Bial

FINAL REPORT

April 1, 2003 through November 30, 2005

"I just had this feeling…"

A Somatic Marker Approach to Understanding Intuitive Decision Making

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Exploration • Understanding • Application

THE UNIVERSITY OF NORTHAMPTON

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Summary

Recent research by a number of investigators has indicated that autonomic nervous system responses, particularly the skin conductance response (SCR), might serve as indicators of precognitive information processing. These observations strongly suggest that the brain systems that subserve orienting responses, fear responses, and other emotional processing may play a role in translating precognitive information into human behaviour.

Work by Damasio and colleagues has shown the importance of the emotional system in assisting human decision making. It does this primarily by constraining the number of options (from which alternative decisions can be drawn) through a biasing process based on memories of emotional body states—somatic markers in Damasio's terminology—generated by previous experience with the possible options. This project explores the possibility that precognition and other extrasensory information may reach consciousness or influence behaviour in a manner similar to the operations of Damasio's somatic markers.

This project consisted of two experiments of similar design. The first experiment was a close replication of an experiment used by Bechara and Damasio that uses SCRs as an indicator of somatic markers in action while the subject makes decisions in a simulated gambling task now known as the Iowa Gambling Task. As participants "played" the IGT, they learned that some of the card decks involved were riskier than others (because they would sometimes result in financial punishments) and eventually normal participants (as opposed to brain-injured patients) learned to avoid the risky decks. The interesting finding with normal subjects was that the SCRs indicated that the subject knew emotionally that some choices were riskier before they knew it consciously.

In the first experiment of this project we attempted to replicate the Bechara studies very closely while adding an investigation of individual differences using two well-documented personality inventories. Participants completed the NEO-FFI and the Myers-Briggs Type Indicator prior to visiting the laboratory for an IGT session with skin conductance monitoring.

In the second experiment we changed the experiment so that it was not possible for subjects to determine which decks were risky ones by learning which position they occupy. This was done by using a true random number generator to shuffle the deck position prior to each trial. This made it a test of precognitive intuition (and ESP test). The goal was to see if participants would demonstrate SCR responses to the decks that would deliver a punishment, or if they would manage to avoid making disadvantageous choices more than chance would predict. Either

of these outcomes would suggest that participants were making use of precognitive information in their decisions.

Unfortunately the results of both experiments were somewhat disappointing. A full report on the results of the experiment is appended and forms part of this final report.

Activities Report

The project was originally awarded to Dr. Broughton while he was director of Intuition Laboratories, Inc. Shortly after, however, Dr. Broughton relocated to Great Britain where he was appointed Senior Research Fellow at University College Northampton, in Northampton. Permission was obtained both from the Bial Foundation and from University College Northampton for the research project to be transferred to the Psychology Division at UCN where there is already an active programme of parapsychological research underway. This caused a delay in the start of the project so that the project began on April 1, 2003. (Intuition Laboratories still exists but is not actively operating in the United States at the present time. University College Northampton, following a long period of rigorous scrutiny by UK higher education officials, was granted full university status with research degree awarding powers in August 2005 and is now known as The University of Northampton.)

In the first six months of the project, the technical objectives of the project were completed. Specifically:

1. I have developed the computer-based "gambling task" to investigate skin conductance responses while making risky decisions. This is closely modelled on the work of Bechara as outlined in several publications. The original plan was to build the computer programme around the Psylab SC5A skin conductance monitor available from a previous Bial bursary. I have done this, but after relocating the project to Northampton, I additionally built into the programme the capacity to work with another popular skin conductance monitoring system (which is used in the psychology department), the BioPac MP150. Adding this dual functionality took additional time but the result is a flexible testing system that can be used with two popular SCR systems and can easily be modified to work with others. The system was thoroughly tested and "exercised" with pilot subjects.

2. Using the IDL programming language, and with the assistance of Dr. Ed May, I developed analysis programs based on the technologies created under previous Bial bursaries. These permitted completely inde-

pendent replication of the Bechara and Damasio analyses.

3. The basic testing system for this experiment has been designed and built for easy duplication for other researchers.

For the first experiment testing of participants began in early 2004 and continued through March. Testing in the second experiment followed closely and continued through May 2004.

Regrettably data analysis was delayed considerably for several reasons: my relocation within the UK, the need to spend two months teaching in Edinburgh covering a course that would have been taught by the late Professor Robert Morris, and then my accepting a full-time teaching post as a senior lecturer at The University of Northampton. Data analysis was finally carried out in September and October of this year.

Results Summary

In the first experiment the IGT behavioural results (i.e., the card-selection behaviour of the participants) showed a significant learning effect, which was expected, but the learning curve increased rather more slowly than expected based on prior research. The skin conductance results were broadly in line with previous findings by Damasio and colleagues, but failed to reach significance. None of the personality factors from either instrument significantly discriminated IGT performance, though there was some suggestion that participants who scored high on the NEO-FFI openness to experience factor preferred the risky decks more than those who were lower in openness. MBTI judging-perceiving facet was significantly negatively correlated with the anticipatory SCRs in the IGT, especially in the earlier trials, suggesting that judging oriented participants produced larger SCRs.

Most interestingly, the overall pattern of the IGT behavioural results was very similar to that found by other researchers (Evans, Kemish, & Turnbull, 2004) whose research indicated that a university education may attenuate the emotional learning of the IGT. IGT scores in this experiment, which used university participants, were similar to those reported in the Evans study, and both differed from Bechara and Damasio's typical results for normal participants (Bechara & Damasio, 2002; Bechara, Damasio, Tranel, & Damasio, 1997). It seems plausible that a similar education effect was present in this experiment and may be worth investigating further.

The second experiment showed no overall evidence of precognitive intuition either in the behavioural data or the SCR data. MBTI extraversion-introversion (EI) and judging-perceiving (JP) facets correlated significantly negatively with the number of punishments delivered, suggesting that extraverts and perceiving types were more successful at avoiding punishments.

In all cases the significances must be treated cautiously as they were drawn from analyses with multiple variables.

Expenses

Attached is a spreadsheet supplied by the school accountant, who has taken over administration of research grants with the School of Social Sciences which details expenses to June of 2005. A number of expenses are being held pending arrival of the final instalment.

The initial instalment of €20,250 was transferred to Intuition Laboratories. This resulted in a US Dollar amount of $21,264.70 that was transferred by cheque to University College Northampton and resulted in £13,608. The second instalment was paid directly to the University and converted to £13,680.

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"I JUST HAD THIS FEELING..."

A SOMATIC MARKER APPROACH TO UNDERSTANDING INTUITIVE DECISION MAKING

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ABSTRACT: In the continuing search for physiological and behavioural indicators of intuitive psi performance recent work has use autonomic responses of the emotional system to reveal physiological responses that appear to anticipate future emotional shocks. In conventional neuroscience Damasio and colleagues have demonstrated that similar physiological responses of the emotional system play an important role in decision making. In an experiment in which the participant learns to avoid 'risky' decisions the Damasio team have shown that the emotional system learns which decisions are risky before the participant is cognitively aware of the risk. Damasio and others have suggested that this role of the emotional system may underlie conventional intuitive decisions.

It is argued that if precognitive intuition exists as a human ability the efficiencies of evolution could well have amalgamated a system that utilizes decision-relevant precognitive information with existing systems that support the decision-making process, such as the emotional system.

Two experiments were conducted to examine aspects of the emotional system in intuitive decision-making. The first was a replication of the basic Bechara-Damasio experiment exploring individual differences. Fifty participants completed the MBTI and NEO-FFI and a computerized version of the Iowa Gambling Task (IGT) while skin conductance responses (SCR) were monitored. The second experiment, with 24 participants, was similar to the first, except that the IGT was modified to be a test of true precognitive intuition (by randomizing the card deck placement).

In the first experiment the IGT behavioural results (card-selection) demonstrated a significant learning effect, but not as early in the run as typically seen. Anticipatory SCR results were broadly similar to that found by the Damasio team, but failed to reach significance. None of the personality factors from either test significantly discriminated IGT behavioural performance, though the NEO-FFI openness to experience factor was suggestive that participants high on openness preferred risky choices. MBTI judging-perceiving facet was significantly negatively correlated with anticipatory SCRs, especially in the earlier trials, suggesting that judging oriented participants produced higher anticipatory SCRs. Overall, the IGT behavioural performance most closely represented other recent research that demonstrated university education may attenuate emotional learning in the IGT, and it is suggested that something similar may be operative in this experiment.

