

# Temporal reproduction of duration as a function of numerosity

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One, three, or five dark dots were tachistoscopically presented for 300, 600, or 900 msec to subjects. Temporal reproduction of stimulus duration was shown to be a monotonically increasing function of numerosity of dots. Accentuation of this monotonicity took place when changes in stimulus duration were made less frequent, not when changes in numerosity were made less frequent.

Two previous studies (Mo, 1971, 1974) indicated that, if each stimulus consists of a number of dark dots, the judgment of duration is a monotonically increasing function of numerosity of such dots. However, these two studies relied on the methods of psychophysical recognition and discrimination, respectively, and, as such, dealt with durations which were more or less at the neighborhood of one jnd. Therefore, it is possible that the demonstrated monotonic effect may be occasioned by preference of such a nontemporal stimulus attribute as numerosity as a cue for temporal judgment because of task difficulty. That is, the question as to whether the monotonic relation so demonstrated was independent of discriminability of durations was not raised. One way of dealing with this question is to investigate the effect of numerosity on temporal judgment of durations which are perfectly discriminable. Since the method of temporal reproduction meets this requirement, this study attempts to demonstrate the monotonic effect of numerosity on temporal judgment of perfectly discriminable durations using this method.

## EXPERIMENT I

### Method

Twenty undergraduates, 9 male and 11 female, served as subjects. Their age ranged from 18 to 34 years with the mean age of 21.8 years. They were assigned to two groups, Group 1 and Group 2, of 10 each. Each stimulus was 21.6 x 18.1 mm rectangular white card bearing either one, three, or five dark dots. These dots were distributed randomly on each card by means of a nine-cell rectangular grid measuring 3 x 3 cm. Assignment of dots over this grid was done by using two-digit random numbers. There were altogether 30 cards, each 10 cards bearing either one, three, or five dots. Each stimulus was presented by means of a Lafayette U-1 electronic tachistoscope.

The procedure was typical of that of temporal reproduction. Immediately following presentation of each stimulus, subject's task was to depress a telegraph key with his right index finger for the duration judged to be equivalent to the stimulus duration. The depression of the telegraph key also produced a 1000-hz tone, delivered through a loud speaker located about 2 m to the right of the subject. The sound pressure level, measured at subject's location, was 66 dB. For all subjects, stimulus durations

This study was supported in part by funds from the Faculty Research and Professional Growth Committee, Southern Colorado State College.

were 300, 600, and 900 msec. A preliminary check showed that these durations were sufficiently different from each other for errorless verbal recognition.

Groups were distinguished on the basis of relative frequency of stimulus durations. For Group 1, each stimulus duration was presented for 18 trials randomly. For Group 2, the 600-msec stimulus duration was presented for 36 trials, and the 300- and 900-msec stimulus durations were each presented for 9 trials. It is assumed that change of stimulus duration from 600 to either 300 or 900 msec would appear more sudden or abrupt for Group 2 than Group 1. For all subjects, each numerosity was presented for 18 trials randomly. Recording of temporal reproduction was done with a Standard electric timer.

### Results

The response measure was temporal reproduction, that is, the duration of the subject's depression of the telegraph key, recorded to a nearest 10 msec on each trial. Means of this measure with respect to numerosity and stimulus duration were calculated and are shown in Figure 1.

It is observed that the general tendency is for temporal reproduction to increase as numerosity increases ( $F = 5.39$ ,  $df = 2/36$ ,  $p < .01$ ). It may be also observed that this tendency seems more accentuated for Group 2 than for Group 1. However, the  $F$  ratio for the effect of groups and their interaction with numerosity did not satisfy the 5% level of significance. The effect of stimulus duration was not treated in analysis of variance, because stimulus durations were originally so chosen on the basis of perfect discriminability.

