refers to the emotional value a given stimulus holds for the individual, which may range between being pleasant to unpleasant (Gazzaniga et al., 2009). Our responses from emotions can be either learned responses to stimuli that give some emotional value or unlearned responses to stimuli with an intrinsic affective attribute (Ochsner & Gross, 2005). Learned responses may involve taking a detour when walking home from work with the purpose of avoiding crowded places because such places tend to give you anxiety. Unlearned responses may involve looking the other way when we see something unpleasant.

Emotions can also involve multiple types of appraisal processes, which help to evaluate the meaning of a stimulus in relation to current goals (Ochsner & Gross, 2005). In order for a stimulus to induce an emotional reaction, it needs to be somewhat motivationally meaningful. In this way, the outcome of the emotional reaction is due to the appraisal process (Etkin, Egner, & Kalisch, 2011).
2.1. Theories of emotion

As mentioned earlier, emotions are said to consist of three components. However, different theories exist about how emotions are generated and when in time the different components of emotion take place. Therefore theories of emotion involve questions such as do we label the feeling (experiential) as fear after we feel our heart pounding (physiological) or do we start running away from danger because we feel afraid (behavioral) (Gazzaniga et al., 2009). One should keep in mind that there are many theories of emotion. However, only a few of the more major theories, both traditional (e.g., James-Lange theory, Cannon-Bard, etc.), along with some newer theories (e.g., Modal Model), will be laid out in the text below.

2.1.1. James-Lange theory. William James and Carl Lange believed that emotions are subjective outcomes of bodily responses, thus, we cannot feel an emotion without having some reaction in the body, such as a pounding heart (James, 1884; Lange, 1922). To describe the assumption of this theory, James used the example of a bear and the emotion fear. According to the theory, meeting a bear in the woods would induce a bodily reaction (physiological, heart pounding) and you start running (behavioral). While you are running, you become aware that your heart is pounding and that you are running, which leads you to think that you are afraid (subjective outcome) (James, 1884). Thus, James proposed that the behavioral response happens automatically, outside our conscious awareness, and when we become aware of our physiological and behavioral response, we also become conscious of our emotion and are able to subjectively label it (James, 1884).

Furthermore, Lange assumed that brainstem nuclei were important for generating emotions since they control cardiac function. In this view, Lange believed that the bodily reaction to a given stimulus sends feedback to the brain in order to generate an emotion (Lange, 1922). The James-Lange theory does not propose any specific brain region for generating emotions. However, it does suggest that the neocortex aids in processing
emotional states within our conscious awareness (James, 1884; Lange, 1922). James-Lange theory was proposed during the late nineteenth century and a new theory of emotion took form in the early twentieth century as a counterproposal by Walter Cannon and Philip Bard (Bard, 1928; Cannon, 1927).

2.1.2. Cannon-Bard theory. Cannon and Bard believed that bodily reactions could not by themselves count for generating an emotion and that feedback processes of hormones and neurons were too slow for generating an emotion (Bard, 1928; Cannon, 1927). Therefore, Cannon-Bard theory suggests that the cortex and the sympathetic nervous system work simultaneously to generate an emotion (Bard, 1928; Cannon, 1927). For instance, using the example of meeting a bear, the emotional stimuli (bear) would first be processed in the thalamus, then simultaneously be directed to hypothalamus and neocortex. Neocortex would allow for interpreting the stimuli, which would lead to the emotional feeling, which in this case would be within our awareness making us feel afraid. However, the hypothalamus would connect with the sympathetic nervous system to make a bodily response, such as running away from the bear. In this view, the neocortex would work fast in generating the emotional conscious feeling, while the sympathetic nervous system would be a bit slower and responsible for the emotional reaction (Cannon, 1927). Thus, Cannon-Bard theory suggests when meeting a bear we feel afraid simultaneously as we react to the bear.

However, the Cannon-Bard theory has not fully been supported by researchers in explaining how emotions are generated (Gazzaniga et al., 2009). Instead, the theory introduced a new way of thinking, meaning that emotions might involve parallel processing.

2.1.3. Appraisal theories. Unlike the two previously described theories, appraisal theories are a broad category of theories which have the view that emotions emerge from our appraisal of external and internal events to cause an emotional outcome (Kolb, Whishaw, & Teskey, 2016). In short, appraisal in the context of emotion refers to evaluating what the
external or internal stimuli means to a given individual (Etkin et al., 2011). Appraisal theories differ from each other in the way that they have different criteria for appraisal and what is appraised (Gazzaniga et al., 2009). Also, appraisal is subjective (within our awareness), since individuals evaluate the meaning of a stimulus in relation to themselves, therefore, appraisal may lead to individual differences in how we react to emotional stimuli (Etkin et al., 2011).

One version of appraisal theory was put forward by Richard Lazarus in which emotions can be seen as the outcome of a calculation (Lazarus, 1993). In other words, if an individual encounters with a stimulus, he or she would calculate the benefit versus the risk in relation to harm, thus, the emotion would be the outcome of the calculation (Lazarus, 1993). Within this theory, both environmental and personal factors are important when individuals are considering the benefit versus risk when encountering a stimulus, thus, it is not only the stimuli itself that generate the given emotion (Lazarus, 1993). In short, this theory suggests that the emotional outcome comes after the cognitive appraisal has taken place, but also that the step before an emotional outcome may take place outside our awareness (unconscious) and automatically (Lazarus, 1993). In the case of meeting a bear, the individual spots the bear, which leads to cognition and a fast calculation of benefit versus risk. The individual realizes that he or she is in danger and then feels afraid, leading to a response, which may be to run away. Thus, within this view, we make decisions about stimuli related to our well-being (Lazarus, 1993).

2.1.4. Singer-Schacter theory. Jerome E. Singer and Stanley Schachter suggested that emotions are generated through physiological arousal and that cognitive factors aid in explaining what is felt, leading to labeling an emotion (Schachter & Singer, 1962). Thus, Singer-Schacter theory is a type of appraisal theory but also a blend of James-Lange theory.

Singer-Schacter theory of emotion generation emerged from a study in which participants were injected with adrenaline and divided into two groups (Schachter & Singer,
1962). One group was told that the injection contained vitamins which would not give rise to any side effects. The control group was informed that they would feel their heart pounding fast and even experience shakings in the body, thus, symptoms related to adrenaline (Schachter & Singer, 1962). Participants were then, one by one, introduced to an experimenter who was in disguise as a participant, the disguised experimenter would then behave either in an angry or euphoric way (Schachter & Singer, 1962). Afterward, participants were asked questions such as how they were feeling and why. Those who did not know that they were given adrenaline explained their bodily reactions to the environment, that is, the disguised experimenter’s behavior (Schachter & Singer, 1962). However, those who knew that they might experience bodily reactions told that what they experienced was due to the injection (Schachter & Singer, 1962).

Returning to meeting a bear, Singer-Schachter theory would explain that seeing the bear would generate a bodily response, such as fast heartbeat, which would lead to cognition where the individual would realize that he or she is facing a dangerous animal, which would give rise to feeling the emotion fear. Thus, the emotion would not be generated until physiological arousal and cognitive factors are appraised in relation to the stimuli (Schachter & Singer, 1962).

2.1.5. LeDoux’s high road and low road. LeDoux’s high road and low road theory of emotion suggests that two systems of emotion work simultaneously to generate an emotion (LeDoux, 2000). The first, is a neural system that generates our emotional response to a given stimulus. The second system, which according to this theory is separated from the first system, is responsible for generating our emotion that is within our awareness (LeDoux, 2000). The first system is suggested by LeDoux (2000) to be processed fast and developed through evolution in order help us survive and act fast in threatening situations. However, the second system is believed to be learned from our experiences and act a bit slower than the
first system (LeDoux, 2000). By using the example of meeting a bear, both systems would be activated simultaneously, meaning that our bodily response and our feeling would occur at the same time. We might start running away from the bear and at the same time recall that bears are dangerous and might try to harm us, which would lead us to experience the emotion fear. Within LeDoux theory, we can experience the emotion of fear both within and outside our awareness, meaning that the first system which is processed fast would count for unconscious processing and the second for conscious processing of emotion (LeDoux, 2000).