The second experiment showed no overall evidence of precognitive intuition either in the behavioural or the SCR data. MBTI facets extroversion-introversion (EI) and judging-perceiving (JP) correlated significantly with the number of punishments received with the extraverts and perceiving types receiving fewer punishments than introverts and judging types, however these significances must be treated cautiously.

A principal challenge for parapsychology is to identify the brain components involved in the acquisition and utilization of extrasensory or intuitive information. Recent developments in emotion research, particularly the growing understanding of the relationship between the emotional systems of the brain and its decision-making processes, opens new avenues for intuition research. This project drew upon several lines of research in parapsychology and neurophysiology to explore a new approach to understanding how anomalous information might influence behaviour.

Physiological evidence of ESP

Systematic searching for physiological indicators of ESP began in the 1960s with the work of Douglas Dean (E. D. Dean, 1962, 1966; E. D. Dean & Nash, 1967) who reported evidence for ESP between an agent and a subject in finger plethysmograph recordings from the subject. Tart (1963) reported evidence for ESP in an experiment in which the agent (Tart) received electric shocks while the subject's skin conductance, finger pulse volume, and EEG were being monitored. Subsequently, skin conductance, as a measure of arousal, shifted from being used as a possible indicator of ESP to being used as a target in apparent psychokinesis experiments. Seen by many as an analogue for mental healing, this research, known as DMILS (distant mental influence on living systems) demonstrated that persons ("influencers") could intentionally alter the skin conductance of a distant subject (for reviews, see Braud & Schlitz, 1989; for reviews, see Schlitz & Braud, 1997; Schmidt, Schneider, Utts, & Walach, 2002).

Taking a different approach, Levin and Kennedy (Levin & Kennedy, 1975) and later Hartwell (1978) looked for evidence of ESP in experiments which examined subjects' contingent negative variation (CNV), a slow brainwave potential seen just prior to making voluntary acts, in conjunction with presumably ESP-influenced actions. These experiments also provided promising, though not unequivocal, evidence of ESP. More recently, brain wave research in the form of studies of event related potentials (ERPs) linked to psi task performance have been conducted by Don and his team (for a summary see Don, McDonough, & Warren, 1998), who also report promising indicators of ESP processing in the brain.

One of the important developments in the search for physiological indicators came several years ago when Radin introduced a new method for using human autonomic nervous system (ANS) responses as indicators of precognition (Radin, 1997). Radin's method uses one of the strongest autonomic reactions, the orienting response, a set of psychophysical changes experienced by an organism facing a "fight or flight" situation. In humans, the physiological reactions include dilation of the pupils, increased sweating, heart rate changes and vasoconstriction.

In Radin's experiments, a subject sits comfortably in a chair while skin conductance, heart rate and blood volume are monitored. On a computer screen, the subject is presented with a randomly selected sequence of calm or emotionally arousing pictures. The calm pictures may include images of flowers, file cabinets, furniture, while the arousing pictures may include mutilated bodies, scenes of threat and violence, or erotic images. As expected, the calm pictures elicit little or no orienting response while the arousing pictures elicit a pronounced orienting response. To look for evidence of precognition, or *presentiment,* as he termed it, Radin examined the physiological records for *5 seconds prior to the exposure of the image*. Radin found that just prior to the exposure of a picture, skin conductance would rise, but it would rise more prior to an arousing picture than a calm one, even though the subject had no way of knowing what type of picture would appear.

Since Radin's first studies of the "orienting pre-sponse," there have been a number of replications and considerations of possible artefacts (Bierman, 1999, 2000; Bierman & Radin, 1997; Radin, 1998, 2000). Bierman has recently used a similar experimental design to look for evidence of the pre-sponse using fMRI (Bierman & Scholte, 2002), with encouraging results.

Two recent Bial-sponsored projects have made important improvements to the methodology and analysis for this type of research. May and colleagues reported two experiments in which a startle paradigm (shocks or loud noise) replaced the emotionally arousing images and found strong evidence for "prestimulus response" (PSR), the latest name for the phenomenon (May, Vassy, & Spottiswoode, 2002). Importantly, May, et al. observed that the PSR phenomena might consist of one or more smaller skin conductance responses (SCRs) that occur immediately prior to stimulus onset, rather than the small rise in tonic skin conductance level (SCL) that earlier work showed. It should be noted that the earlier work averaged the skin conductance for the two conditions, and this could cause multiple SCRs distributed in the prestimulus period to look like a rise in SCL. Broughton (2002a) did not find overall evidence of a PSR effect, however his data confirmed the observations by May et al. concerning the nature of the PSR effect.

Intuition and Precognition

Intuition is a concept familiar to all, highly prized in business, but not much studied by psychologists. Jung (1976/1921) considered intuition as one of the four basic mental functions (along with sensing feeling and thinking), but the more common interpretation is that intuition is a talent for rapid assessment of information resulting in advantageous judgments without conscious awareness (e.g., Hebb, 1946). More recently, some psychologists have been focusing on the practical nature of intuition, trying to understand its operation in the day-to-day operations of the business world (Agor, 1984, 1986; Westcott, 1968). Drawing on the work of Wescott, I have elsewhere described what can be called practical intuition (Broughton, 2002a; Broughton & Bourgeois, 2001) as having three "normal" components:

1. Information in conscious awareness—what one knows about a given situation.
2. Information not within conscious awareness (i.e., deep in long-term memory and not easily accessible). This includes past information acquired either consciously (as in reading something) or unconsciously (as in an overheard conversation, as well as contemporary information gathered unconsciously, such as sensing the emotional state of a colleague.
3. An ability, perhaps more highly developed in some people, to synthesize this conscious and unconscious information and to assess outcome probabilities in an unconscious manner.

To these three normal components, the evidence from parapsychology argues that, for at least some instances of intuition, *precognition* or seeing the future may serve as a fourth component, or may substitute for components 1 or 2. Laboratory evidence for precognition is very robust (Honorton & Ferrari, 1989), and it is one of the best attested forms of spontaneous ESP (Rhine, 1961, 1969). Although many of the spontaneous cases involve dramatic dreams or visions of future events, the greater proportion of them are in the form of strong hunches or feelings that lead to a particular course of action. Rhine (1962) specifically labels these cases as "intuitive" and notes that they are the most common form of spontaneous ESP that occurs in the awake state. Dean (1974) has collected a number of spontaneous ESP cases of the intuitive type that resulted in practical benefits in the business world.

I have argued elsewhere that psi ability should be viewed in an evolutionary context, where it operates in complete integration with all the other remarkable abilities of human consciousness (Broughton, 1988). Evolution has endowed humans with unmatched information gathering and processing capabilities that have brought the species to where it is today in an extremely short span of evolutionary time. Precognitive intuition—seeing the future—may well be just one of the components of this complex system. The "normal" operation of precognition, in contrast with the dramatic examples of prophetic dreams and such that catch our attention, may involve small amounts of information that arrive below the level of consciousness. Schmeidler (1988) has observed that precognitive perceptions generally do not seem to reach the level of conscious awareness. Such a process, when recognized at all, would seem like intuition as it is commonly understood.

Evolution is a remarkably economical process. It is not inclined to build entirely new systems, but rather it adapts existing systems to serve new functions. The way precognitive intuition gets its job done is likely to be in the form of an "add on" or an adaptation of an existing system, and we should keep this in mind when we try to understand how it works.

Emotions and Behaviour

Recent research and a growing understanding of the role of the emotional systems of the brain in human decision-making and behaviour have raised an interesting candidate for one of the brain systems on which evolution may have grafted the means for utilizing precognitive or general extrasensory information.

The important work of Damasio and his colleagues have led to an understanding of the human emotional system in which it plays a crucial role in decision making, a realm that has heretofore been considered the province of the rational (cortical) mind (Damasio, 1994). Formalized as his somatic marker hypothesis (Bechara, Damasio, & Damasio, 2000; Damasio, 1994, 1996), Damasio's model shows how various components of our emotional system interact with memory and other brain systems to produce a highly efficient, rapid-responding, decision-making system ideally suited to the evolutionary survival of humans.

