Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 40(0)

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Publication Date

2018

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Abstract

The Iowa Gambling Task (IGT) is an established tool used for evaluating the role of emotional learning under conditions of uncertainty. To date, however, the majority of studies have not explicitly manipulated the emotional content within the IGT or examined the effect of doing so on different populations. We address this gap in the present study, focusing our analysis on two groups: low vs. high psychopathy individuals in subclinical populations. Our findings demonstrate that emotional content boosted learning for the high but not the low psychopathy group.

Keywords: Iowa Gambling Task; emotional learning; psychopathy; decision making

Introduction

The Iowa Gambling Task (IGT) is an experimental paradigm developed by Damasio (1994) to evaluate the role of emotional learning in decision making. The IGT requires participants to gain as many points as they can by making selections from four decks of cards. When turned over, each card indicates a reward or a punishment (e.g., points or money). Two of the decks are "good" decks that will yield winnings over time, while the other two decks are "bad" decks that will result in losses over time. Thus, to win, individuals must learn to avoid the bad decks.

Damasio (1994) proposed that the IGT measures *emotional* learning, which involves obtaining information from emotion-related constructs, called somatic markers, rather than cognitive constructs. In the context of the IGT, the rewards and punishments over time from a given deck determine the somatic marker for that deck. These markers reflect the deck's long term consequences and so help drive decision making in future selections.

The IGT is commonly used to evaluate various clinical populations' ability for emotional learning, including individuals with substance abuse problems or psychopathic traits (Mahmut, Homewood, & Stevenson, 2008). Although the findings have not always been consistent (Adinoff et al., 2003; Losel & Schmucker, 2004), in general, it is established that various clinical populations have trouble learning to avoid the bad decks compared to healthy controls (Barry & Petry, 2008; Mahmut, Homewood & Stevenson, 2008). This inability to learn to avoid the bad decks is attributed to poor emotional learning.

Despite this established tradition of using the IGT to evaluate emotional learning, it is not clear that emotional learning is actually required for the IGT. For instance, there is no conclusive neural evidence that emotion is involved in the IGT learning process (Dunn, Dalgleish, & Lawrence, 2006) and Maia and McClelland (2004) have demonstrated that there is sufficient explicit "rational" information to account for learning in the IGT. Consistent with this, higher intelligence scores predict better IGT learning (Webb, DelDonno, & Killgore, 2014). Likewise, poor performance on the IGT in clinical populations can be attributed to poor focus and poor rational thought processes related to the clinical problem.

The issue with the proposal that the IGT measures emotional learning is that the constructs of emotional learning and rational learning are confounded in the IGT. The higher overall punishment rate in the bad decks is assumed to create negative emotional associations with those decks, but the punishments also provide statistical information indicating the bad decks are a poor choice. Thus, the IGT provides both emotional and rational feedback for each deck, making the role of emotion unclear. To discern the role of emotional learning in the IGT, the level of emotion experienced during the IGT must be controlled without altering the rational information provided by the task. Along these lines, Heilman, Crisan, Houserm and Miu (2010) and Bollon and Bagneux (2013) showed that manipulating participants' emotion *before* the IGT influenced IGT performance. For instance, Bollon and Bagneux (2013) showed that people perform worse on the IGT when they experienced emotions associated with uncertainty. However, these results could stem from the *a priori* induced emotion affecting rational thinking during the IGT.

Davies and Turnbull (2011) and Hinson, Whitney, Holben, and Wirick (2006) went a step further by associating the entire decks with positive or negative emotional labels. The labels were either congruent with the

decks (e.g., positive words with good decks and negative words with bad decks) or incongruent with the decks (e.g., negative words with good decks and positive words with bad decks). Participants performed better in the congruent conditions than incongruent ones. However, emotionally labeling the decks can provide rational cues on a deck's utility. Thus, interference from incongruent labeling and facilitation from concurrent labeling can be interpreted as interfering or facilitating rational learning processes.

