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Decision-making and the Iowa Gambling Task
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Psychology Education Title: Decision-making and the Iowa Gambling Task

Overview

Decision-making is an important component of human executive function, in which a choice about a course of action or cognition is made from many possibilities. Damage to the inferior parts of the frontal lobes can affect a person's ability to make good decisions. However, while decision-making deficits can have a large impact on one's life, these deficits can be difficult to quantify in the laboratory. In the mid-1990s, a task was designed to mimic real life decision-making in the laboratory. This task, known as the Iowa Gambling Task (IGT), is a cognitively complex task used widely in research and clinical studies as a highly sensitive measure of decision-making ability.¹⁻³

In the IGT, a participant is shown four decks of cards and chooses to reveal a card from one deck on each turn. When a card is turned over, the participant will receive some money, but sometimes will also be required to pay a penalty. Two of the decks have higher payoffs, but also have high penalties such that choosing from these decks leads to a net loss in the long term. The other two decks have lower payoffs, but also present smaller penalties, so that choosing from these decks leads to a net gain. Thus, to make an advantageous choice, participants must integrate information about losses and gains over time.

This video demonstrates how to administer the IGT to compare the performance of patients with damage to the ventromedial prefrontal cortex to a group of matched control subjects, revealing the unique contribution of this brain region to decision-making.

Procedure

1. Participant Recruitment

1.1. Patient Recruitment

1.1.1. Recruit ten patients with damage to the ventromedial sector of the prefrontal cortices.

1.1.2. Damage to this region is confirmed by neuroimaging with MRI. The ventromedial prefrontal cortex is located at the most anterior medial wall of the cerebral cortex, on the ventral surface. Damage can be unilateral or bilateral, but should not extend beyond the ventromedial prefrontal cortex. An example of the brain of such a patient is shown in Figure 1.

1.2. Control Recruitment

1.2.1. Recruit twenty participants without brain damage, who are matched in age and intellect with the patient population.

1.3. Make sure that the participants have been fully informed of the research procedures and have signed all the appropriate consent forms.

2. Data Collection

2.1. In order to examine decision-making deficits in patients with ventromedial prefrontal cortex damage, patients and control participants will perform the Iowa Gambling Task.¹

2.2. Seat the participant at a table in front of four decks of identical-looking cards.

2.3. Give the participant \$2000 in play money.

2.4. Provide instructions to the participant about how the experiment will unfold.

2.3.1.2.4.1. Tell the participant that the game requires a series of card selections, turning over one card at a time from any of the four piles of cards.

2.4.2. Tell the participant that the goal of the task is to maximize profit on the loan money.

2.4.3. Tell the participant that after turning each card, they will receive a certain amount of money (predetermined for each card turn from each deck).

2.4.4. Tell the participant they are free to switch from any deck to another, at any time, as often as they want.

2.4.5. There is no time limit for the participant to choose a deck.

2.5. Begin the task.

2.3.2.2.5.1. After turning some cards, the participant is given money but also has to pay a penalty. The amount of the penalty is announced after the card is turned, and is predetermined for each card turn from each deck (known only to the experimenter: **Figure 2**). Give the participant the amount of play money that they earn, and tell them to hand the experimenter any money they have lost, before proceeding to the next turn.

2.3.3.2.5.2. Turning a card from deck A or B yields \$100, turning a card from deck C or D yields \$50. Penalty amounts are higher in decks A and B than in decks C and D.

2.3.4.2.5.3. Decks A and B are equivalent in terms of overall net loss over trials, but in deck A the punishment is more frequent and of lower magnitude than in deck B.

2.3.5.2.5.4. Decks C and D are equivalent in terms of overall net gain, but in deck C the punishment is more frequent and of lower magnitude than in deck D.

2.6. Use the preprogrammed schedule of reward and punishment on the score card (Figure 2).

2.6.1. For example, if the participant first chooses a card from Deck A, they get a \$100 reward and no punishment.

2.6.2. If the second card choice is also from Deck A, they get a \$100 reward and no punishment.

2.6.3. If the third card choice is also from Deck A, they get a \$100 reward and a \$150 punishment.

2.6.4. Keep track of the card turns by marking each of the 100 turns in the appropriate cell in Figure 2.

2.6.5. The participant makes 100 card turns, choosing a card from any deck each time. Since there are only 40 cards in each deck, they might run out of cards in a given deck before the end of the experiment.

3. Data Analysis

3.1. Observe and compare the timeline of responses for control and patient populations. Then, to analyze patients' performance and compare their performance to normal performance, use an analysis of variance (ANOVA) to examine the number of cards from each deck chosen by normal controls and by patients. The ANOVA should have the variables of group (controls vs. patients) and choice (A, B, C, D).

- 3.2. A subsequent Newman-Keuls t-test can be used to show which pairwise differences contribute to significance of the ANOVA.

