Chronic pain and the perceived value of monetary reward

E. L. PARKS[1], A.T. BARIA, M. N. BALIKI[1], *A.V. APKARIAN[1, 2]

[1]Dept of Physiology, [2]Dept of Anesthesiology, Northwestern Univ. Med. Sch., Chicago, IL

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INTRODUCTION

We previously demonstrated that chronic pain impairs emotional decision-making during a monetary gambling task (Apkarian et al., 2004). Here we present preliminary results for two gambling tasks: gains vs. losses and gains vs. time, comparing chronic low back pain patients to healthy subjects. These tasks allow us to independently measure specific parameters for the perception of value during decision-making.

METHODS

- 9 healthy subjects and 10 chronic low back pain (CBP) patients participated in each study.

Experiment 1 investigated the magnitude of loss aversion during decision-making under risk (Tom et al., 2007).

- Participants decided whether to accept or reject gambles that offered a 50/50 chance of gaining or losing differing amounts of money. The data was then fit with a straight line using the size of each potential gain and loss as independent variables and acceptance/rejection as the dependent variable.

- The resulting regression coefficients for loss and gain variables served as individual measures of *loss* and *gain sensitivity.*

- The ratio of loss to gain responses was then used to calculate for each participant the level of *behavioral loss aversion* (λ).

Experiment 2 investigated the subjective value of delayed monetary rewards (Kable & Glimcher, 2007).

- Subjects decided either to accept a fixed immediate reward or a larger delayed reward that varied randomly from trial to trial.

- Subject-specific constants (k) for temporal discounting of monetary value were calculated with a single parameter hyperbolic function and then compared between groups.

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Experiment 1: Loss Aversion

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Task Design. Trials began with a red dot followed by a display showing the amount of potential gain (in green) and loss (in red). Subjects then had 5s to consider their choice before a green dot signaled for an accept or reject response. Value amounts ranged from $10 to $38 for gains and $5 to $19 for losses. Each potential gain/loss combination was presented 4 times for a total of 64 trials.

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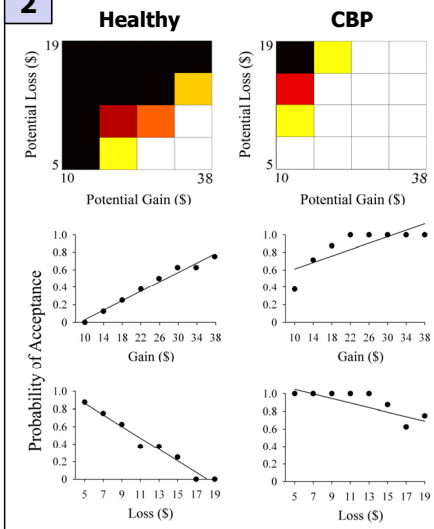

Example data from 1 healthy subject (left) and 1 CBP patient (right). *Top:* Color-coded heatmaps representing probability of gamble acceptance for each gain/loss combination (white indicates high willingness to accept the gamble, black indicates low willingness to accept the gamble). Probability of acceptance for each gain (*middle*) and loss (*bottom*) amount. Regression coefficients of fitted lines represent gain sensitivity and loss sensitivity.

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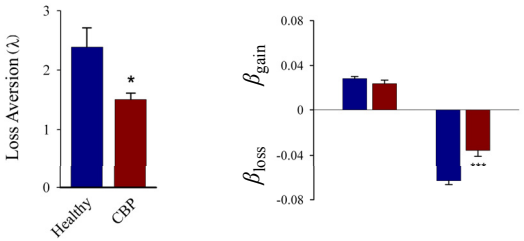

Behavioral loss aversion was significantly decreased in CBP (p= 0.01). CBP patients were significantly less sensitive to absolute losses (p = 0.0004) than healthy subjects, despite equal sensitivity to gains.

Experiment 2: Temporal Discounting

4

Task Design. Trials began with a red dot followed by a display showing a choice amount of money (range $32 - $60) for a specific time delay (range 1 – 90 days). Subjects had 5s to consider their choice before a green dot signaled for a response of either accepting the option presented (delay) or rejecting (indicating a preference to receive $30 immediately).

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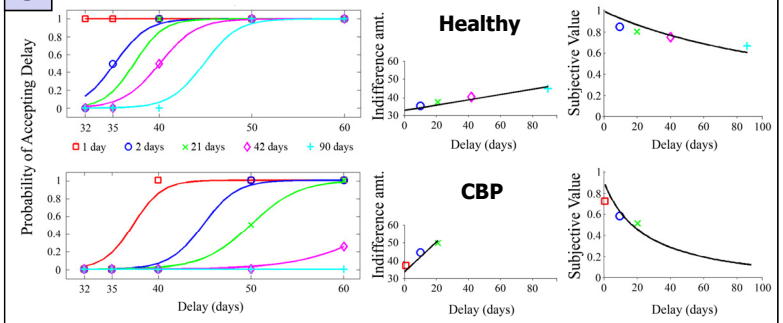

The effects of temporal delay on perceived monetary value in 1 healthy subject and 1 CBP patient. *Left*: Probability of accepting a larger amount of money as a function of delay. *Middle*: Indifference amounts include delays chosen greater than half the time. *Right*: Subjective value constants (k) for temporal discounting.

Between groups, subjective value discounting rates differed between healthy subjects and CBP patients (borderline significance, p = 0.06), with CBP patients exhibiting less willingness to accept delayed rewards.

CONCLUSION

Preliminary results suggest that CBP patients exhibit riskier decision-making behavior and are less averse to losses relative to gains. This effect seems to be driven specifically by decreased sensitivity to loss. These results replicate our earlier findings that chronic pain impairs decision-making under risk (Apkarian et al., 2004).

A borderline significant difference was also observed between CBP patients and healthy subjects in a temporal delay task, with CBP patients exhibiting greater impulsivity and decreased willingness to wait.

We are continuing to collect more data and use these tasks in fMRI studies to identify related brain activity differences between the groups.