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Emotional Awareness and Psychophysiological Markers of Performance on the Iowa Gambling Task

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EMOTIONAL AWARENESS AND PSYCHOPHYSIOLOGICAL MARKERS OF PERFORMANCE ON THE IOWA GAMBLING TASK

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Under the Direction of Tricia King, Ph.D.

ABSTRACT

The present study examines the relationship of emotional awareness to anticipatory psychophysiological markers and performance on the Iowa Gambling Task (IGT). The IGT is a computerized card game that simulates real-life decisions through uncertainty of reward or punishment. The participant's goal is to make advantageous card choices. Anticipatory somatic markers of physiological arousal, like electrodermal activity and heart rate, have been proposed to bias decisions in the IGT. The central hypothesis is that a participant's emotional awareness is related to their ability to make advantageous decisions through biasing psychophysiological responses. The Toronto Alexithymia Scale was used to assess each participant's emotional awareness. Less emotional awareness was associated with enhanced performance on the IGT. However, anticipatory physiological arousal (electrodermal activity and heart rate) and emotional awareness yielded no significant relationships. Findings suggest a need for further research on cognitive models, such as the expectancy valence model, in relation to decision-making.

INDEX WORDS: Decision making, somatic markers, Somatic Marker Hypothesis, Iowa Gambling Task, emotional awareness, Toronto Alexithymia Scale-20

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Introduction

Bridging the gap between our knowledge of physiological and psychological phenomena related to complex decision-making has been a persistent force behind research in the past two decades (Bechara, Damasio, Damasio, & Anderson, 1994; Damasio, 1996; Crone et al., 2004). While a great deal of research has focused on the domains of decision-making, emotions, and physiological responses, few investigators have examined the interrelatedness of these seemingly distinct constructs or as they relate to emotional awareness (Bechara, et al., 1999; 1997; 1996; Suzuki, Hirota, Takasawa & Shigemasu 2003). Some have studied the subjective awareness, education, sex differences, age, and many other clinical samples on the nature of decision-making on the Iowa Gambling task, but none have considered emotional awareness as reported on clinical self-report measures (Evans, Bowman & Turnbull, 2004; Evans, Kemish, and Turnbull, 2004; Bolla, Eldreth, Matochik, and Cadet, 2004; Hooper, Luciana, Conklin, Yarger, 2004). The theories behind these studies originate with the somatic marker hypothesis (SMH) (Bechara et al., 1994).

Antonio Damasio has spent the last several years researching the emotional deficits and decision making processes of individuals with damage to the ventro-medial prefrontal cortex (VMPFC). Interestingly, Damasio (1994) noted that these patients did not exhibit notable intellectual or cognitive deficits. These findings have been contested in psychophysiological literature as researchers continue to disagree over the origins of and mechanisms underlying these deficits (Maia & McClelland, 2004, Dunn et al., 2005). Based on their work with individuals with VMPFC damage, Bechara and colleagues (1994) proposed the SMH to explain the lack of decision-biasing physiological responses and advantageous judgments in these patients. The SMH holds that understanding one's emotions is important in many facets of life and may be driven by psychophysiological biasing responses known as somatic markers. This hypothesis is based on the assumption that emotions are representations and regulatory actions of a complicated host of homeostatic changes that occur in response to different situations (Dunn et al., 2005). In decision-making, emotional situations call on the somatic markers to help distinguish promising options. In normal samples, Bechara et al. (1994, 1996) found a positive correlation between performance on the Iowa Gambling Task (IGT) and differential somatic markers for advantageous or disadvantageous decisions. Anticipatory skin conductance responses were measured for magnitude and shown to occur at different strengths depending on the uncertainty of outcome during a trial of the IGT. The IGT is designed to imitate real life decision-making in terms of uncertainty of reward and punishment. While they are playing the game, participants must determine through selection of cards, which of the decks are advantageous or disadvantageous in terms of the reward that is produced (Bechara et al. (1994; 1996).

Support for the SMH comes from signs of autonomic nervous system arousal while participants are playing the IGT. Autonomic arousal is measured by changes in skin conductance response (SCR), which is thought to influence healthy participants into choosing the advantageous decks. Normal participants showed changes in anticipatory SCR before receiving reward or punishment (Bechara et al. 1994; 1996). As participants became experienced they began to produce significant changes in anticipatory SCR while they were evaluating which deck to choose. Anticipatory event related changes in SCR had a higher magnitude when selecting from a 'risky' deck, when compared to 'safe' decks (Bechara et al., 1994; 1996). Bad or 'risky' decks yield a high immediate gain but larger future loss, and long term loss, while good decks yield a lower immediate gain but a smaller future loss, and a long term gain.

Other psychophysiological indices like electrocardiograms [ECG] have been shown to be useful, in addition to skin conductance, by lending more support for physiological changes while participants are making decisions. Crone, Somsen, Van Beek, and Van Der Molen (2004) have found evidence for the slowing of interbeat intervals (IBIs) as a somatic warning signal in good performers, with a general slowing in all participants before a card choice.

These psychophysiological responses may function at a conscious level, in which the individual recognizes the bodily and emotional changes that are occurring as result of a given situation or an unconscious and unaware level in which the bodily and emotional changes are not recognized dependent on the individual's emotional awareness. Evans, Bowman, and Turnbull (2005) looked at the role of subjective experience and emotional awareness in relation to performance on the Iowa Gambling Task in participants with schizophrenia. They found greater emotional awareness significantly correlated with better performance on the IGT. They state that emotional awareness may be better appreciated in regards to complex decision-making. This study looked at the emotional awareness of the participants through asking participants their analysis of how 'good' or 'bad' each deck was after each 20 card block. In comparison of these ratings to the participant's actual performance, they found that both control participants and patients with schizophrenia were more aware of the nature of the task than their behavioral data showed (Evans et al. 2005). The findings in the current study may give power to previous research by showing similar findings, but with comparison of self-report measures indicating level of emotional awareness rather than descriptions of intuition through the IGT.

