The Impact of Emotional Cues on Decision-Making and the Additional Influence of Stressful Situations

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Abstract

The purpose of this study was to test the somatic marker hypothesis (SMH) by systematically manipulating emotional contexts by using an altered version of the Iowa Gambling Task (IGT). This modified decision-making task presented happy or sad abstract faces in the feedback stage of the IGT, where the emotional valence of the face was either congruent or incongruent with the feedback delivered. A conceptual replication of the existing literature is demonstrated in this study, while further investigating the effects of acute stress on decision-making under risk conditions. In order to test the effects of incidental acute stress and emotional context congruency on IGT performance, this study used a 2X2 design (experimental congruent, experimental incongruent, control congruent, control incongruent). Acute stress was induced on experimental subjects using the paced serial auditory addition test (PASAT-C). Interestingly, the research revealed that emotions caused by the stress task elicited intrinsic emotions and cognitive resources relevant to the IGT task. These intrinsic emotions were found to benefit performance in the experimental condition when the emotional context was congruent ($p<.01$), however performance was impaired in the incongruent emotional context, caused by a disruption in the creation of somatic markers during feedback processing. Explanations for these paradoxical findings are discussed in relation to the cognitive resources evoked by the PASAT-C, which may have benefitted the decision-making process. It is important to further explore the influence of stress on emotion-based learning because often decisions have to be made under suboptimal conditions such as distraction by unrelated tasks or stressful situations.

Keywords*: somatic marker hypothesis, Iowa Gambling Task, emotional context congruency, incidental emotions, acute stress*

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Abbreviations

- **SMH –** Somatic Marker Hypothesis
- **SM –** Somatic Markers
- **IGT-** Iowa Gambling Task
- **PASAT-C-** Paced Auditory Serial Addition Task
- **GSR-** Galvanic Skin Response
- **SCR-** Skin Conductance Response
- **HR-** Heart Rate

Introduction

In everyday life, making decisions based on the probability of future outcomes is routine. We are regularly confronted by situations where a choice must be made from several alternative options. Sometimes the outcome of each option is known before making the decision, but more often individuals are forced to make a choice not knowing the potential outcomes, resulting in levels of risk, or ambiguity. Extensive research on the science of emotion has outlined the beneficial effects of intrinsic emotions on decision-making which are referred to as somatic states (Bechara, Damasio & Damasio, 2000). When making a decision, people can rely on these affective signals to guide towards advantageous outcomes. A post-decision feedback manipulation test is performed here to test the reliability of this phenomenon, whereby the emotional context received after a punishment or reward during ambiguous decision-making is disrupted. The main assumption is that the emotional context incongruent with the feedback received would interfere with the creation of affective signals to guide optimal decision-making. However in everyday life decisions are commonly made while being occupied with many other exterior factors, often characterized as stressful situations. Based on empirical evidence of the association between emotions and information processing (Clore, Schwarz & Conway, 1994) the main aim to explore here is whether people process emotional feedback cues more readily in a decision-making task when an acute stressed mood state is induced.

Neuroanatomical and cognitive framework for decision-making

Economic research aiming to describe the rules that control human decision-making is expanding its focus beyond simple cost-benefit analysis. The assumptions of traditional economic theories were based primarily upon the rational Bayesian maximization of expected utility. The significance of this theory was in the relationship that existed between knowledge and performing behavioural decisions; that "one does what one knows", (Naqvi, Shiv & Bechara, 2006). During the 1970's and 1980's there was a shift in the research that violated these normative assumptions of economic behaviour, and in the 1990's, implicit emotions and bias became an influential factor to all forms of decision-making, especially during ambiguous and risk-taking situations (Hastie & Dawes, 2011).

In recent decades, decision-making has become an area of particular interest to neuroscientific researchers, as they have begun to explore the neural processes behind why individuals make successful and unsuccessful decisions. This research has converged with previous economic theories by suggesting that decision-making involves not only the calculation of expected utility based on conscious explicit knowledge of consequences, but also covert (unconscious) processes resulting from the influence of affective signals in guiding thought processes. One specific neurobiological theory of decision-making is of particular relevance here, known as the somatic marker hypothesis (SMH), which suggests that emotional (somatic) states bias decision-making towards optimal performance; minimizing disadvantageous choices and maximizing advantageous outcomes.

The orbitofrontal cortex is the most critical structure of the neural system necessary for optimal cognitive processing during decision-making. However, decision-making is not mediated through this structure alone; other cortical and subcortical components such as the amygdala, the somatosensory/insular cortices and the peripheral nervous system also play a primary role.

A driver of research in this area was a series of studies carried out by Antonio Damasio on patients with impairments in the ventromedial sector (vmPFC) of the brain, resulting in profound disruptions of social behaviour. While the intellectual abilities of these patients would be fully intact, they would be unable to adapt to social conventions, or choose advantageously in decisions relating to their own personal lives. It was observed that these individuals were unable to react to emotional circumstances, suggesting abnormalities in their cognitive processing of emotions and feelings. This led to the formulation of the underlying theories of the SMH, while Damasio hypothesised that this impairment in vmPFC damage patients was caused primarily by their inability to rely on affective signals to guide decision -making, especially in instances of uncertainty. Somatic states are exposed through physical cues as well as activity patterns in somatosensory structures. An important result was obtained from an automatic index of emotional arousal in these vmPFC patients, measured by skin-conductance response (SCR) during a decision-making task. Bechara, Damasio, Tranel and Damasio (1997) demonstrated that normal subjects elicited larger SCR's when deciding on a choice that resulted in a punishment than when choosing a reward outcome. VmPFC patients had intact SCR's in response to both disadvantageous and advantageous outcomes, but they could not anticipate these responses to enhance future performance. Since SCR's represent physiological indices of an automatically controlled affective state, the anticipation of emotional influence for future outcomes of decisions can thus be seen as a role of this region of the brain. In other words, it connects the facts of a given situation with the emotion previously paired with it during earlier exposure to the same situation. These potential linkages are so called "dispositional", because they do not explicitly declare the emotional states, instead the affective signal experienced by that behaviour in the past is re-enacted by acting on the appropriate cortical and subcortical structures (Damasio, 1989).

Emotional and bodily states respond to outcomes of reward or punishment resulting from a decision, triggered by activation in the amygdala. Not only are these dispositions elicited by the body in motor terms; they are also represented through sensory imagetics, which are activated by associated higher order cortices. There are two different ways in which this can occur. At the cortical level, inside the insular cortex, the mapping of these bodily states leads to reliance on affective reactions often known as conscious "gut" feelings, which are attributed towards different response options. In contrast, at the subcortical level, this non-conscious approach follows a pathway within the mesolimbic dopamine system, whereby individuals choose advantageously in the absence of emotional desire for that choice. Sanfey, Rilling, Aronson, Ny-strom & Cohen (2003) found that the volume of activation in the insular cortex is directly linked to the possibility of refusing to accept an unfair offer of money. Thus the insular cortex may serve a significant function in determining risk and influencing behaviour based on anticipating emotional cues from potential outcomes, and this is especially the case for negative emotional consequences of behaviour. The mesolimbic dopamine system plays a vital role in decision-making, as Schlutz, Dayan & Montague (1997) demonstrated by showing that an error signal occurs between the actual reward and the previously predicted reward, and further, that this signal can moderate a bias towards advantageous decision-making in the future. When these higher-order cortices are activated by emotional dispositions where factual aspects have been previously classified, recall of these facts experienced by imagetic form is necessary. Ventromedial prefrontal linkages and emotional dispositions are also activated, and this effort of combined behaviour is the process of reconstructing a previously learned factual-emotional set. The soma change as a result of this reactivation process, and then these changes are transmitted further to the somatosensory cortices via a "body loop". In contrast, an "as if body loop" also exists, whereby the body is bypassed and signals are relayed to somatosensory structures, following patterns appropriate to the situation. This idea of the "as if body loop" is consistent with the view of Rolls (1999) that the only function of bodily signals during the decision-making process is to produce noise. Each of these complex processes can remain covert (unconscious) where the somatic state acts as an incentive signal, or can become overt (conscious) where the somatic state establishes a biasing signal. Specific outcomes of option pairs can be quickly rejected so that other facts that that are linked to more relevant situations can be processed more efficiently. Thus the SMH acts as a constraint mechanism leading to more efficient logic decision-making based on the probable outcomes of various courses of action. Specifically in decision-making under ambiguity where previous individual experiences guide responses, such constraints can lead the individual to decide more competently.

The Gambling Task

Empirical support for the SMH is collected through a neuropsychological paradigm primarily designed to assess emotion-based learning through a "real-world" decision-making task (Bechara, 2004). The study of vmPFC patients required an instrument to measure deficits in their emotional processing, and an exercise known as the Iowa gambling task (IGT) fulfilled this requirement. This task was developed to stimulate the rewards, punishment and uncertainty of everyday decision-making through an opaque cost-benefit schedule. It comprises of four decks of cards A, B, C and D and participants are instructed to maximize the profit on a loan of play money (Bechara, Damasio & Damasio, 2000). The value characteristics of each deck are not disclosed, but participants can infer the probabilities of loss or gain for each deck over time based on the feedback received after each trial. However, the sequences of reward and punishment are pre-programmed, with only the examiner holding this knowledge. The four decks differ in the frequency and magnitude of gains and losses, so participants must strive to select cards from less attractive but more advantageous decks in the long term (C & D), where subjects get €50 every time they select a card, and punishment results in a total loss of €250 for every 10 cards. However subjects should avoid selecting from disadvantageous decks that appear attractive at first, where they receive €100 for every card selected (A & B), but encounters a total net loss of €1250 for every 10 cards.