Aïte et al. (2013) further developed the IGT congruency paradigm to investigate emotional learning. In contrast to the works cited above, Aïte et al. (2013) associated the emotional labeling with the rewards and punishments on individual cards rather than the decks. For example, in the congruent condition, happy faces were presented following rewards and fearful faces following punishments. There was a significant facilitation effect for the congruent condition over a control condition that did not include emotional information. This result can be interpreted as the congruent condition boosting the negative and positive emotional impact of the punishments and rewards, respectively, but further investigation is needed to validate these findings.

In general, while these studies produced results consistent with the presence of emotional learning, the above discussion also highlights that it is challenging to design an experiment that can categorically rule out that learning in the IGT is rational instead of emotional. However, if emotional learning is a factor then it should be possible to garner evidence by gathering converging results from different types of emotional manipulations within the IGT. With this in mind we designed a different variant of the IGT to test for emotional learning.

Present Study

The present study included people high and low in subclinical psychopathy, a population prior work has shown to have deficits in emotional learning and problems with learning from punishments (Lykken, 1957; Newman and Kosson, 1986; Blair et al., 2004). In line with these results, people higher in psychopathic traits perform poorly on the IGT than people with lower psychopathic traits (e.g., Mahmut et al., 2008; Mitchell, Colledge, Leonard, & Blair, 2004). In theory, people high on psychopathy do poorly on the IGT because the punishments do not produce an emotional reaction (or produce a weak emotional reaction), so emotional learning is impaired due to a lack of emotional information.

We defined *emotional information* as information arising from the strength of emotional responses and *emotional learning* as learning from emotional information. This is distinct from *emotional effects on learning*, where emotions impede or facilitate rational learning (e.g., by modulating attention).

We manipulated emotional information by presenting negative emotion-inducing images following card selections resulting in lost points. In each case, the magnitude of the emotional impact of the image was designed to match the numerical severity of the punishment. Thus, in the modified IGT conditions, all of the decks included negative imagery, since all the decks had punishment cards. Importantly, the emotional information in the images did not add information to the task that was not already available in the punishments amounts.

If the reported inability of people high on psychopathy to learn the IGT is due to a problem with emotional learning then boosting the strength of the emotional information could improve learning. However, if the reported inability of people high on psychopathy to learn the IGT is due to a problem with rational learning then redundantly adding the same punishment information through the severity of the negative imagery should not improve learning. In our study, we also included people low on psychopathy to replicate the effect that higher psychopathy scores predict worse performance on the IGT.

Method

Participants

The participants were 250 undergraduate students (M_{age} = 21.12 years, SD = 3.44) who participated for extra course credit. Due to a software error, 30 participants were not properly randomized to one of the study conditions. To avoid bias, we excluded this condition and the present analysis is based on data from 220 participants (143 identified as female; M_{age} = 21.20 years, SD = 3.58).

Materials

Standard and Modified Iowa Gambling Task. The experiment included a standard and a modified version of the IGT. The decks of cards in each version were identical (four decks per version with 40 cards per deck). As is standard in the IGT, two of the decks provided small rewards in terms of points, but also small punishments (see Decks C and D in Figure 1, top), while two of the decks had higher-reward cards but also higher-punishment cards (see Decks A and B in Figure 1, top).

For the modified IGT, we kept the structure of the task the same, but added either neutral or affect-inducing images (depending on the condition), shown immediately after making a card selection and before displaying the points earned or lost (see Figure 1, bottom). The 140 images came from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). IAPS images have validated ratings for valence, arousal, and labels for discrete emotion categories (Lang et al., 2008; Mikels, Fredrickson, Lingberg, Magilo, & Reuter-Lorenz, 2005). Thus, IAPS provides an established way to manipulate emotional content, since prior work has confirmed the target emotion is induced by a given image.