In the current study, we evaluated the participant's emotional awareness. The self-report measure of emotional awareness is the twenty-item Toronto Alexithymia Scale [TAS-20], which measures deficits in identifying and describing emotions (Taylor & Bagby, 2004). Alexithymia can be descriptively defined as "difficulties distinguishing between different emotions and insufficient realization that some physical sensations may be the manifestation of emotions, difficulties in verbally expressing emotions, limited imagination and fantasy life, and thoughts are directed at external reality and hardly or not at inner experience" (Kooiman, Spinhoven, Trijsburg, 2002). This measure assumes that the more alexithymic one is, the higher their score on the TAS-20. It is based a scale of 1 to 100, a score greater than or equal 71 qualifies a patient as clinically alexithymic. Alexithymia is not necessarily considered a distinct disorder, but a continuous personality trait (Taylor, 1984), therefore it is useful in non-clinical applications (as cited in Gohm & Clore, 2000). Due to this continuous personality trait, the scale can be considered dimensional, in that, those who score higher are less emotionally aware and those that score lower are more emotionally aware. This construct is measured by the TAS-20, which has been tested, retested, and revised for validity and reliability in different languages and populations (Bagby, Parker, Taylor, 1994a; 1994b; 2003a; 2003b). The TAS-20 is considered the most well-established method of describing the alexithymia construct (Lundh, Johnnson, Sundqvist, and Olsson, 2002). Meta-emotional functioning is measured with the TAS-20 through three factors of alexithymia: difficulty identifying and distinguishing between feelings and somatic sensations (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT).This measure has been used in many different studies to evaluate the relation of alexithymia, including emotional processing, neurobiology, developmental psychology, dreaming, and depression. Its relation to psychophysiology also has been studied in different experimental paradigms. The psychophysiological methods used to appraise the autonomic arousal in relation to this construct include heart rate, blood pressure, skin conductance, muscle activity, and vagal tone (Taylor & Bagby, 2004). The studies have had conflicting results due to the use of different paradigms.

Other researchers have also evaluated the TAS-20 in its relation to emotional awareness. In a study reviewing how well self-report scales that look at emotional experience assess its different facets, Gohm and Clore (2000) found the TAS-20 to excel in evaluating the aspects of clarity and attention. Clarity is defined as "the ability to identify, distinguish, and describe specific emotions" (p.686), while attention to emotion is defined as "the extent to which individuals monitor their emotions, value their emotions, and maximize their experience of emotion" (p.684). The DIF factor was found to measure clarity of emotional experiences. The EOT factor was thought to measure attention to emotions, but their discussion of this factors validity in measuring attention is tentative. They mention the EOT factor as not only pertaining to feelings, but thoughts as well; therefore being also considered part of the absorption aspect. Absorption is described as "the tendency to get immersed in sensory or emotional experiences, to be open to experiencing feelings, and to attend to one's internal state and processes" (p.683). The undefined nature of the EOT factor makes its relevancy to these hypotheses suspect.

Neilsen and Kaszniak (2006) used these factors in conjunction with other self-reports and a heartbeat detection task to evaluate a persons emotional awareness. These were compared to the psychophysiological measures of SCR and facial electromyography (EMG) on meditators and non-meditators while viewing masked and unmasked emotionally charged pictures. They found that meditators, or people with a lot of introspective practice, reported higher clarity and had lower arousal in comparison to non-meditators. This study provides support for the somatic marker hypothesis and lends justification for examining the effects of emotional awareness in decision-making processes (Neilsen & Kaszniak, 2006).

The goal of this study is to examine the relationships between performance on the IGT, psychophysiological responses (SCR and ECG), and self-report measures of emotional awareness (TAS-20) in a sample of college students. This project is hoped to further our understanding of how subjective reports of emotional awareness correlate to arousal (skin conductance responses and heart rate) and complex decision-making. The TAS-20 will be examined to determine the extent of emotional awareness of the participants. A low score is considered to demonstrate high emotional awareness and a high score is low emotional awareness. The first hypothesis is individuals who endorse greater emotional awareness will make more advantageous decisions on the Iowa Gambling Task. Secondly, individuals who endorse greater emotional awareness will exhibit greater change from baseline of anticipatory skin conductance level on ‘risky’ decks of the IGT. Finally, individuals who endorse greater emotional awareness will exhibit a slower heart rate when choosing from ‘good/less risky’ decks.

Methods

Participants

Thirty-seven participants were recruited at Georgia State University from various psychology classes in partial fulfillment of course requirements. The present study was one component of a larger psychophysiological study that focused on examining emotional responses as they relate to memory. The participants ranged in age from 18 to 50 years (*M*=21.32, *SD*=5.97). The sample consisted of more women than men (13 men, 24 women). The sample was racially and ethnically diverse (15 Caucasian, 14 African American, 3 Asian, 1 Cape Verdean, 1 East African, 1 Pacific Islander, and 2 undefined). According to the Edinburgh

Handedness Inventory, 29 participants were dominantly right-handed and 8 were dominantly left-handed. All subjects reported they were healthy, no history of brain injury or surgery, and no psychiatric disorders. Eight participants reported they had experienced a head injury or loss of consciousness. Two participants reported at least a week of hospitalization from a head injury. All other reported head injuries resulted in momentary loss of consciousness. Two participants reported they had experienced a seizure and both only reported one occurrence. Level of education ranged from 1st year to 4th year undergraduate college students (M= 14.02, SD= .80).

The Iowa Gambling Task

A computerized version of the Iowa Gambling Task was utilized in the present study (Bechara et al., 1999). The computerized format is based on the original manually administered task as described by Bechara et al. (1994). This computerized version includes programming features that collect the behavioral data in a text format, standardizes intertrial interval time, and graphically indicates money borrowed and money earned.