Since three stimulus durations were greatly different from each other, and the resultant temporal reproduction correspondingly ranged widely, analysis of data in terms of successive differences of temporal reproduction with respect to numerosity may be attempted. Since the sum of such successive differences is equivalent to the difference between the temporal reproduction associated with five and one dots, the absolute level of temporal reproduction associated with three dots becomes irrelevant once this difference score is used to investigate the monotonic effect of numerosity on temporal reproduction. For Group 1, such difference scores were  $-.3$ ,  $4.9$ , and  $39.5$  msec for 300-, 600-, and 900-msec stimulus durations,

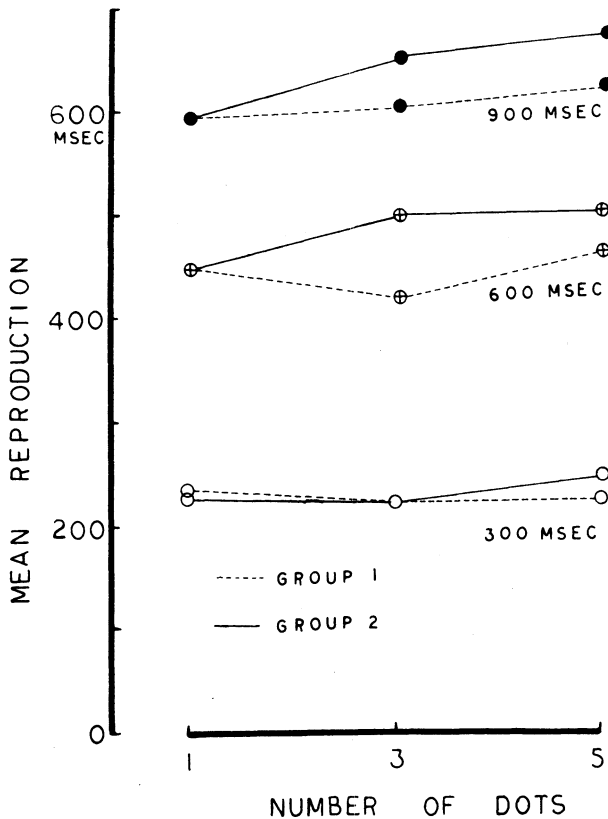


Figure 1. Mean temporal reproduction in msec with respect to stimulus duration and numerosity of dark dots (Experiment I).

respectively. For Group 2, difference scores were 39.4, 43.2, and 72.9 msec in the same order of stimulus durations. The mean difference scores for Group 1 and Group 2 were 14.7 and 48.8 msec, respectively, and the results of the Mann-Whitney U test performed show that these two means were significantly different from each other ( $U = 22, p < .05$ , two-tailed). It can be concluded that the monotonic relation between numerosity and temporal reproduction becomes more accentuated once changes in stimulus duration become infrequent, and therefore, presumably more sudden.

### EXPERIMENT II

#### Method

Relative frequencies of numerosity instead of stimulus duration were manipulated in this experiment. Subjects were 10 male and 10 female undergraduates. Their ages ranged from 18 to 29 years, with a mean of 21.9 years. They were assigned to two groups of 10 subjects each.

For Group 1, each numerosity was presented for 18 trials randomly. For Group 2, cards bearing three dots were presented for 36 trials, and cards bearing either one or five dots were presented for nine trials, respectively. For all subjects, stimulus durations were 300, 600, and 900 msec and each duration was presented for 18 trials randomly. The rest of the procedure was the same as that in Experiment I.

#### Results

The response measure was temporal reproduction

(key depression) recorded to a nearest 10 msec in each trial. Mean temporal reproductions with respect to numerosity and stimulus duration are shown in Figure 2. The results of analysis of variance conducted show that the only significant effect was that of numerosity ( $F = 6.34, df = 2/36, p < .01$ ). Difference scores with respect to numerosity for Group 1 were 8.9, 31.2, and 41.5 msec, for 300-, 600-, and 900-msec stimulus durations, respectively. As for Group 2, difference scores were .9, 62.2, and 47.1 msec for the same order of stimulus durations. The means of difference scores were 27.2 msec for Group 1 and 36.7 msec for Group 2. The results of a Mann-Whitney U test conducted show that these two means are not significantly different from each other at 5% level.

### DISCUSSION

The monotonic effect of numerosity on temporal judgment of perfectly discriminable durations has been demonstrated, implying that such an effect is not attributable to discriminability of durations.