Maia and McClelland (2004) discovered three levels of awareness in IGT performance. Level 0 relates to unconscious knowledge about the contingencies of the values of the decks, while level 1 represents a situation where participants have some level of conscious preference for some decks, but lack any explicit knowledge to support the reason for their preference. Finally at level 2, full awareness of the contingencies of each deck is gained, and players are able to use this knowledge to explain their bias towards specific decks. Importantly it must be noted that although individuals may have conscious knowledge of the facts, potential values, and strategies used to make a decision in the IGT, this is separate from being consciously aware of the affective signals involved in decision-making, or of the exact nature of their involvement. In contrast to the SMH, Maia and McClelland (2004) argue that verbal reports of explicit knowledge about consequences of decks would be enough to guide advantageous behaviour in the absence of somatic markers. This suggests that people may have conscious knowledge of the reward outcomes as soon as they choose advantageously, rather than relying on non-conscious biases to guide decision-making. The three levels of conscious awareness proposed by Maia and McClelland are similar to the "pre-hunch", "hunch" and "conceptual" periods introduced by Bechara, Damasio, Tranel & Damasio (1997). The opposing view of these two theorists is that in the SMH, non-conscious bias is believed to guide decision-making before conscious knowledge whereas Maia and McClelland suggest that activity at the pre-hunch phase (level 0) is a conscious process. This phenomenon was examined in a study by Bechara, Damasio, Tranel & Damasio (2005) where performance on the IGT was interrupted by frequent questions that the participant was required to answer relating to conscious awareness of the situation (but not somatic markers). All subjects generated gain/loss SCR's after card selection and anticipatory SCR's were only recorded in normal subjects (5-s before choosing from a deck) when pondering risky choice behaviour, however prior to having conscious knowledge of the situation they chose advantageously. This act of pondering before making a decision is always regarded as a conscious process, whether or not it is explicitly accessible in the conceptual phase or even during the pre-hunch phase, when knowledge about preferences and facts is absent. An anticipatory SCR is initially non-conscious, but can evolve into a conscious process in the form of a "gut feeling" and non-conscious SCR's are activated no matter what level of knowledge is available during the time of pondering. Thus, it is clearly demonstrated that conscious knowledge alone is not sufficient for guiding advantageous behaviour, and its absence does not preclude one from reward decision-making.

There are two systems that support decision-making in the Dual process theories proposed by Kahneman (2003). An intuitive-experimental system undermines System 1 which involves fast effortless processing while also incorporating the influence of emotions, and for this reason it is often used in decisions made under ambiguity. System 2 however is termed as the rational-analytical system, which is a more deliberate response that requires active executive functioning such as cognitive flexibility, which relates to the ability to delay gratification. In addition research suggests that executive processes may also be involved in decisions of uncertainty (Brand, Recknor, Grabenhorst & Bechara, 2007), and that decisions involving a risk component may depend on emotional feedback cues (Brand, Roth-Bauer, Driessen, & Markowitsch, 2008). The robustness of System 1 was tested using the IGT and an executive parallel task, where subjects who performed the executive task and the IGT obtained similar results as the control participants who only performed the IGT (Turnball, Evans, Bunce, Carzolio & O'connor, 2005). This unrelated executive task was not found to impair performance on the IGT because decision-making relied on feedback processing rather than conscious deliberate reasoning. However in comparison to the effortless nature of System 1, if both tasks demand resources of System 2 processing, a parallel executive task can have detrimental effects on performance outcome. This was demonstrated using the Game of Dice task (GDT; Brand, Fujiwara, Borsutzky, Kalbe, Kessler, Markow-itsch, 2005) which instructed participants to follow explicit rules relating to rewards and punishments. When the n-back parallel task was introduced with increasing levels of difficulty, the presence of this additional task impaired one's ability to guide decisions in an advantageous direction (Starcke, Pawlikowski, Wolf, Altstötter-Gleich & Brand, 2011). The adoption of an intuitive versus analytic decision-making system depends not only on task demands, but also on the mood state of the individual during the decision-making task. The impact of mood states on people's tendencies to base decisions on gut feelings or a deliberate analytic process has been demonstrated (de Vries, Holland & Witteman, 2008). In previous research, mood has been found to be a consistent predictor of the type of system people use to process information (Bless & Schwarz 1999; Bolte, Goschke & Kuhl, 2003; Isen 1999; Ruder & Bless, 2003; Martin & Clore, 2001). It was hypothesised that when awareness was at level 1 (Block 2) without explicit knowledge of the contingencies of the game, people in a positive mood would rely more on affective signals, and choose more advantageously than people in a negative mood. To test the different levels of awareness during the IGT, cards 1-20 were divided into blocks 1, 2 & 3, each relating to elevating levels of conscious awareness in the task. There are three separate studies reported in this paper. Firstly in study 1, mood was assessed using a computerized scale and the IGT was then performed after a short unrelated filler task. In study 2, participants were split into two groups, with each group induced to either a positive or negative mood state by watching emotional video clips. Mood state was then assessed, and the IGT performed. The third study only differed from the second in the use of a computerized version of the IGT. All three studies relating to mood states influenced performance on the IGT, therefore it is suggested that mood states act as a moderator to the type of strategy that guides one's decision-making. It was found that in a positive mood state, people rely more on affective signals to guide responses, while in a negative mood, people may use a more deliberate, analytic decision strategy.

Emotions

Decisions can be viewed as a passage through which emotions guide daily efforts to avoid negative feelings and increase positive feelings, a process which can even take place without conscious awareness, thus emotion and decision-making go hand in hand (Keltner & Lerner, 2010). There are however distinct types of emotions; integral and incidental emotions. Integral emotions relate to one's judgement or choice at hand whereby the individual may feel distressed about the possible outcome of a risky choice and they may resort to choosing the safer option than the possibly more lucrative outcome. These may serve to bias the decision-making process, even when cognitive information which would suggest different courses of action is present. Loewenstein, Weber, Hsee & Welch (2001) claims that these types of emotions are highly influential in the case of perceptually vivid decision-making, which can supersede more rational courses of action. Incidental emotions have been found to carry over from one situation to another, and therefore may affect decision-making by emotions caused by an unrelated event (Keltner & Lerner 2010, Lerner & Tiedens, 2006). Earlier studies show that this carryover effect of incidental emotions usually occurs either implicitly or explicitly and takes a valence based approach, whereby emotions would be categorised into negative or positive divisions, and emotions with the same valence would produce similar outcomes. Johnson and Tversky (1983) designed the first study which demonstrated the effects of incidental mood on the perception of risk and a valence-grounded approach was used. Subjects were asked to read newspaper articles relating to either positive or negative incidents, they were then asked to estimate the rate of fatality for a range of possible causes of deaths (i.e. brain tumour, heart disease). When compared to the participants who read positive articles, it was found that the participants induced to a negative mood by reading the negative articles reported more pessimistic estimates of fatality frequencies. Although the articles were unrelated to the judgement of fatality frequencies, the mood itself affected all judgements made around that time.

One moderating factor related to this phenomenon is that individuals with high emotional intelligence can successfully identify the cause of their current emotional state and therefore have the ability to eliminate any potential undesired effects of incidental emotions (Yip & Côté, 2012). It was demonstrated in one study that incidental anxiety did not have any impact on risk perception when participants were given an understanding about the source of their incidental anxiety prior to completing the task. Consistent with these findings, Webb, DelDonno & Killgore (2014) hypothesised that the majority of variance in IGT performance was accounted for by cognitive intelligence (IQ) rather than emotional intelligence (EI) measures. Additionally, Demaree, Burns & DeDonno (2010) argues that poor performance on the IGT can be explained by a cognitive deficit rather than a lack of generating somatic marker signals. Here, it is suggested that a cognitive ability known as reversal learning is necessary to gain knowledge of the advantageous strategy. However, EI measures used in this study may not adequately assess the emotion-related signals proposed by the SMH that are required for optimal decision-making. In order to test EI in relation to the SMH, it would be necessary to record anticipatory SCR's during the IGT in conjunction with EI measures. Also in line with the SMH, it may only be those who have the ability to understand their own emotional fluctuations that use this knowledge to enhance their performance on the IGT.

There are three types of emotions that influence decision-making; one's current emotional state, anticipatory emotions and the emotion that you feel after you have made the decision. A previously mentioned study by Johnson & Tversky (1983) investigated the effects of mood on risk perception. This phenomenon also relates to performance in the IGT whereby a positive mood state results in participants choosing from more advantageous decks (De Vries, Holland & Witteman, 2008). An experience that is emotionally or physiologically challenging undermines the word stress (McEwen, 2007). Extensive research on the study of stress and decision-making suggest that both chronic and acute stress affect the capacity of cognitive function. Stress is often incidentally triggered during the decision-making task through unrelated previous events. It would be important to investigate the relationship between events and emotions in order to enhance peoples understanding about the source of their stress and, in turn, minimize the influence of incidental stress on decisions that involve elements of risk. The effect of intrinsic emotions on decision-making was investigated by Preston, Buchanan, Stansfield and Bechara (2007) to test whether incidental or anticipatory stress would be beneficial or disruptive to the decision-making process. It was assumed that participants would be slower to learn the IGT if a stressor such as the anticipation of giving a public speech was introduced. In line with this hypothesis, previous research suggests that the unrelated stresses of exam pressure and negative feelings evoked by pictures could result in disadvantageous short-term choices on a gambling task (Gray, 1999). In this study (Preston et al., 2007) participants were informed that the speech was voluntary and that they could withdraw their participation at any stage. It was found that the anticipation of giving a speech served as a an effective stressor, as an increase in heart rate and blood pressure was observed in experimental subjects, only after the stressor was presented. Definite statements can therefore be made about the social and biological effects of stress on behavioural decisions. It is likely that the anticipation of giving a speech distracted participants during the first block, thereby delaying the learning of contingencies of the four card decks until the second block. Thus, in relation to these findings it is suggested that intrinsic emotion relevant to the task is beneficial in guiding advantageous decision-making (Zeelenberg & Pieters, 2006). In contrast, extrinsic emotions that are present by unrelated means may disturb prefrontal functioning and lead to an impairment in one's ability to determine the costs and benefits of the outcomes of their choices.