Self-report psychopathy scale (SRP). The Self-report psychopathy scale, SRP (Paulhus, Hemphill, & Hare, in press) is an established 64-item self-report questionnaire used to assess the level of psychopathic traits in subclinical populations; the instrument demonstrates good reliability

Deck	Type	Reward points (% reward cards)	Punishment points (% punishment cards)
A	R	100 (50%)	-250 (50%)
B	R	100 (90%)	-1250 (10%)
C	A	50 (50%)	-50 (50%)
D	A	50 (90%)	-250 (10%)

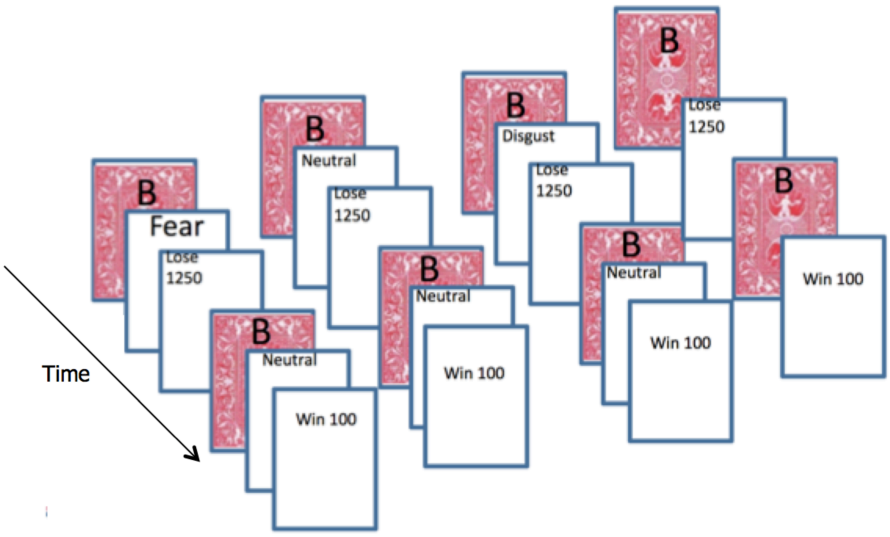

Figure 1: (top) Description of the reward and punishment cards in the risky (R) and advantageous (A) decks; (bottom) Sample presentation sequence of selecting a reward and punishment card for risky Deck B in each condition: fear, neutral, disgust, and the standard IGT, left to right.

and validity (Neal & Sellbom, 2012). The SRP asks participants to rate the degree to which various statement relate to themselves (e.g., "I have tricked someone into giving me money", "It's fun to see how far you can push people before they get upset") on a Likert range from 1 (*Disagree Strongly*) to 5 (*Strongly Agree*). A higher score on the SRP indicates a greater degree of psychopathic traits, with a maximum score of 320.

Procedure

The study was conducted online in a single session that lasted approximately an hour and a half. After participants provided consent, they then completed the demographics and SRP scale (participants also filled in several additional surveys, which were not included in the present analysis). Following completion of the surveys, the IGT portion of the experiment began. Participants were told that the purpose of the task was to gain as many points as possible, and that points are gained or lost by selecting cards from the four decks. Participants were unaware that some decks were good (or bad).

We used a between-subjects design, with participants randomly assigned to either the *standard* IGT condition (n = 67), or one of the *modified IGT* conditions (*neutral* IGT, n = 52; *disgust* IGT, n = 58; *fear* IGT, n = 43). In all conditions, participants were shown the four card decks simultaneously and made selections from the decks – the experiment ended after a participant made 100 selections (i.e., *trials*). After a card selection, participants were immediately shown the point value of their selection (*standard IGT* condition), or an image for 1 second followed by the point value (*modified IGT* conditions, see Figure 1, bottom).

Since our goal was to boost the emotion associated with the punishment cards, the reward cards in all *modified IGT* conditions were always followed by an emotionally neutral image (Figure 1, bottom). In contrast, the punishment cards varied their emotional content based on the condition (e.g., for the *disgust* condition, images inducing disgust; for the *fear* condition, images inducing fear). To determine which image to show after a card selection, we

1. Mapped the discrete emotion category of an image to a given condition (e.g., images categorized as "disgust" according to Mikels et al. (2005) rating system were assigned to the disgust condition) and
2. Mapped the valence and arousal ratings to the point value of a given card (e.g., more punishment resulted in images being shown that were more intense according to Lang et al.'s (2008) rating system).