It was previously shown (Mo, 1971) that, if durations are not perfectly discriminable, relative suddenness of changes in both numerosity and duration would accentuate the monotonic effect of numerosity on temporal judgment. In comparison, the results of the present study show that, when durations are perfectly discriminable, such accentuation seems to accompany relative suddenness of changes in stimulus duration but not in

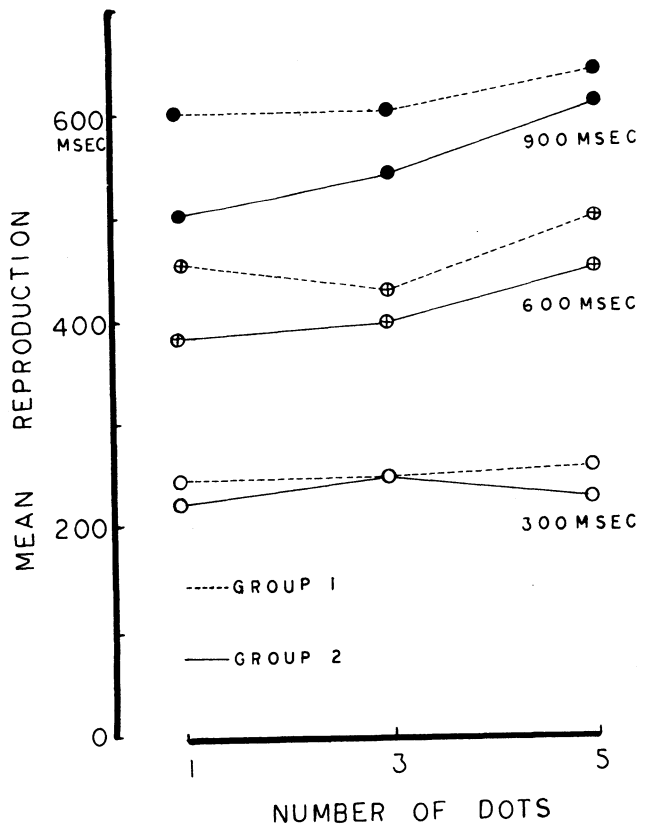


Figure 2. Mean temporal reproduction in msec with respect to stimulus duration and numerosity of dark dots (Experiment II).

numerosity. Why this accentuation is more pronounced with respect to changes in duration than in numerosity is not clear. However, it can be reasonably concluded that the monotonic effect of numerosity on temporal judgment is independent of temporal discriminability.

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(Received for publication November 25, 1974.)

*Bulletin of the Psychonomic Society*  
1975, Vol. 5 (2), 167-169

# Contrast effects with shifts in punishment level

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The present experiment was designed to investigate the effects of shifts in punishment level using a successive shift procedure. Rats were given a constant reward (two pellets) throughout training but received varying intensities of brief electric shock (punishment) in the goalbox. During preshift, subjects ran for 40 trials to either .1, .4, or .8-mA shocks in the goalbox. All subjects were then shifted to .4 mA in the goalbox for 40 trials. The results showed that subjects shifted to a higher intensity shock ran slower than subjects originally trained on that higher intensity shock (negative contrast). There was no evidence of a corresponding positive contrast effect. The data were discussed with respect to their implications for theories that attempt to treat reward and punishment in comparable theoretical fashion.

A positive contrast effect is said to occur when subjects shifted from a small magnitude of reward to a large magnitude run faster than subjects which have received only the large magnitude of reward. A negative contrast effect involves the converse situation (subjects shifted from large to small magnitude of reward run slower than subjects which have received only the small reward magnitude).

Evidence for contrast effects when positive incentives are manipulated is voluminous, recent studies indicating that positive contrast (Mellgren, 1971, 1972; Nation, Wrather, & Mellgren, 1974; Shanab & Ferrell, 1970; Shanab, Sanders, & Premack, 1969) and negative contrast effects (cf. Black, 1968) have occurred with some regularity.

Although there are functional and theoretical precedents for treating punishment and reward as joint

determinants of the same theoretical construct (e.g., Logan, 1969), the effects of increases and decreases in punishment have apparently received little attention in recent years. In fact, other than a few conceptually related punishment studies (e.g., Church, 1969) there do not appear to be any available punishment studies specifically relevant to contrast.

The purpose of this study was to provide further information regarding the effects of shifts in punishment (negative incentive), holding positive reinforcement constant. One shifted group receive .1-mA shock in the goalbox during Phase 1, then .4 mA during Phase 2 while the other shifted group received .8-mA shock during Phase 1 followed by .4 mA in the second phase. The control group received .4-mA punishment throughout training. All groups received a constant reward consisting of two food pellets on each trial throughout the experiment.

## METHOD

### Subjects

The subjects were 30 male albino rats of the Sprague-Dawley

This research was originally submitted to the University of Oklahoma by the senior author as partial fulfillment of the requirements for the PhD degree.

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