The Gambling task presents the participant with four decks of cards; labeled A, B, C, and D above each deck. The participant selects from these decks, using a mouse, throughout the task. Each time a card is chosen the computer produces a distinct, slot-machine like sound. Then it generates a message indicating the amount of money won. Immediately after the signal of money won (lasted about 3 seconds after the card choice), the computer either displays a loss message (lasted about 2.5 seconds) and/or the “please wait” message (lasted about 6 seconds), which allows for psychophysiological recording (described below). At the end of the “please wait” message, the participant is able to select another card. The intertrial interval is about 9 seconds for trials in which participants only win with no punishment, and 11 seconds for trials with both reward and punishment. Every card selection is recorded by the program in a text format, including this information: trial number, deck choice, money won, money lost, total score, money borrowed, and time between the end of the “please wait” message and next card choice in milliseconds. Participants also see two bars at the top of the screen indicating the money they have borrowed or owe (red) and the money the have gained (green). The green bar increases when they win money and decreases when they lose. The only time the red bar changes is when they have lost a certain amount of money, then the computer gives them more money, which is added in $2000 intervals to the red bar.

There are 100 trials in the task and 60 cards in each deck. The backs of the cards look like real cards and with each card selection the card changes to either black or red. The color of the card has no relevance to the outcome, but only occurs because of the task’s basis on the original version of this task (Bechara et al., 1994).

Each deck is set to certain reward and punishment magnitudes and frequencies. Deck A and B are considered to be “disadvantageous” because they lead to a net loss over time, although they have a larger immediate magnitude of money won. Decks C and D are considered to be “advantageous” because they lead to a net gain over time, although they have a smaller immediate magnitude of money won. As opposed to the net gain or loss over time, the magnitudes of the disadvantageous versus the advantageous decks are inversely related to produce an effect of a gambling attitude. The frequencies of punishment are also different according to deck. Decks A and C have a 5:10 probability of being punished, where as, decks B and D have a 1:10 probability of losing. In each trial the participant always wins money, but is occasionally punished according to the chosen deck’s punishment frequency. The task is designed according to these schedules to ensure a level of uncertainty while the participant is trying to learn which decks are best.

To summarize the events in the task, the computer prompts the participant to “please pick a card.” Then depending on the card choice, the program indicates how much money they won, and if they are punished, how much they lost. Then a “please wait” message appears allowing for psychophysiological responses to return to base line. Once this message disappears, the participant is once again prompted to “please pick a card.” Decks A and B are considered to be “disadvantageous” or bad and Decks C and D are “advantageous” or good.

Procedure

Upon arrival, the participants were greeted and presented with an informed consent describing the experiment. After obtaining consent, the participants were asked to go to the restroom and thoroughly wash particular areas of their skin, including both hands, forehead, and areas around the eyes. After returning, the experimenter prepared the skin and attached the electrodes. The participant sat in front of a laptop computer that was on top of a table. After performing other tasks in the experiment, we began the gambling task. The participants were verbally instructed according to the script provided with the gambling task program (Appendix). Once the task was completed the participant was given other tasks related to other elements of the experiment like the mini-mental status exam, a recognition for pictures task related to an earlier task, and several self-report forms ranging from measures of apathy to emotional regulation. Finally, as part of the self-report packet, the participants were given the Toronto Alexithymia Scale (TAS-20). When the self-report measures were completed the participant was debriefed and dismissed.

Psychophysiological Data Recording and Reduction

Participants sat in a comfortable chair in a well lit laboratory. The gambling task was presented on a laptop computer with a 12 inch screen on a flat table in front of a double sided mirror. The participant was instructed to keep their non-dominant hand still on the arm rest of the chair to reduce movement artifact.

The electrocardiogram (ECG) and skin conductance level (SCL) were continuously recorded through the experiment. Event markers denoting the moment of each card selection was entered based on the real-time sound channel in the acquisition file off-line after the experiment. The ECG was recorded from three 1 3/8" disposable, pre-gelled, vinyl electrodes. Two electrodes were placed in the area above of the participant's two lowest rib bones and the ground was placed on the left collar bone. The baseline period for SCL was defined as 4 seconds after the card choice and the anticipatory period for SCL was defined as the 4 seconds immediately preceding the card choice. Skin conductance data was recorded at a constant voltage (0.5 V) with 5 cm wide, Velcro-wrapped AgAg/Cl electrodes attached to the distal phalanx of the middle and index fingers of the non-dominant hand (29 left, 8 right). Electrocardiogram signals were amplified by a Biopac ECG100c amplifier. Skin conductance signals were amplified by a Biopac GSR100c amplifier set to an AC setting. Both amplifiers were part of a Biopac system that sent all amplified signals through a Biopac MP150 digital filter. Once filtered the data was sent via Ethernet cable to a data recording Dell workstation computer in an adjacent laboratory. The data was collected and transformed using Acqknowledge 3.7.3 data acquisition software at a sampling rate of 2500 samples per second. Heart rate data was manually cleaned after software analysis to eliminate any physiologically impossible readings and artifacts. Skin conductance data was screened for excessive noise artifact before analysis in EDA software. The ECG and SCL signals were reduced and analyzed using Mindware Heart Rate Variability Analysis software and Mindware Electrodermal Activity Analysis software.