In the somatic marker hypothesis, whenever stimuli are encountered in the environment, the memory of that encounter includes not just the sensory and cognitive aspects, but also the state of the body (the viscera, primarily) that was associated with the emotional reaction to that encounter. This is the *somatic marker* for that mental datum. An encounter with a snake is likely to be associated with a somatic state that includes all aspects of a fear response (sweaty palms, racing heart, queasy stomach), while an encounter with an individual of possible romantic interest might engender a different set of positive emotional responses in the body. When the images of that encounter are recalled, so are the somatic markers (though this is probably not conscious). The somatic marker hypothesis posits that one of the inputs to human reasoning and decision-making is a memory or re-experiencing of the emotional body states (feelings) that prior experience has associated with the specific aspects of the decision or matter under consideration. The hypothesis suggests that somatic markers operate by constraining or biasing the options available for any given decision, thus reducing a potentially very large number of options to a range that is more manageable for a logic and cost-benefit analysis. (Consider, for example, the relative efficiency of a purely logic-based evaluation of possible places to have lunch versus the "I *feel* like Chinese." approach.)[1]

In a recent examination of the various types of spontaneous psychic experiences, which, it may be argued, provide a reasonably good picture of how anomalous or intuitive information operates normally, I noted that there are a good many points of contact between the manner in which spontaneous cases influence behaviour and the way the emotional system influences behaviour along the lines suggested by Damasio (Broughton, 2002b). Dreams, for example, which are the most common means by which psychic information enters human consciousness, seem to involve processing in the limbic system as well as the visual association cortices, as shown by recent PET studies (Braun et al., 1998). Intuitive psychic experiences, the second most common type, often are experienced as feelings, and often result in decisions or behaviours without any cognitive involvement or overt knowledge (see, for example, Stevenson, 1970).

Others have noted that spontaneous ESP is most often associated with emotional situations, such as events involving anxiety or apprehension about significant others (Sannwald, 1963; Schouten, 1979, 1981, 1982). Ullman (1977/1986) notes that psychic dreams often involve situations where there is a potential threat to relationships with loved ones. Evidence from experimental research (Delanoy, 1989; Moss & Gengerelli, 1968) has shown that emotional targets are more likely to be successful than neutral targets in free-response ESP tests.

Thus, there is ample reason to suppose that if evolution has built an ability to deal with anomalous information into human consciousness, it may well have done that by adapting parts of the brain's emotional systems.

Physiology of emotions and decision making

Exploring the role of the ventromedial prefrontal cortex (VPC) in decision making, Bechara et al. devised a novel task to simulate real-life decision making in a situation that involves personal risk and uncertainty (Bechara, Damasio, Damasio, & Anderson, 1994). In the task, the subject was loaned $2,000 (play money) and asked to maximize his or her holdings by drawing reward and penalty cards from four decks of cards. Unknown to the subject, decks A and B offered large rewards (payouts) but even larger penalties (fines), while decks C and D offered smaller rewards but even smaller penalties. Thus, decks A and B offered disadvantageous choices while C and D were advantageous to the subject over the long run. Also, the subject did not know how many times they would be allowed to draw cards (which was 100 times). Bechara et al. found that normal subjects rapidly learned to prefer the good decks (C and D) and avoid the bad decks. Subjects with damage to the VPC consistently preferred the bad decks, but subjects with brain damage elsewhere performed as controls. This task is generally referred to by the developers as the "Gambling Task" (GT) but most other investigators call it the "Iowa Gambling Task" or IGT.

Later Bechara et al. used the same task to further explore these findings in the context of Damasio's somatic marker hypothesis (Bechara, Tranel, Damasio, & Damasio, 1996). Normal subjects and patients with VPC damage performed the card deck task while skin conductance was monitored. Both patients and normals generated SCRs after selecting cards that were followed by rewards or penalties. After a few trials, normal subjects began to generate SCRs prior to selecting a card (while they considered their decision), but VPC patients did not. This was inter-

[1] This is a grossly oversimplified version of a sophisticated and fecund model. The original sources should be consulted for a serious appreciation of the hypothesis.

preted as supporting the somatic marker hypothesis in that VPC patients seemed unable to generate the somatic signals that would bias their decisions away from the disadvantageous decks. In a subsequent experiment (Bechara, Damasio, Tranel, & Damasio, 1997) the team found that normals generated greater anticipatory SCRs prior to choosing from the bad decks than the good decks, while VPC patients generated little or no SCR activity and it did not differ between decks. For normals, this SCR pattern began even before they expressed any awareness that there was a difference between the decks. The authors interpret the findings as demonstrating that non-conscious biases guide behaviour (via somatic markers) even before conscious knowledge does, and that without such biases knowledge itself may be insufficient to ensure advantageous behaviour. In their most recent research, Bechara et al. have demonstrated that the amygdala plays a major role in the creation of the biasing signals and in decision making (Bechara, Damasio, Damasio, & Lee, 1999) leading them to suggest that mechanisms through which emotion modulates memory and decision making may be inseparable in the amygdala (Bechara, Damasio, & Damasio, 2000).

Studies using fMRI along with SCR monitoring in a similar card deck task with normal subjects have shown that specific areas of the brain are activated during the anticipatory SCRs (Critchley, Elliott, Mathias, & Dolan, 2000). Among other areas of the brain (especially the cerebellum), the medial prefrontal cortices were active during SCRs, particularly the right hemisphere. Critchley et al. used a technique that attempted to separate brain activity associated with the generation of the SCR from the feedback of the somatic state, and they observed more activity in the medial prefrontal cortices during the somatic feedback. They interpret their findings as "consistent with the proposal that the peripheral autonomic states are centrally integrated with systems important for motivational behaviour."

The Emotional System and Individual Differences.

Following Damasio and Bechara's initial experiments the IGT, both with and without SCR monitoring, has been used to explore the emotional component of decision making in a variety of ways. Numerous studies have used the IGT to investigate brain and other neural functions in the context of the somatic marker hypothesis (e.g. Bechara & Damasio, 2002; Clark, Manes, Antoun, Sahakian, & Robbins, 2003; North & O'Carroll, 2001), and others have investigated cognitive and behavioural differences. Overman (2004) observed sex differences among adolescents and adults in IGT performance that suggested females were responding to different aspects of the task than males. Crone and colleagues (Crone, Vendel, & van der Molen, 2003) demonstrated that individuals with high cognitive disinhibition (diminished ability to inhibit or withhold responses) performed less well on the standard IGT whereas individuals with high behavioural disinhibition showed no impairment. Schizophrenic patients show a pattern of impaired performance on the IGT that differs both from normals and patients with orbitofrontal cortex (OFC) damage, suggesting that schizophrenics have a pattern of compromised decision making that is different from patients with OFC damage (Shurman, Horan, & Nuechterlein, 2004).

Suzuki and colleagues compared the IGT performance of normals (university students) based on the magnitude of the SCR response in the appraisal part of a trial (when the result of the choice is revealed after a card choice) and found that participants with low SCRs for the appraisal portion persisted with risky choices in the IGT, suggesting that variations in the somatic emotional response may influence the decision process (Suzuki, Hirota, Takasawa, & Shigemasu, 2003).

The education level of the participant has been shown to have an unexpected effect on IGT performance. Evans, Kemish and Turnbull (2004) found that while all participants performed similarly in the early blocks of IGT trials, the less well educated participants continued to improve in later blocks whereas university educated participants did not. In the later blocks of trials the less well educated selected the less risky deck about twice as frequently as the university educated. The investigators interpret this to suggest that tertiary education may cause a greater reliance on cognition over emotion in decision making.

Research Objectives

The converging lines of evidence outlined above point to the possibility that the emotional systems of the human brain and body might have a role in mediating anomalous information into human behaviour or cognitive awareness. The evidence for a prestimulus response marker for ESP suggests that we are seeing that process in action. To date, however, the evidence linking ESP or intuition to the emotional system via the responses of the ANS has come from an experimental design in which the subject remains passive and is presented with various stimuli. If, as I have argued, a main purpose of ESP or intuition is to serve as an aid to improved decision making (Broughton, 1988), then it would be important to see if there is any evidence that precognitive intuition can bias decision making through emotional system responses in a manner similar to somatic markers. The groundbreaking work of Bechara has demonstrated that learned (but still unconscious) biases can improve decision making. Can we also demonstrate that unlearned, precognitive information can bias decision making in the same manner?

The first objective of the project was to replicate independently the findings of Bechara et al. (1996) regarding learned anticipatory SCRs using a system that is integrated with the technology that had been used to investigate PSR effects. At the same time, since there has been little or no investigation of how individual differences might interact with performance in the IGT, the project examined personality factors using scales that have shown promise in parapsychological intuition testing.

The second objective was to adapt the Bechara testing approach to one that would investigate anticipatory SCRs that could be due only to precognitive information and to conduct a pilot study to examine the feasibility of larger projects.

METHOD

Participants

For the replication phase of the project, 50 participants[2] were drawn from the university community, including primarily students but also some staff members. Participants were recruited on the basis of interest and availability. The median age of participants was 21, range 18–60. There were 13 males and 37 females.