Acute stress can be understood as an array of extrinsic emotions that arise when an individual is being emotionally and physically challenged by a stressor that is not related to the decision-making process. When one is confronted by such stressors, it provokes an activation of a neuroendocrine stress response that is stimulated by two dominant physiological response pathways. Firstly, the sympathetic nervous system is activated, and this takes place immediately after the onset of the stress response which leads to elevated levels of catecholamines, disrupting normal function in pre-fontal activity (Arnsten, 2009). The hypothalamic-pituitary-adrenal (HPA) axis is the second response pathway, a second defence wave, related to increased release of glucocorticoid cortisol (McEwen, 2006). Previous research investigated the impact of acute stress and a parallel executive task on a decision-making task under risk (Pabst, Schoofs, Pawlikowski, Brand & Wolf, 2013), known as the Game of dice task (GDT; Brand et al., 2005). Stress was successfully induced using the trier social stress test (TSST), which was observed through elevated SNS responses and slower activation of the HPA axis. Interestingly, the stressed participants performing the additional executive task did not show different results from the controls; it was suggested that the effects of stress and a second task cancelled each other out, at least at the behavioural level. However, consistent with previous findings in the single-task condition, stressed participants chose more disadvantageously, resulting in less rewarding long-term outcomes than non-stressed participants (Starcke & Brand, 2012). Thus, performance was only affected in the single-task participants and not in the parallel-task condition, which may suggest that the two negative components of stress and a parallel task led to an unequal usage of cognitive ability on both tasks. Another possible explanation is the idea that stress increases the cost of the switch between tasks, which prolongs the duration of the task (Plessow, Kiesel & Kirschbaum, 2012). This additional delay could effectuate an enhanced performance on the GDT, by affording the participant more time to weigh up the costs and benefits of each potential outcome.

It has been suggested by extensive research findings that acute stress can lead to a reduced ability in learning from negative feedback in order to enhance future performance (Petzold, Plessow, Goschke & Kirschbaum, 2010). A study investigating the impact of pre-existing affective biases on emotional based learning (Davies & Turnbull, 2011) was conducted using an altered version of the IGT, which had emotional pictures presented in the feedback stage that were either congruent or incongruent with the decks payoff values (i.e. advantageous or disadvantageous). It was found that an incongruity between the decks payoff values and the emotionally salient pictures impaired participant's performance on the IGT when compared to the controls in the congruent condition. Although these findings are significant in determining the effectiveness of pre-existing biases, they do not provide an understanding of the importance of emotional responses to rewards and punishments in the decision-making process, which undermines the role of somatic markers.

A study was designed by Aïte, Borst, Moutier, Varescon, Brown, Houdé & Cassotti (2003) with the main aim of testing the SMH by placing affective stimuli in the post decision (feedback-stage) phase of the IGT. A new version of the IGT was created where a picture with the emotional valence of facial expressions is presented on the screen of a computer, being either congruent or incongruent with the feedback received. When the emotional context is congruent with the feedback delivered, happy faces appear after one gains a reward, and when punishments are received, fearful faces are presented on the screen. However, when the emotional context is incongruent with the feedback, happy faces are presented when one receives a punishment and fearful faces are associated with rewards. It was hypothesised that the manipulation of the emotional context should impair performance in the incongruent condition by interfering with the formation of somatic markers necessary for emotion-based learning and choosing advantageously in the IGT. In this way, the properties of the SMH would be tested as the emotional context that is congruent with the feedback received should also enhance performance on the IGT by assisting with the creation of somatic markers. In the control condition there were no faces presented in the feedback phase. Research on the accuracy of facial recognition has found increased activation in the amygdala for emotional facial expressions that carry more intrinsic values than neutral faces, which implies that certain emotions can be elicited by presenting emotional facial expressions in the feedback stage (Gupta, Koscik, Bechara & Tranel, 2011). Specifically, the emotions of happiness and fear were chosen because previous findings suggested that happiness triggers an approach response whereas fear evokes an avoidance response both in relation to rewards and punishments in the IGT (Adams, Ambady, Macrae & Kleck, 2006; Lerner & Keltner, 2001). Therefore presenting bias during the feedback stage should effectively modulate the total net decision feedback. Consistent with the proposed hypothesis of this study it was found that participants chose more advantageously when the emotional context was congruent with the feedback (i.e. happy faces following rewards and fearful faces in response to punishments). However this capacity to choose advantageously was impaired when the emotional context was incongruent with the feedback received (i.e. happy faces relating to punishments and fearful faces after rewards). In addition, the control condition showed a consistent tendency to choose advantageously over time which is in line with previous findings of performance on the IGT task (Bowman, Evans & Turnbull, 2005; Cassotti & Moutier, 2010). Thus, this study supported findings of the SMH whereby the creation of somatic markers were disrupted by the incongruent emotional context, resulting in impaired learning of decision-making on the IGT. A major gap exists in the research however, as this is one of the few studies that acknowledges the relevance of tones, facial expressions and written feedback in understanding emotion based learning as applied to performance in the IGT.

The Present Research

The purpose of the present study is to demonstrate whether individuals process emotional cues more readily in stressful situations. The study described in this paper is a conceptual replication of the study conducted by Aïte.et.al. (2013), aimed to test the SMH by demonstrating how pre-existing affective biases modulate emotional-based learning using an altered version of the IGT task. The SMH proposes that choosing advantageous cards is a result of emotional-based learning. In order to test the SMH, somatic markers (SM) were triggered by systematically manipulating the emotional context related to the primary inducers that would either reinforce or interfere with the creation of somatic signals. In this study positive or negative facial expressions (i.e. happy and sad) will be presented in the feedback stage that will either be congruent or incongruent with the written feedback delivered on the screen. It is suggested that compared to the congruent conditions, the incongruent condition will lead to impaired performance on the IGT. Therefore, the first aim of this study will be to investigate if somatic markers are a fundamental process by which decisions are made under risk circumstances. This will be achieved by systematically manipulating emotional contexts, which will be associated with performance outcomes on the IGT (i.e. rewards and punishments). The IGT is used as a decision-making cost-benefit analysis task, used to mimic important decisions made in one's personal life.

There is empirical evidence that outlines the effectiveness of incidental emotions (Preston et al., 2007; Keltner & Lerner, 2010), thus an investigation to test whether incidental stress would benefit or disrupt decision-making will be carried out in the current research. As such, the second aim of this study is to demonstrate whether incidental emotions would impair performance on the IGT by creating interference with the task-related emotion essential to guide advantageous choices. Decisions are often made in stressful situations where unrelated factors may influence one's choices. It is important to test the effects of these unrelated factors in order to improve decision-making strategies in instances of stress which would lead to enhanced emotion regulation. Acute stress will be induced on experimental participants using a modified version of the Paced Auditory Serial Addition Task (PASAT-C) and galvanic skin responses (GSR) will be recorded to measure levels of stress in participants. This computerized task requires the participant to add a number that is presented on the screen to the previously presented number. After the participant has answered the sum, he/she is then required to ignore that calculation and add the following number to the previously presented number. For example the correct calculations to the series of 7, 8, 4, 5, 2, would be 15, 12, 9, 7, (Lejuez, Kahler & Brown, 2003). There are certain modifications in the PASAT-C that add to the pressure of the task, such as an unpleasant auditory feedback of a bomb exploding when one answers incorrectly, and increasing 'levels', in which the latencies between number presentations is shortened. The impact of incidental emotional stress on IGT performance will be demonstrated by a moderation effect. This emotion-decision-making relationship is a curvilinear function of the strength of external conditions and these unrelated factors (incidental emotions) are assumed to set boundary conditions for the applicability of SMH theories. Enhanced awareness of incidental emotions may have developmental and evolutionary implications as people better understand that sometimes the source of emotion is unrelated to the task at hand, leading to better emotional regulation.

Hypothesis 1 states that there will be a difference in performance accuracy on the IGT in the congruent and incongruent emotional context.

Hypothesis 2 states that acute induced stress will amplify the effects of emotional cues leading to impaired decision-making in IGT performance.

Hypothesis 3 suggests that an increase of physiological arousal will be observed in subjects who complete the PASAT-C task.

Method

Participants

This research was a between-participants design, utilizing a stratified, random sample of forty undergraduate students from the National College of Ireland population. Posters were hung in the halls of the college with a heading clearly stating that volunteers were needed to take part in a 15 minute psychological experiment, a brief description of the experiment, and the contact details of the researcher. 20 students responded by text message, and dates were arranged that suited both the students and the researcher to conduct the experiment. Another 28 students showed interest in taking part in the experiment by word of mouth, and when these students approached the researcher to express their interest in volunteering, a date and time was arranged. Although 48 appointments were arranged, the total number of participants that actually took part in the experiment was (n=40); some students were not included in the study because they did not show up to their assigned appointments. Additionally, students were not included in the study if they met the exclusion criteria which included individuals with any type of mental illness or learning disability. The sample of participants selected from the student body population of National college of Ireland ranged in age from 19-27 with a mean age of 22 (SD=2.08). The samples of participants were then divided into 4 subgroups of known size according to gender. In order to generate an evenly mixed gender sample, each of the four groups consisted of 5 males and 5 female participants (n = 10; 5 male, 5 female). Although participants were unaware of this process, randomization was utilized by placing all the names of the participants in two separate bowls according to gender and then lots were drawn that determined which male and female participants were included in each condition. The eight participants that were included in the first condition were named the experimental congruent cohort (EC) and then the second group which also consisted of the same number of participants were assigned to the experimental incongruent cohort (EI). There were also two control conditions, the congruent control (CC) and the incongruent control (IC), with an additional 10 participants assigned to each of these conditions. All subjects were informed that they would be competing against all other participants in the IGT and PASAT-C tasks, and before completing the task participants were made aware that the individual who achieves the highest score will receive a 15 euro voucher for the café “Seven Wonders”. Each participant taking part in the study was also asked to sign a written consent form in compliance with institutional guidelines governing the use of human research participants.

Design

This research was undertaken to determine whether emotional cues are processed more readily in stressful situations. A 2X2 quantitative between-subjects true experimental design was used. The variables (IV) that were tested comprised of levels of stress and context congruency. Subjects were randomly assigned under experimental or control conditions, thereby eliminating the influence of systematic bias. This randomization approach reduced the effects of internal validity and allowed for an increase in the control over extraneous variables that could potentially influence the dependent variable which is the decision-making task.

Materials and Apparatus

The data collected from the participants in the experimental conditions, both congruent (EC) and incongruent (EI) groups consisted of two components; the PASAT-C task and the IGT. All of these participants took part in the computerized stress inducing task known as the Paced Auditory Serial Addition Task (PASAT-C; Lejuez et al. 2003) which is a highly renowned behavioural measure of persistence. In support of its construct validity this test has been used extensively in research and laboratory studies to stimulate psychological stresses in the form of anxiety, anger and frustration (Lejuez, Kahler & Brown, 2003). In terms of the task's predictive validity, evidence has shown that the PASAT-C can predict early treatment dropouts amongst a population of substance users (Daughters, Lejuez, Kahler, Strong & Brown, 2005). Extensive research also reported that the PASAT-C has a high degree of reliability; when the final scores of participant trials are correlated they generally range from .76 and .95 (MacLeod & Prior, 1996; Ponsford & Kinsella, 1992). In support of this evidence, the current study also found average scores within this range.