2.1.6. The modal model of emotion. Gross and Thompson (2007) present a model of emotions called the modal model of emotion which focuses on what occurs before an emotion starts, the response of the individual to the given emotion and what occurs in between the two. Gross and Thompson (2007) put forward three core features of emotion within this model which the modal model is based on.

The first core feature of emotions concerns situations and goals and refers to the importance a given situation means for an individual’s goal. Within this core feature, it is the meaning that will give rise to an emotion. Also, the meaning may change with time, and if that occurs, the emotion itself may also change (Gross & Thompson, 2007). The meaning may change “due either to changes in the situation itself or to changes in the meaning the situation holds” (Gross & Thompson, 2007, p. 4). For example, watching a game of basketball, the situation would be watching the game and the goal would be for your team to win. You might first experience excitement because your team is in the lead, but as the time goes the situation changes, and the other team takes the lead which changes your emotion from feeling excited to nervous.

According to Gross & Thompson (2007), the second core feature of emotion involves changes within the body such as physiological changes, changes in behavior or changes of
subjective experience. Due to different changes within the whole body, emotions may be said to involve multiple systems which may help us to act upon our emotions in different ways.

The third core feature concerns the flexibility of emotions due to changes in the whole body (Gross & Thompson, 2007). This core feature of emotion implies that we can impact how we act upon our emotions. For instance, changing our behavior may involve not showing with our face that we are angry (Gross & Thompson, 2007). Therefore, this core feature is of importance since flexibility makes it possible for us to regulate our emotions (Gross & Thompson, 2007).

The modal model of emotion is based on the above described core features of emotion, which first suggest that there is a situation that gets the individual’s attention. This situation holds some specific meaning for the individual. Which, in turn, gives rise to a flexible and coordinated multiple systems within the whole body that is related to the ongoing situation (Gross & Thompson, 2007).

According to Gross & Thompson (2007), the modal model suggests that emotions are generated over time through four steps or sequences: situation, attention, appraisal, and response. First, the sequence starts with a situation that is psychologically significant. The situation may either be external (Gross & Thompson, 2007) such as meeting a bear, or internal such as mental representations of a situation (Gross & Thompson, 2007), for instance, feeling that one is not a good student. Whatever the case may be, the situation is attended to, which leads to an appraisal process whereby the individual interprets the meaning of the emotional situation and appraisal then gives rise to the emotional response (Gross & Thompson, 2007). However, the emotional response may lead back to a new situation, making the sequence start over again (Gross & Thompson, 2007). For instance, two friends start arguing whereby one of them starts to cry, which creates a new situation where the other friend tries to comfort the friend who is crying. The modal model of emotion is thus
a type of appraisal theory where appraisal is key to generate an emotion (Gross & Thompson, 2007).

2.2. Neural Systems and Emotion

The nervous system plays an important role within generating emotions not only because the nervous system is involved in creating behavioral and physiological responses, but also since arousal is part of many theories of emotion (Gazzaniga et al., 2009).

The nervous system consists of the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS consists of the brain and spinal cord and the PNS consist of ganglia and nerves and is located outside the CNS (Gazzaniga et al., 2009). In short, the role of the CNS is to deliver instructions to the PNS, such as to move our hand. The role of the PNS is to deliver the instructions from the CNS to the concerned muscle which enables the hand to move. These two systems work together with both the somatic motor system, which controls the body's voluntary activation of muscles and the autonomic nervous system (ANS), which controls the body's visceral functions, such as the heart and activation of more smooth muscles (Gazzaniga et al., 2009).

The ANS consists of two branches, the parasympathetic and sympathetic branch (Gazzaniga et al., 2009). The parasympathetic branch helps us to breathe in a less rapid way, decreases heart rate and increases our digestive functions, in other words, it helps the body to rest (Critchley, 2005). In contrast, the sympathetic branch is activated when we need to increase our heart rate, make muscles ready for action, and so on (Critchley, 2005). Thus, the sympathetic branch is active when the body needs to prepare itself for action (Critchley, 2005). For instance, when we need to defend ourselves or flee from something we experience as threatening, such as meeting a bear. Combined, the parasympathetic and sympathetic branch help our body to achieve a normal state, also referred to as homeostasis (Critchley, 2005).
As mentioned, arousal is part of many theories of emotion and is regulated by the reticular activating system (RAS) (Mesulam, 1998). RAS, which has connections from the brainstem to the cortex via pathways through thalamus and hypothalamus, is also involved in mediating our attention (Mesulam, 1998). Hypothalamus, however, is not only involved with RAS but also in regulating our ANS (Gazzaniga et al., 2009). Furthermore, researchers believe that different neural systems are activated depending on which situation one is exposed to or what kind of emotional task one is facing, making the neural network of emotions somewhat complex (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012).

One part of the brain which is involved with emotional processing and has particularly been associated with the emotion fear is the amygdala, in plural amygdalae (Feinstein, Adolphs, Damasio, & Tranel, 2011). The amygdala is a somewhat complex part of the brain and each amygdala consists of 13 nuclei. Each nucleus serves different functions. For example, the basal nucleus helps us to mediate our behavior, as when we run away from threatening bears (Gazzaniga et al., 2009). There are different ideas about the amygdala's role in emotion. For instance, in a study by Feinstein et al. (2011), the researchers investigated if a damaged amygdala would prevent the experience of fear by inducing fear to a female patient to whom they refer as SM. When the researchers exposed SM to fear-triggering stimuli, such as haunted houses, scary movies, snakes and spiders, SM did not report experiencing fear nor could fear be seen in her behavior, such as if she would avoid snakes or spiders. Worth to mention, SM was able to feel and generate other emotions than fear. Also, SM reported that she used to avoid snakes and spiders before damaging her amygdala. Feinstein et al. (2011) therefore suggest that the amygdala is an important brain region for generating the experience of fear.

As mentioned before, the neural network of emotions is somewhat complicated since different things affect our emotions and emotions, in turn, affect different cognitive processes
such as attention, decision making, memory and learning (Gazzaniga et al., 2009). However, for the purpose of this thesis, decision making along with some studies of decision making and emotions will be covered in more detail in the next chapter.

3. Decision Making

Goal-oriented behavior can be said to begin with a decision about how we are going to reach a goal and, since our lives are full of multiple options, every day involves some kind of decision making (Gazzaniga et al., 2009). A decision is therefore referred to as choosing one option from a variety of options based on what we believe the consequences or reward of our choice might be, meaning, we consider the value which the option we choose might bring (Rangel, Camerer, & Montague, 2008).

Even if we make decisions, such as choosing to pay for a gym card so that we can work out at the gym, we may not always use our gym card. This is something that economists want to understand, why and how we make the decisions that we do. These questions, why and how, have made a new field to emerge called neuroeconomics which has the aim of understanding the neural mechanisms behind decision making (Rangel et al., 2008; Sanfey & Chang, 2008).

Neuroeconomics uses the methods and concepts of neuroscience to form an understanding of economics and social science which makes neuroeconomics an interdisciplinary field (Rangel et al., 2008; Sanfey & Chang, 2008). In turn, the research from neuroeconomics may aid in understanding the functional organization of the human brain (Rangel et al., 2008; Sanfey & Chang, 2008).

3.2. Theories of Decision Making

There are two types of theories that try to explain how we make a decision, normative and descriptive theories (Gazzaniga et al., 2009), in which expected utility theory and prospect theory are the most dominant (Rangel et al., 2008).
3.2.1. Normative decision theories. These theories try to explain how people should make decisions that will lead to the best outcome. That is, if we have multiple options, and one of them would lead to the best outcome, we should pick that particular option. However, these theories usually fail at predicting what people end up choosing because people do not always tend to make rational decisions and hence, do not always pick the best option (Gazzaniga, Heatherton, & Halpern, 2015).