The only exception was that in the *neutral* condition, the punishment cards were paired with neutral images designed to not elicit an emotional response. Thus, this condition is similar to the standard IGT, but allowed us to control for any possible stimulation induced by the mere presence of an image.

Results

In preparation for the analysis we used the standard method applied in IGT research (e.g., Mitchell et al., 2002, Werner, Duschek et al., 2009), which involves dividing the 100 trials each participant completed into five blocks (e.g., Block 1 corresponds to trials 1-20, Block 2 to trials 21-40), and calculating the number of *risky selections* (A+B) and the *net score* [(C+D) – (A+B)]. Below, we use risky selections as the dependent variable (note that the results, including the statistical parameters, are identical if net score is used instead).

For the present analysis, our primary goal was to understand the impact of negative emotion induction on learning to avoid the risky decks. Thus, we collapsed the two negatively-valenced emotion conditions (fear and disgust), into a *negative valence* condition, and the two neutral conditions (neutral and standard), into a *neutral valence* condition. Before doing so, we verified that there was no difference between the two negatively-valenced conditions, and no differences between the two neutral conditions, as confirmed by

- a mixed ANOVA (disgust vs. fear, $F(3.5, 367.5) = 0.77$, $p = .53$; neutral vs. standard, $F(3.5, 367.5) = 0.77$, $p = .78$,
- visual inspection of graphs showing performance over blocks in each of the conditions (the graphs for *disgust* and *fear* conditions, with block in the x-axis and number of risky decks selections on the y-axis were virtually identical - this was also the case for the graphs for *neutral* and *standard* IGT conditions).

Our sample displayed moderate levels of baseline psychopathy as captured by the SRP ($M = 152.76$; $SD = 30.64$), for instance compared to Neal and Selbom (2012)'s SRP college sample mean of 121.17. As expected, psychopathy was positively related to the total mean number of risky deck selections, $r(218) = .27$, $p < .01$, with individuals higher on psychopathy making more risky deck selections overall.

To investigate the interaction between psychopathy and emotion and its impact on IGT performance over time, we divided individuals into a *low psychopathy* group (bottom 40% of the SRP scores) and a *high-psychopathy* group (top 40% of the SRP scores). We did not include the middle 20% since this has the potential to obscure results (as individuals closer to the mean are essentially arbitrarily assigned to a given group). Our results hold if a different split is used, e.g., bottom and top 33%.

Impact of Emotion Induction and Psychopathy on Learning

To understand how induced emotion affects learning in the IGT, as well as how psychopathy interacts with this process, we used a mixed ANOVA with *psychopathy* (low, high) and *condition* (neutral valance, negative valance) as the two between-subjects factors and *block* as the within-subjects factor.

Of primary interest is the three-way interaction (*block* x *psychopathy* x *condition*), which informs on how emotion and low vs. high psychopathy traits influence IGT learning. The interaction was significant, $F(3.5, 619.2) = 2.82$, $p = .03$, $\eta_p^2 = .016$. As shown in Figure 2, there was a marked difference in terms of learning for the low vs. high psychopathy groups and this difference depended on the type of emotion induction present (negative vs. neutral). In the negatively-valenced condition, both the low and high psychopathy groups show a reduction in the number of risky deck selections over time, i.e., by block 5, both have a similar number of risky selections, $t(83) = .56$, $p = .58$. In contrast, in the neutrally-valenced condition, only the low psychopathy group showed a reduction in the number of risky selections while the high psychopathy group learning is flat, i.e., by block 5 the low psychopathy group made significantly fewer risky selections than the high psychopathy group, $t(73.9) = 4.1$, $p < .001$.

A key implication of these findings is that emotion induction in the IGT only effected individuals with higher levels of psychopathy. The low psychopathy group's graphs for the two conditions are not significantly different (confirmed by an ANOVA reporting a non-significant *block* x *condition* interaction, $F(3.4, 300.1) = 0.7$, $p = .55$, $\eta_p^2 = .008$). In contrast, the high psychopathy group's graphs do show an interaction between block and condition (confirmed with an ANOVA that included only the high psychopathy individuals, $F(3.6, 312.6) = 3.3$, $p = .014$, $\eta_p^2 = .036$). As shown in Figure 2, the high psychopathy group in the negative valence condition made significantly fewer risky deck selections in block 5 than the high psychopathy group in the neutral valence condition, $t(88) = 2.1$, $p = .039$.