The 20-item Toronto Alexithymia Scale (TAS-20)

The TAS-20 is a self-report scale aimed at measuring deficits in identifying and describing emotions (Bagby, Parker, & Taylor, 1994). Meta-emotional functioning is measured with the TAS-20 through three factors of alexithymia: difficulty identifying and distinguishing between feelings and somatic sensations (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT). An item on the DIF dimension is “I am often puzzled by sensations in my body.” The DIF element of the TAS-20 is of particular interest in this study. The DDF factor contains items that evaluate how well the person can describe their feelings. One item in this factor is “I am able to describe my feelings easily.” The EOT factor evaluates the participant’s ability to consider their environment in respect to their emotion. An example of this factor’s items is “I prefer to just let things happen rather than to understand why the turned out that way” (Bagby et al., 1994). The EOT factor is not used to evaluate a participant’s emotional awareness because of its controversial definition described in the introduction. The participants rate each item from 1 (strongly disagree) to 5 (strongly agree) scale. The highest possible score on the TAS-20 is 100. A score greater than or equal to 71 is considered to be clinically significant for the diagnosis of alexithymia. Inter-rater reliability coefficients are strong for both the DIF factor and Total TAS-20 score (DIF; men r =0.81, women r = 0.79, all r =0.80; TAS-20; men r =0.86, women r =0.85, all r =0.86; Parker et al., 2006). Validity of this scale is also strong for student samples for both the DIF factor and the TAS-20 score (DIF α=0.79; TAS-20 α=0.80; Bagby et al., 1994a).

Results

The TAS-20 scores were computed into z-scores from gender-specific and total population normative data. This sample exhibited normal distribution characteristics in (M = -.20 ± 1.0 z) DIF factor z-score and TAS-20 total z-score (M = -.07 ± 1.1) (Parker et al., 2003a).

Figure 1 illustrates a general trend of more advantageous decisions on the IGT over time. Males demonstrated larger mean increases between blocks than females; particularly from block 1 to 2 and block 3 to 4. Figure 1 also shows a mean increase in Females exhibited a gradual increase in advantageous decisions over time on the IGT.

Correlation analyses were used to demonstrate the learning trends, as illustrated in Figure 1, among the card choices per block. Starting with Block 2, performance on blocks is shown to predict the future block scores and total score for the task with strong positive correlations. These strong correlations help demonstrate the learning that occurs across blocks. Block 1 does not predict any of the future blocks or total gambling score. Block 2 (21-40) predicts performance for both blocks 3 and 4. Block 3 (41-60) predicts block 4 performance. Block 4 significantly predicts performance for block 5. Most notably, except for block 1, all blocks predict the total score outcome with a significant positive correlation.

Table 1

Correlations among net card choices (good minus bad) per 20 card block

Good Choices	Block 1	Block 2	Block 3	Block 4	Block 5	Total
Block 1	--	-.06	.09	.04	-.02	.25
Block 2		--	.54**	.42**	.28	.63**
Block 3			--	.71**	.25	.79**
Block 4				--	.51**	.85**
Block 5					--	.67**

*$p < .05$ ** $p < .01$

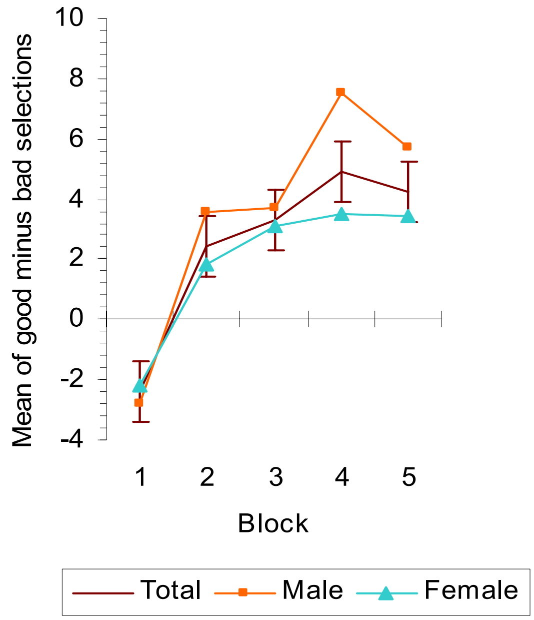

Figure 1. Traditional gambling scores as a function of gender and total to show performance of participants on the Iowa Gambling task.

Hypothesis 1: Individuals who endorse greater emotional awareness will make more advantageous decisions on the IGT.

To test the behavioral aspect of the hypotheses, correlations were run between TAS-DIF factor, TAS-20 total score, and the difference score between disadvantageous and advantageous choices in each block of 20 card selections (e.g. if a participant chose 13 good decks and 7 bad decks in the third block [trials 41-60], then 6 was correlated with the different dimensions of the TAS-20). Pearson's *r* coefficients for these correlations are shown in Table 2. As seen in Table 2, block 3 (trials 41-60) shows significant positive correlations with the DIF factor and total scores for the TAS-20. DIF factor z-scores for males have a strong trend toward a positive correlation with good choices in block 3, but lack significance. Also among the DIF dimension z-scores for females, there were significant positive correlations for block 4 and the total number of good choices. There was no significant age difference between males and females, $t(35)$ = .56, p< .58 or education level, $t(35)$= -1.5, p< .15.

Table 2
Correlations between Z-Score of the Toronto Alexithymia Scale (TAS-20) and card choices (good minus bad) per 20 card block

TAS-20	Block 1	Block 2	Block 3	Block 4	Block 5	Total
Factor 1: DIF	.12	.15	.40*	.31	.00	.29
Male DIF	-.10	-.03	.41	.28	-.29	.03
Female DIF	.20	.32	.41*	.39*	.19	.47*
Total TAS-20	-.11	.16	.35*	.24	-.06	.17
Male TAS-20	-.28	-.19	.16	.10	-.22	.-.12
Female TAS-20	-.08	.40*	.42*	.35	.02	.34

* p < .05

Hypothesis 2: Individuals who endorse greater emotional awareness will exhibit greater change from baseline of anticipatory skin conductance level on 'risky' decks of the IGT.

The next set of analyses examined the relationship between the psychophysiological SCL data, the DIF factor, and TAS-20 total scores. First, correlations were run with the difference in averaged SCL between the baseline and anticipatory periods for the disadvantageous choices per 20 card block and the TAS-20 data. Most of correlation coefficients were not significant in this initial comparison, although there was a significant correlation between SCL difference in Block 1 and z-scored TAS-20 DIF factor for females, total TAS-20 for females, and TAS-20 total. These correlations can be seen in Table 3. Table 4 depicts the means and standard deviation of change in anticipatory SCL per block. There were no significant differences in means and standard deviations between blocks.