This computerized task involves the participant performing a serial addition task of numbers presented one at a time on a laptop screen. On the upper middle area of the screen, one large box presents the numbers that subjects are required to calculate. The digits are presented in the box on the screen within a relatively large rectangle. Underneath this box in the lower middle area of the screen is a keypad (presenting the numbers 1-20) and the subject is required to answer the sum by using the computer mouse to click on the correct number(s) on the keypad provided. The digits on the keypad are presented within a square box where the top row contains numbers ranging from 1-10, and the second row numbers ranging from 11 to 20. The final box on the screen during this task shows the participant's score at any given time, which is continuously updated after each response. The participant is required to add the digit presented on the screen to the previously presented digit, and then answer the sum correctly by clicking on the numbers on the keypad provided. After the participant has answered the sum they are then asked to ignore that sum and continue performing the task by adding the next number shown on the screen to the last number shown. The three levels of this task aim to elicit levels of acute stress as the levels increase in difficulty by reducing the duration of the latency between number presentations. The latency within each level decreases from 3 seconds to 1 second, while the length of each level also increases. The first two levels are 2 minutes long and run continuously without a break. A short 1 minute break is then given before level 3 begins, which then lasts for another 3 minutes. Unlike levels 1 & 2, in the final level of the task participants are informed that they have the option to quit the task by clicking on the "escape" button that is presented on the screen below their keypad and that this would terminate their exposure to the task if they did not wish to continue for the final duration of 3 minutes. In order to provide incentive motivation for the participants to achieve the highest score possible, they are informed that their points will be recorded along with their performance on the IGT to be in the chance to win a "Seven Wonders" cafe voucher.

In order to measure physiological arousal during the acute stress inducer task a GSR apparatus is used to record the electrical resistance of the skin using PowerLab equipment. An increase in skin conductance levels is proportional to the secretion of sweat, and when an individual feels stressed, the activity in sweat glands is activated which directly increases skin conductance. The hands and feet are the areas in the body where sweat glands are most dense. For this reason, finger electrodes are placed on the participant's non-dominant hand in order to convert biological signals into analogue electrical signals. The GSR amp is connected to the back of the PowerLab, and the red and black finger electrodes are connected to the front of the GSR amp, following the colour scheme on the GSR amp. The magnitude of difference in the scores of Skin conductance (uS) and heart rate (bpm) can be obtained by subtracting the average score during the baseline from the average score during experimentation.

Contrastingly, in the two control conditions, participants watch a short video clip to induce a calm mood state. This 2 minute video consists of a series of clips from various tropical beach settings, and audio sounds of waves crashing on the beach played in the background (Metz, 2013). This procedure required the participant to watch and listen to a mood-suggestive video chosen by the researcher in an effort to elicit specific mood state, in this case a calming mood state. According to many researchers, emotion elicitation using music and film clip inductions seem to be the most significant methods of inducing moods (Gerrards-Hesse, Spies & Hesse, 1994; Westermann, STAHL & Hesse, 1996). It is also suggested that multiple inductions combined together at the same time are more effective than singular inductions alone (Bower, 1981), and therefore produce increased mood stability over time. Mayer, Allen & Beauregard (1995) designed the most successful emotion elicitation procedure by associating guided imagery with appropriate congruent background music which resulted in increased effectiveness of the induction. This technique is similar to the type of video clip used in the current study as it combines both the visual imagery of the beaches and tropical settings, guided by the sound of the waves, in order to induce a calm mood state.

Participants in all four conditions performed the Iowa Gambling Task (IGT) (Bechara.et.al, 1994). This task was used to test the participant's capacity to effectively learn a punishment-reward contingency in order to maximise their potential gains with a loan of play money. This version of the IGT was distributed under the GNU General Public License and the authors of this software are Grasman and Wagenmakers (2005). In this task, there were four decks (A, B, C, D) presented to the participant on the middle of the screen, and individuals are given a loan of €2000 play money to begin with. Participants were informed about the aims of the game through a brief description at the start of the task; the main goal is to maximise their profit over the course of 100 trials by selecting cards by clicking on one of the four decks on the screen. Each time the participant draws from Decks A and B they yield a total gain of €100 on average and Decks C and D yield gains of €50 profit on average. However although decks A and B may seem attractive at first, they have been termed “disadvantageous” because they result in a total net loss of €250 after a selection of 10 cards (Bechara, Damasio, Damasio & Anderson, 1994). In contrast, Decks C and D have been termed as “advantageous” in the long-term because after 10 card selections individuals received a net gain of €250. The gains and losses are randomized within blocks of ten trials to ensure that all the losses are distributed evenly throughout the 100 trials and not at the end of the experiment. The outcome measure that was used was based on the total money won and this was calculated by subtracting the total disadvantageous decks from the advantageous decks ([A+B] – [C+D]). An extractor tool was used to export the participant’s data from the “data-archive. Txt” file into individual text files which saved participant’s responses into binary variables for each trial in order to simplify the data for analysis. A horizontal bar at the top of the screen displayed the amount of money won or lost after each trial. There were 100 trials in each task and it took approximately 10 minutes to complete. The emotional context was systematically manipulated in the IGT task used in this study. Two of the conditions performed a version of the IGT where the emotional context was congruent with the feedback given to the participant, while subjects in the other two conditions were presented with an incongruent emotional context. In both of these conditions after the feedback of each card selection was presented on the screen, an additional emotional face was presented on the top left corner of the screen. This image of a happy or sad face was visible on the screen until the participant clicked on the button to continue to the next trial. Extensive research on the study of facial recognition provides evidence that viewing emotional faces results in higher activation in the amygdala than the presentation of neutral faces, suggesting that specific emotions can be elicited by the presentation of emotional faces (Gupta, Koscik, Bechara, & Tranel, 2011; Vuil-leumier & Driver, 2007). In an effort to reinforce the participants' emotional reactions to rewards and punishments, the two facial expressions that were chosen to include in the study were those of happiness, which has been found to result in approach responses, and fear or sadness, which have been found to elicit avoidance responses (Adams, Ambady, Macrae & Kleck, 2006; Lerner & Keltner, 2001). In the congruent conditions, happy faces were presented when the individual received a reward and fearful faces after punishments, the delivery of these faces being based on the participant's card selection in each trial. However in the incongruent conditions this was reversed; fearful faces were presented following reward outcomes and happy faces after punishments. This is illustrated in Figure 1 below. In addition, it must be noted that the same facial images were presented in each trial for both happy and sad emotions therefore individuals performance on the IGT could not be affected by the ethnicity of the face which has been found to contribute to the decision-making process (Davies & Turnbull, 2011).

Figure 1 *The Iowa Gambling Task with manipulated emotional context congruency*

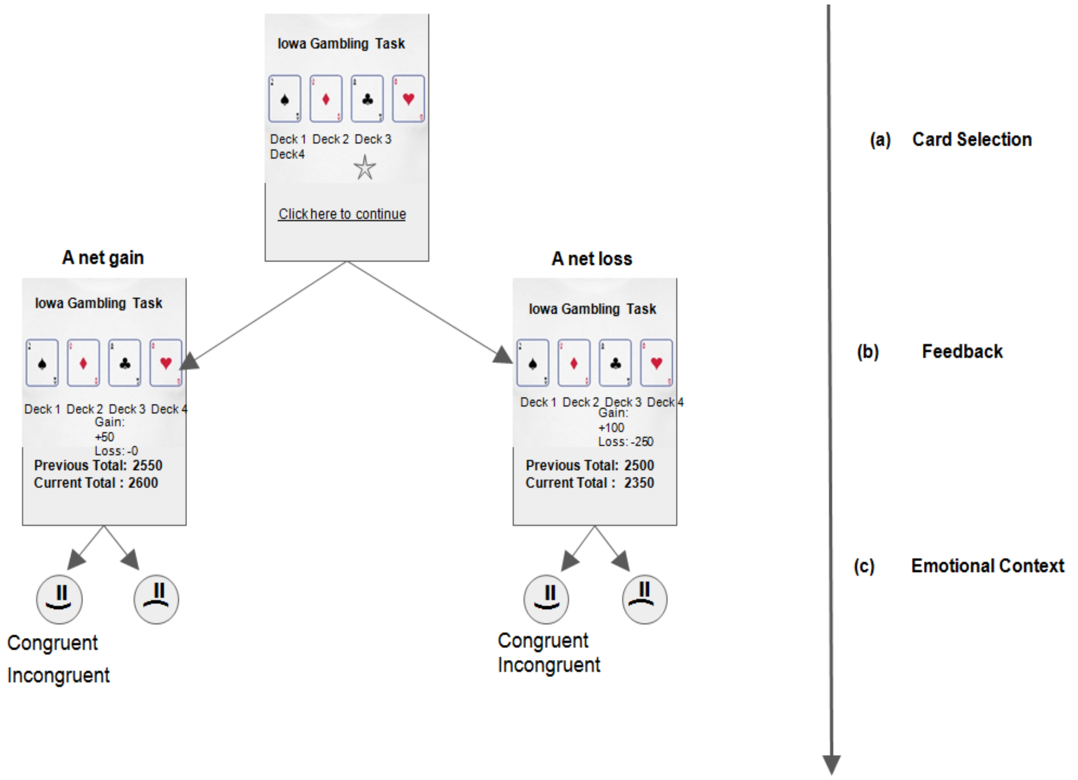

Figure 1 *The procedure used in the altered version of the IGT. (a) Four cards are presented in a row on the screen and the participant is required to select one card that could be from the advantageous decks (C and D) or the disadvantageous decks (A and B). (b) Once a card is selected from the row the card reveals whether the participants choice has resulted in a net gain (left) or a net loss (right). (c) The emotional context condition is presented at the same time as all other visual feedback and this is shown in the top left corner of the screen. The emotional faces(c) are either congruent or incongruent with the feedback presented in (b).*

