Biological Psychology 123 (2017) 286–293

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Go for broke: The role of somatic states when asked to *lose* in the Iowa Gambling Task

Rebecca J. Wright[a,*], Tim Rakow[b], Riccardo Russo[a]

[a] Department of Psychology, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, United Kingdom
[b] King's College London, Institute of Psychiatry, Psychology & Neuroscience, Department of Psychology, United Kingdom

ARTICLE INFO

Article history:
Received 28 September 2015
Received in revised form 24 October 2016
Accepted 26 October 2016
Available online 29 October 2016

Keywords:
Decision-making
Somatic marker hypothesis
Iowa gambling task
Loss
Skin conductance

ABSTRACT

The Somatic Marker Hypothesis (SMH) posits that somatic states develop and guide advantageous decision making by "marking" disadvantageous options (i.e., arousal increases when poor options are considered). This assumption was tested using the standard Iowa Gambling Task (IGT) in which participants win/lose money by selecting among four decks of cards, and an alternative version, identical in both structure and payoffs, but with the aim changed to *lose* as much money as possible. This "lose" version of the IGT reverses which decks are advantageous/disadvantageous; and so reverses which decks should be marked by somatic responses – which we assessed via skin conductance (SC). Participants learned to pick advantageously in the original (*Win*) IGT and in the (new) *Lose* IGT. Using multilevel regression, some variability in anticipatory SC across blocks was found but no consistent effect of anticipatory SC on disadvantageous deck selections. Thus, while we successfully developed a new way to test the central claims of the SMH, we did not find consistent support for the SMH.

1. Introduction

The Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994) was devised in order to understand the decision making deficits shown by patients with damage to their ventromedial prefrontal cortex (VMPFC); in particular, their tendency to repeat disadvantageous courses of action. The decrement in these patients' personal, financial and social decision making following their brain damage – despite intact intelligence, attention, memory and language skills – led to the development of the Somatic Marker Hypothesis (SMH; Damasio, Tranel, & Damasio, 1991; Damasio, 1994). Reflecting these patients' difficulties expressing emotions, and their altered physiological responses to emotional but not neutral stimuli, Damasio hypothesized that the VMPFC played a role in successful decision making (Damasio et al., 1991; Damasio, 1994). The SMH proposes that emotions we experience act as biasing signals (somatic markers; e.g., as assessed by skin conductance) that help guide decision making. Poor outcomes elicit intense somatic signals that 'mark' the course of action that led to those poor outcomes. When this course of action is considered in a subsequent decision, the somatic signals are activated and so serve to reduce the likelihood of repeating previous poor decisions.

The IGT requires participants to select from four decks of cards, from which they either receive a monetary reward, or a combined monetary reward and punishment (loss), which are revealed upon selecting the card (see Table 1). Two decks (termed "bad decks") offer high ("immediate") rewards but large ("delayed") punishments. The other two ("good") decks offer lower ("immediate") rewards and smaller ("delayed") punishments. To be successful at the IGT, participants must learn to forgo large immediate gains in order to avoid the larger delayed punishments. The structure of the rewards and punishments is such that calculating the exact long-run average outcomes of the decks was presumed to be unlikely by Bechara et al. (1994). Instead, participants must use more intuitive decision making processes that, according to the SMH, are determined by emotional hunches that participants develop about the decks when playing the task. Healthy control participants should learn to select more from the good decks by the end of 100 selections. Patients with VMPFC damage, however, continually select from the bad decks throughout the game (Bechara et al., 1994). However, more recent research has shown the reward structure is cognitively penetrable (Maia & McClelland, 2004) and while not all healthy participants learn to select from the good decks, some VMPFC patients have shown learning on the IGT (e.g., Fellows & Farah, 2005).

* Corresponding author.
E-mail addresses: rjwrig@essex.ac.uk (R.J. Wright), tim.rakow@kcl.ac.uk (T. Rakow), rrusso@essex.ac.uk (R. Russo).

http://dx.doi.org/10.1016/j.biopsycho.2016.10.014

Table 1
Reward and punishment structure of the IGT (original version; Bechara et al., 1994).

Deck (Type/Punishment frequency)	Reward per card	Number of losses per 10 cards	Total Loss per 10 cards	Net outcome per 10 cards
A (Bad/Frequent)	100	5	−1250	−250
B (Bad/Infrequent)	100	1	−1250	−250
C (Good/Frequent)	50	5	−250	250
D (Good/Infrequent)	50	1	−250	250

Bechara, Tranel, Damasio, and Damasio (1996) hypothesized that ("anticipatory") somatic states arising prior to card selections differentiate between good and bad decks (thereby facilitating advantageous selections). Results from skin conductance (SC) data show that both control and patient groups have greater skin conductance responses (SCR) after selecting a card containing a punishment compared to a card containing a reward only – thereby marking poorer outcomes with greater arousal. However, while control participants develop elevated anticipatory SC in the few seconds *prior to selecting cards* from bad decks, VMPFC patients do not (Bechara et al., 1996).