For the exploratory phase 24 new participants were obtained in the same manner. The median age of participants in the exploratory phase was 21.5, range 18–44 There were 8 males and 16 females.

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[2] *A total of 53 participants were tested, but early in the process it was discovered that minor* technical problems (subsequently corrected) rendered the data of three participants unusable.

In all cases the exclusion criteria were any indicators of neurological impairment, mental illness, learning disorders or mental retardation.

Measuring learned and precognitive anticipatory SCRs

The basic design of the Bechara gambling task (IGT) is described in a pair of papers (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Tranel, & Damasio, 1997). The subject sits quietly before four decks of cards labelled A, B, C, and D. The subject receives a $2,000 (play money) "loan" and is instructed to turn over cards from the four decks, one at a time, each time the experimenter says "go." The subject knows that the cards will either cause him or her to get more money or to pay a penalty, but knows nothing more. The cards have no intrinsic value but the experimenter, who is present with the subject, reports rewards and penalties according to a pre-programmed schedule. The effect of the schedule is that drawing from decks A and B yields higher rewards, but also higher penalties while decks C and D have smaller rewards but even smaller penalties. Over time, drawing from decks A and B results in a net loss while drawing from decks C and D results in a net gain. Within each pair, the overall result is the same, but decks A and C mete out penalties in smaller increments while B and D have large penalties at longer intervals.

For skin conductance monitoring, the subject sits quietly in a chair while skin conductance is recorded from the non-dominant hand. With minimal movement, the subject uses his or her dominant hand to turn over the cards, but makes no other moves. The anticipatory period (for anticipatory SCRs) is defined as the period from when the experimenter announces the reward/penalty to when the subject picks up a card.

For the purposes of this project, the IGT was implemented in a computer program and the subject used a conveniently placed mouse to make his or her choices with the dominant hand. The mouse and mouse pad were placed on padded 'lap tray' that the participant placed on his or her lap, making it possible to move the mouse with only the slightest of wrist and hand movement. The same program also collected the skin conductance data from the monitoring device and synchronized it with the gambling task events. One modification was introduced to avoid the possibility of positional bias in the choice of cards. The position of the pair of advantageous and disadvantageous decks was randomly changed from left to right side from participant to participant. Additional software for this was developed based on that by May (May, Vassy, & Spottiswoode, 2002) for use in PSR experiments.

The precognitive version of the task operated in the same manner, but instead of a programmed schedule of rewards and penalties, the determination of rewards and penalties was governed by a true random process. Several options for implementing a truly random schedule were evaluated during the development of the program. The method selected was to use the existing reward schedule, but randomize the decks under the labels. This was equivalent to randomly re-arranging the four cards on each trial in an otherwise standard IGT test.

Psychophysiology

Skin Conductance (SC) was measured using a "Psylab" SC5A-SA digitizing skin conductance coupler from Contact Precision Instruments. This is a high-quality device with 0.1 μSiemens accuracy, a self-calibrating function, and 24-bit resolution. Sampling is at 40Hz and digitized data are transmitted to a controlling computer via a standard serial data port. Silver-silver chloride electrodes (8-mm) were secured to the distal phalanges of the participant's non-dominant hand using an adhesive collar and suitable electrode paste in accordance with recommended procedures (Boucsein, 1992; Lykken & Venables, 1971).

Psychological Instruments

Two general personality inventories that have been used in previous ESP and intuition research were used. In free-response ESP research the Myers Briggs Type Indicator (MBTI) (Consulting Psychologists Press) has been one of the most successful in predicting scoring. Less work has been done with the NEO-FFI (PAR, Inc.) where only one factor (openness to experience) has shown promise in free-response ESP research. The MBTI, in particular, contains scales for factors (thinking-feeling and judging-intuition) that might be expected to reflect a sensitivity to subtle emotional signals. In this experiment MBTI Form G and NEO-FFI short form were used and feedback was provided to all participants using the standard reporting forms.

Procedure

Participants were informed of what their tasks in the experiment would be and the general purpose (without disclosing details of the hypotheses). All participants signed an informed consent agreement. Participants were given the MBTI and NEO-FFI in an envelope to complete at their convenience, but normally prior to the gambling and skin conductance task.

IGT testing took place in an Industrial Acoustics sound-proofed room in the Perception Laboratory of the Psychology Division. Participants sat in a comfortable chair with a lap desk for the mouse while they engaged with the IGT. Participants were asked to remain still, except for slight movements of the dominant hand to move the mouse in the process of selecting a card on the screen.

Participants were paid £15 on completing the experiment.

For the replication phase of the project an effort was made to duplicate, on a computer, the method used by Bechara et al. (1996). Participants were initially prepared for skin conductance and promptly tested for SCR levels using a simple startle test. All participants produced an acceptable response and then waited a minimum of another 10 minutes to complete acclimatization of the electrodes. On instruction from the experimenter participants began the card selection task while the experimenter monitored performance, pausing to ask the participant about any awareness he or she had about the nature of the decks. On completion participants were debriefed and paid.

Planned Analyses

Planned analyses of the replication study included both an analysis of the skin conductance response and the behavioural performance of the participants. The current method of analyzing the skin conductance data has evolved from the initial method used by Bechara (Bechara, Damasio, Tranel, & Damasio, 1997) in which the analysis segments were determined by the stages at which the participant began to have a hunch or a full understanding of what was happening. The method for segmenting the SCR analysis periods in this project follows that used by Bechara in recent published reports (Bechara & Damasio, 2002). In this version the run is divided in such a way as to approximately represent the pre-punishment phase (1-10), the pre-hunch phase (11-20), hunch phase (21-60), and the concept phase (61-100). For the behavioural analysis the IGT run is divided into 5 equal parts.

For the SCR analysis, the period for measuring the anticipatory SCR was set for 3 seconds prior to making the card selection. This was set in part because it is the same as had been established in prior prestimulus response testing, and because it was a "safe" distance from the appraisal SCR of the prior trial. SCR data was de-trended using a linear fitting routine. The window for examining appraisal or punishment responses was set at 5 seconds following the card selection. For the appraisal period both area under the curve measures and a count of NS-SCRs would be examined following the discovery (Broughton, 2004; May & Spottiswoode, 2003) that pre-stimulus responses in psi research appear to consist of averaged NS-SCRs. Following observations by Bierman (2000) that conventional experiments such as the IGT may contain SCR evidence for precognitive anticipation of undesirable consequences, one of the planned analyses was to compare SCR responses prior to punished choices with non-punished[3]

In the behavioural analysis the measure used is calculated by subtracting the number of times the disadvantageous decks are chosen (A'+B') from the number of times the advantageous decks were chosen (C'+D') resulting in a net score. Net scores were calculated overall and for the 5 periods of the IGT. Participants were dichotomized along the various personality factors from the MBTI and the NEO-FFI and their behavioural performance was examined.

For the exploratory second phase of the project, the principal measure was behavioural, whether or not the participants achieved a higher monetary score than chance would predict (reflecting a combination of picking the higher reward and avoiding the punishments) as well as simply avoiding selecting punishment cards more than chance would predict. In the SCR data, the response before selecting cards with punishments was compared with the non-punished selections.

RESULTS

Phase One—Replication

All statistical analyses reported here were done using SPSS V11. Raw skin conductance data was processed by custom programmes written by Edwin May of the Laboratories for Fundamental Research and modified by the author using IDL 6.1 (Interactive Data Language).

Table 1 presents the general profile of the sample on the two personality tests.

[3] It should be noted, however, that there is a logical problem in this analysis because if an anticipatory SCR response actually has an effect of warning the participant, then it will not result in a punished trial. Thus, the most effective anticipatory SCRs should result in non-punished choices and this analysis (as with Bierman's) will only catch the ineffective anticipatory SCRs.

Table 1
Personality data for participants in phase 1. N=50.

Test/factor	Mean and SD
MBTI	
Extraversion-Introversion	95.00 ± 25.295
Sensing-Intuition	101.96 ± 24.866
Thinking-Feeling	102.68 ± 21.561
Judging-Perceiving	100.48 ± 29.717
NEO-FFI	
Neuroticism	55.26 ± 11.842
Extraversion	53.14 ± 10.729
Openness to experience	54.16 ± 9.043
Agreeableness	45.94 ± 10.481
Conscientiousness	41.48 ± 11.445

Behavioural data: The overall behavioural performance of participants is shown in Figure 1. The general increase of Net Scoring over the 5 blocks is apparent, but the slope of the rise is more gradual than typically found in Bechara type experiments. As expected, the experiment demonstrated significanct evidence of learning, $F(1,49) = 22.4$, $p = 0.00002$[4].