Discussion

Our results indicate that emotional learning does take place in the IGT. The results for the neutrally-valenced conditions replicate the finding that participants high on psychopathy have reduced IGT performance. However, when the emotional information was boosted through negative imagery in the experimental condition, the high psychopathy participants were able to learn to avoid the risky decks in the IGT (albeit more slowly than the low psychopathy participants as shown in Figure 2, right). Overall, this suggests that people high on psychopathic traits are not unable to learn from emotional information, but may have weak emotional reactions. However, as our study only included subclinical psychopathy, these conclusions should not be extended to clinical psychopaths.

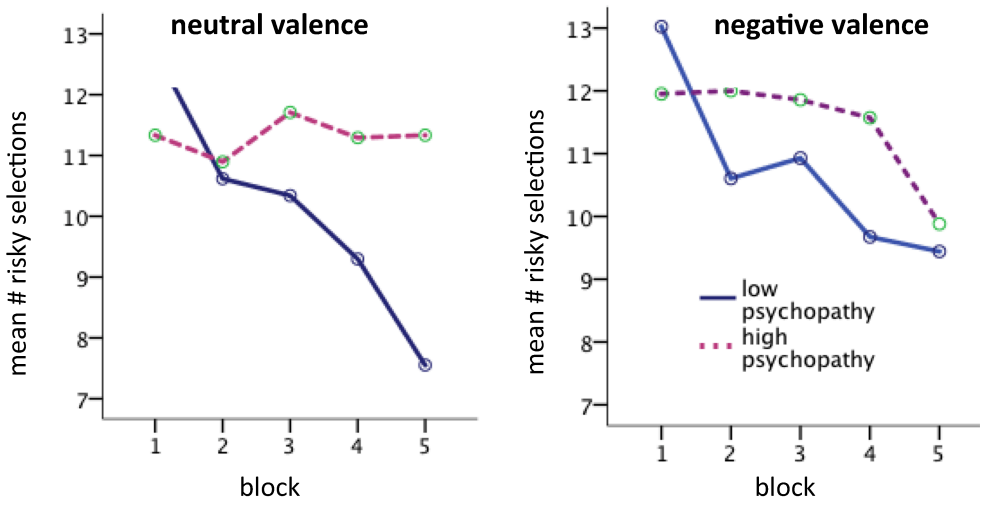

Figure 2: Interaction between the emotion conditions (neutral vs. negative valence), learning, and psychopathy (low vs. high).

The images in our study did not add additional information beyond the punishment amounts as their intensity matched the punishment amounts. Thus, the only difference between the conditions was the presence of the emotional imagery. One could argue that the improvement in performance was due to an emotional effect on rational learning, by assuming that the emotional imagery increased motivation to minimize the punishments and so induced a focused learning effort. However, this is not likely as we did not find improvement in performance for the low psychopathy group in the emotional condition.

In terms of non-clinical populations, Davies and Turnbull (2011) did not find a facilitating effect for emotionally labelling the *decks*, while Aïte et al. (2013) did get a facilitating effect for emotionally labelling the *cards*. There are several explanations for why we did not get an effect for the low psychopathy participants while Aïte et al. (2013) did get an effect. First, Aïte et al. (2013) used a modified payoff scheme, while we did not. Second, Aïte et al. (2013) provided emotional boosts for both punishments and rewards, while we boosted only punishments. Finally, while we provided emotional boosts that matched the punishment magnitudes, Aïte et al. (2013) provided the same emotional boost (e.g., the same fearful face for punishments). Any one of these differences could account for the discrepancy and more experiments that systematically manipulate emotional information in the IGT are needed to address these questions. Another avenue for future work relates to investigating the effect of positive emotional information. This could be done through an experiment where the rewards are paired with positive images and punishments are paired with neutral images. This would clarify whether positive emotional information also impacts IGT performance.

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