To date, there is limited research that provides evidence for the reliability of the IGT. Ernst, Grant, London, Contoreggi, Kimes, & Spurgeon (2003) has found evidence of learning effects in IGT performance on a sample of healthy control adolescents and adult subjects and also on a substance use cohort. Evidence of learning was found when a second IGT task was administrated with a delay of one week, however, this effect was not found in the third cohort of adolescents with substance abuse disorders. Similar results were also found amongst a group of smokers and non-smokers whereby risk-taking behaviour was decreased over the course of three separate administration sessions during experimentation (Lejuez et al., 2003). However, the clinical manual (Bechara, 2007) did not focus on the effectiveness of the IGT for re-test purposes. Therefore due to lack of evidence in support of the IGT as a reliable measure over time, it's applicability to test participant's decision-making over multiple administrations is limited. However this limitation did not affect the test's reliability in the current study, because the participant was only exposed to the administration of the test on one occasion, thus ruling out the influence of learning effects or pre-exposure to the task. This was also controlled for on the consent form where it clearly stated that if participants have used the IGT before that they should inform the researcher, and that their participation would not be accounted for in the analysis of data. Evidence to support the construct validity of the test reflects the findings of the somatic marker hypothesis which suggests that performance on the task is influenced by emotional processing. The extensive research relating to this phenomenon shows that this task effectively measures what it purports to measure. Evidence has been found for the ecological validity of the IGT in relation to risky behaviours, however the link between the task and real-world testing of decision-making is unclear when it relates to financial or medical decision-making. Therefore future research should focus on evaluating this relationship. This does not impact the applicability of the IGT in the current research study because it is focused on risky behaviour in relation to affective states which has been supported by the SMH (Bechara, Damasio & Damasio, 2000).

Procedure

A pilot study was first conducted in order to test the equipment being used in the experiment and also to record the length taken to complete each task. The study consisted of 4 individuals (n=4), one person was allocated to each of the conditions. The most efficient method of data collection in each condition was formulated and then used for the research study. Prior to beginning the experiment, participants were given an informed consent form that provided the individual with a brief description of the study (*see appendix A and B*) but still left an element of curiosity about the research idea under question. The form included all details of the study that subjects should know including risks, discomforts, participant rights and confidentiality. The participant and the researcher both signed their names to agree that consent has been given and that the information is understood clearly by the individual. Each participant was allocated to a specified condition based on lots drawn from two gender specific bowls.

In both experimental conditions each participant completed the PASAT-C task. However, before the task commenced the GSR apparatus was set up by the researcher. Firstly, the GSR amp was zeroed before the equipment was connected to the volunteer. The researcher had to ensure that the electrodes were undisturbed on the desk and then the "Open Circuit Zero" button was clicked and changed to "Subject Zero". Then when this button was clicked again, the equipment was zeroed for 1 minute. The participant was asked to remove any jewellery on their non-dominant hand and then GSR finger electrodes were attached to this hand. The finger pulse transducer was attached to a middle finger on the same hand as the finger electrodes. The participant was asked to relax, close their eyes and place their hand on their lap. A baseline recording of the participant's skin conductance was then obtained by clicking the start button on the computer and this was stopped when the researcher felt confident with the quality of the recordings. If a steady baseline was not being recorded and the researcher was unsatisfied, the equipment was adjusted and connections were checked before continuing. Subjects were given clear guidelines of how to perform the task correctly. They were told which box on the screen that the number would appear in and that they had to use the keypad provided to answer each mathematic calculation. They were then asked to click start on the screen of the laptop and on a separate computer the researcher also clicked start to record the skin conductance and heart rate of the participants while they were completing the task. The PASAT-C took 6 minutes to complete. However in the 3rd level of the PASAT-C, participants were informed that they could quit the task at any time, for any reason that they did not want to continue their exposure to the task. This procedure was performed by 20 participants, 10 of whom followed on to complete the IGT with an incongruent context and 10 of whom performed the IGT with a congruent emotional context. In the experimental condition, GSR measurements were recorded for 5 minutes after the experiment during a recovery period in order to evaluate individual's response to stressful protocol. If individuals still felt stressed after this recovery period then appropriate interventions were put in place (i.e.) longer debriefing periods or a telephone follow-up that evening. In the IGT all participants were given an identity code to log on to the program instead of using their own names. In comparison to the experimental conditions, subjects in the control conditions watched a 2 minute video clip which was used to induce a calm mood state. GSR measurements were again recorded using the same procedure as the experimental conditions. Subjects in the control condition then performed the IGT, 10 of whom completed the incongruent emotional context and 10 of whom performed the congruent context. After the IGT was completed, participants were then debriefed about the actual nature of the study and the purpose of the PASAT-C to induce acute stress and also the calming mood induction method in the control. Subjects were informed of the principal aim of the study and also about the emotional context manipulation in the incongruent conditions.

Results

Hypothesis 1 and 2

Hypothesis 1 stated that there would be a significant difference in performance accuracy between participants who performed the IGT in the congruent and incongruent emotional contexts. In relation to the IGT, the 100 trials were divided into 5 separate blocks consisting of 20 trials in each block. The total amount of selections from the two disadvantageous decks (A and B) were calculated and subtracted from the total selections made from the advantageous decks (C and D) and this was performed separately for each block of trials. Superior performance in the IGT was indicated by higher scores.

The initial (first 40) trials of the IGT are usually recognized as choices made under ambiguous conditions as participants would not yet have learned the outcome probabilities of the decks. However as the participant progresses to the last 60 trials of the IGT they may have acquired some knowledge about the possible outcome probabilities associated with the four decks (Bechara et al., 1997). Therefore, in order to test decision-making under risk the last 60 trials were separated from the initial trials for analysis.

A two-way between groups analysis of variance was conducted to explore for: (i) the impact of emotional context congruency on performance in the last 60 trials of the IGT, and (ii) to explore the impact of the PASAT-C on performance in the last 60 trials when compared to control subjects. Participants were divided into four groups for analysis (experimental congruent, experimental incongruent, control congruent, control incongruent). The interaction effect between the congruency of the emotional context and the experimental and control groups was not statistically significant, $F(1, 36) = 3.58$, $p = .06$. However in support of hypothesis 1, a main effect for emotional context congruency was found ($F(1, 36) = 6.89$, $p = .01$), although the effect size for this difference was very small (partial eta squared = .01). Post-hoc comparisons using the Tukey HSD test indicated that the experimental congruent group ($M = 22.4$, $SD = 16.88$) scored significantly higher ($p = .01$) than the experimental incongruent condition ($M = -1$, $SD = 21.40$); and significantly higher ($p = .03$) than the control incongruent group ($M = 1$, $SD = 17$). The control congruent group ($M= 4.8$, $SD=6.4$) did not differ significantly from any of the other groups. The main effect for group experimental and control, $F(1, 36) = 2.3$, $p=.14$, did not reach statistical significance. Therefore as a result of these findings the second hypothesis which stated that acute stress would amplify the effects of emotional cues leading to more disadvantageous behaviour in the IGT was only partially supported as the experimental conditions performed significantly better than participants in the control conditions. However, in the incongruent condition emotional cues were processed more readily and impaired performance as a result. The mean difference in IGT scores for all conditions in the last 60 trials can be seen in figure 2.

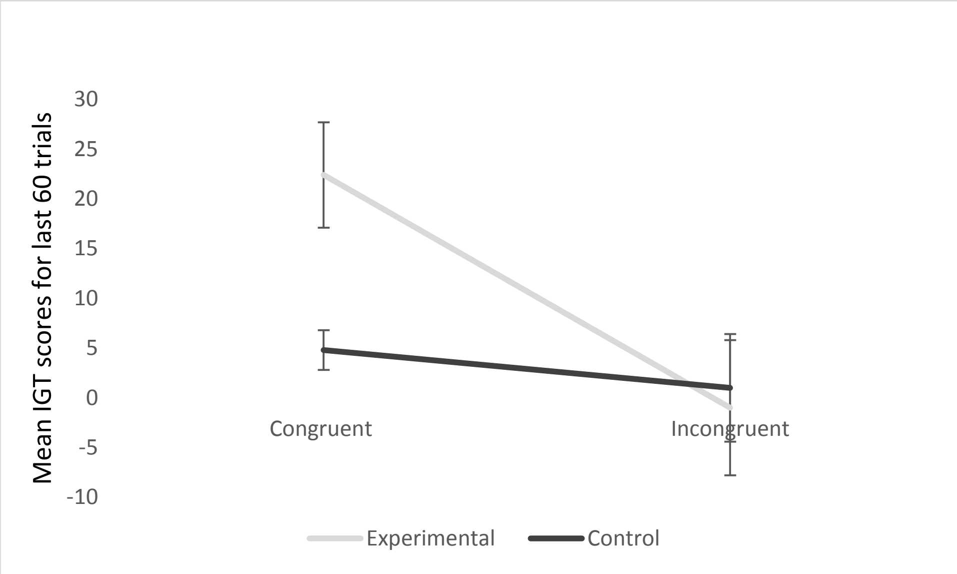

Figure 2. *The mean IGT scores for the last 60 trials for the experimental congruent, experimental incongruent, control congruent and control incongruent conditions. Higher IGT scores indicate optimal performance. Error bars represent one standard deviation around the mean.*

Hypothesis 3

The third hypothesis that was proposed was related to the physiological arousal in the experimental conditions. It was hypothesised that participants who completed the PASAT-C task would have increased arousal in GSR measurements when compared to their baseline recordings.

In order to evaluate the GSR data, a paired samples t-test was conducted to evaluate the difference in skin conductance (μS) levels between the baseline and experimental measurements during the PASAT-C task. A significant increase in skin conductance levels was found from Time 1 during baseline ($M = 5$, $SD = 1.23$) to Time 2 during experimentation ($M = 5.4$, $SD = 1.26$), $t(19) = -3.507$, $p < .002$ (two-tailed). The mean increase in skin conductance measurements was -.44 (95% confidence interval ranging from -.696 to -.176). However, the eta squared statistic (0.3) indicated a relatively small effect size. Figure 3 represents the SCR data for experimental participants at baseline and then when completing the PASAT-C task.