One normative decision theory, called expected utility theory, suggests that people will choose the option with the most utility or value to them after they have thought through the different alternatives (Von Neumann & Morgenstern, 1947). In people’s attempt to be rational, they may rank their options and weigh the options against each other to pick the option which they believe will have the most value to them (Von Neumann & Morgenstern, 1947). For instance, Sara works as a homeschool teacher and has applied for work at different schools since she wants to try to work in a different environment. Sara receives different job offers, such as temporary employment as a teacher at a school near her home, or a permanent employment as a teacher in a different town. When making the decision on which job to take, or whether to stay at the current job, Sara would rank and weight these alternatives against each other and choose the job which holds the most value to her. Thus, Sara would try to make a rational decision by estimating the expected value that each job might bring (Von Neumann & Morgenstern, 1947).

3.2.2. Descriptive decision theories. Instead of trying to explain how people should make decisions, descriptive decision theories try to explain what people end up deciding (Gazzaniga et al., 2009). According to these theories, even if people understand the possible outcomes of different options they often make irrational decisions, that is, people do not always choose the ideal or best option. Therefore, in this view, descriptive decision theories suggest that people may show biases in their decision making (Gazzaniga et al., 2015).
One example of a descriptive decision theory is the *prospect theory* (Tversky & Kahneman, 1992), which is a theory from the field of *behavioral economics*. Prospect theory suggests that people’s current state plays a role in their decision making (Tversky & Kahneman, 1992). State in this context would refer to the individual’s perceived status or position in life.

Prospect theory suggests that it is more important for people to choose an option which may lead to a smaller loss than to choose an option which would lead to some gain, thus it is more important to avoid losses (Tversky & Kahneman, 1992). Also, when people try to estimate these gains or losses, they compare their options to their current state (perceived status) despite how much or little wealth or resources that they may have. This is referred to as *reference dependence*, meaning, the outcome of the decision is evaluated due to the current state (perceived status) of the individual (Tversky & Kahneman, 1992).

Furthermore, prospect theory draws attention to another factor that plays a role when individuals make decisions, called *probability weighting*, which refers to the fact that people look at the probabilities of different choices in a subjective way (Tversky & Kahneman, 1992). For instance, if one knows beforehand what one might lose by picking alternative A which is a smaller loss when compared to alternative B, which may lead to an even greater loss, one would pick alternative A (Tversky & Kahneman, 1992). Also, when people look at the probabilities in a subjective way they may feel as if the difference between 0 and 50 euros is larger than the difference between 100 and 150 euros, even though the difference is the same.

Prospect theory tries to predict the pattern of how people will behave when making risky decisions (Tversky & Kahneman, 1992). The theory, therefore, implies that people tend to overestimate events that have a low chance to happen (i.e. low-probability events), such as winning the lottery. According to the theory, people act less cautious when dealing with low-
probability gains, such as with lottery tickets, and with high-probability losses such as betting on a horse over and over again with the hope that the horse eventually will win (Tversky & Kahneman, 1992).

On the other hand, people are said to underestimate events which are more likely to happen (i.e. high-probability events) (Tversky & Kahneman, 1992). This is so because people act cautiously when dealing with high-probability gains such as when buying a house, and for low-probability losses such as buying an insurance (Tversky & Kahneman, 1992). Thus, reference dependence and probability weighting together distinguish the prospect theory from the expected utility theory (Purves et al., 2012).

3.3. Reward and Value

It is important to understand how our brain processes reward and estimates value to understand the neural processes which are involved in our decision making (Gazzaniga et al., 2009). First, a reward can be divided into two categories, primary reinforcers and secondary reinforcers (Delgado, Jou, & Phelps, 2011).

3.3.1. Primary reinforcers. For instance, food, sex, and water are seen as primary reinforcers that directly concern our survival and thus have intrinsic value (Delgado et al., 2011). Our response or value to primary reinforcers can be said to be innate (with us from birth) or shaped by our experience (Delgado et al., 2011).

3.3.2. Secondary reinforcers. Rewards, such as status and money, are seen as secondary reinforcers and they have no intrinsic value per se, however, through their association with other types of reinforcement they become rewarding (Delgado et al., 2011). For instance, one can use money to access other rewards (Delgado et al., 2011).

3.3.3. Value. The concept of reward and value is a bit tricky since value has several components, which may be both external or internal, and are together evaluated subjectively by the individual (Gazzaniga et al., 2009). There are also several factors or components that
aid in our representation of value such as payoff, probability, effort or cost, context, and preference (Gazzaniga et al., 2009). For instance, let’s say that you are out in the woods for picking blueberries and mushrooms and you start to consider the factor of payoff. You might think of the options and rewards of your current location in the woods. For example if you stay you might get a handful of blueberries, but a whole basket of mushrooms. However, you start to think of the probability. Meaning, you consider the likelihood of attaining your reward since you wanted to pick both blueberries and mushrooms. If you start considering another picking spot, you might think of the effort or cost of moving, for instance, if you stay where you are you might get the mushrooms, however, if you walk for one hour you might get blueberries. In this factor of effort and cost, you also consider how long you are willing to wait to get your reward, which is referred to as temporal discounting. However, you might also start to consider the context which involves external factors such as what time it is, or you might consider internal factors such as if you are hungry. Lastly, you might consider your own preference, meaning, you might just be satisfied with the current spot for instance due to its scenery (Gazzaniga et al., 2009). Due to all these factors, which are involved in forming our subjective value, it is not unexpected that people might be somewhat inconsistent in their decision making, since how we look and respond to these factors may change by the hour (Gazzaniga et al., 2009).

3.4. Emotion and Decision Making

Most models of decision making look at the cost versus benefit outcome of a decision, meaning most models of decision making are based on logical principles from an economic and mathematical view (Sanfey & Chang, 2008). However, even if these models follow logical principles they tend to fail when it comes to describing how people end up acting (Sanfey & Chang, 2008).
Antonio Damasio with colleagues was in the early 1990s working with a patient referred to as E.V.R that had damage to his orbitofrontal cortex (Bechara, Damasio, Damasio, & Anderson, 1994). When the researchers studied patient E.V.R they found that he could come up with solutions to problems. However, he could not prioritize these solutions, leading him to have problems with making good decisions (Bechara et al., 1994). Observing E.V.R, along with observing patients with both orbitofrontal and ventromedial prefrontal cortex (vmPFC) damage, led Antonio Damasio to develop a theory concerning the role of emotion in decision making called somatic marker hypothesis (Damasio, 1996). The somatic marker hypothesis was put forward due to the connections which orbitofrontal cortex has with areas involved with emotion processing, such as the hypothalamus, amygdala, insular cortex and cingulate cortex (Damasio, 1996).