Figure 2 illustrates the mean change in SCL per card position in each deck. Notice the larger differences of the bad decks (deck A; M = -.008 ± .211 μS; deck B; M = -.015 ± .254 μS) versus the good decks (deck C; *M* = -.006 ± .191 μS; deck D; *M* = -.0002 ± .240 μS) after the 25th card choice in those decks. In relation to frequency of punishment, decks A and C, which have a punishment frequency of 5:10, and decks B and D, which have a punishment frequency of 1:10, show no Cohen's *d* effect size. In regard to net gain, both bad decks and good decks also show no Cohen's *d* effect sizes.

Table 3

Correlations between Z-Scores of the Toronto Alexithymia Scale (TAS-20) and the difference in averaged skin conductance level (SCL) between the baseline and anticipatory periods for bad choices per 20 card block

TAS-20	Block 1	Block 2	Block 3	Block 4	Block 5
Factor 1: DIF	-.29	-.06	.21	.16	-.03
Male DIF	.18	-.40	.41	.02	-.004
Female DIF	-.43*	-.02	.10	.21	-.04
Total TAS-20	-.33*	-.03	.12	.23	.03
Male TAS-20	-.05	-.41	.24	.09	.006
Female TAS-20	-.41*	.009	.08	.26	.04

* $p < .05$

Table 4

Mean SCL difference by deck by block

Deck	Block 1	Block 2	Block 3	Block 4	Block 5
A	-.037(.102)	.008(.069)	-.004(.097)	.007(.089)	.008(.133)
B	-.009(.058)	-.019(.09)	-.011(.156)	-.032(.148)	-.019(.101)
C	-.016(.157)	.036(.104)	.025(.076)	.002(.157)	.005(.042)
D	-.041(.140)	.029(.094)	-.001(.056)	.006(.082)	.006(.091)

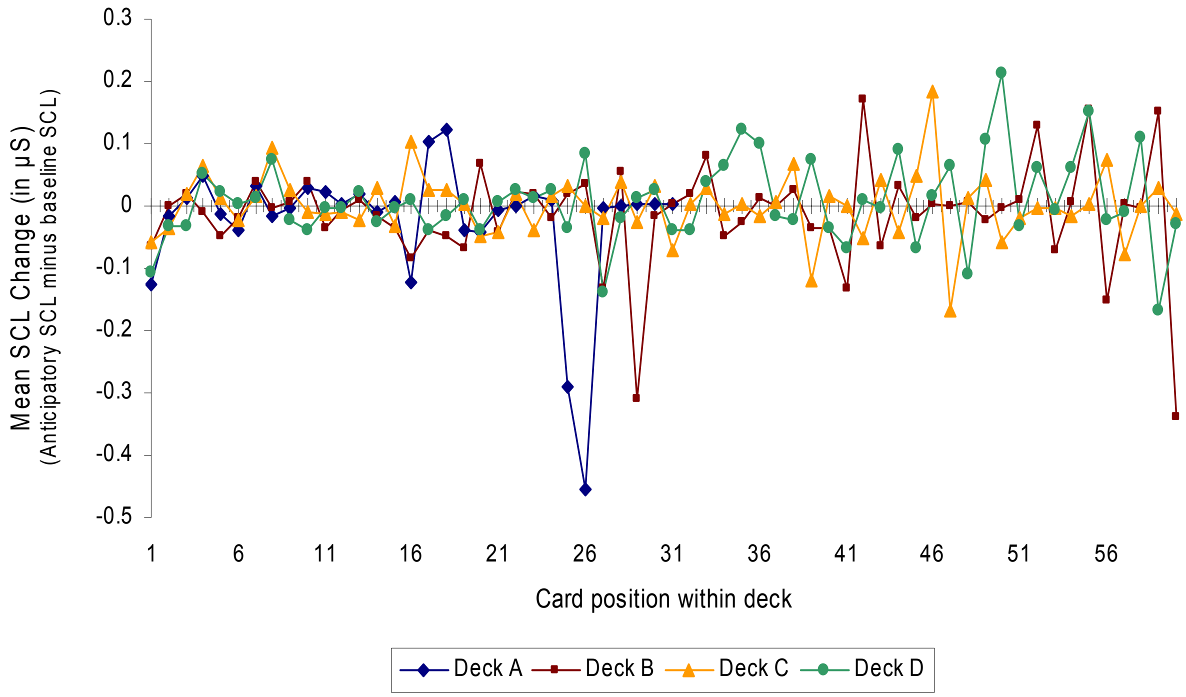

Figure 2. Mean skin conductance level change (SCL) per card position for each deck.
Notes: There are sixty cards per deck and at least one participant made it to the 60th card in decks B, C, and D. The furthest position for deck A is choice 31. Decks A and B are considered "bad" decks and decks C and D are considered "good" decks.

Hypothesis 3: Individuals who endorse greater emotional awareness will exhibit a slower heart rate when choosing from 'good/less risky' decks.

Finally, correlations were run to determine the relationship between the anticipatory inter-beat intervals (IBI) of the heart rate for good choices and the TAS-20. The correlations were not significant, although there were inverse negative and positive trends with males and females. Males tended to have negative correlations with blocks 2 through 5, whereas females tended to have positive correlations with all of the blocks although each was not significant. These correlations are shown in Table 5. Table 6 depicts the means and standard deviation of interbeat interval per block. There were no significant differences in means and standard deviations between blocks.

Figure 3 illustrates the trend of participants' heart rate slowing before choosing good cards (deck C; *M* = 798.96 ± 161.59 ms; deck D; *M* = 782.80 ± 140.48ms) as opposed to bad cards (deck A; *M* = 782.02 ± 142.77 ms; deck B; *M* = 761.43 ± 135.54 ms). Cohen's *d* for heart rate before good cards resulted in a small effect size of 0.11, while heart rate before bad cards also resulted in a small effect size of 0.15. In analysis of effect sizes in heart rate for punishment frequency, decks A and C produced no effect, while decks B and D show a small effect of 0.15.