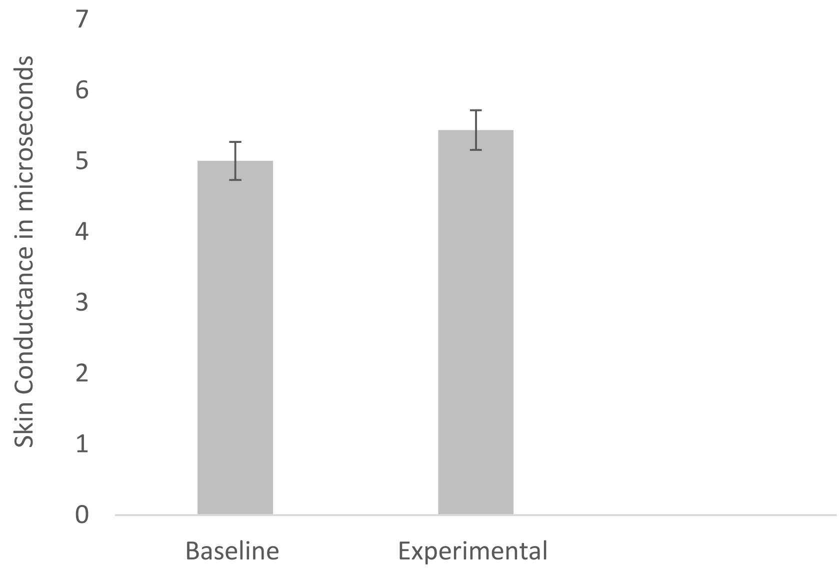

Figure 3. *Mean levels of skin conductance in microseconds (μS) for experimental congruent and experimental incongruent conditions at baseline and experimental time periods (Δ). Error bars signify one standard deviation around the mean.*

This type of analysis (paired samples t-test) was repeated in order to analyse heart rate measurements (in bpm) between the baseline and experimental periods during the PASAT-C task. There was a significant increase in heart rate levels from Time 1 in baseline measurements (M = 74.7, SD = 4.4) to Time 2 during experimentation (M = 76.7, SD = 3.7), t (19) = -6.164, $p < .002$ (two-tailed). The mean increase in heart rate measurements was -2.0 (95% confidence interval ranging from -2.67 to -1.32). A medium effect size was then found as indicated by the eta squared statistic (0.6). The mean difference in heart rate measurements between baseline and experimental time periods can be seen in figure 4.

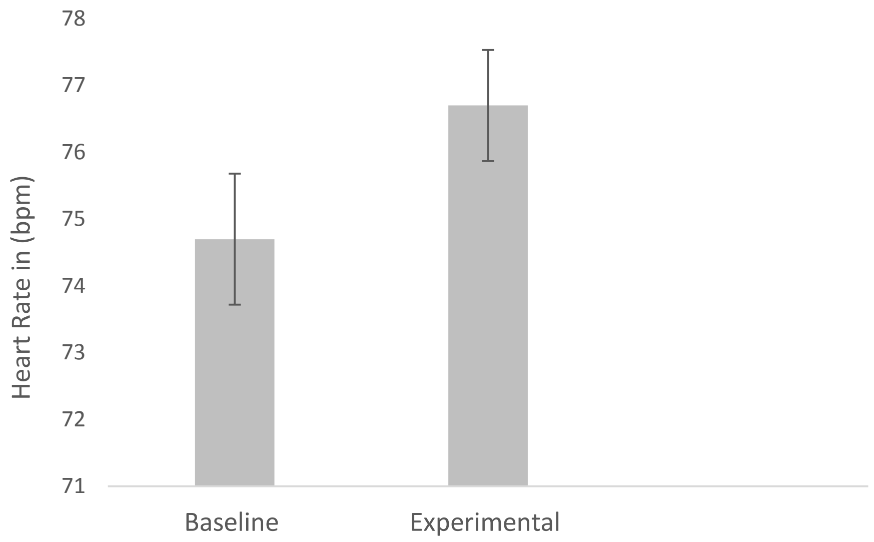

Figure 4. *Mean levels of heart rate in (bpm) for experimental congruent and experimental incongruent conditions at baseline and experimental time periods (Δ). Error bars signify one standard deviation around the mean.*

Additional Analysis

A mixed between-within subject's analysis of variance was conducted on each condition separately as the overall analysis did not have sufficient power to perform an overall mixed between-within analysis due to the small sample size of participants (n=40). Firstly, a test was conducted in order to discover any difference in scores between the five blocks of trials in the IGT for the experimental congruent cohort. It was found that there was no significant interaction between the five trials, Wilk's Lambda = .59, F (2.14, 4) p=.19, partial eta squared = .59. Although this analysis was not directly linked to the hypotheses, it was interesting to report on it for all four conditions in order to examine if each group effectively learned the contingencies of the decks across all 5 blocks of trials, which would be signified by an increase in scores over time. A mixed between-within subject's analysis of variance was again conducted to see if there was a difference in scores between the five blocks of trials in the IGT for the experimental incongruent condition. There was no significant interaction found between the five blocks, Wilk's Lambda = .76, F (4, 6) p=.78, partial eta squared = .23. In relation to the control congruent cohort, there was no significant interaction between the five blocks of trials, Wilk's Lambda = .77, F (4, 6) p=.78, partial eta squared = .22. The final mixed between-within subject's analysis of variance was performed to see if there was a difference in scores between the five blocks of trials in the IGT for the control incongruent cohort. Similar to the other control condition, there was no significant interaction between the five blocks, Wilk's Lambda = .68, F (4, 6) p=.61, partial eta squared = .32. The difference in the mean scores and standard deviations for all four conditions (n=40) when split into 5 separate blocks of trials is reported in table.

Table 1: *Mean scores in the IGT in 5 blocks of trials across all 4 conditions.*

Group	**EC**		**EI**		**CC**		**CI**	
Time Period	M	SD	M	SD	M	SD	M	SD
Block 1	6.2	6.2	.0	3.3	1.2	2.6	2.2	8.1
Block 2	7.2	5.6	1.4	4.9	.6	3.2	-.4	10.5
Block 3	5.6	6.2	-.6	6.0	1.2	3.1	.4	9.3
Block 4	9.2	6.3	-.4	10.9	1.4	2.3	2.8	8.8
Block 5	7.6	8.8	.0	5.4	2.2	4.0	2.2	5.7

Discussion

Feedback manipulation

The altered version of the IGT used in this paper (Grasman & Wagenmakers, 2005) provided the modifications necessary to investigate the extent to which emotional bias impacted emotion based learning in this complex decision-making task under circumstances of risk, intricacy, ambiguity and dynamic feedback manipulation over time. The present study was a conceptual replication of the Aïte.et.al. (2013) study, whereby the primary aim was to examine the SMH by investigating the underlying processes people adopt when they are required to make an ambiguous decision. In order to test this phenomenon, the feedback presented in the IGT was systematically manipulated (however the present research is generalised to a more abstract emotional context). The findings reported here accurately support the results found in the Aïte.et.al. (2013) study, as the results showed a significant effect on IGT performance as a result of manipulated emotional feedback. The ability to maximise one's profits by choosing advantageously was found to increase when the emotional context was congruent with the feedback (i.e. happy faces presented after rewards and fearful faces after a loss), as opposed to the incongruent emotional feedback manipulation which was found to impair performance on IGT (i.e. happy faces after punishments and fearful faces after rewards). Previous research on pre-existing affective biases used a modified 3-deck gambling task where the primary goal was also to test the effects of emotional context congruency on decision-making (Hinson et al., 2006). Emotionally salient words were correlated with task objects whereby the value of these affective biases were either congruent (good-good; bad-bad) or incongruent (good-bad; bad-good) with the incentive values of the decks. When the affective bias were incongruent it was found that individuals performed significantly worse than the controls in the congruent condition. Additionally, in support of the SMH, individuals in the previously mentioned study who were in the incongruent emotional context failed to develop anticipatory SCR's which has been found to be an accurate indicator of affective guidance during the decision-making process in the IGT (Bechara et al., 2000). Consistent with previous research in this area of social cognition, Davies & Turnbull (2011) also replicated this imbalance between the congruent and incongruent emotional labels associated with feedback in the IGT. However, in order to form this incongruity effect between the decks incentive values, salient pictures were labelled to each deck which were pleasant for disadvantageous (i.e. Deck A-monkey, Deck B – kittens) and unpleasant for advantageous outcomes (i.e. Deck C- Snake; Deck D-Spider) in the IGT. The manipulation of affective values was thus reversed for the congruent condition. In accordance with the present research, Aïte.et.al., (2013), Hinson et al., (2006) and the previously mentioned study (Davies & Turball, 2011), all findings demonstrated how the association of an incongruent effect between salient labels and the rewarding properties of the advantageous decks resulted in impaired performance on the IGT. In relation to the congruent condition, the current research also shows how a congruent association facilitated learning of the contingencies of the decks, leading to enhanced performance in the last 60 trials ($F(1, 36)= 3.58$, $p= .01$). One possibility which may explain this trend of disadvantageous outcomes of decision-making as a result of an inconsistency between emotional facial expressions and task rewards may be related to the association of cognitive appraisals with deck labels. For example, the fact that participant's were aware that their feedback was being presented by a computer based facial expression with either negative (i.e. fearful) or positive (i.e. happy) valence could have been mediated by cognitive processes related to the participants initial decision biases. Alternatively, in line with the SMH, another explanation is that the emotional labels fostered the development of somatic markers in the congruent condition, and then this ability was thus impaired and disrupted in guiding advantageous decision-making when emotional faces were incongruent with the feedback presented. This type of feedback processing may have important implications for pathological gamblers. Decision-making deficits could be overcome through reinforcing a congruent emotional context during feedback processing where gamblers could overcome problems related to the cause of their addiction (Goudriaan, Oosterlaan, de Beurs & van den Brink, 2005).

Stress

The second aim of the study was to determine whether an additional numeric task (PASAT-C; Lejuez et al. 2003) used to induce acute stress on participants would amplify processing of emotional cues which was assumed to cause a reduction in advantageous behaviour in the IGT. However, in relation to the current findings this hypothesis was only partially supported, as the experimental group that performed the stress test performed substantially better than the control conditions. During stress induction an increase in SCR's and heart rate was found, which clearly indicated that participants experienced levels of arousal to some degree when completing the number task. Although the experimental group performed better on the IGT, this finding was only valid when the emotional context was congruent with the feedback delivered in the IGT; participants in the experimental incongruent group did not differ significantly from the control conditions.