However, findings for these "anticipatory skin conductance responses" (aSCR) are not consistent. Bechara and Damasio (2002) reported variance in the aSCRs of healthy participants who were poor performers in the IGT, with some developing anticipatory markers as would be predicted but this did not facilitate advantageous play, yet some studies find elevated aSCRs only in the highest performing sub-groups of participants (e.g., Carter & Smith Pasqualini, 2004; Crone, Somsen, Van Beek, & Van der Molen, 2004). Crone et al.'s (2004) moderately performing group, showed lower aSCRs but improvement in deck selections across the game; indicating learning can take place in the absence of somatic markers. Another challenge comes from Suzuki, Hirota, Takasawa, and Shigemasu (2003) who found no difference between anticipatory SC on early and later trials – failing to provide support for anticipatory markers developing as the game progresses and subsequently guiding behaviour in the IGT.

The structure of the reward and punishment schedule – as distinct from each deck's expected value (i.e., mean loss/gain) – has been suggested as an alternative explanation for elevated aSCRs found for bad decks. Modifying the good decks to have the higher rewards and punishments (but still an overall net gain), Tomb, Hauser, Deldin, and Caramazza (2002) found greater aSCRs *prior to* selecting from good decks; the opposite of what the SMH predicts. Tomb et al. (2002) suggested somatic markers were driven by the immediate action being taken, rather than by longer-term outcomes. Yen, Chou, Chung, and Chen (2012) modified the IGT to test whether aSCRs were due to differences in expected value (EV) or differences in the riskiness of the decks. They found that anticipatory SC marked the preferred choices across different stages of learning in the game; greater for the high-risk bad deck early on, then greater for low-risk good deck later in the task. Chiu et al. (2008) also adapted the IGT to create the Soochow gambling task: the good and back decks had the same EVs as in the original IGT, but punishments occurred on 4/5 cards in the good decks and only 1/5 times in the bad decks. Chiu et al. (2008) found that participants chose more from the bad decks, suggesting that the frequency of gains and losses took precedence over EV.

If conscious awareness of advantageous play can occur before aSCRs develop, this would negate the need to use somatic states to guide decision making. Bechara, Damasio, Tranel, and Damasio (1997) measured SCRs during the IGT but also assessed participants' knowledge about the decks at points throughout the game to determine when participants became aware of the best strategy for advantageous play. The assessment of conscious knowledge led Bechara et al. to describe four conceptual stages in the game: 'pre-punishment', 'pre-hunch', 'hunch' and 'conceptual' stage. They concluded that, in healthy controls, *covert* somatic markers develop in response to experienced outcomes and influence decisions, *and* that this occurs prior to the generation of *overt* responses to such outcomes.

Maia and McClelland (2004) examined participants' knowledge using Bechara et al.'s (1997) questions but posed additional more detailed questions and found that participants had consciously available knowledge, which enabled them to perform well, at an earlier stage in the IGT than Bechara et al. (1997) reported. Other studies have supported Maia and McClelland (e.g., Gutbrod et al., 2006; Evans, Kemish, & Turnbull, 2004) but only Fernie and Tunney (2013) replicated Maia and McClelland's exact method – using questions from Bechara et al. (1997) and from Maia and McClelland's (2004) – while additionally measuring SC. Fernie and Tunney (2013) found no differences in aSCRs between the decks, or between the question groups, prior to acquiring task knowledge. Outcome SC following punishments was larger for the disadvantageous decks in the pre-knowledge period, but only for participants who went on to display knowledge. The authors concluded that a lack of conceptual knowledge together with a lack of differential aSCRs does not hinder successful play in the IGT.

Maia and McClelland (2004) suggested the poor performance of patients with VMPFC damage could be better explained by an inability to carry out reversal learning by inhibiting the win-stay-lose-shift strategy typical of many learning from feedback tasks (Restle, 1958; Rolls, 2005) when experiencing a punishment in the advantageous decks. To investigate this, Fellows and Farah (2005) switched the IGT deck structure so that the disadvantageous decks were no longer the better decks during the initial trials, and found VMPFC damaged patients' performance on the task equaled that of healthy controls. However, Bechara, Damasio, Tranel, and Damasio (2005) state that reversal learning is not the *only* requirement for successful IGT performance; rather, a "stop signal" (which could take the form of an emotional signal) would also need to develop.

Research from other experiential decision tasks (i.e., where the participant receives feedback on their choices) highlights that – even if participants successfully inhibit win-stay lose-shift responses – they may still have difficulty choosing well. The principle "do what works best most of the time" is a good heuristic for predicting patterns of choice in experiential tasks (Rakow & Newell, 2010). For example, Yechiam, Rakow, and Newell (2015) found that, even when decision makers are informed about each option's payoff distribution, disadvantageous options with a rare but "catastrophic" outcome can be popular choices if the feedback one receives emphasizes that – on almost all occasions – this delivers a better payoff than a (safe) option with higher EV. This conforms to the patterns of preference observed for deck B in the IGT from which nine in every ten cards yields a positive outcome: Steingroever, Wetzels, Horstmann, Neumann, and Wagenmakers' (2013) report a preference for this low-frequency-of-punishment bad deck over the good decks in most studies; and this "prominent deck B phenomenon" has also been discussed by Lin, Chiu, Lee, and Hsieh (2007) and Dunn, Dalgleish, and Lawrence (2006).

To further investigate the influence of the IGT's EV and punishment frequency on subsequent choices, and the development of somatic markers, we created a *lose* version of the IGT, which simply reversed the original instruction from winning, to losing money.