3.4.1. Somatic marker hypothesis. Within the somatic marker hypothesis, decision making is seen as a process which may be influenced by marker signals that are generated through bioregulatory processes (Bechara, Damasio, & Damasio, 2000). These marker signals are suggested by Bechara et al. (2000) to express themselves in the form of feelings and emotions. This is so because emotions may be expressed in our body through physiological arousal, and the outcome of a generated emotion is generally said to be expressed in the brain by temporary changes in the activity pattern of somatosensory structures (Bechara et al., 2000). Therefore these marker signals, generated by emotions, are referred to as somatic markers (Bechara et al., 2000). In other words, if we are facing a situation where we need to make a decision, the situation may lead us to react emotionally to it and the emotion, in turn, generates physiological arousal. The emotional reaction is therefore said to be expressed in our bodies as somatic markers, and these somatic markers are suggested to act as an important guide in our decision-making process (Bechara et al., 2000).
The somatic marker hypothesis is based on four main assumptions (Bechara et al., 2000). First, our ability to make decisions and reason depends on many levels of neural activity which may lead our reasoning and decision making to be expressed either by being cognitively conscious to us or outside our awareness (Bechara et al., 2000). Thus, the decisions we make may not always be within our awareness. Second, cognitive activity is dependent on different processes such as working memory, emotion, and attention and these processes act as support for decision making and reasoning (Bechara et al., 2000). Third, decision making and reasoning is dependent on our available knowledge of options, actions, situations, and their potential outcomes (Bechara et al., 2000). This type of knowledge is stored in a dispositional form in higher order cortices and some subcortical nuclei, meaning the knowledge is implicit and not organized topographically within the brain (Bechara et al., 2000). However, this type of knowledge may be made explicit in the shape of images or complex and varied forms of motor responses (Bechara et al., 2000).

Lastly, the fourth assumption namely that knowledge can be divided into three forms (Bechara et al., 2000). First, knowledge may be gained by personal experience or be innate when it comes to our bodily states, actions, bioregulatory processes and explicit emotions. Second, knowledge about actions, facts (such as rules), and objects tends to be made explicit in the form of images. Third, the vmPFC is suggested to link our bioregulatory states with our factual knowledge so that we can form associations (Bechara et al., 2000). Also, our bioregulatory states, which includes our emotional states, are said to be associated with previously experienced situations (Bechara et al., 2000).

The above means that when we find ourselves in a situation which is similar to one we have previously been exposed to, we might recall previously learned knowledge that in turn induces the relevant somatic markers. These somatic markers, which include musculoskeletal, endocrine, and autonomic changes, form a particular emotional state
(Bechara et al., 2000). For instance, if you are driving on a road and see a speed limit sign you might decide to slow down your speed. You decide to slow down your speed because you have the facts about what the speed limit is and you have previously received a speeding ticket on the same road which made you feel bad. Thus, the somatic marker may guide your behavior, in this case, you slow down the speed to avoid a ticket and to avoid feeling bad (Bechara et al., 2000).

Somatic markers are therefore said to aid in the process of decision making by acting as a rule of thumb that allows us to make good decisions effectively and without necessarily having to think through the options and their value in a logical way (Bechara et al., 2000). This is so because, within the somatic marker hypothesis, the reactivation of emotional states serves as the logical reasoning (Bechara et al., 2000).

To test some of the aspects of the somatic marker hypothesis, studies (e.g., Bechara, Damasio, Tranel, & Damasio, 1997) have used the Iowa Gambling Task (IGT). The aim of the IGT is to resemble situations which may occur in our real life. Such situations may sometimes be uncertain and the outcome of our decisions may either lead to punishments or rewards (Bechara et al., 2000).

In the IGT, the participant is handed play money and is told to make a profit by picking cards from four different decks (Bechara et al., 2000). From the card decks, named A, B, C, and D, the participant can draw one card at a time, from whichever deck he or she desires, and at any time. Furthermore, the decks yield different rewards and punishments, that is, different gains and losses. The participant is not told which deck is more advantageous, or that they are required to draw a total of 100 cards (Bechara et al., 2000). For instance, cards in deck A and B give 100 dollars per card, and cards in deck C and D give 50 dollars per card. However, the participant will encounter unpredictable losses regardless of which of the four decks he or she chooses to pick a card from because after every 10 cards picked from
each deck a loss will occur (Bechara et al., 2000). The loss or punishment is higher in decks A and B, and lower in the decks C and D. In every 10 cards picked from decks A and B, the subject will lose a total of 1250 dollars, and in every 10 cards picked from decks C and D the subject loses a total of 250 dollars. Thus, in the long run, decks C and D are more advantageous than decks A and B, since decks C and D will, in the end, lead to a gain of 250 dollars in every 10 cards, and decks A and B will lead to a loss of 250 dollars in every 10 cards (Bechara et al., 2000).

3.5. Studies of Emotion and Decision Making

In a study by Bechara et al. (1997), six participants with decision making abnormalities and with bilateral damage of the ventromedial area of the prefrontal cortex (these participants will be referred to as patients), and 10 participants without any brain damage (which will be referred to as normal participants) played the IGT. Skin conductance response (SCR) was measured in all participants while they played the IGT (Bechara et al., 1997). The participants were instructed as in the way described in the text above. Also, to explore the participant’s knowledge, reasoning and whether the participants understood the nature of the game before or after conceptualizing it, the researchers continuously assessed the participant’s performance during the whole play (Bechara et al., 1997).

According to Bechara et al. (1997), at the beginning of the game, and thus before encountering any losses, the participants did not generate any significant anticipatory SCRs and they preferred the decks A and B. It was only until the normal participants had picked around 20 cards and encountered some losses from the decks A or B that they began to generate anticipatory SCR (Bechara et al., 1997).

After the participants had drawn around 50 cards, the normal participants reported as if they felt that the decks A and B were riskier than decks C and D. At this stage and until the end of the game, the normal participants generated anticipatory SCR when they considered
picking a card from deck A and B. However, none of the patients had generated any anticipatory SCRs or reported that they felt decks A and B as risky at this stage (Bechara et al., 1997). It was only until the normal participants had picked around 80 cards that they reported knowledge about why decks C and D were more advantageous in the long run. However, three of the 10 normal subjects did not figure out the nature of the game, but still picked cards from the more advantageous decks C and D. On the other hand, three of the patients did figure out the nature of the game after they had picked around 80 cards, but even with the knowledge of the game, the three patients still picked cards from the disadvantageous decks A and B. Also, the patients did not generate any anticipatory SCRs during the whole game (Bechara et al., 1997).

The results in this study indicate that even though half of the patients did gain knowledge about the correct strategy and the nature of the game, they failed at making good decisions and did not generate any autonomic responses (Bechara et al., 1997). On the other hand, normal participants managed to make good decisions before they were aware of which decks were more advantageous. Also, the normal participants, before they were aware of which decks would lead to a risky outcome, generated anticipatory SCRs when they considered the disadvantageous decks (Bechara et al., 1997).

Bechara et al. (1997), suggest, due to the results, that two chains of events occur which are believed to interact and take place in parallel when we are in a situation in which we need to make a decision based on the sensory representation of the given situation. In one of the events, neural systems are activated and these neural systems are suggested to contain nondeclarative knowledge about similar situations that the individual previously has experienced as emotional. Also, the nondeclarative knowledge is believed to be held, among other areas, by the vmPFC (Bechara et al., 1997). These neural systems are suggested to be activated either because the situation itself triggers facts which the individual holds, or by the
sensory representation of the situation (Bechara et al., 1997). In other words, somatic markers are generated, which in turn, act as an unconscious support bias for the individual's cognitive reasoning and evaluation of the situation (Bechara et al., 1997).

In the other chain of events, the representation of the situation leads the individual to recall facts which are relevant to the given situation, such as previous outcomes of similar options (Bechara et al., 1997). With these facts, the individual may form strategies in relation to the different options which the situation may hold. Thus, the researchers suggest that the first event occurs outside the individual's awareness, being unconscious to the individual, and the other occurs within the individual's awareness, being conscious to the individual (Bechara et al., 1997).

A similar study by Li, Lu, D'argembeau, Ng and Bechara (2010), in which functional magnetic resonance imaging (fMRI) was used while healthy participants took part in IGT, points to the same direction, supporting the somatic marker hypothesis. According to Li et al. (2010), the findings from this study suggest the involvement of a neural network when participants play the IGT. For instance, the posterior cingulate cortex and insula formed representations of emotional states, the dorsolateral prefrontal cortex was activated for working memory and vmPFC and orbitofrontal cortex put the two previous processes together. Furthermore, the anterior cingulate cortex and ventral striatum were suggested to be engaged in forming behavioral outcomes (Li et al., 2010).