Representative Results

In one hundred card draws from four decks, normal controls made more selections from the good decks (C and D), and avoided the bad decks (A and B). In contrast, patients with ventromedial prefrontal cortex damage made more selections from the bad decks (A and B), and avoided the good decks (C and D; **Figure 3**). The number of cards selected by controls from decks A and B were significantly less than the number of cards selected from those decks by the patients. In contrast, the number of cards selected by the control population from decks C and D were significantly more than the number selected by patients.

These results show that the patients perform differently in this task from healthy controls, in that they tend to draw from high reward/high punishment decks more frequently even though these decks result in long term losses. Examination of the pattern of responses shows that this deficit in performance is stable over time. While controls initially sample from the bad decks, they eventually learn to avoid them. Patients, on the other hand, continue to sample from the bad decks throughout the experiment. Since participants must rely on their ability to estimate which decks are risky and which are profitable over time, patients' performance mimics their real-life inability to make advantageous decisions. This task allows the detection of the impairment in these patients in a laboratory setting, and provides insight into the role of the ventromedial prefrontal cortex, which appears crucial for incorporating emotional knowledge about decision outcomes into behavior.

Applications

This task can serve to assess decision-making deficits in a variety of populations. For example, in addition to patients with damage to the ventromedial prefrontal cortices, patients with bilateral amygdala damage also show severe decision-making impairments that can be measured by the Iowa Gambling Task. Additionally, disadvantageous decision-making characterizes various psychopathological conditions, including substance addiction, pathological gambling, schizophrenia, obsessive-compulsive disorder, anorexia nervosa, attention deficit/hyperactivity disorder, psychopathy, obesity, and many others.

One of the advantages of this task is its ability to distinguish among different cognitive contributions to the complex process of decision-making. For example, we can compare the performance of patients with ventromedial prefrontal cortex (VPMFC) damage to patients with schizophrenia, both of whom show deficits on the task. The tendency of VPMFC patients to choose from the bad decks has been interpreted as a deficit in incorporating information about long-term future consequences into behavior; in these

patients, choices are made only on the basis of potential short-term reward. Patients with schizophrenia also choose more frequently from the bad decks than normal controls. However, their distinctive pattern of choices, in which they tend to choose more often from the decks with low frequency, high magnitude losses (decks B and D), reveals a different underlying deficit.⁴ This pattern of choices suggests that schizophrenic patients are sensitive to the frequency of reward versus punishment, but fail to advantageously take into account the magnitude of the punishment. Thus, the IGT is able to reveal a range of cognitive contributions to decision-making that may be associated with dysfunction in different brain regions.

Legend

Figure 1: Computer reconstruction of the brain of a patient with VMPFC damage. This patient has bilateral damage to the medial prefrontal cortex, as shown in this 3D reconstruction made from MRI images. Images courtesy of Hanna Damasio.

Figure 2: Programmed schedule of reward and punishment. This chart is used by the experimenter to determine the reward and punishment for each card turn. The participant is rewarded with the dollar amount in the first column, and is presented with a punishment based on the schedule detailed in the following columns. Each row represents one deck of cards, either A, B, C, or D. For each card turn from that deck, the participant receives the dollar amount in the first cell. Each column represents the card turn from that deck. For example, the first two turns from deck A have no penalty, then the third turn from deck A has a \$150 penalty. There are 40 cards in each deck, each represented by a column in the chart.

Figure 3: Control subject and patient performance on the Iowa Gambling Task. In one hundred card selections from four decks, normal controls made more selections from the good decks (C and D), and were more apt to avoid the bad decks (A and B). In contrast, patients with ventromedial prefrontal cortex damage made more selections from the bad decks (A and B), and avoided choosing from the good decks (C and D).

