

Time Estimation by Patients with Frontal Lesions

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Introduction

I propose investigating time estimation in patients with frontal lobe damage, and replicating the paradigms used in a study done by Mimura et al. (2000), to further research the effects of frontal lobe damage in time estimation. Previous studies indicate that time estimation is dependent on an internal or biological clock that is mediated by frontal brain regions (Church, 1984; Meck, 1983; Meck et al., 1984). Some researchers believe that flawed estimates of time are due to a damaged or unstable internal clock, or to lack of impulse control and the tendency to terminate actions prematurely. Other studies show frontal lesions to interfere with working memory (Mimura et al. 2000; Baddeley 1986; Shimamura, 1995).

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Patients with frontal lesions have flawed estimations of time. Mimura et al. (2000) found that estimations of short durations (less than 28 seconds) were pathologically increased by such patients. This effect is greatest for the shortest interval tested, 8 seconds, and declines as the intervals grow longer, to reverse beyond 28 seconds. The rapid fading and replacement of contents from short-term storage suggests that the frontal lobe patient incorrectly believes that more time has passed than actually is the case. Correspondingly, their duration estimates are excessively long (Kinsbourne, 2000). As durations become longer, weakness of working memory interferes with the rapid turnover of stimuli in awareness, resulting in time estimates that are more attenuated.

This proposed study will further support the theory that working memory plays a role in temporal cognition by replicating Mimura et al.'s (2000) finding that working memory deficits inflate subjective estimation of short intervals (less than 28 seconds).

Research Participants

Participants will be recruited from the Center for Cognition and Communication (CCC) in New York City, and the New School University graduate and undergraduate programs.

- 1) Four (4) female and two (2) male patients with frontal lesions from the CCC.
- 2) Normal, healthy control participants with no evidence of frontal lesions or other cortical damage.

Procedure

Experiment 1: Verbal Time Estimation

A) Retrospective Paradigm- participants will engage in an activity without being forewarned that s/he will have to estimate the duration of the task. Only when s/he completes the activity does the tester ask for an estimation of time engaged in the activity. This is a single trial method.

B) Prospective Paradigm- participants will be alerted, at the start of the first trial, that s/he will be asked to estimate the total time of the trial. S/he may engage in any mechanisms (not including a timepiece) to help aid her/his estimation.

Participants will sit facing a computer monitor in a semi-darkened room. On each trial, the participants will be required to read numbers (1-9) aloud in order to prevent sub-vocal counting (distracter stimuli). The number stimuli will be presented in random sequence on the monitor throughout each predetermined interval and timing will be measured with a stopwatch.

Participants will verbally estimate a filled interval of 58 seconds without any advance notice that they will be asked for time estimation. This one-time retrospective paradigm will be followed by a prospective paradigm, in which subjects are warned before each trial that they will be asked to estimate how long the trial has lasted. Time intervals will be 8, 28, 58, 88, and 118 seconds. Each time interval will be presented four times in a random sequence of 20 trials.

Experiment 2: Present Time Estimation

Participants are instructed to count silently at a one second rate from the examiner's start to stop signal. No distracter tasks are used. Intervals are identical to those in Experiment 1 in length,

8, 28, 58, 88, and 118 seconds, and are presented in random order twice for a total of 10 trials. Time intervals are measured with a stopwatch.

Experiment 3: Time Production

Participants perform the same prospective paradigm as in Experiment 1. However, in this condition, participants are asked to indicate when they believe a predetermined time interval is over. Therefore, they are actively estimating a pre-specified time, rather than estimating it at a moment dictated by a trial event. Intervals are 8, 28, 58, 88, and 118 seconds and each are requested four times in a random sequence for a total of 20 trials. Participants are asked to verbally announce when they believe that the time has elapsed. To help the participant keep the task in mind, the tester will hold up a card that indicates the amount of time of each requested interval.

Hypothesis

As found in the Mimura et al. study (2000), patients with frontal lesions have flawed estimations of time. Short durations (less than 28 seconds) are pathologically increased. The effect is greatest for the shortest interval, 8 seconds, and declines as the intervals grow longer, to reverse beyond 28 seconds. Participants with frontal lesions will estimate time intervals less accurately than normal controls.

In experiment 1, participants with frontal lesions will overestimate shorter intervals (28 seconds and under) and will underestimate longer intervals (58 seconds and above).

In experiment 2, participants with frontal lesions will overestimate/over-count shorter intervals (28 seconds and under), but will be more variable and closer to nor-

mal accounts in the longer intervals (58 seconds and above).

In experiment 3, participants will again overestimate shorter intervals (28 seconds and under) and will be closer to normal accounts in the longer intervals (58 seconds and above).

Author's Note ~ The individual results of experiment 3 of the Mimura et al. (2000) study were extremely variable. Two participants severely overestimated the intervals, while five participants tended to underestimate the intervals. This variance led to a normal looking group mean. It will be interesting to see what the CCC frontal population estimates.

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