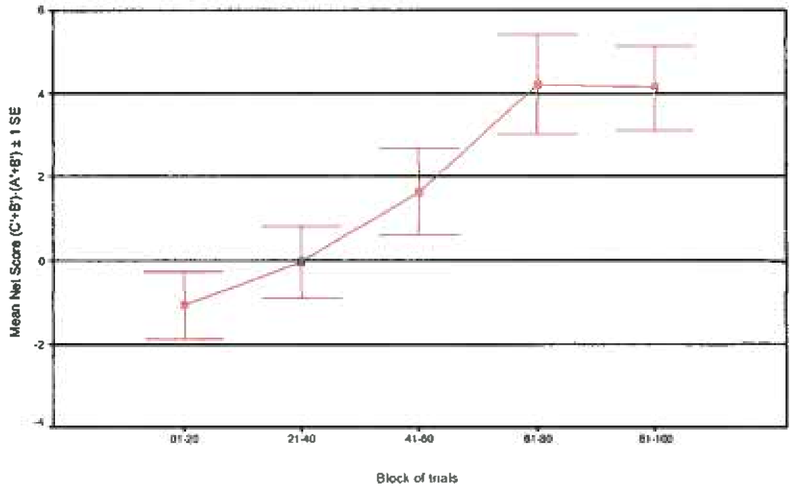

Figure 1. Overall behavioural data (Net Score) of all participants in the phase 1 experiment. Note the incline over time as participants learned to avoid the bad (disadvantageous) decks.

Since this experiment employed a slight modification in the Bechara design (randomly positioning to the left or right side the advantageous and disadvantageous deck pairs) the data were examined to see if there was any difference between positions. No difference was observed, $F(1, 48) = 0.461$, ns.

Participants were classified by MBTI type and performance on the four scales. Introverts performed slightly better than extraverts, but not significantly so, $F(1, 48) = 1.96$, *ns. The other three factors did not discriminate on the behavioural* measure. Performance graphs are in Appendix 1.

Participants were dichotomized on the 5 NEO-FFI factors. Only the openness to experience factor came close to discriminating IGT performance with those

[4] All *p*-values are two-tailed throughout.

participants who were high on openness tending to prefer risky choices more than those who were low on openness, $F(1, 48) = 2.42$, $p = .13$. Behavioural performance graphs for NEO-FFI factors are in Appendix 2.

Following the work of Suzuki et al. (Suzuki, Hirota, Takasawa, & Shigemasu, 2003) which showed that participants who demonstrated *lower* SCR for the appraisal portion of the trial (after the reward and punishment (if any) was revealed) in the early trials tended to persist with more choices of the disadvantageous deck, participants were dichotomized on the appraisal SCR for the first 20 trials. Participants with low appraisal SCRs performed significantly better across all blocks in the IGT than those with higher appraisal SCRs, $F(1,48) = 5.55$, $p = .023$, contradicting Suzuki's findings.

Skin Conductance Response: Fitted SCRs from the 3-second period before bad (disadvantageous) and good (advantageous) decks were averaged over the four periods specified in the analysis as well as over the entire IGT session. The analysis produced a measure equivalent to the area-under-the-curve used by Bechara. The analysis software also produced a measure of the difference between the area under the curve for the bad decks and the good decks in each block of cards for each person. While the overall pattern of results was similar to that found in experiments by Bechara, the results failed even to approach statistical significance, Decks $F(1,49) = 0.037$, *ns*, Blocks $F(2, 147) = 0.330$, *ns*. The results of the bad and good decks separately are shown in figure 2 and the area of difference scores are shown in figure 3.

The basic analyses were repeated using the NS-SCRs ("bumps") but these did not produce anything notably different than the area-under-the-curve analyses.

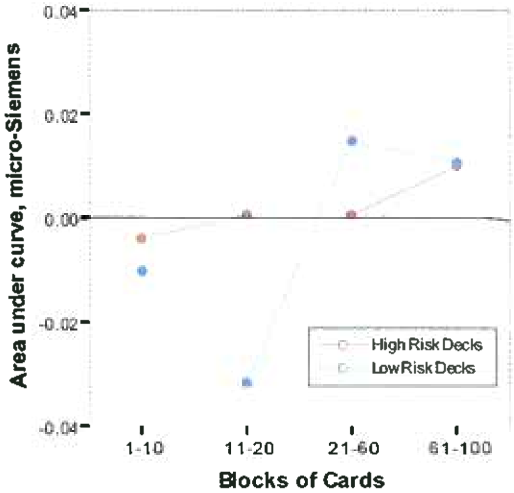

Figure 2. Bad (high risk) decks produced higher SCRs relative to the good decks in the second block of trials, where this difference is thought to reflect the pre-hunch emotional assessment of the riskiness. None of the differences is significant

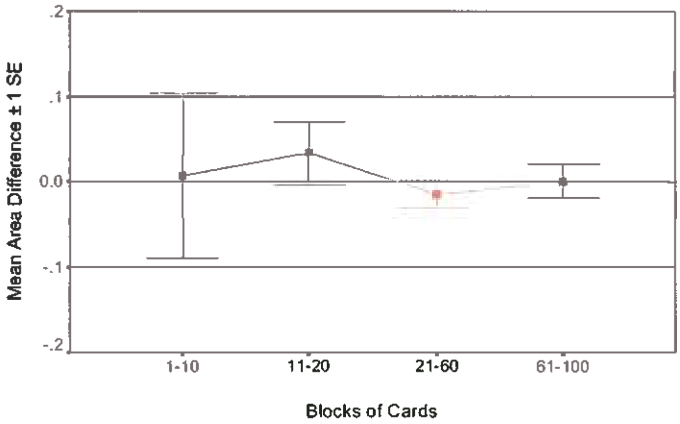

Figure 3. Mean area difference between bad (risky) and good decks. Note in the second block of trials the higher area difference reflects the higher SCR for the bad decks in that block.

Anticipatory SCRs for disadvantageous (high risk) deck selections were examined according to the four MBTI factors and the five factors of the NEO-FFI. The MBTI factor JP (judging-perceiving) was found to be negatively correlated with SCRs ($r = -.33$, $p = .02$) overall, and particularly strongly in the first (1–10) segment of trials ($r = -.48$, $p < .001$), and consistently negative in all other segments. No NEO-FFI factors were correlated with SCR performance.

Anticipatory SCRs prior to punished choices were compared with those prior to unpunished choices. Punished choices were preceded by non-significantly higher SCRs than non-punished choices, $t(49) = 1.57$, ns.

In the general character of the skin conductance of the participants, the MBTI SN (sensing-intuition) factor correlated negatively with participant skin conductance lability ($r = -.31$, two-tailed $p = .03$).

The significance of any of these p-values should be considered cautiously since they are selected from a larger number of related tests.

Phase Two—Exploratory ESP phase

Twenty-four participants were in phase two. The general profile of these participants on the two personality tests is shown in table 2.

Table 2
Personality data for participants in phase 2. N=24.

Test/factor	Mean and SD
MBTI	
Extraversion-Introversion	99.25 ± 22.798
Sensing-Intuition	96.25 ± 23.904
Thinking-Feeling	88.50 ± 19.384
Judging-Perceiving	93.17 ± 27.937
NEO-FFI	
Neuroticism	54.42 ± 11.256
Extraversion	48.25 ± 10.779
Openness to experience	53.21 ± 11.190
Agreeableness	44.50 ± 12.810
Conscientiousness	43.13 ± 11.141

The principal analysis in the exploratory phase, where no learning was possible, was to examine if the behavioural performance indicated that the participants were managing to avoid punishments better than chance would predict. To establish the chance parameters, 100,000 simulated runs of the phase 2 version of the test were done. This produced a normal distribution with a mean of 29.8 and standard deviation of 2.23. The 'winnings' score produced a normal distribution with a mean of 1512.5 and a standard deviation of 453.47.

The mean number of punishments obtained was 29.5, which was not significantly different from the expected mean of 29.8, $t(23) = -0.218$, *ns*. The mean winnings obtained was 1494.8, which was not significantly different from the expected mean of 1512.5, $t(23) = -0.170$, *ns*.

MBTI factors extraversion-introversion (EI) correlated positively with the number of punishments obtained ($r = .546$, $p = .006$). This resulted from a roughly even spread over the grand mean with the E-type participants producing a mean of 28.50 and the I-type participants producing a mean of 30.50. Judging-perceiving (JP) correlated negatively with punishments ($r = -.473$, $p = .02$), and also spanned the grand mean with J-type participants producing a mean of 29.87 and P-type participants producing a mean of 28.89. None of the NEO-FFI factors showed notable correlations.

