Decision Making and the Somatic Marker Hypothesis

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Overview

• Emotion and the somatic marker hypothesis
• Tests of the somatic marker hypothesis
• Concluding comments
Emotion and the somatic marker hypothesis

• Background
  – Prefrontal Region
    • Function
    • Damage
    – Acquired Sociopathy
Emotion and the somatic marker hypothesis

• The somatic marker hypothesis
  – Rationale
  – Details of the somatic marker hypothesis

• A neural network for somatic markers
  – Additional details of the somatic marker hypothesis
  – Connections of the ventromedial prefrontal cortex
Tests of the somatic marker hypothesis

• Experiment with emotionally charged stimuli
  – Subjects:
    • Ventromedial prefrontal damage (VMP) patients
    • Brain-damaged controls
    • Normal controls
  – Stimuli:
    • Orienting stimuli
    • Neutral pictures
    • Emotional pictures
Tests of the somatic marker hypothesis

– Response:
  • Skin conductance response (SCR)

– Results:
  • Figure 73.1

– Conclusions:
  • The results provide evidence that VMP patients have lost the ability to generate normal somatic responses to emotionally charged stimuli.
  • The authors believe that this defect is a key component of the explanation as to why the real-world social behavior of the patients is impaired.
Figure 73.1
Tests of the somatic marker hypothesis

• The Gambling Task
  – Subjects:
    • Ventromedial prefrontal damage (VMP) patients
    • Brain-damaged controls
    • Normal controls
  – Stimuli:
    • Card decks A and B (disadvantageous)
    • Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Subjects select a card from any deck
  • Subjects receive either a reward or a reward plus a punishment (varies by deck and position in a deck)

– Results:
  • Figure 73.2
  • 3(group) x 2 (deck) x 5(block) ANOVA

– Conclusions:
  • These results demonstrate that as the task progressed, both control groups showed a strong shift away from the bad decks and towards the good decks.
Figure 73.2

The figure shows the total number of cards selected from different decks across the 1st to the 100th trial for three groups: Normal Control (N=44), Brain-damaged Control (N=6), and Ventromedial Prefrontal (N=6). The decks are categorized as Disadvantageous (A & B) and Advantageous (C & D). The graphs illustrate the order of card selection for each group.
Tests of the somatic marker hypothesis

– Conclusions (continued):

• However, the VMP patients failed to shift their behavior toward more advantageous responding. In fact, these patients persisted reliably with the bad decks during the last 40 trials of the session.

• Follow-up studies after one month and six months showed that the control subjects improved their performance over time. This was demonstrated by the fact that they avoided the bad decks even earlier in the game compared to their original session. Thus, they retained their learning from the original session.
Tests of the somatic marker hypothesis

– Conclusions (continued):

• However, the VMP patients did not improve their performance over time. This was demonstrated by the fact that they performed in a similar defective manner (disadvantageous responding) at both the 1-month and 6-month follow-ups.
Tests of the somatic marker hypothesis

- The Gambling Task + SCR measurements
  - Subjects:
    - Ventromedial prefrontal damage (VMP) patients
    - Normal controls
  - Stimuli:
    - Card decks A and B (disadvantageous)
    - Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Card selection and consequences are same as G. task
  • A psychophysical measurement (SCR)

– Results:
  • Classified the SCRs into three types:
    – Reward SCRs
    – Punishment SCRs
    – Anticipatory SCRs
  • Figure 73.3
  • Figure 73.4
Figure 73.3
Tests of the somatic marker hypothesis

– Conclusions:
  • The authors interpret these results to indicate that the absence of anticipatory SCRs in the VMP patients is a physiological correlate for their insensitivity to future outcomes.
  • This interpretation is compatible with the idea that these subjects fail to activate biasing signals which would serve as value markers in the distinction between choices with good or bad future outcomes.
Tests of the somatic marker hypothesis

- The Gambling Task + SCR + Self-Report
  - Subjects:
    - Ventromedial prefrontal damage (VMP) patients
    - Normal controls
  - Stimuli:
    - Card decks A and B (disadvantageous)
    - Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Card selection and consequences are same as G. task
  • Psychophysical measmt. (SCR) is same as G. task
  • Self –report (subjects answered 2 questions @ task)

– Results:
  • Classified the experiment into 4 knowledge periods:
    – Pre-punishment
    – Pre-hunch
    – Hunch
    – Conceptual period
  • Figure 73.5
Figure 73.5
Tests of the somatic marker hypothesis