Table 5

Correlations between Z-scores of the Toronto Alexithymia Scale (TAS-20) and the anticipatory inter-beat interval (IBI) for good choices per 20 card block

TAS-20	Block 1	Block 2	Block 3	Block 4	Block 5
Factor 1: DIF	-.007	-.10	-.17	-.12	-.07
Male DIF	-.19	-.48	-.51	-.46	-.36
Female DIF	.25	.23	.18	.22	.18
Total TAS-20	.02	-.10	-.15	-.11	-.08
Male TAS-20	-.06	-.37	-.38	-.38	-.34
Female TAS-20	.35	.23	.18	.21	.19

* $p < .05$

Table 6

Mean anticipatory IBI by deck by block

Deck	Block 1	Block 2	Block 3	Block 4	Block 5
A	790(138)	745(203)	775(132)	791(141)	777(144)
B	783(133)	772(128)	770(137)	781(133)	773(142)
C	772(132)	773(133)	776(132)	786(131)	769(117)
D	783(131)	776(119)	785(138)	777(135)	779(153)

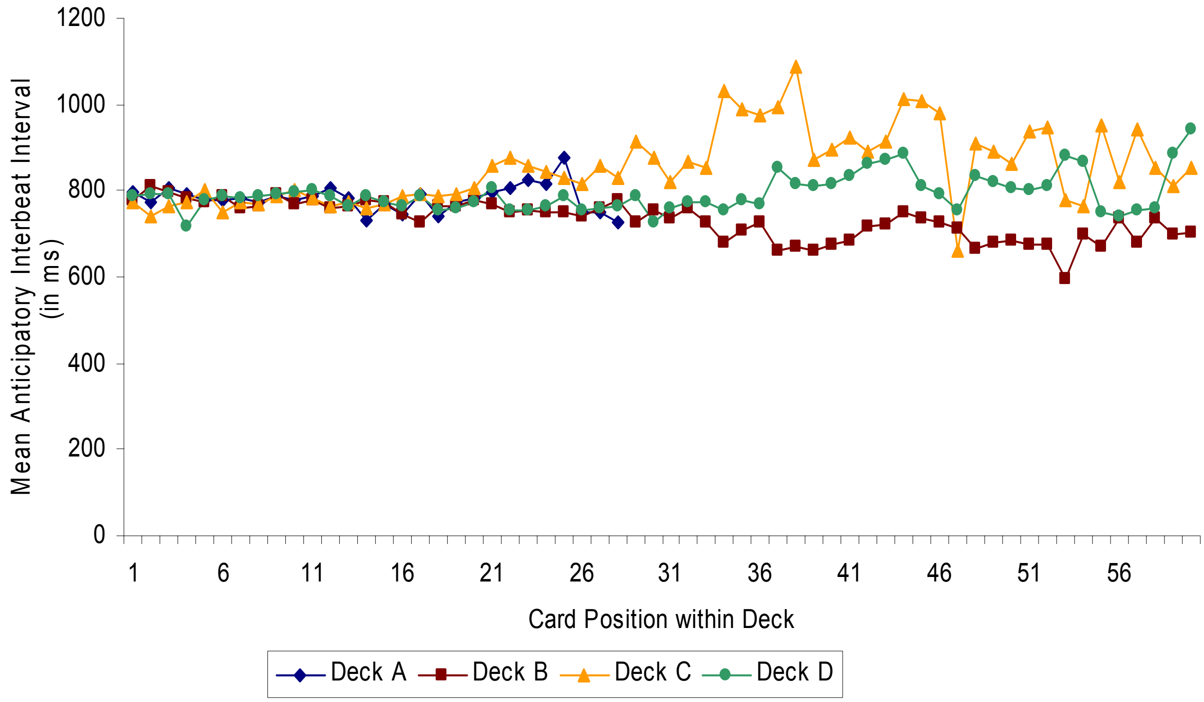

Figure 3. Mean anticipatory Interbeat Interval (IBI) per card position within each deck.
Notes: There are sixty cards per deck and at least one participant made it to the 60th card in decks B, C, and D. The furthest position for deck A is choice 31. Decks A and B are considered "bad" decks and decks C and D are considered "good" decks.

Discussion

Lower emotional awareness, or higher levels of alexithymia, is associated with more advantageous decisions. In regard to previous research and our hypotheses, this finding is counter intuitive. To support the Somatic Marker Hypothesis, greater levels of emotional awareness would relate to better performance. This positive correlation of level of alexithymia and performance is demonstrated in block 3 for the whole group. Participants with low emotional awareness make more advantageous decisions in this block. This finding could suggest that those who are less emotional aware took a rational approach rather than reacting to the hypothesized emotional biases in the task. The lack of emotional awareness may have made these participants use more cognitive strategies in the task, similar to those proposed by Yechiam, Busemeyer, Stout, and Bechara (2005). Yechiam et al. proposes that decision-making on the Iowa Gambling Task is continuously influenced by attention to gains and losses, recent effects, and response sensitivity. This cognitive model is known as the Expectancy-Valence Model. More research in this area is needed to distinguish the cognitive aspects of the Iowa Gambling Task in normal populations.

The same relationship also shows those who endorse greater emotional awareness, or low levels of alexithymia, made more disadvantageous decisions in block 3. These participants may demonstrate more impulsivity, preferring immediate rather than long-term gains, when making decisions. A similar relationship has been found in a study of cocaine abusers on the Iowa Gambling Task (Stout, Busemeyer, & Lin, 2004). Also using the Expectancy-Valence Model, they found that cocaine abusers were less responsive to losses. The current study also demonstrates less responsiveness to losses by those who endorse greater emotional awareness, suggesting that emotional awareness effects impulsivity and importance of immediate rewards in this sample. Future research should use the Expectancy-Valence model to examine the cognitive constructs related to decision-making.