Skin conductance response analysis: In the exploratory phase, the only SCR effect that might be expected was the possibility of an elevated response prior to punishments suggesting precognitively based anticipatory response. Area under the curve measures for the anticipation period prior to card selections that resulted in punishments were compared with the same prior to cards that did not result in punishments. The difference was not significant, and the pre-punishment selections resulted in slightly lower SCRs, $t(23) = -0.447$, ns. General skin conductance lability for all participants was correlated with the two personality tests. No factors produced significant correlations, and the MBTI SN-type participants produced a non-significant positive correlation ($r = .282$), which was the opposite of that found with phase 1 participants.

Discussion

The behavioural results from phase 1 of this project conform to the general pattern of findings reported by Bechara and Damasio, as well as others, but only weakly so. As can be seen in figure 1, there was clearly significant evidence of learning to avoid the bad decks over the course of the experiment, but it was not as sharply increased in the 21-40 block of trials as one might have expected. This is presumably the block in which the emotional learning is most effective. Also, the concluding Net Score achieved by participants (just over 4) is somewhat lower than normal participants in Bechara's studies (typically 7–8).

It is worth noting, however, that the behavioural results in this study most closely resemble those produced by university undergraduates in a recent study by Evans, Kemish and Turnbull (2004). That investigation compared participants who left school by age 16 with a group of university undergraduates. The school leavers went on to achieve a mean Net Score of about 12 in the final block, whereas the undergraduates reached a mean Net Score of only about 5, similar to the result in the present experiment. Evans, Kemish and Turnbull suggest that "tertiary education specifically discourages the use of emotion-based learning systems in decision-making" (page 240) but also note that probably those with tertiary education rely on both emotional and cognitive input for decision making while those without may be more reliant on emotional system input. The bulk of the participants in the present study were university undergraduates or postgraduates, and the testing took place in a clearly academic context. It is possible that the educational state of the participants as well as the environment worked to attenuate any effect that emotional system input might have. Clearly this issue bears further scrutiny and a variety of factors need to be considered, including the possibility that the experimental demand characteristics were different for the students who came to the experiment (presumably from the department or school in which the study took place) and the school leavers who would have come from outside the university.

The experiment by Evans, Kemish and Turnbull (2004) did not include an SCR component so nothing can be said about the actual response of their participants' emotional systems. In the present study, however, there is little evidence that the emotional system was responding to the risk level involved in the deck choices. Is it the case that education level and possibly the academic context suppresses the unconscious emotional response to the deck choices, or does a greater reliance on the cognitive component of the decision factors cause emotional system information that is present to be ignored? These are questions for future research. Indeed, the proposed interpretation by Evans, Kemish and Turnbull presents a curious paradox if it should be the case that greater education *impairs* effective decision making in certain contexts.

If education makes a difference, it is not unreasonable to expect that personality styles may interact with performance in the IGT since aspects of one's personality often involve how one interprets information or how one decides in certain circumstances. The results from the present study did not provide any clarity with regard to the two well-understood personality measures that were used. The results provided a suggestion that the NEO-FFI openness-to-experience factor bore a negative relationship to performance on the IGT. At one level this would appear to be counterintuitive since the domain of openness is seen to include "aesthetic sensitivity, attentiveness to inner feelings" (Costa & McCrae, 1992, page 15), however it was also noted that persons high on openness are "willing to question authority, and prepared to entertain new ethical, social and political ideas" (page 15), which might suggest more intellectual and cognitive approaches to decision making.

It is not clear what to conclude from the fact that the present study contradicted the findings of Suzuki, et al. (Suzuki, Hirota, Takasawa, & Shigemasu, 2003) who found that participants with low appraisal SCRs (the period when the monetary consequences of the decision are made apparent) in the early part of the experiment were likely to persist with a greater number of disadvantageous choices throughout. In the present study, participants with low appraisal SCRs performed significantly better in the IGT. The statistical effect is, however, somewhat weaker than Suzuki et al.'s and should be treated cautiously.

The absence of a robust confirmation of the basic Bechara and Damasio findings for the SCRs is disappointing. While the a key element—the general rise in SCR response to risky decks over the course of the experiment—is present, as is the higher level of SCR response to risky decks in the crucial card block 11-20, which is after the first punishments have been delivered and learning is presumably taking place, none of the effects were even close to significance. It is not possible to determine why the response (if it was really present) was so attenuated, but suggestions such as the mainly student participant sample or differences in the way physiological measures were obtained deserve consideration.

Punished card choices were preceded by a slightly higher anticipatory SCR than non-punished card choices, but the difference was not significant, and thus fails to confirm Bierman's (2000) observations in other mainstream data.

Despite the lack of an overall confirmation, there was some suggestion of differential SCR response amongst those with different profiles on the MBTI judging-perceiving factor. Those participants with a judging attitude tended to produce stronger anticipatory SCR responses to risky decks than those with a perceiving attitude, particularly early in the card sequence. The judging factor is associated with those who are prone to making decisions, seeking closure, planning operations or organizing activities. The perceiving attitude tends to result in spontaneous, curious and adaptive behaviour. While it is possible to see a logical connection between the activities of a J individual and the SCR responses, it is premature to speculate too broadly on a weak statistical foundation.

In the phase 2 experiment that was designed to look for a precognitive anticipatory SCR there was no evidence of an overall effect in the behavioural data. Participants in general failed to depart significantly from the mean number of punishments expected by chance or the mean amount of winnings expected by chance. Despite the lack of overall effects, the MBTI scales EI and JP correlated significantly with the number of punishments obtained. Participants classified as eExtraverts by the MBTI obtained fewer punishments than introverts, which, if this is a psi effect, would be in accordance with a large amount of previous work (Honorton, Ferrari, & Bem, 1992). MBTI perceiving types also managed to avoid punishments more than judging types, but this does not accord well with the observation in phase 1 that it was the judging types who produced the higher anticipatory SCRs. In the absence of an overall effect caution must be exercised regarding these suggestions.

Phase 2 anticipatory SCR results were nil. The only expected effect was that there would be higher SCRs before choices resulting in punishment and there was no evidence for this. In fact overall there was no evidence of anticipatory SCRs similar to what is found in the earliest stage of the standard Bechara type experiment. This might be expected given that the phase 2 experiment is effectively punishment on a random reinforcement schedule.

In summary, it would seem that phase 1 produced a severely attenuated "Bechara effect," possibly due to the effect of education and testing environment. Certain suggestions of relationships with personality factors that have a measure of face validity were found, but whether these would have been any stronger in the presence of a more robust overall effect remains speculative.