– Results (continued):
  • Figure 73.6

– Conclusions:
Figure 73.6
Tests of the somatic marker hypothesis

- D.R. and DNMS vs. The Gambling Task
  - Subjects:
    - Ventromedial prefrontal damage (VMP) patients
    - Dorsolateral prefrontal damage patients
    - Normal controls
  - Stimuli:
    - Delayed response task (to assess working memory)
    - DNMS task (to assess working memory)
    - Gambling task (to assess decision making)
Tests of the somatic marker hypothesis

– Response:
  • Subject tries to select the appropriate stimulus

– Results:
  • Performance on these tasks differed depending on the location of the brain damage

– Conclusions:
  • Thus, a double dissociation, cognitively and anatomically, is supported by the results from the anterior VMP patients and the right dorsolateral patients.
Tests of the somatic marker hypothesis

– Conclusions (continued):

• This outcome indicates that the decision-making impairments produced by VMP damage are not directly or solely the result of a working-memory impairment.

• However, it is probably true that severely impaired working memory comprises the efficiency of decision making to some extent. The right dorsolateral subjects’ scores are evidence of this.

• Also, the most likely scenario for an isolated impairment in decision making would involve an anteriorly situated VMP lesion.
Tests of the somatic marker hypothesis

• The Gambling Task w/ altered punishment
  – Subjects:
    • Ventromedial prefrontal damage (VMP) patients
    • Normal controls
  – Stimuli:
    • Good decks (hi immediate punishment, long-term gain)
    • Bad decks (low immediate punishment, long-term loss)
Tests of the somatic marker hypothesis

– Response:
  • Card selection

– Results:
  • VMP patients opted for decks with lower immediate punishment and hence ended up with higher long-term loss as a consequence
  • All VMP patients and controls generated normal SCRs to rewards and punishments

– Conclusions:
  • These findings are inconsistent with an interpretation that the VMP patients’ poor performances are simply the result of an insensitivity to punishment.
Tests of the somatic marker hypothesis

– Conclusions (continued):
  • These findings are also inconsistent with an interpretation that the VMP patients are hypersensitive to reward.
  • The evidence from the studies thus far strongly implicates the explanation that the defective strategy of the VMP patients is attributable to an overall insensitivity to future consequences.
Tests of the somatic marker hypothesis

• The amygdala and the Gambling Task
  – Subjects:
    • Patients with bilateral amygdala damage
    • Patients with unilateral left amygdala damage
    • Patients with unilateral right amygdala damage
  – Stimuli:
    • Card decks A and B (disadvantageous)
    • Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Card selection

– Results:
  • Patients with bilateral damage:
    – Failed to learn to avoid the bad decks (Fig. 73.7)
    – Failed to generate anticipatory SCRs
    – Failed to generate reward SCRs or punishment SCRs
  • Patients with unilateral damage:
    – Did not have impaired performance of the task
    – Did not have impairments in anticipatory SCRs
    – Did not have impairments in reward or punishment SCRs
Figure 73.7

Bilateral Amygdala Subjects (N=5)

- Disadvantageous Decks (A & B)
- Advantageous Decks (C & D)

Total # of Cards Selected from Decks

Order of Card Selection from the 1st to the 100th Trial
Tests of the somatic marker hypothesis

– Conclusions:
Tests of the somatic marker hypothesis

- The right somatosensory/insular cortices and the Gambling Task
  - Subjects:
    - Patients with right somatosensory/insular cortex damage
    - Patients with left somatosensory/insular cortex damage
    - Normal controls
  - Stimuli:
    - Card decks A and B (disadvantageous)
    - Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Card selection

– Results:
  • Figure 73.8

– Conclusions:
  • The results support the idea that the right somatosensory/insular region, but not the left, is another important component of the neural network subserving somatic marker activation and decision making.
Tests of the somatic marker hypothesis

- The peripheral nervous system and the Gambling Task
  - Subjects:
    - Patients with peripheral neuropathy (mainly sensory)
    - Normal controls
  - Stimuli:
    - Card decks A and B (disadvantageous)
    - Card decks C and D (advantageous)
Tests of the somatic marker hypothesis

– Response:
  • Card selection

– Results:
  • The peripheral neuropathy patients

– Conclusions:
Concluding comments

• Summary:
  – VMP patients have abnormalities in:
    • SCR to emotional pictures
    • SCR to anticipatory periods in the Gambling task
    • Making wise decisions for future outcomes in G. task, even when they consciously know the proper strategy

• Comments