Although previously mentioned studies suggest that anticipatory stress and negative affect can modulate the decision-making processes, (de Vries et al., 2008; Johnson & Tversky., 1983; Preston et al., 2007; Petzold et al., 2010) to date, there is no theoretical evidence to explain why stress should impact the decision-making process in particular ways. From an evolutionary perspective, Cannon (1914) theorised that a stress response is elicited by the organism in order to enhance one's ability to cope in circumstances that require increased attention for action and protection. If this type of situation was to arise, a "fight-or-flight" response would be activated in order to allow the organism to adapt to the adverse effects of the stressors (Nesse & Young, 2000). According to the dual-process theory (Kaheneman, 2003) it is proposed that there are two cognitive routes to decision-making; system 1, which is the heuristic, fast and effortful process, and system 2, which involves more deliberate complex computation of the various choice options. Based on the evolutionary properties of the stress response, it is suggested that instances of stress would recruit their cognitive resources from system 1 (Yu, 2016). In this type of situation, a fear response would be initiated and then avoidance behaviour would be activated with little thought put into the decision process. The main differences between these dual-process systems relate to the amount of dominance and specific ordering of cognitive processes. However, this association between stress and system 1 depends heavily on the type of stressor causing the response. For example, tasks which aim to induce acute stress in a laboratory setting regularly load executive resources such as the TSST (Starcke & Brand, 2012) and the PASAT-C (Lejuez et al. 2003), which are both based on numeric challenges. This would mean that stress that is induced in this way does not follow system 1 pathway, instead these executive tests probe "reasoning operations" which are properties of the analytic resources of system 2. A study was conducted to determine the consequences of incorporating the operation of a logical reasoning system with frugal heuristics (system 1) (Turnbull et al., 2005). In this study the IGT was used as the effortless operation and automatic cognitive processes associated with the intuitive system 1. In order to test this issue subjects were required to perform the IGT and they were also asked to perform a secondary executive task (random number generation) which is known to load on executive function ability (Baddeley & Della Sala, 1996). The two control conditions consisted of one group, which performed no secondary task, and another control who performed a secondary task that was unrelated to reasoning operations and based on system 1. Although the group that performed no secondary task scored the highest in the IGT, it is interesting to note that the individuals who performed the IGT with a secondary executive task performed significantly better than participants who performed the non-executive dual-task. In the present research study, participants were required to acquire cognitive resources from system 2 to perform the PASAT-C and then an intuitive processing style was adopted when completing the IGT. However, significantly different results may have been found if participants were induced to acute stress by the threat of a shock (Keinan, 1987) or the unrelated pressure of exams (Gray, 1999) which would not have required resources from system 2. One explanation for the findings of the present study whereby the effects of the stress inducer seemed to enhance IGT performance may have been a result of intrinsic emotions during the executive task that were relevant to probability and numbers which effectively facilitated advantageous behaviour in the IGT- with one exception. Instances whereby emotional resources were manipulated by the presence of incongruent emotional context led to impaired intuitive processes of system 1, which can be observed in the incongruent experimental condition. Although participants in the experimental cohorts may have been more aware of the specific facts, outcomes and strategies involved in the IGT as a result of performing the PASAT-C, which may have acted as a "warming up" task, they were not consciously aware of the SM's involved in biasing their decisions. This reliance on feedback processing can be clearly observed in EI. Furthermore, this supports the notion that the IGT can be solved by emotional feedback processing under risky conditions resulting in intuitive decision-making which also supports the SMH (Starcke et al., 2011).

Another possible explanation is that the stress task (PASAT-C; Lejuez et al. 2003) may have increased the cost of the switch between the two tasks that experimental participants were required to complete. This relates to the individual actively recruiting the cognitive resources between task demands and prolonging the switch between two tasks (Plessow, Kiesel & Kirschbaum, 2012). An increased time frame spent on this switch could have enhanced performance on the IGT because the participants may have spent more time analysing the alternative options during decision-making. In order to discover if this was a factor which may have led to the experimental cohort performing better in the congruent condition, additional research should study the effects of changes in speed in task execution between stressed and non-stressed participants. Additionally this shift between tasks may have evoked a cognitive inflexibility within participants from serial processing (PASAT-C) to parallel-task processing in the IGT, causing a cognitive shift to a more simplified response strategy (system 2-system1) which could benefit advantageous decision-making when the emotional context was congruent. However, when the feedback processing was modified, performance was thus impaired as a result. The effect of switching between different types of processing has been demonstrated in a study with rodents, where simplifying cognitive resources led to enhanced performance (Schwabe, Schächinger, de Kloet & Oitzl, 2010). Additionally, participants in EI may also have been decision makers with lower executive functions which have been found to be associated with reliance on learning from feedback (Brand et al., 2009). Therefore, these individuals may not have had the capacity to effectively perform this strategy shift, leading to poorer performance on the IGT, and also as result of an incongruent emotional context. In relation to this idea, future research should perform executive functioning tests on all participants in order to investigate this phenomenon.

Emotional intelligence is the ability to have adequate knowledge about emotions and using them adaptively allowing one to reason about the source of their emotions (Salovey & Mayer, 1990). This relates directly to the ability-approach model proposed by Mayer and Salovey (1997) which focused primarily on emotional understanding ability. In this model, the association between the cause and effect of emotions with particular life events are effectively analysed, which is based on forward (predicting which emotions would affect events happening in the here and now) and also backward analysis (discovering which past events are causing current emotions(MacCann & Roberts, 2008; Mayer & Salovey, 1997). Adults can have significantly varied emotional understanding abilities, and people with higher abilities in this domain can more accurately identify which life events cause particular emotions that they may be feeling. In contrast, individuals with a lower capacity of understanding their emotions would be more inclined to identify the causes of their emotions incorrectly. One of the main advantages of having high emotional intelligence is that people can eliminate the effects of anxiety or stress that would be unrelated to current decisions that they might have to make (Yip & Côté, 2012). Previous research has shown the influence of incidental emotions to bias how much people are attracted to one another (Dutton & Aron, 1974), also in marketing research where emotions have been shown to influence how much customers would be willing to pay for various products (Lerner, Small & Loewenstein, 2004). In relation to risk taking, the effect of incidental stress occurs when individuals misattribute their anxious emotions to performing current decisions rather than to the actual source of their emotions (Slovic, Finucane, Peters & MacGregor, 2002). As a result of misattribution being one of the main causes of the influence of incidental emotions, individuals with high emotional understanding ability clearly identify these carry-over effects. In relation to the present research, individuals in the experimental conditions performed the PASAT-C task while they were connected to GSR equipment to record HR and SCR. Participants were intrigued by the GSR equipment when they entered the lab; most may have never seen this type of apparatus before. Although participants were not told about why GSR measurements were being recorded, a large proportion of students would have presumed that it was related to their performance on the PASAT-C, as both were performed simultaneously. This is one major limitation of the current research, because individuals would have been aware that the PASAT-C task was the event that caused them to feel aroused. Therefore, this eliminated the possibility of misattribution to occur, which has been found to be the cause of the carry-over effect of incidental stress that would lead to risk taking behaviour in the IGT. A more appropriate procedure would be to collect data over two different time periods so that participants would be unable to suspect the source of their induced emotion, resulting in a more reliable measure of testing the effects of incidental emotions on decision-making.

The type of sample used in the current research may also be a contributing factor in understanding why the PASAT-C task did not cause a negative effect on performance on the IGT. Participants for this study were recruited from the National College of Ireland, therefore all individuals were third level students. The question which must be addressed is whether this stress task was emotionally challenging for this sample of participants? Although cognitive intelligence measures do not predict emotional intelligence abilities, a more diverse sample of participants may have been more effectively generalised beyond the student population. The emotional understanding ability of participants would also be an appropriate measure in order to control for this extraneous effect of emotional intelligence, which is also another limitation of the current research. Hypothetically, the students involved in the experimental conditions of this study may have been proficient in understanding their own emotional fluctuations and also their own emotional "hunches" (Bechara et al., 1997), and further, capable of using this knowledge to facilitate their ability to choose advantageously in the IGT when the emotional context was congruent.

Limitations

In relation to the PASAT-C task used in this study in an attempt to induce acute stress in participants, it was shown from GSR measurements that the task did cause an increase in arousal levels. However it is questionable as to what type of effect this task elicited on experimental subjects. One possibility is that this task may have evoked intrinsic emotions in subjects that were related to the task. For example, the stress task was based on the calculation of number sequences, which may have elicited emotions that are related to the IGT, such as increased attention to number sequences which is also related to the IGT as it focuses on maximising one's profits with a loan of play money and determining the probability of various outcome choices. Alternatively, the influence of extrinsic emotions may have been a more effective inducer of stress, such as the anticipatory stress of giving a public speech (Preston et al., 2007). Future research should explore incidental emotions by induction tests that are unrelated to the decision-making task and implemented on participants discretely during the experimental process. It would be paramount to ensure that deception about the source of their stress is sustained throughout, in order to explore this interaction effect more accurately. In addition, an interesting consideration for future research would be to record the reaction times and final scores of participants who completed the PASAT-C task. In this way, direct associations between speed on PASAT-C task, GSR measurements and also IGT performance could be demonstrated to further explore the effects of incidental emotions on decision-making.

A gradual learning curve across the 5 blocks in the IGT was not found in the control conditions of this experiment. This may have been a result of this study being underpowered with the relatively small sample size (n=40). Alternatively, the calming video that the control participants watched could have also had an impact on IGT performance. Some research suggests that relaxing music is sometimes used to distract individuals from stressful stimuli (White, 1999). If this task was effective in inducing a calm and relaxed mood, it may have been that the calming effect diverted participant's attention too much and therefore served as a distracter from learning in the IGT. In order to provide more valid and reliable results, the control condition should have completed a task similar to the experimental condition without the effect of the emotional stressor. The non-executive task used in Turnbull et al., (2005) study may have been more appropriate whereby control subjects were simply asked to recite the sequence of numbers 1 through to number 9. In addition, the present study did not examine the difference in GSR measurements between the experimental and the control conditions. This data was only used to test the effects of the stress task on experimental participants. Therefore, another possible explanation would be that participants in the control condition did not take the task as seriously as subjects in the experimental conditions, as GSR equipment was not present; an influence which may have added an element of intrigue to the study for some individuals who took part.