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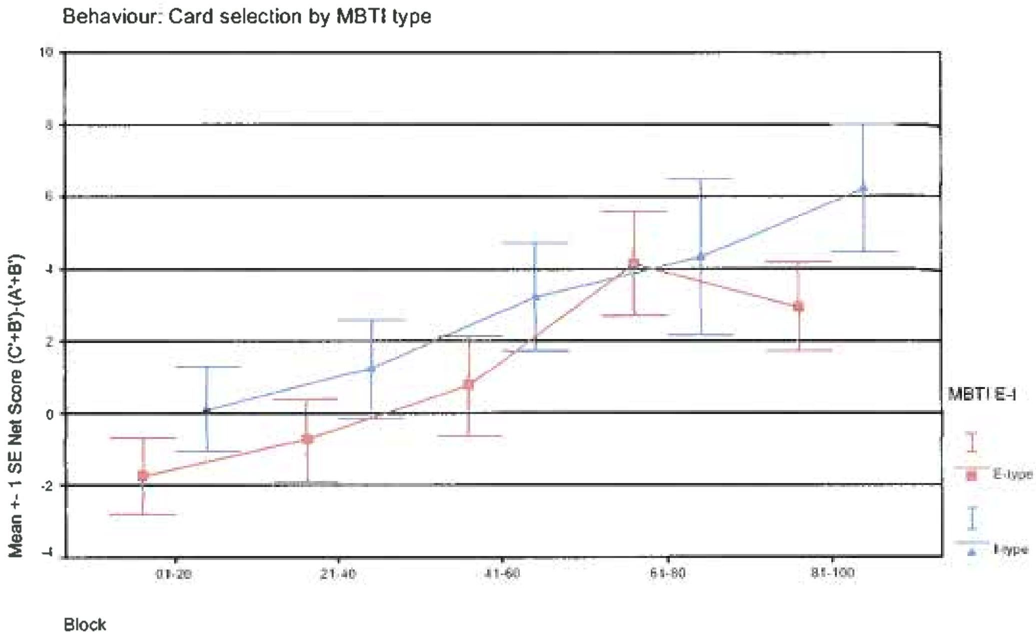
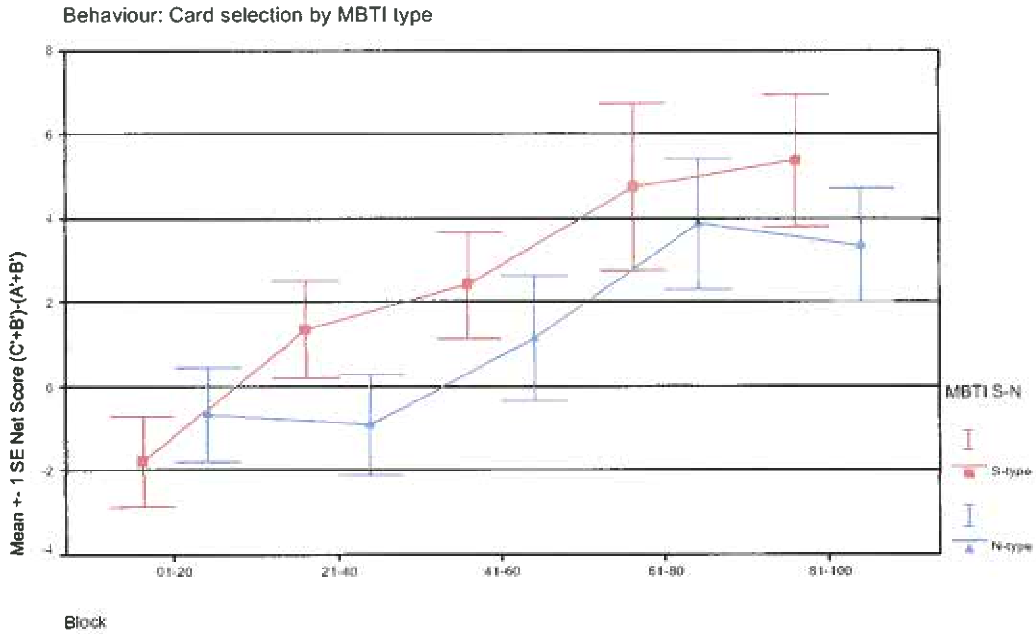
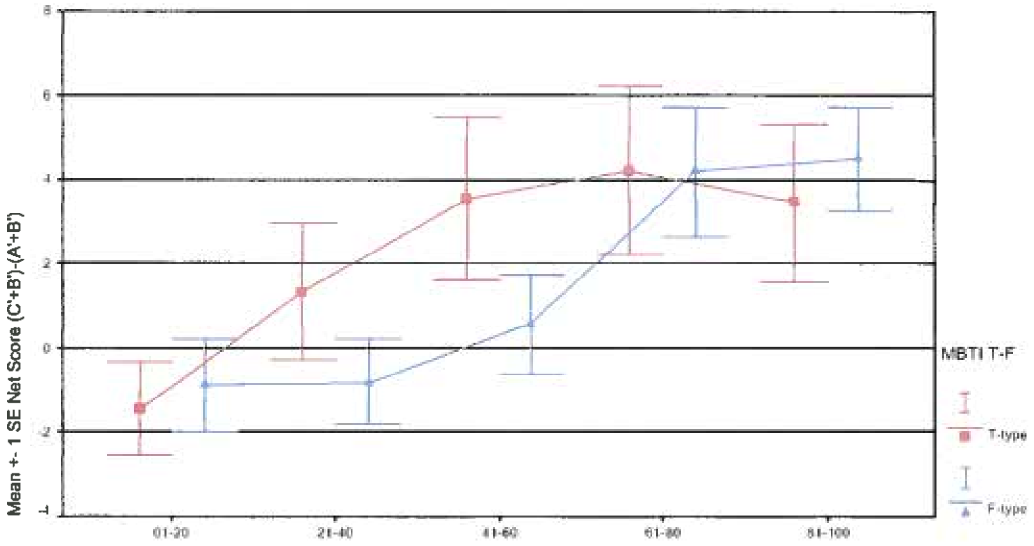
APPENDIX 1: Behavioural performance on IGT by MBTI type





Behaviour: Card selection by MBTI type



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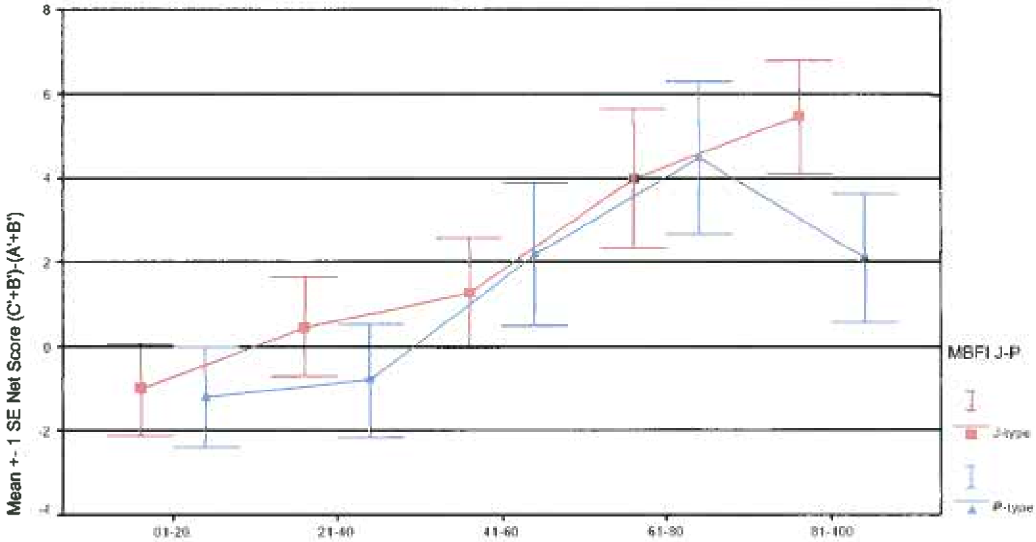
Behaviour: Card selection by MBTI type



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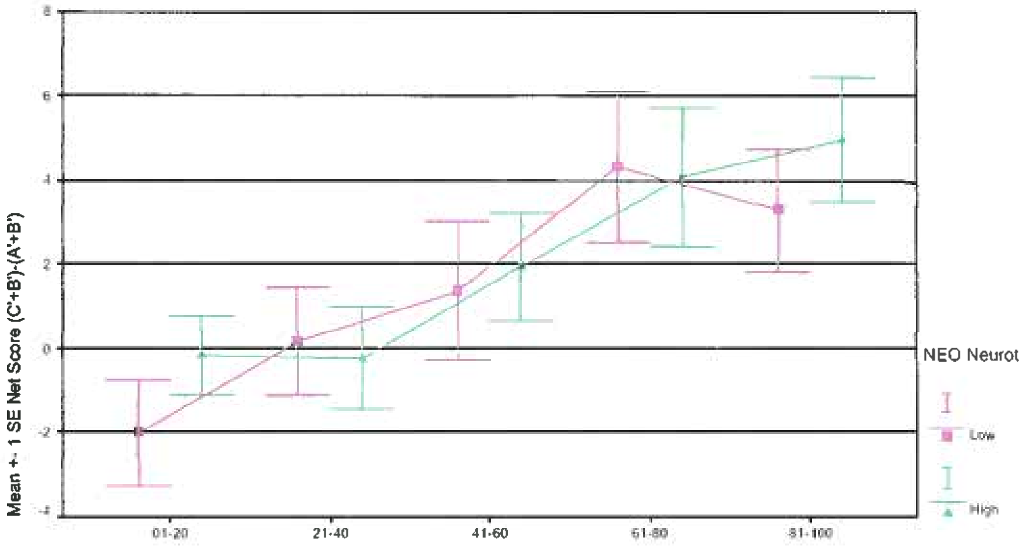
APPENDIX 2: Behavioural performance on IGT by NEO-FFI factor

