

General Methods

All of the experiments described below will employ methods closely modeled on those of Bechara et al. (1997), and any differing methods will be noted. References will be made to those methods in Bechara et al. (1997) that are described in more detail by other experiments on the Gambling Task (Bechara et al., 1994; Bechara et al., 1996; Bechara, Tranel et al., 2000) or in the SCR recommendation paper to which these studies refer (Fowles, Christie, Edelberg, Grings, Lykken, and Venables, 1981).

Subjects

Subjects for both experiment 1 and experiment 2 were male and female Harvard University undergraduate students, aged 18-22. Subjects in Bechara et al. (1997) were male and female patient and control populations ranging in age from 51 to 65 years of age, with an average of 13 years of education. Subjects in the present studies thus differ from those seen in previous experiments in terms of age and also certain cognitive traits associated with being a student of Harvard University (possibly including an increased ability to calculate during the task and a greater working memory ability). Although these differences are important, they do not suggest that these two populations will perform differently on either the behavioral or psychophysiological measures of the gambling task. Indeed, a number of studies have shown that behavioral performance on the gambling task is relatively invariant with respect to

gender and years of education (Bechara, Damasio & Damasio, 2000). Although age differences in performance have been found, impairment has been noted to begin at approximately 64 years of age (Bechara et al., 2000a), which is above the age range studied in Bechara et al. (1997). Likewise, the somatic marker hypothesis does not specify a different function of bodily responses during different points in aging, and thus SCRs are predicted to measure similar responses across all ages.

Materials

Four decks of 40 cards each were used in the task. In each deck, 20 cards had a red face while 20 had a black face (Bechara et al., 1994). Cards were custom-made for the experiment, though they looked similar to real decks of cards. A large-display calculator was used to keep track of monetary rewards and punishments during the game. Although in Bechara et al. (1997), a set of facsimile U.S. bills was used for this purpose, the calculator was required in this experiment in order to simplify the tasks of the experimenter. Further, the calculator display is similar to another standard method of monetary scorekeeping in which a green bar changes length during a computerized version of the Gambling Task experiments (Bechara et al., 1999; Bechara, Tranel et al., 2000).

Apparatus and Skin Conductance Response Recording

Recording of SCRs was conducted with Biopac Student Lab Pro software, using an MP-30 amplifier. A high-pass filter was set at .05 Hz, and a low-pass filter was set at 35 Hz. Gain was set at a magnification of 25,000 times, and AC amplifier coupling was

used. SCRs were recorded from the thenar and hypothenar eminences of each hand (Fowles et al., 1981) using a Biopac SS3LA Galvanic Skin Response Transducer.

Before experimentation, the MP-30 amplifier was tested for accuracy by placing resistors across the electrodes and measuring conductance values.

The specific brand of recording apparatus used in the present experiment differed from that used in previous gambling task studies (Bechara et al., 1996; Bechara et al., 1997). In these studies, a Grass Model 7 polygraph equipped with Type 7OSC oscillographs, Type 7DA driver amplifiers, and Type 7P1 preamplifiers was used (Tranel & Damasio, 1994). This polygraph was also equipped with Wheatstone bridges, allowing for a reversal of polarity during the experiment. Although the apparatus used in the present study did not have this particular capacity, this did not affect the experimenter's ability to accurately record SCRs.

In order to ensure a contact point of exactly 1 cm² for both electrode contact points (Fowles et al., 1981), two 1 cm² collars were attached to the thenar and hypothenar eminences of the subjects' non-dominant hands. The two electrodes were then placed on the adhesive collars with a generous amount of Biopac Gel 100 electrode gel, facilitating the recording of all skin areas within the collar. Finally, a glove of appropriate size was placed on the subjects' hands with a mesh area on the palm that comfortably but firmly held electrodes in place.

Card Task and Recording of Skin Conductance Responses

Subjects sat in a sound-free room in a comfortable chair and were given a consent form (see Appendix). Throughout the experiment, the temperature of the room was kept between 70° and 78° Fahrenheit, as measured by a thermometer. Subjects were briefed about the SCR equipment before its application. After sensors were attached, a 5-minute relaxation period followed during which subjects were instructed to sit quietly in order to stabilize SCR measurements (Tranel & Damasio, 1994). After this relaxation period, the experimental task began.

Four decks of cards were placed on the table at which the subjects sat. Cards were placed close to the subject so that minimal movement was required to turn over cards. Each deck of cards was placed 1.25 inches away from the adjacent deck. Subjects turned over all cards with their dominant hand while the experimenter added wins and subtracted losses from their total on the calculator. In addition, during recording of SCRs, subjects were asked to remain quiet and still and to try not to engage in any movements other than postural adjustments. All measurements of SCR activity during card turns were recorded from the non-dominant, gloved hand (Bechara et al., 1996). Subjects were instructed to place their non-dominant hand on their thigh with the palm facing upwards. SCRs generated during trials in which subjects coughed, sneezed, moved their recorded hand, or firmly touched their face were excluded from analysis.