Also, in a study by Christakou, Brammer, Giampietro and Rubia (2009) where IGT was used along with fMRI, the researchers found a similar neural network to be activated in the performance of IGT. Nevertheless, the researchers do not believe that development of somatic markers is necessary for decision making. Instead, the researchers suggest that vmPFC and dorsolateral prefrontal cortex are involved in mediating us to make advantageous decisions over less advantageous decisions (Christakou et al., 2009).
Despite some support for the somatic marker hypothesis, the study by Bechara et al. (1997) has received some critique concerning the participant’s knowledge about the IGT (Maia & McClelland, 2004). According to Maia and McClelland (2004), somatic markers may not guide participant’s behavior in choosing advantageously since the participants may know more about the advantageous strategy within IGT earlier in the game than thought by Bechara et al. (1997).

To test their assumptions, Maia & McClelland (2004) repeated the study from Bechara et al. (1997) in two conditions by using normal participants and without measuring participant’s SCRs. In one of the conditions, the researchers used the same questions as in the old experiment, and in the other condition, the researchers used more detailed questions about the participant’s knowledge related to the IGT. Otherwise, the procedure of the IGT was the same. According to Maia & McClelland (2004), the replicated condition gave the same results as the study by Bechara et al. (1997). However, the other condition, which had more detailed questions, revealed that the participants had more knowledge about which strategy was more advantageous (Maia & McClelland, 2004).

Due to these results, the researchers suggest that participants are consciously aware of which strategy is more advantageous and that unconscious biases, in the form of somatic markers, do not guide the participant’s decision before the participants are aware, thus conscious, of the strategy. However, the researchers do still keep it as an open question whether conscious knowledge about the strategy played a role in the participant’s actual decisions since the participants reported knowledge about the IGT but did not always choose the most advantageous decks (Maia & McClelland, 2004).

In a study by Van’t Wout, Kahn, Sanfey and Aleman (2006), the researchers used a different decision task, called the Ultimatum Game (UG) (Güth, Schmittberger, & Schwarze, 1982), to investigate if emotional arousal may be related to decisions made in the UG by
measuring participants SCRs. In the UG the setting is socially interactive. This means that two participants interact in the decision task (Van’t Wout et al., 2006), as compared to the IGT, where there is only one individual at a time that participates (Bechara et al., 2000).

In the UG, two participants (players), must agree on a sum of money which is handed to them by the experimenter. One player acts as a proposer and the other player acts as a responder. The proposer’s task is to make a proposal concerning how the money should be split between the proposer and the responder. The responder’s task is to either accept or reject the proposer’s offer. Furthermore, there is only one round in which the proposer can make a proposal and the responder may only respond one time. This means there is no second round of the game if the responder rejects the sum of money offered by the proposer. The same applies if the responder accepts the sum of money offered by the proposer. In this case, the two players split the money accordingly to the proposer’s offer (Van’t Wout et al., 2006).

Within this study, 30 participants participated (18 females, 12 males) in which participants were told that they would only act as a responder after they had been instructed about the nature of the game (Van’t Wout et al., 2006). However, it was pointed out in the instructions that the participant’s partner (the proposer) in the UG would participate in the game independently. This means that there would be no new encounter with the proposer. Furthermore, the participants played a total of 20 rounds, in which during 10 rounds of the game a computer acted as a proposer, and during the other 10 rounds, a person acted as the proposer.

In each round, 5 euros were supposed to be divided between the proposer and responder. Also, the participants were told that they would be paid the money that was shared in each round. The participants were also paid 5 euros for their participation, with an additional 10% amount of the money they received in the UG (Van’t Wout et al., 2006). In 10
rounds of the game, money was offered to be split in half, 2.50 euros to each, and thus split fairly. In the other 10 rounds, the money was offered in an unfair way.

According to Van’t Wout et al. (2006), all the offers which were fair, thus split in half, were accepted by the participants. However, not all of the unfair offers were accepted. Also, the participant acceptance rate decreased the more the offers became unfair. Moreover, 47.22% of the participants rejected unfair offers given by the computer proposer. However, the rejection was higher when there was a person proposing unfair offers, in which 60.56% participants rejected the unfair offers. The participants generated higher SCRs in unfair offers when compared to fair offers.

The findings in this study suggest that increased emotional arousal was experienced by the participants when they encountered unfair offers compared to fair offers (Van’t Wout et al., 2006). Moreover, emotional arousal was related to rejecting unfair offers when the unfair offers were given by a human proposer. Thus, due to the results, the researchers suggest that emotional arousal plays an important role in decision making (Van’t Wout et al., 2006).

The next chapter will cover emotion regulation along with investigating to what extent emotion regulation may influence our decision making.

4. Emotion Regulation

How we regulate our emotions is of importance since emotions and well-being go hand in hand (Gross, 2014). Even though emotions can be helpful to us, they can also be maladaptive, especially when the wrong type of emotions flourish for too long and are too intense for the ongoing situation (Gross, 2014). Therefore, it is important that we try to regulate our emotions, particularly when they are of the wrong type (Gross, 2014).

Thompson (1994) defines emotion regulation as the intrinsic and extrinsic processes that are responsible for evaluating, monitoring, as well as modifying emotional reactions to
reach one’s goal. Gross (1998) offers a similar definition of emotion regulation and explains it as a process where individuals can impact their emotions, meaning, which emotions they have and when they have them, and also how they express and experience their emotions. In other words, emotion regulation refers to the regulation of emotions rather than what is regulated by emotions (Gross, 2014). These processes of emotion regulation can be either controlled or automatic, thus, they may be conscious or unconscious to us. According to Gross (2014), when emotion regulation is defined in this way, many different types of activities can be counted as emotion regulation, such as going for a walk to calm down after a stressful day or calling a friend to cheer yourself up. Gross (2014) therefore implies that it is important to describe the central features of emotion regulation.

4.1. Central Features of Emotion Regulation

There are three central and common features of emotion regulation (Gross, 2014). The first is focused on modifying the emotion-generative process, that is, *activation of a goal*. The activation of a goal can be regulated either intrinsically (in oneself) or extrinsically (in someone else), however, they can also co-occur (Gross, 2014). One example of intrinsic emotion regulation would be that Sara regulates her own emotions, but if Sara tries to regulate Adam’s emotions it would be extrinsic emotion regulation. However, if Sara was to regulate Adam’s emotions to calm herself down, it would be a co-occurrence of both intrinsic and extrinsic emotion regulation.

The second central feature of emotion regulation involves the processes that *give rise to the emotion trajectory* (Gross, 2014). The emotion trajectory may be interpreted as the processes through which the emotion is regulated. For instance, there can be different ways to regulate emotions and they can vary between being *implicit* (unconscious) and *explicit* (conscious) (Gross, 2014). Implicit emotion regulation can be seen as an automatic process since it would occur outside our conscious awareness. On the other hand, explicit emotion
regulation can be seen as a controlled form of emotion regulation since the emotion is regulated within our awareness (Gross, 2014). An example of implicit and automatic emotion regulation, and thus outside conscious awareness, would be looking the other way when someone is typing their credit card code. An example of explicit, and thus, conscious emotion regulation would be trying to talk in a calm way to an angry customer even though we might be stressed. Thus, the second central feature of emotion regulation concerns strategies and processes (implicit or explicit) that are used and activated in order to reach some desired goal (Gross, 2014).

The third central feature of emotion regulation involves influencing the dynamics of emotion regulation, or in other words, the magnitude, rise time, duration, latency, and offset of responses in behavioral, physiological or experiential systems (Gross, 2014). Depending on which goal that has activated the individual, emotion regulation can affect the dynamics, such as the magnitude, latency, duration, etc., of the emotional outcome in the way that the dynamics may be decreased or increased (Gross, 2014). For example, if emotion regulation is used in a way that decreases the dynamics of the emotion as it unfolds, then the individual might respond to the emotion physiologically. However, the individual might not show this to the outside world. This means that the result of the emotion may occur without being noticeable to others that are observing the individual (Gross, 1998). Thus, the third central feature of emotion regulation concerns the outcome and consequences of the chosen strategy used to reach the activated goal (Gross, 2014).