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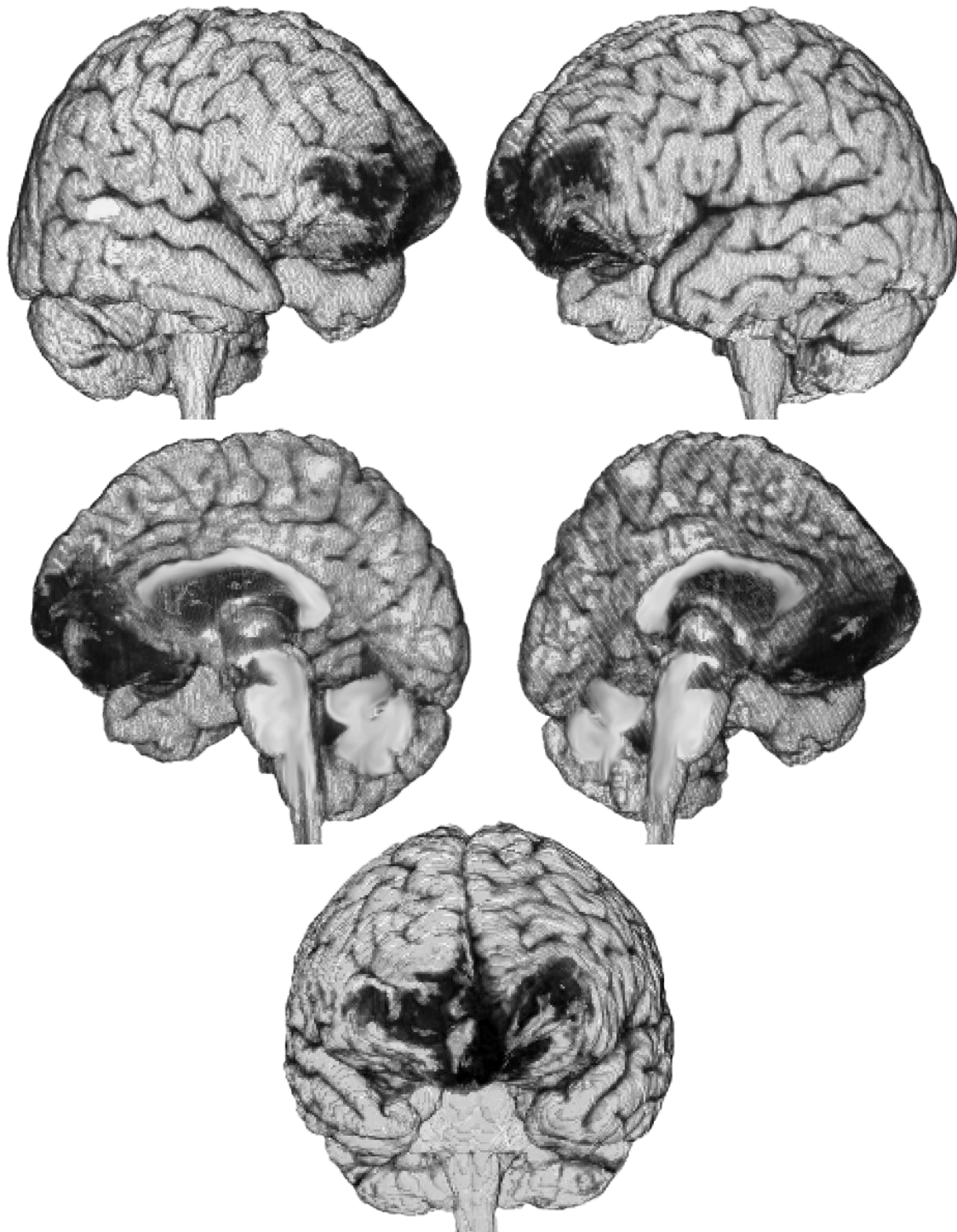


Figure 1: Computer reconstruction of the brain of a patient with VMPFC damage. This patient has bilateral damage to the medial prefrontal cortex, due to surgical resection of a meningioma. Shown here is a 3D reconstruction made from MRI images. Images courtesy of Hanna Damasio.

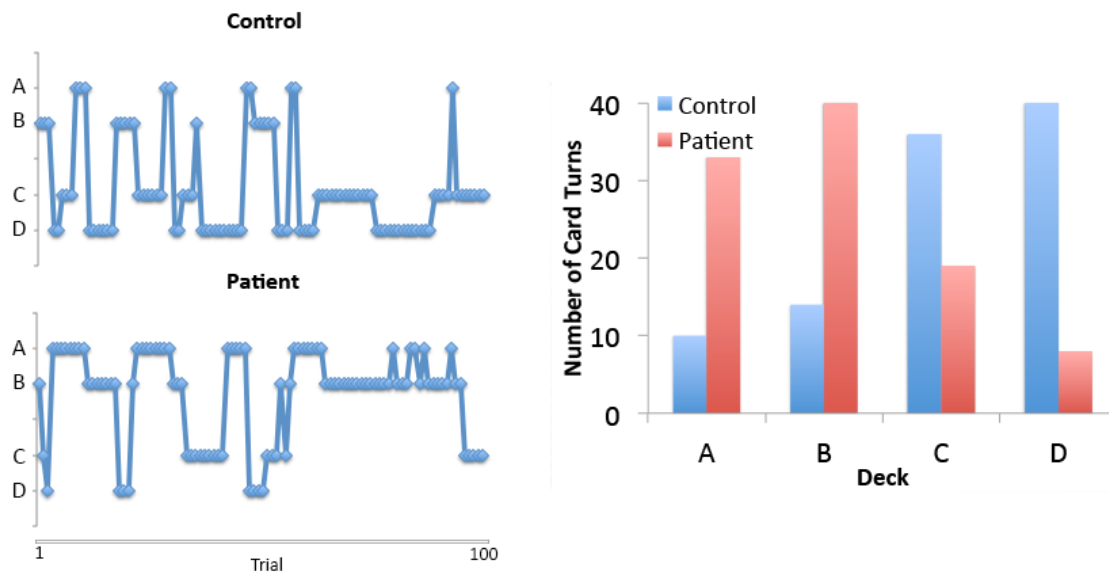


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