

Investigation into the effects of cognitive load on time judgements.

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Abstract

The purpose of this experiment was to investigate the effects of cognitive load on time perception. The tasks used were a random number generation task as compared to a random word generation task, and subjects were asked to perform these for either thirty or sixty seconds. It was expected that the word generation task would be more cognitively demanding than the number task and thus this would result in more variance in time estimates from the actual time. The results of a Kruskal-Wallis one way ANOVA found no significant differences between the conditions, indicating that cognitive load of these tasks has no effect on time duration judgements. However, a number of methodological flaws could be responsible for these results and these are outlined in the discussion section.

Introduction

In our experiment, the article that has been most relevant and which has provided a springboard for our own experiment is Dan Zakays article on 'Relative and Absolute Duration Judgements Under Prospective and Retrospective paradigms.'

Zakays research investigated our ability to estimate time duration under differing conditions. Differing cognitive loads such as simple Vs complex tasks were compared, duration judgements relative to another ongoing stimuli Vs absolute duration judgements were also compared. Finally prospective Vs retrospective judgements were examined where in the former subjects were told in advance they would need to judge duration whilst in the latter condition the subjects had no prior warning. The results that Zakay gained indicated that cognitive load significantly affected our ability to perceive time. He also found that time judgements improved if subjects consciously attempted to log time (as in the prospective condition) and also could estimate duration as relative to another stimulus marker.

Zakay's study clearly indicates that our success in judging time rests upon intervening factors such as cognitive load and expectation. It throws up important questions as to the brain's ability to manage and co-ordinate cognitive resources and also how time judgements may prove to be a mental gauge on the cognitive difficulty of a task.

Our experiment expands on the investigation into cognitive load effect by studying the relative demands of word and number generation. We also investigate the area that Zakay suggested further research into, that being different time intervals and their effect on judgement accuracy. We hope to discover a

difference in cognitive load between our two conditions as will be reflected in subjects time judgements and draw conclusions about the nature of these tasks and also about our methods of logging time itself.

Alternative Hypothesis :

Cognitive load as experienced in our word and number tasks will have an effect on time judgements.

Null Hypothesis :

Cognitive load as experienced in our word and number tasks will not have an effect on time judgements.

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Method

Subjects

The sample of subjects used in the experiment were from a student population with age range between 20 and 22 years, all with a similar level of education and randomly distributed between males and females. This gave a total of 40 subjects who participated in the experiment.

Materials

Subjects were given a blank sheet of paper to write their words or numbers on and a sheet of paper with a straight line on it to represent time between 0 and 3 minutes. There were no other materials necessary for the experiment.

Design

Between subjects design.

Procedure

The 40 subjects and 4 conditions were split between the four experimenters, so 10 subjects completed each condition. Subjects were given no indication of the true purpose of the experiment by the experimenter. Depending upon which condition the subjects had been allocated to, each subject was instructed to generate a list of either words or numbers while the experimenter discretely timed either 30 seconds or 60 seconds. When the time had lapsed, subjects were given the piece of paper and asked to mark on the line how long they thought the word or number task had taken. Afterwards, subjects were debriefed on the purpose of the experiment.

Results

The data gathered were the estimations of how long the subjects thought the experiment lasted. As we were concerned with how these results varied from the actual time taken, the data gathered had the actual time of the experimental condition subtracted from them (e.g. an estimate of 45 seconds in the 30 second group would give a variance of 15 seconds). All these results were converted to positives (as this study was not concerned with the direction of the differences) and all statistics were carried out on these converted results.

Descriptive Statistics

The mean variance and the standard deviations for all conditions are shown in Table 1. below, and the same information is represented in graphical form in Graph 1.

Table 1.

	Mean	St. Dev	Max	Min
Num. 30s	13	13.5	40	0
Word 30s	11	9.07	30	0
Num. 60s	16	14.49	45	0
Word 60s	14.5	14.8	45	0

Note : **Num. 30s** refers to the condition where subjects were asked to generate random numbers for 30 seconds, **Word 60s** refers to word generation for 60 seconds, etc. etc.