4.2. Emotion Regulation Strategies

As mentioned earlier, different things can count as emotion regulation strategies and therefore Gross and Thompson (2007) distinguish between five different types of emotion regulation strategies. These five strategies are distinguished by when they have the most influence on the emotion-generative process.
The first strategy of emotion regulation in the family of five, *situation selection*, is the most future-oriented approach. It involves the actions an individual makes when he or she is facing a situation. One can either take actions to avoid or approach a given situation, with the purpose of influencing desired or undesired emotional outcomes (Gross & Thompson, 2007). For example, one might not take the car for a drive when it is rush hour in traffic, with the purpose of avoiding the anxiety that they suspect they will feel if doing so. Situation selection may be used either as intrinsic or extrinsic emotion regulation. However, it may be hard to predict exactly how oneself or another individual might feel when encountering the situation (Gross, 2014).

The second emotion regulation strategy is called *situation modification* and involves modifying the external features of a situation in order to change its emotional effect (Gross & Thompson, 2007). In this strategy, the efforts are made directly to the given situation, and not beforehand, as would be expected in situation selection. Situation modification does not involve modifying the internal features such as cognition. Instead, it involves modifying the external environment, meaning, the physical environment (Gross & Thompson, 2007). For example, one might hide his or her diary when a friend is visiting, so that the diary is not out in the open for the friend to see.

So far, the two above described strategies concern changing the external environment. However, the third emotion regulation strategy *attentional deployment* involves the individual’s use of attention to influence their emotions in an ongoing situation (Gross & Thompson, 2007). Thus, attentional deployment, in contrast to situation selection, may be seen as an internal emotion regulation strategy (Gross & Thompson, 2007).

There are two forms of strategies within attentional deployment, *distraction* and *concentration* (Gross & Thompson, 2007). Within distraction, the individual moves their attention away from the situation (Gross & Thompson, 2007), such as looking the other way
when something disturbing appears on the TV-screen. Also, individuals may focus their attention on different aspects of the ongoing situation or change their internal focus in order to increase or decrease the emotional outcome (Gross & Thompson, 2007). For instance, when changing the internal focus, one might listen to calming music to distract oneself from being nervous when sitting in the waiting room at the hospital. Concentration is another type of attentional deployment and involves drawing attention to features that are emotional within a given situation (Gross & Thompson, 2007). In other words, the individual chooses what to mentally focus on (Gross & Thompson, 2007). For example, when standing on a rooftop, the individual might be frightened of heights, and may choose not to look down, but instead concentrate on their breathing in order to regulate the ongoing emotion. However, according to Gross (2014), distraction is one of the more common emotion regulation types that is used within attentional deployment.

According to Gross & Thompson (2007), the fourth emotion regulation strategy, cognitive change, involves changing the meaning of a situation by altering how we appraise a particular situation we are in with the goal to affect the emotional significance of the situation. We can change the meaning of the situation either by changing how we think about the situation or about our ability to handle the situation (Gross & Thompson, 2007). Sara might feel she did badly on an exam and tell herself that she did the best she could in order to calm down and regulate her emotion about the situation. However, if Sara feels that the exam will be hard to pass before she has opened the exam sheet, she could tell herself that she holds the ability to pass the exam since she has studied hard beforehand.

Cognitive change may be used in two ways, either to regulate an ongoing emotional response or to generate an emotional response in the absence of one (Ochsner & Gross, 2005). One type of cognitive change is reappraisal which refers to changing the meaning of a situation with the goal to alter the impact of the emotion (Gross & Thompson, 2007). For
instance, seeing a picture of a wounded animal in a cage may generate negative emotions, but by reappraising the situation, one might change the meaning of the situation into that the animal has been rescued and on its way to receive help, thereby generating positive emotions.

The last emotion regulation strategy in the family of five is response modulation and occurs late in the emotion-generative process, thus, after an emotion has been triggered (Gross & Thompson, 2007). Response modulation refers to directly affecting the behavioral, physiological or experiential components of a triggered emotion. In order to target a physiological or experiential component, drugs may be used, such as if one suffers from anxiety (Gross & Thompson, 2007). On the other hand, relaxation techniques and exercise may be used to decrease the negative emotion that may occur within the physiological or experiential components of emotions. Other things that may be used to modify the experience of the triggered emotion are, for instance, nicotine, food, and alcohol (Gross & Thompson, 2007).

To regulate behavioral components of emotional responses, we may hide our emotions by not expressing them with our face, such as not expressing fear when talking to our boss even though we might be afraid (Gross & Thompson, 2007). One form of response modulation, expressive suppression, involves trying to inhibit an ongoing expressive behavioral response which may be caused either by a positive or negative emotion (Gross, 2014).

Cognitive reappraisal (cognitive change) and distraction (attentional deployment) are the two types of emotion regulation strategies that are well-studied. Both are thought to affect the emotional response early in the emotion-generative process (Paul, Simon, Kniesche, Kathmann, & Endrass, 2013). Thus, both cognitive reappraisal and distraction are said to be antecedent-focused, that is, before the emotional response starts, rather than response-focused strategies, which tend to focus more on modulating the actual emotional response (Paul et al.,
However, distraction is thought to influence the emotion-generative process earlier than cognitive reappraisal (Paul et al., 2013).

4.3. Studies of Emotion Regulation and Decision Making

Emotions can affect our decision-making process in different ways, such as when we consider and evaluate different options and their possible outcomes (Grecucci & Sanfey, 2014). Hence, it is generally accepted that emotions play a role in human decision making (Heilman, Crișan, Houser, Miclea, & Miu, 2010). One way which has been used to look at how cognition and emotion interact is to apply emotion regulation strategies to decision-making tasks, in order to see if emotions may affect the decision made by individuals (Van’t Wout, Chang, & Sanfey, 2010).

Two studies were made by Heilman et al. (2010), in an attempt to investigate whether the emotion regulation strategies reappraisal and expressive suppression would influence decision making. The researchers used the IGT and one other economic game called the Balloon Analogue Risk Task (BART) (Lejuez et al., 2002) to test decision making under uncertainty and risk.

BART can be used to measure decisions made under risk, by letting the participants pump balloons which are presented on a computer screen and from which the participant can earn money. The balloons have different exploding thresholds and once a balloon explodes, the money which may have been earned in the balloon is lost (Lejuez et al., 2002).

In the first study, the researchers’ successfully induced two negative emotions, disgust and fear, by letting 60 participants (56 females, 4 males) watch two short movie clips which would induce such emotions. Participants were also instructed to either suppress, reappraise or none of the two while watching the movies. The participants were divided into six groups based on which emotion regulation strategy they were supposed to use, or not use, and type of movie they would watch. The researchers also took pre – and post-tests of the participants’
emotions and they controlled that the participants had used the instructed emotion regulation strategy. Afterward, the participants completed computer versions of both IGT and BART (Heilman et al., 2010).

According to Heilman et al. (2010), the results from the first study indicated that the participants which had used reappraisal showed a decrease in their experience of disgust and fear when compared to the control group (those who did not use any emotion regulation strategies). However, a decrease in the emotions disgust and fear was not shown in the group that used suppression (Heilman et al., 2010). In general, the first study indicated that reappraisal may increase risk-taking decisions in BART since more balloons were pumped when participants had used reappraisal. Also, reappraisal was associated with performance on the IGT, the participants were able to figure out the nature of the game much earlier and therefore they also gained more profit in the IGT (Heilman et al., 2010).