Although SCR measurements were recorded in this study to investigate the effects of the PASAT-C on arousal levels, another limitation of this study is that SCR's were not recorded during performance on the IGT. Usually, as an index of SM's many studies have recorded SCR's during the IGT before and after the decision maker chooses an outcome. In this way, the researcher would be able to explore the "reward/punishment SCR's" and compare the effects of the manipulation of the emotional context of control subjects in relation to anticipatory SCR's. These responses would usually be triggered in the 5 second window before selecting from a specific deck (Bechara et al., 2005), which would generate accurate findings relating to non-conscious SM's. It would be particularly interesting to observe these effects when the emotional context is incongruent with the feedback presented, also recording SCR's during this time of feedback processing. Recording emotional reactivity during performance on the IGT would also be a more effective approach in analysing the effects of incidental emotions that may have carried over from the PASAT-C task. This would provide a more specific explanation for how emotions exert their impact on social cognition during the decision-making process. Using this method, one would be able to find out whether the PASAT-C task and the modified emotional feedback cues were beneficial to the creation of SM's during decision-making, or whether they caused interference. Furthermore, additional research should also focus on measuring neurochemical substrates such as dopamine and serotonin, as it is possible that this is where the modulator effects of stress and emotional feedback processing may influence social cognition in the IGT.

One of the strengths of this study is that it incorporated an equal gender balance into the sample size in order to provide more generalized results. Although gender effects were not controlled for during analysis it would be important to investigate these differences; there is extensive research available indicating a gender divergence in decision-making strategies. In relation to IGT performance it has been consistently found that stressed males take part in more risk-taking behaviour, choosing cards that would seem attractive at first but disadvantageous in the long run. This resulted in lower profits overall when they were compared to their female counterparts who also performed the stress task (Preston et al., 2007; Van den Bos, Harteveld, & Stoop, 2009). Previous research has found that stress can significantly intensify behavioural biases, showing that decision makers who would usually be more cautious and risk-averse will play it safe, while individuals who usually tend to be risk-seekers would choose more risky outcomes (Porcelli & Delgado, 2009). Therefore, individual differences should also be recorded for each participant using a specific questionnaire to probe risk taking behaviour in future research.

Conclusion

This present study provides a conceptual replication of Aïte.et.al., (2013) research, and also supplies empirical evidence that the manipulation of the congruency of emotional context with feedback presented in the IGT significantly affects performance outcome. Despite the control conditions inaccurately learning the contingencies of the task, performance in the experimental conditions improved in the congruent emotional context, and as expected, performance was impaired in the incongruent condition. It is inferred from the findings that these effects were a result of reinforcement of SM's in the congruent group assisting the creation of affective signals, and disruption of SM's in the incongruent group having the opposite effect; an influence which is known to guide advantageous behaviour in the IGT (Bechara, Tranel & Damasio, 2000). In relation to the complex issue of the relationship between stress and decision-making, this study provides an extension of the existing literature regarding the modulation of stress on decision-making through beneficial drivers elicited by a secondary executive task. Specifically, this study has important implications for the induction of acute stress in a laboratory setting. It provides useful guidelines for future research in relation to the importance of deception when investigating the effects of the carry-over of emotions from one situation to the next. Some previous research findings run counter to the results found in this study suggesting that stress has detrimental effects on decision-making. However, it is important to note from this study that it depends largely on the type of stress task used to induce acute stress, and whether the demands of the task require parallel or serial cognitive processing styles. The main aim was thus partially supported. Although stressed participants performed better than control conditions, it was found that the experimental cohort processed emotional feedback more readily in an incongruent emotional context.

There is a gap in social cognition literature in relation to the impact of feedback processing on emotion-based learning and the boundary effects that unrelated factors could potentially have for SMH theories. This study provides a platform for future research in this area, and suggests that it would be of benefit to put in place facilities to educate people about the importance of incidental emotions and unconscious affective biases. As a result of this knowledge, people's ability to understand their own emotional fluctuations on the decision-making process could be significantly enhanced leading to better emotional regulation.

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Appendices

Appendix A. Information sheet

The impact of Emotional Cues on decision making and the additional influence of stressful situations

You are invited to participate in a research study that will form the basis for an undergraduate thesis. Please read the following information before deciding whether or not to participate.

What are the objectives of the study? We can only inform you that we are conducting research on the processes underlying the influence of emotional-based learning on decision making under risk. A complete debriefing will be offered after participation, where any questions will be answered.

Do I have to report any personal information? It is the right of the participant to report to the experimenter if they have any type of mental illness or learning disability. Contact details are also required.

What does participation involve? Firstly participants will take part in a short interactive session with two small creative tasks involved. Individuals will be required to complete an arithmetic challenge whereby numbers will be presented on the screen of the computer and you will be required to answer by pressing the correct keys on the keyboard. Participants will then be asked to take part in a decision making task called the Iowa Gambling Task. Individuals who choose from the advantageous decks will receive more points and the person who gains the most points will win a voucher worth 15euro for a café "Seven Wonders" beside the National College of Ireland.

Right to withdraw Participants have the right to withdraw from the research at any time for whatever reason.

Are there any benefits from my participation? While there will be no direct benefit from participation, studies like this can make an important contribution to our understanding of some of the processes underlying the role of emotions in decision making. As such, the findings from this study may be presented at national and international conferences and will be submitted for publication in the psychology news release in National College of Ireland. Interim and final reports will be prepared. However no individual participant will be identified in any publication or presentation. Individuals will have the chance to win a voucher for accuracy of performance during their participation.

Are there any risks involved in participation? There are no risks associated with participation and any inconvenience involved in taking part will be limited.

Confidentiality All individual information collected as part of the study will be used solely during the experimental purposes.

Contact Details
If you have any further questions about the research you can contact:
Researcher: Nicole Donovan, 0879753425 (nicole.donovan@student.ncirl.ie)
Supervisor: Nigel Vahey

Appendix B. Consent Form

I have read and understood the attached Information Leaflet regarding this study. I have had the opportunity to ask questions and discuss the study with the researcher and I have received satisfactory answers to all my questions

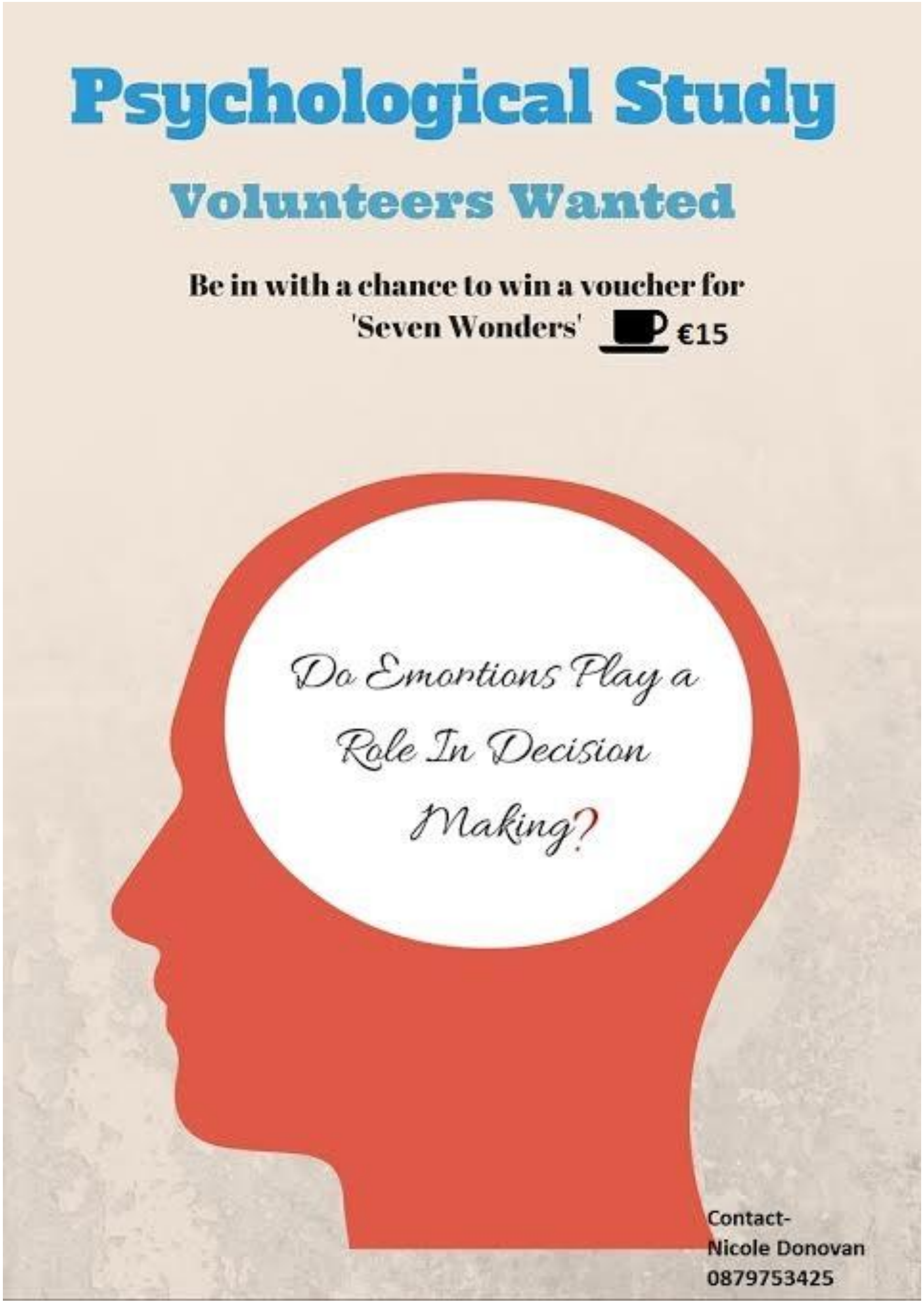
I understand that I am free to withdraw from the study at any time without giving a reason and without this affecting my training

I agree to take part in the study

Participant's Signature: ______________________________ Date: _________

Participant's Name in print: _________________________

Appendix C. Poster



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This signed form must be appended to all hard bound and electronic copies of your thesis submitted to your school