The above relationship was exhibited in block 3. The third block, in past research (Bechara & Damasio, 2005), is designated to be part of the "hunch" period in which participants begin to distinguish between the good and bad decks. The results from this study appear to support that, for this sample, block 3 is the time in which the "hunch" period occurs in relation to those lacking in emotional awareness. Of note, this relationship did not continue to emerge in block 4 and 5. This is also inconsistent with the previous research on the behavioral performance and the somatic marker hypothesis. Future research should continue to examine the course of this relationship.

Interestingly, in our study, a high score in a female's subjective in ability to identify her feelings, which indicates less emotional awareness, predicted advantageous performance in block 3, 4, and the total outcome. This suggests that females with less emotional awareness may have used the cognitive approach proposed earlier. The overall pattern for the entire sample may be driven by the female's significant relationships. It is possible that true differences exist between men and women and how their level of emotional awareness relates to performance on the Iowa Gambling Task.

Gender differences were found in a validation study of the Levels of Emotional Awareness Scale for children (LEAS-C; Bajar, Ciarrochi, Lane, & Deane, 2005). They suggest that gender differences in emotional awareness occur at a young age, with females reporting to be more emotionally aware than males. However, studies of adult gender differences in emotional awareness have shown more similarities than differences between genders (Parker et al., 2003). Our findings could be a function of differential sample sizes between males and females. If the sample sizes were more evenly distributed, similar effects in males may have been demonstrated, therefore showing a relationship between performance in block 3 and emotional awareness in both genders. Gender differences or similarities in emotional awareness's relation to decision-making should be examined in future studies.

Behavioral performance analyses on the IGT shows, beginning with block 2, future choices and total outcomes are predicted by the preceding blocks. Bechara et al. (1994) and many other behavioral performance oriented studies also demonstrate early prediction of future outcomes in performance on the IGT. Individual levels of emotional awareness could be important in predicting future decisions because, as hypothesized by the SMH, unconscious and conscious perception of the viscera is essential to distinguishing good and bad decisions. The level of emotional awareness was comparable to levels reported in previous studies with large samples (Parker et al., 2003). This sample is homologous to control samples in other studies evaluating emotional awareness via different measures (Gohm & Clore, 2000; Nielsen & Kaszniak, 2006). The samples also appear to be comparable to previous samples in different aspects of emotional experience like clarity, attention, and absorption. Gohm (2003) provides evidence that self-reported emotional awareness is essential in predicting how individuals make judgments in emotionally-charged situations. Performance trends may be better differentiated if the experiment was designed to utilize another gambling task condition that mixes the decks' gain and punishment frequency characteristics with other deck distinctions, like the E'F'G'H' deck version (Bechara et al, 1997).

Analysis of the differences in the baseline and anticipatory skin conductance level (SCL) for bad choices and its relationship with emotional awareness yielded several interesting results. Those who endorse greater emotional awareness, or lower levels of alexithymia, demonstrated an increase in skin conductance level differences in block 1. Previous research would suggest this relationship should not exist because of lack of experience in the task. This relationship should begin to exist in later blocks once the participant has gained knowledge of the decks reward and punishment characteristics. Bechara et al. (1996, 2005) and many others have found that normal participants autonomically respond during the anticipatory period before risky or bad card choices once the participant enters the "hunch" period of the task, typically part of block 3. In previous research on autonomic response and the IGT, normal participants also exhibited a higher magnitude response when selecting from risky decks compared to the safe decks (Bechara et al., 2005). Our sample also performed comparably to high, moderate, and bad performers in Crone et al. (2004), but there low skin conductance levels in our sample demonstrated patterns similar only to the bad performer group in the Crone et al. In comparison of the behavior trends for the current sample, the emotionally aware participants were predicted to show larger differences in SCL in the third block. Interestingly these physiological markers were not observed in this block. This finding is consistent with individuals who endorse greater emotional awareness do not appear to demonstrate differences in skin conductance levels or improved performance as we had predicted.

Utilizing the measurement of electrodermal responses in the anticipatory period with change in SCL, instead of skin conductance responses (SCR) may have contributed to the difference with previous findings. Change in SCL does not have the same temporal resolution as SCRs and cannot define event-related responses. The lack of significant changes in anticipatory SCL changes may also be due to low sensitivity of the alternating current (AC) setting, as opposed to direct current (DC), on the amplification module in this study. However, there may be some benefits to using the AC setting. Schaefer and Boucsein (2000) proposed and demonstrated technical and metric advantages in using AC settings to measure EDA with the phase angle of the waveform as a measurement of SCR. Using AC instead of DC also helps to prevent both skin and electrode polarization (Schaefer & Boucsein, 2000). These techniques might be another way to look at EDA in relation to decision-making. For ease of comparison to previous research, future studies should physiologically acquire data with the DC setting because SCR and magnitudes can be obtained instead of change in SCL.

Electrodermal activity can be measured with several different phasic response and tonic level classifications. Conductance is the reciprocal of skin resistance and is the preferred EDA value, because it is more appropriate for averaging and other statistical analyses (Andreassi, 2000). Phasic responses are brief fluctuations in EDA and tonic level is relatively steady EDA.

SCR is a measure of phasic activity, while SCL is a measure of tonic activity. SCR has been the favored measure of EDA in previous decision-making research because of better temporal resolution and potential to define event-relatedness (Bechara et al., 1994; 1996; Crone et al., 2004; Suzuki et al., 2003). Without being able to define event-related responses through precise temporal resolution, we could not rule out the possibility of unrelated arousing thoughts during the IGT that could influence the physiological data acquired because the temporality of our measures was skewed. Measuring changes in SCL does not elicit these benefits, but is not without its advantages. A benefit of measuring the change in SCL between the baseline and the anticipatory period is it resolves the problem in the analysis of SCRs of differential level dependency. In analysis, SCRs are measured according to the gradually drifting tonic level, which can skew the magnitude of the response.