Behavioural: Card selection by NEO-FFI facet



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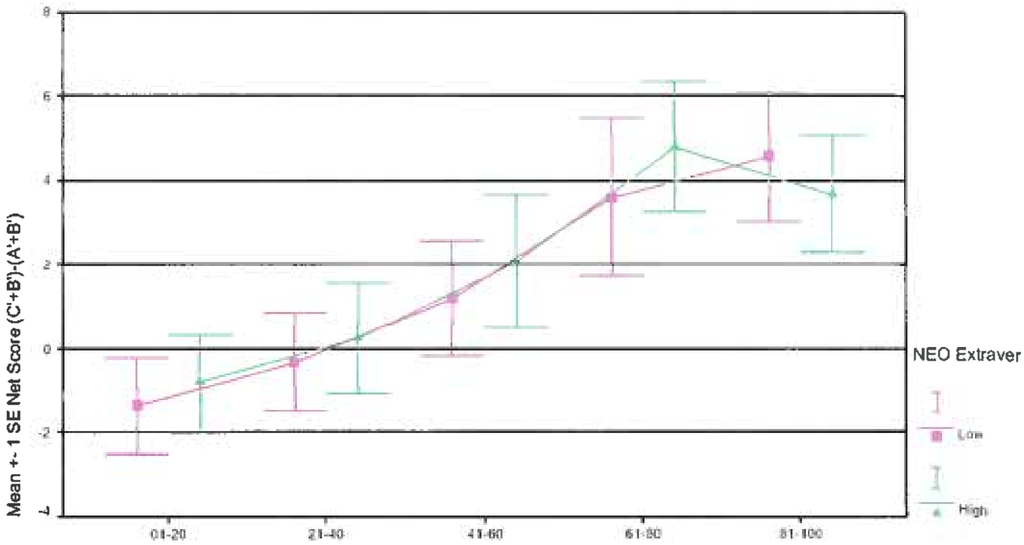
Behavioural: Card selection by NEO-FFI facet



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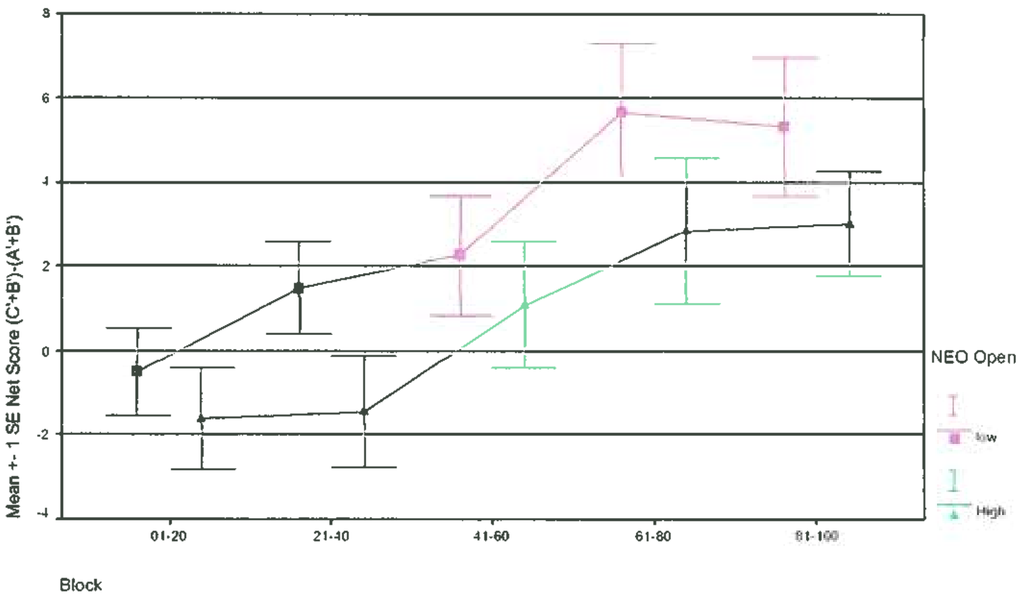
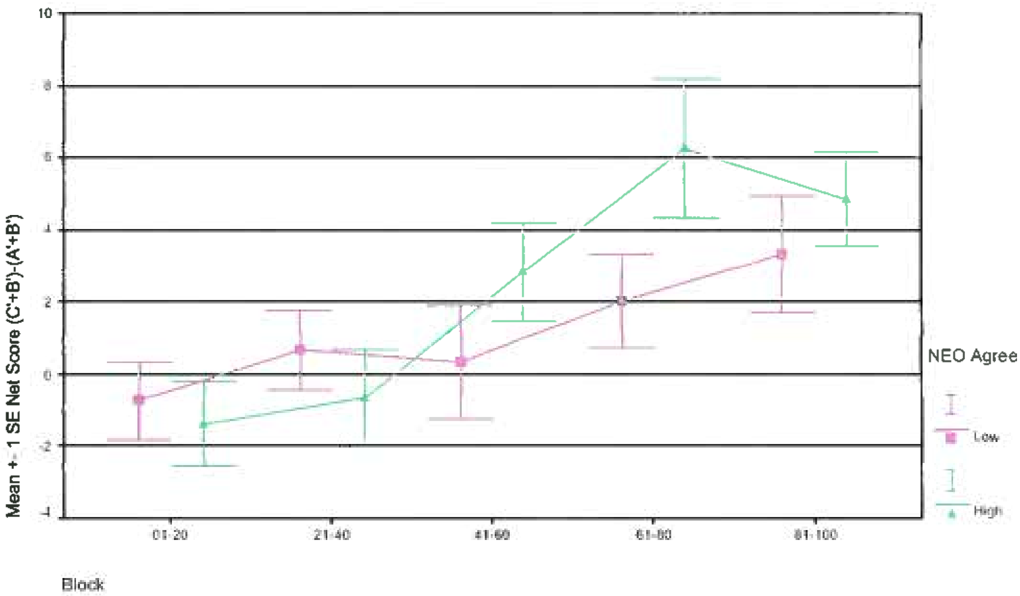
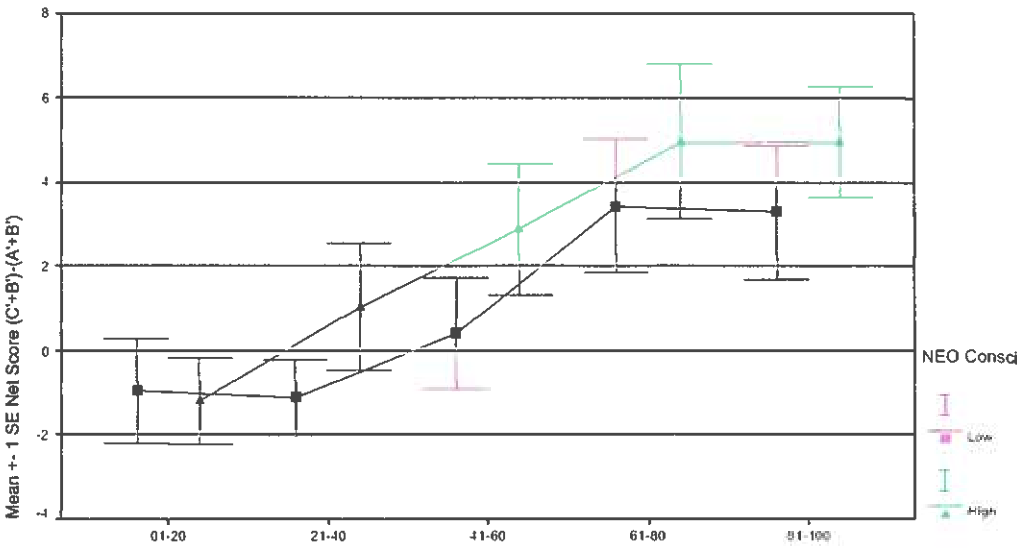
Behavioural: Card selection by NEO-FFI facet



Behavioural: Card selection by NEO-FFI facet



Behavioural: Card selection by NEO-FFI facet



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Bial

Code	**RSSCRS**
Old Code	**RREXFB**
Title	**I just had a feeling" A Somatic marker approach to understanding intuitive b**

Aug 2002 - July 2003

Salary April 03	1,240.71
Salary May 03	1,633.32
Salary June 03	1,633.32
Salary July 03	1,633.32
Research Systems Inc.	1,521.63
support services	1360.81
Income	-13608.09

Aug 2003 - July 2004

Salary Aug 03	1,633.32
Salary Sept 03	1,633.32
Salary Oct 03	1,633.32
Salary Nov 03	1,633.32
Salary Dec 03	1,633.32
Salary Jan 04	1,633.32
Salary Feb 04	1,633.32
Salary March 04	1,633.32
Salary April 04	2,153.15
Expenses	23.03
Expenses	229.87
Dell	1,245.50
Dell	29.38
Payments for participants	300.00
Payments for participants	300.00
Payments for participants	300.00
Income	-13,680.06

Aug 2004 - July 2005

Payments for participants	195
Total Balance at 21/06/05	**-422.55**