Before the task began, subjects were given a loan of play money; the specific amount allocated varied by condition and will be described more completely later on. After subjects turned over a card, they always received some money as a reward, but on other occasions, were required to pay some money as a penalty; these values were registered on the calculator so that the subject could see their running total. For instances in which a card was associated with both punishment and reward, the experimenter first provided the reward, and then the punishment, thereby keeping these transactions separate. The net gain or loss in these instances was not verbally reported to subjects.

The experimenter kept track on a score sheet (Figure 1 and Figure 8) of the order in which the subject selected the red and black cards, as well as the corresponding amount of money exchanged. In each experiment, one score sheet was used for all subjects. Cells on the

score sheet containing a negative number or a '0' represent red cards whereas empty cells represent black cards. Thus, the order of red and black cards in each deck could be constructed from the score sheet in preparation for each subject. Again, the red and black color appeared on the face of the cards, thus making it impossible for subjects to see the color of a card before it was turned over.

The experimenter recorded the subjects' responses and inserted markers into the SCR record following the procedure of Bechara et al. (1996). Subjects were instructed not to pick a card until the experimenter said the word "go." Until that time, subjects were instructed to continue thinking about their next card choice. When the experimenter said the word "go," a marker was inserted into the SCR record. Upon completion of the money exchange, another marker was inserted into the SCR record. In this way, SCR responses to particular card choices were isolated. The time interval between card selections was measured by two rules: it was never shorter than 15 seconds, and the experimenter never said "go" if the subject was generating an SCR or experiencing a "steep recovery" from generation of an SCR (Bechara et al., 1996).

SCRs recorded during the task were divided up into three categories: 1) reward SCRs: generated during the 4 second period immediately after a subject turned a card associated with only reward, 2) punishment SCRs: generated during the 4 second period immediately after a subject turned a card associated with reward and punishment, and 3) anticipatory SCRs: generated in the time between the completion of the money exchange and the next card selection (Bechara et al., 1996). The magnitude of an SCR was defined as the amplitude of the largest SCR occurring in the time window (Bechara et al., 1996; Bechara et al., 1997).

After the first 20 card choices and each 10 selections after that, subjects were asked two questions (Bechara et al., 1997): (i) "Tell me all you know about what is going on in this game,"

and (ii) “Tell me how you feel about this game.” During this time, recording of SCRs was temporarily stopped, and the experimenter dictated subjects’ responses.

Task Instructions

Before the experimental task, subjects were read the following instructions (adapted from Bechara et al., 2000b) and were asked if they understood. Any confusion was clarified.

In front of you, there are four decks of cards A, B, C, and D (*all the decks were face-down, i.e., the black and red colors were hidden, and the subject saw four identical decks of cards*).

I want you to select one card at a time from any deck you choose. I want you to show it to me like this (*showing the color to the examiner was demonstrated*), and then to place it in front of you like this (*the card was placed with the black or red color facing up, directly in front of the deck from which the card was picked*). For all card turns please use your dominant hand.

I will give you some money each time you select a card.

I will not tell you how much money you will get. You will find out as we go along.

Every so often, however, you will have to pay me some money too. I will not tell you now when these payoffs will occur or how much they will cost you. You will find out as we go along.

You are absolutely free to switch from one deck to the other at any time, and as often as you wish. If you run out of cards in a specific deck, you must pick from other decks.

The goal of the game is to win as much money as possible, or avoid losing as much money as possible.

You won’t know when the game will end. You should keep on playing until I tell you to stop.

It is important to know that the colors of the cards are irrelevant in this game and that there is no way for you to figure out when you lose money based on the color you see. All I can say is that some decks are worse than others. You may find all of them bad, but some are worse than others. No matter how much you find yourself losing, you can still win if you stay away from the worst decks. Please treat the play money in this game as real money, and any decision on what to do with it should be made as if you were using your own money.

I will give you now this loan of play money. At the end, I will collect back the loan and see how much you won or lost.

A few times during the game, I will ask you questions about your thoughts on the game. When you are actually playing the game, however, it is important

that you not talk and that you keep your hands as still as possible when you are not turning over a card, because the equipment being used is very sensitive to talking and movement. Please do not make any movements during the game other than postural adjustments.

It is also important that you not pick a card until I say the word "go." Until I say, "go," continue to contemplate your next card choice.

During the experiment please keep your recorded hand palm-up; this will help avoid movement artifacts.