A relationship between the changes in anticipatory heart rate to emotional awareness was not demonstrated. In order to provide support for this hypothesis or the Somatic Marker Hypothesis there would have to be positive correlations between emotional awareness and heart rate. Although there were positive correlations in males, these were not statistically significant. The lack of these findings is also consistent with the lack of skin conductance differences.

With regard to psychophysiological analyses, this study has a few limitations that could be alleviated in future research of these constructs. First, the computerized version of the task had no defined and prompted period for the participant to think about the next card choice. The time given was also very short in duration. These issues could have caused impulsive, non-deliberate decisions in some of the participants, affecting their performance on the task. This impulsivity due to quick choices may have contributed to the proposed impulsivity of those with high emotional awareness. Suzuki et al. (2003) fixed these issues with the gambling task by inserting a period before each card choice in which the participant was to “consider which deck you will choose.” Inserting a “consideration” period also provides ample time for a potential skin conductance response to occur. The second methodological issue was there was not sufficient time, according to the literature (Bechara & Damasio, 2005), for the EDA to return to baseline after the card choice. This concern might also contribute to the small change in SCL found in this study. These findings could be influenced by arousal to the reward and punishment given to the participant after their card choice (Bechara et al., 1994; Crone et al. 2004). Without enough time to let the SCL return to baseline after the card choice, these reward and punishment responses may be averaged in with the actual baseline, in turn, raising the baseline period’s average. A higher baseline average creates smaller changes in SCL before the card choice when it is subtracted for the anticipatory period average. This problem could be improved with more time to allow the EDA to subside after each card choice.

In conclusion, our findings did not support our hypotheses or hypotheses posed by previous research. The lack of anticipatory physiological responses only supports one aspect of the relationship between emotional awareness and performance. Without physiological markers participants who endorse less emotional awareness may have been more rational in decision-making, leading to more advantageous decisions in block 3. Conversely, the lack of physiological markers does not explain the preference for disadvantageous choices in block 3. The lack of relationship between emotional awareness, performance on the Iowa Gambling Task, and psychophysiological responses does not provide a coherent theory with regard to previous research. Other theoretical constructs may better predict emotional awareness’s relation to decision-making in uncertain situations. A cognitive approach to this line of research may better explain these relations. Examination of the Expectancy-Valency Model's relation to these constructs could be utilized in this pursuit.

Future studies of emotional awareness and decision-making may benefit from using more psychophysiological counter measures of emotional arousal, like respiration, facial electromyography (EMG), and correlations in functional magnetic resonance (fMRI) or positron emissions tomography (PET). A limitation of this study is large respiratory changes may have confounded some of the heart rate and skin conductance data. Measures of respiration may help account and control for artifacts in EDA and heart rate by temporally matching these arousal measures with gross respiratory fluctuations. Respiratory measures could also demonstrate deeper breaths before good choices for emotionally aware participants. Facial EMG has been shown to relate to affective reactions to emotional stimuli. Its relevancy to affective state may help explain the relation of decision-making to emotional awareness (Dimburg & Petterson, 2000). Future studies using facial EMG in relation to the IGT may show positive affective reactions, like subtle "smiling" or zygomaticus muscle activity, in the anticipatory period before good choices. Possibilities of IGT and emotional awareness studies using forms of functional imaging (fMRI or PET) would also contribute to this line of research. These methodologies might help establish a neural network between the ventro-medial prefrontal and orbitofrontal cortex and networks proposed to be involved in advantageous decision making. (Bechara et al., 1994; Bechara, 2004). Furthermore, the limbic system and other sub-cortical regions are shown to be activated in relation to emotional awareness (Lane & Garfield, 2005; as cited in Panksepp, 2005). Establishing a functional relationship between these areas would greatly inform researchers of the neural correlates to decision-making. A comprehensive study of the IGT and emotional awareness using electrodermal response, heart rate, respiration, facial EMG, and imaging techniques at the same time would best achieve convergent neuropsychological findings for the relation of these constructs.

The present study examined whether emotional awareness is related to performance and psychophysiological markers on the Iowa Gambling Task. In summary, this study shows support for a relationship between one's emotional awareness and one's ability to make decisions in uncertain situations during the "hunch" period, in which the participant is beginning to understand the characteristics of the decks. These findings contest the Somatic Marker Hypothesis posed to describe performance in the Iowa Gambling task. Psychophysiological markers also were not found to relate to an individuals level of emotional awareness. This study will hopefully influence the methodology employed and constructs examined in future studies of decision-making.

Appendix

Instructions for Subject

1. In front of you on the screen, there are 4 decks of cards: A, B, C, and D.
2. When we begin the game, I want you to select one card at a time by clicking on the card from any deck you choose.
3. Each time you select a card, the computer will tell you that you won some money. I don't know how much money you will win. You will find out as we go along. Every time you win, the green bar gets bigger.
4. Every so often, when you click on a card, the computer will tell you that you that you won some money as usual, but then it will say that you lost some money as well. I don't know when you will lose or how much. You will find out as we go along. Every time you lose, the green bar gets smaller.
5. You are absolutely free to switch from one deck to the other at any time, and as often as you wish.
6. The goal of the game is to win as much money as possible and avoid losing as much money as possible.
7. You won't know when the game will end. Simply keep on playing until the computer stops.
8. I am going to give you $2000 of credit, the green bar, to start the game. The red bar is a reminder of how much money you borrowed to play the game, and how much money you have to pay back before we see whether you won or lost.
9. The only hint I can give you and the most important thing to note is this: Out of these four decks of cards, there are some that are worse than others and to win you should try to stay away from bad decks. No matter how much you find yourself losing, you can still win the game if you avoid the worst decks.
10. Also not that the computer does not change the order of the cards once the game begins. It does not make you lose at random, or make you lose money based on the last card you picked.

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