In the second study, the researchers tested if naturally occurring emotions, including both positive and negative emotions, along with the emotion regulation strategies suppression and reappraisal would influence decision making. In this study, 44 students (33 females, 11 males) participated (Heilman et al., 2010). Several days before the experiment took place all the participants had completed their final exams. Due to this, the participants were instructed to report their self-evaluations on how important they felt the exam was along with their performance (Heilman et al., 2010). The students were asked to participate in the experiment immediately after they had found out their result on the exam. Also, the researchers investigated if the students had used any of the two emotion regulation strategies due to knowing their exam result. The participants played the IGT and BART after the researchers had checked for emotion regulation strategies and assessed the participants’ emotions (Heilman et al., 2010).
The results from the second study indicated that the type of emotion regulation strategy used by participants had an effect on both negative and positive emotions (Heilman et al., 2010). Again, the participants which had used reappraisal reported a decrease in negative emotions when compared to the control and suppression group. Also, participants which had used reappraisal and those which used suppression reported a decrease in positive emotions when compared to the control group. In general, the second study indicated that negative emotions which occurred naturally increased the participant’s risk-taking in BART, however, when reappraisal was used incidentally, risk-taking was hindered in BART and better performance was observed in the IGT. Furthermore, positive emotions seemed to reduce risk-taking (Heilman et al., 2010). The researchers suggest, from the results of the two studies, that the emotion regulation strategy reappraisal may influence risk-taking attitudes, in the way that when negative emotions are reappraised this may enable individuals to make riskier decisions in BART and allow for better performance in the IGT (Heilman et al., 2010).

In another study by Martin & Delgado (2011), the researchers investigated if imagery focused emotion regulation could influence participants’ decision making under risk. Furthermore, the researchers also investigated if the striatum was involved in processing reward by using fMRI.

Within this study, 30 participants (15 females, 15 males) participated in which the participants had to make a decision, either to choose between picking a safe choice, which would lead to a guaranteed reward, or a risky choice, which was more of a gamble concerning reward. Since the nature of the task concerned financial decisions the participants had to choose between two monetary lottery options, where one lottery option was safe and the other risky, and while lying in a fMRI scanner. Also, the participants did not find out their outcomes immediately after their decision (Martin & Delgado, 2011).
According to Martin & Delgado (2011), three conditions concerning imagery focused emotion regulation strategies were used, one was to Relax, in which participants were instructed to imagine a peaceful scene. The second strategy was referred to as Look, in which participants were instructed to just respond naturally to the task, thus to think about the decision which would come. The last strategy was referred to as Excite, in which participants were instructed to imagine a scene that was exciting to them, such as a roller coaster ride. The participants made their choice of risky and safe monetary lottery after they had used the instructed regulation strategy (Martin & Delgado, 2011).

The participants which used the Excite strategy did not show any difference in their decision making concerning risky and safe choices (Martin & Delgado, 2011). However, the participants which used the Relax strategy did manage to influence decision making. This is so because those participants made less risky decisions, as when compared to the participants which did not use any strategy (Look strategy) (Martin & Delgado, 2011).

Furthermore, responses in the brain region striatum decreased when participants used the Relax strategy compared to participants which were instructed with Look strategy (Martin & Delgado, 2011). This is interesting since it is suggested that the striatum could be associated with making risky decisions (Martin & Delgado, 2011). According to Martin and Delgado (2011), the results of the study imply that emotion regulation strategies may influence humans in making less risky decisions and thus it may promote more goal-directed behavior. Also, that emotion regulation strategies may influence the neural responses such as in the striatum when it comes to reward-processing (Martin & Delgado, 2011).

In a study by Van’t Wout et al. (2010), the researchers also investigated if the emotion regulation strategies suppression and reappraisal would affect participants’ behavior in the decision task UG. Within this study, 50 participants (38 female, 12 male) participated in the UG. However, two participants were excluded from the UG since they had difficulties using
the emotion regulation strategy reappraisal and suppression (Van’t Wout et al., 2010). Also, participants acted both as proposer and responder with the same partner in each round of the UG. The total amount of money in the pot for each round was 10 dollars and the game was played on a computer. Furthermore, the UG was played 24 for a total of 24 rounds, where each participant played the game for two rounds, with a new partner each time (Van’t Wout et al., 2010). The participants were divided into two regulation conditions and one control group, one group contained participants that were instructed to use suppression and the other group of participants used reappraisal. When playing the UG, participants were instructed to use the given emotion regulation strategy or play without any strategy. After the participants had ended the experiment they were asked to rate how upset they had felt when they had received unfair offers (Van’t Wout et al., 2010).

According to Van’t Wout et al. (2010), the results from the study showed that participants which had used reappraisal as emotion regulation strategy, when acting as a responder, also accepted more unfair offers, compared to when none emotion regulation strategy was used. Moreover, when the participant’s acted as a proposer to the same partner which had made an unfair offer to them previously, and along with regulating their emotions with reappraisal, they made more generous offers compared to the suppression group (Van’t Wout et al., 2010). However, when participants used suppression, no influence on decision making was shown. The researchers suggest due to the results that reappraisal may influence economic decision making in social interactive situations (Van’t Wout et al., 2010).

In an attempt to extend the behavioral results from the previously described study, Grecucci, Giorgetta, Van’t Wout, Bonini and Sanfey (2013), used a similar procedure as Van’t Wout et al. (2010), but with two main differences. For instance, Grecucci et al. (2013) also applied fMRI to explore the neural level of emotion regulation in interpersonal decision making.
Within this study, 21 participants participated (11 male, 10 female), and when participants played the UG, they did so while lying in a fMRI scanner (Grecucci et al., 2013). Furthermore, the researchers investigated whether up- and down-regulation of negative emotions would affect the participant’s decision making. For instance, when participants were instructed to up-regulate, they were supposed to reappraise the intention of the proposer as more negative. On the other hand, when they were instructed to down-regulate, they were supposed to reappraise the intention of the proposer as less negative. There was also another instruction referred to as Look, in which participants were allowed to perceive the situation as they wanted (Grecucci et al., 2013). By investigating up- and down-regulation of negative emotions, the researchers were able to examine if the negative emotions, caused by unfair offers, could be reduced or enhanced due to the regulation strategies. The researchers could also investigate if the instructed regulation strategy would affect the participant’s offer when he or she, later on, acted as proposer (Grecucci et al., 2013).

The results indicated when compared to the Look condition, that more unfair offers were accepted when participants used down-regulation as a strategy, which in turn also led to a decrease in unfair offers proposed later when the roles changed (Grecucci et al., 2013). Also, when comparing the Look condition to the up-regulation strategy, more unfair offers were rejected, but also more unfair offers were proposed when the roles changed (Grecucci et al., 2013). The results from the fMRI showed activation at the neural level in the middle and inferior frontal gyrus when participants used reappraisal (Grecucci et al., 2013). Moreover, when the offers where unfair, activation in the cingulate gyrus and medial prefrontal cortex was observed. Furthermore, when participants used up-regulation as a strategy, activity in the left inferior frontal gyrus was observed. On the other hand, when participants used down-regulation as a strategy, activity was observed in the middle frontal gyrus (Grecucci et al., 2013). Another difference between up- and down-regulation was observed in the posterior
insula. When using up-regulation, more activity was observed in this area, as compared to down-regulation (Grecucci et al., 2013). Thus, the researchers suggest, due to the results that reappraising the situation may influence both the behavior in decision making and the neural activity (Grecucci et al., 2013).

5. Discussion

The aim of this thesis was to investigate to what extent the use of emotion regulation strategies can influence our decision making, along with investigating the neural systems involved. In order to reach the aim and to give the reader an understanding of emotion, emotion regulation, and decision making some background information about these topics have been presented. It is clear from the presented theories of emotion that there are some different views on how emotions may be defined and generated. In general, they all seem to agree that emotions consist of three components, such as experiential (labeling a feeling), physiological reaction, and a behavioral response (Ochsner & Gross, 2005).