Graph 1.

$$\text{standard error} = se = s/\sqrt{n}$$

Non-parametric statistics.

A Krushkal-Wallis 1-way ANOVA was carried out on the data to determine significance. This resulted

in a chi-square value of 0.5604, ($p=0.9054$). This indicated that the results are non-significant over all conditions, meaning that the alternative hypothesis must be rejected and the null hypothesis accepted.

Discussion

The present non-significant results ($p=0.9054$) lead us to reject the alternative hypothesis and consequently to accept the null hypothesis that, cognitive load as experienced in our word and number tasks will not have an effect on time judgements.

The nature of this investigation required that two experimental conditions be used both employing a task that used cognitive resources but that varied in the degree of demand placed on these resources, that is they varied in the amount of cognitive load. A classic example of a task that uses cognitive resources is that of random generation, thus it was decided to use a random word generation task, which was the high cognitive load condition and a random number generation task, which was the low cognitive load condition.

There was no real scientific basis for making this distinction between the two generation tasks and their apparent differences in cognitive load. It was however felt that such a distinction could be made based on personal observations. It was noticed that when producing random words it generally appeared to be that case that one used more effort in thinking of new and unconnected items than when producing random numbers. This is possibly because with number generation one at least has certain parameters to work within, but with word generation there is a great and unlimited choice, unless a defining category is used.

It was hoped that this investigation would show a difference in cognitive load for these tasks as reflected by subjects ability to judge time. Thus for the high load condition (words) it was believed there would be a great disruption in time judgements, as with the greater effort expended time would be perceived to pass quicker. The disrupted time judgement would clearly demonstrate then that cognitive load can effect time judgements and that there is a difference in the cognitive load of the tasks used.. The non-significant results however lend us to conclude with regards to this experiment that time judgements are not effected by cognitive load and that there is no difference in the cognitive load of the tasks.

This is a surprising result in light of personal observations made and in light of Zakay's experiment where quite clearly cognitive load effects perception of time, indicating that tracking time is cognitively demanding, and in light of personal observations made. The theoretical implications of our result then would be that time logging and tracking is not cognitively demanding for the central executive, as we know that the central executive is directly implicated in the process of random generation tasks.

Our results then seem to be contradictory to all that has gone before, there are however several methodological issues that can account for the unusual results. Firstly it would seem that the tasks

chosen did not vary enough in terms of cognitive load and so it would be more appropriate tasks should be chosen in the future. The random generation task could still be employed for the high load condition (as we know that this places demands on the central executive) and a simple drawing task could be used for the low load condition.

Secondly a relatively small and unrepresentative population sample was used. Thus in the future it would be beneficial to have a larger sample size and more randomisation in the allocation of subjects, which in turn will give greater statistical power. It is also essential to have standardised instructions and experimental settings, as in running this experiment people were tested in a variety of settings with many distractions, thus there was a severe lack of control. The subjects should also be stipulated to mark on the response sheet in one way their indicator of judged time, this could either be writing the time or marking on a calibrated line, however only one of these methods should be employed to ensure standardisation and uniformity of the independent variable. It should also be made clear if subjects are required to mark how long they felt the time was or how long they know it was, as there is a great difference between the two.

In light of these modifications then it would seem feasible to replicate the experiment using the different time intervals and obtaining the expected result of cognitive load affecting time judgement. Little could be said about the effect of the time variables in the present experiment due to the lack of difference between the cognitive load tasks. Thus the non-significant result, which would indicate that neither the time intervals chosen were any easier to judge. It should be noted that most of the subjects were aware that they were being timed which as we already know according to Zakay's experiment tends to improve time judgements as subjects are consciously trying to log time. Thus efforts should be made to time subjects secretly. More unusual and shorter times, for example 12 and 15 seconds could also be used, which gets away from the problems of subjects being used to timing and knowing how long 30 seconds and 1 minute feels.

Further research is needed then not only to improve design methods but to establish differences in perceptions of differing times and the possible applications that these results could have in the work place and other situations where time and its perception is important.