Turning to decision making, researchers seem to agree on that emotions may affect our decision making (Grecucci & Sanfey, 2014) as seen in the studies which support the somatic marker hypothesis (Bechara et al., 1997; Li et al., 2010). Even though there is some disagreement around somatic markers and decision making (Christakou et al., 2009; Maia & McClelland, 2004), it seems as if the vmPFC, in particular, is of importance when it comes to our ability to make decisions (Christakou et al., 2009; Li et al., 2010). However, it is safe to say that the process of decision making is still somewhat complicated, since we may have the facts about what would be the best option to choose, but we may not always make decisions based on our knowledge (Bechara et al., 1997; Maia & McClelland, 2004).

We can argue from the presented studies of emotion and decision making that emotional arousal is likely to be involved in our own decision making, as well as in socially interactive settings. This is so because increased emotional arousal was observed when
participants encountered disadvantageous options in the IGT (Bechara et al., 1997) and when participants received and rejected unfair offers in the UG (Van’t Wout et al., 2006). These generated SCRs are interesting since they may indicate that emotional arousal may influence decision making. However, what role these findings actually play in our decision making seems a bit unclear and this could be something for future research to investigate deeper. For instance, emotion regulation strategies could be applied in future research concerning emotions and decision making to investigate if there would be differences within generating SCRs responses.

Turning to emotion regulation, reappraisal seems to be more efficient in decreasing negative emotions than suppression (Heilman et al., 2010). This difference in regulating emotion is not surprising since reappraisal and suppression have different functions. This is so because the function of suppression is not to decrease negative emotions (Thompson, 1994), which the function of reappraisal is (Gross & Thompson, 2007). Therefore one limitation of the presented studies within this thesis is that they only compared reappraisal and suppression. This is can be seen as a limitation, both of the thesis itself and the presented studies, because these two strategies have different functions. Moreover, these two emotion regulation strategies are also suggested to affect the emotional response at different stages within the emotion-generative process (Gross, 2014; Paul et al., 2013).

Looking at emotion regulation and decision making, it is not surprising that the thesis, in general, indicates that emotion regulation influences decision making to some extent. This is so because the above discussed sections clearly indicate that we may influence our emotions by regulating them, but also that emotions themselves may affect our decision making.

The thesis has shown that reappraisal seems to influence decision making in two ways. In BART riskier decisions were made, however, in IGT participants managed to choose
decks more advantageously (Heilman et al., 2010). This difference could be due to the nature of the two tasks since within IGT the participants can figure out the most advantageous strategy (Bechara et al., 2000), however, within BART, there is no strategy per se (Lejuez et al., 2002). Furthermore, imagery focused emotion regulation, in the form of imagining a peaceful scene, may lead to making less risky decisions (Martin & Delgado, 2011). Thus, we may therefore argue that regulating our emotions, in relation to the situation itself (Heilman et al., 2010; Van’t Wout et al., 2010), or to a situation which is not related to the task at hand (Martin & Delgado, 2011), may influence our decision making to some extent.

On the other hand, suppression does not seem to influence decision making. This could be due to that suppression is a response-focused emotion regulation strategy, whereas reappraisal is an antecedent-focused emotion regulation strategy. Research has also indicated that response-focused strategies, compared to antecedent-focused strategies, could have a negative effect on human well-being and are less effective in altering ongoing emotional experiences (Moore, Zoellner, & Mollenholt, 2008). Therefore, suppression may be less effective in influencing decision making. This leads to another question that future research might investigate. Which is, we might first need to distinguish between the effect of positive and negative emotions on decision making. By doing so we might gain a better understanding of which emotion regulation strategies that might have the most influence on decision making.

Looking at the neural level of emotion and decision making, several brain regions seem to be involved in mediating advantageous decisions, such as the vmPFC (Christakou et al., 2009; Li et al., 2010). In addition, an activated neural network was observed when participants played the IGT, including areas such as the posterior cingulate cortex and the anterior insula (forming representations of emotional states), and dorsolateral prefrontal
cortex (for working memory) in which vmPFC is suggested to put these processes together (Li et al., 2010).

The vmPFC may well play an important role in mediating the neural systems of emotional states and working memory in order to enable decision making. This is so because activations in the anterior cingulate cortex and the ventral striatum have been observed in relation to behavioral outcomes in the IGT (Li et al., 2010). This, in turn, is interesting since participants with bilateral damage of the ventromedial area of the prefrontal cortex failed at making advantageous decisions in the IGT (Bechara et al., 1997). Furthermore, some of the participants with damage to the ventromedial area of the prefrontal cortex figured out the nature of the game in IGT, but nevertheless, failed at making advantageous decisions (Bechara et al., 1997). The ventromedial prefrontal cortex seems not only be important in decision making but also within emotion regulation. This is so because activation in the ventromedial prefrontal cortex was observed when participants used the emotion regulation strategy reappraisal (Grecucci et al., 2013).

It is clear from the presented fMRI studies that different neural systems are involved in emotion regulation and decision making. For instance, responses within the striatum decreased when participants made less risky decisions, along with using reappraisal in the form of the imagery focused emotion regulation strategy Relax (Martin & Delgado, 2011).

Neural changes were also observed when up- and down-regulation of emotions influenced decision making (Grecucci et al., 2013). Overall when reappraisal was used, within the UG, activations in the gyrus and the medial prefrontal cortex was observed, however, with some differences (Grecucci et al., 2013). For instance, when up-regulation was used, activity in the left inferior frontal gyrus was observed, and for down-regulation, activity was observed in the middle frontal gyrus. Also, more activity was observed within the posterior insula when up-regulation was used. On the other hand, when offers were unfair,
activation in the cingulate gyrus and medial prefrontal cortex was observed (Grecucci et al., 2013). This is interesting, because this finding may indicate that the medial prefrontal cortex may be important for forming an understanding of good and bad decisions. This is so because participants with damage to the ventromedial area of their prefrontal cortex failed at picking the more advantageous decks in the IGT (Bechara et al., 1997), and activations in the cingulate gyrus and medial prefrontal cortex was observed to be associated with unfair offers (Grecucci et al., 2013).

6. Conclusion

In conclusion, this thesis has shown that regulating our emotions influences our decision making to some extent. This is so because it seems as if reappraisal may influence our decision-making behavior in different ways depending on the task at hand. For instance, reappraisal may lead to less-risk taking and may promote goal-directed behavior but also to increased risk taking. However, reappraisal may also influence our decision making in the way that we make more advantageous decisions. Thus, depending on the situation, reappraisal may influence our decision making in different ways and this difference could be something for future research to investigate.

This thesis also had the aim of investigating how the process of emotion regulation and decision making plays out at the neural level. In this view, the thesis has shown that there may be differences at the neural level, depending on the situation and how emotions are regulated. This is so because the situations and how emotions are regulated seems to influences the neural activity in different ways. For instance, decreased activity in the striatum was associated with making less risky decisions when participants used reappraisal in the form of imagery focused emotion regulation. On the other hand, reappraisal seems to influence activity in the cingulate gyrus and medial prefrontal cortex when individuals are faced with unfair offers.
However, it would be interesting if future research investigated more different emotion regulation strategies, both antecedent- and response-focused strategies, in relation to decision making. Doing so, might also give a better understanding of how emotion regulation influences our decision making. This is so because no differences were observed in decision making when participants used suppression as emotion regulation strategy. Therefore, more research on emotion regulation and decision making could also allow for practical implications in the future. Which, in turn, might help people to make better decisions, or help those who may have trouble with goal-directed behavior.

In all, given the presented studies within this thesis, decision making and emotion regulation are important topics for future research to investigate deeper, along with their neural correlated networks. This is so because both are encountered daily in people’s life, whether it concerns decisions such as healthy food, or more importantly, where to live.
References


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