Bulletin of the Psychonomic Society
1984, 22 (2), 132-134

Ambiguous figure reversal rates and the "repetition effect"

HOLGER KLINTMAN
Lund University, Lund, Sweden

(Bruce O. Bergum, sponsor)

This study examined the relationship between ambiguous figure reversal rates and the so-called "repetition effect," the latter assessed in a two-choice reaction time task with repeated and nonrepeated responses and with three different response-stimulus intervals. Forty-two undergraduate students served as subjects. The hypothesis was confirmed that subjects with high reversal rates would display less pronounced repetition effects than subjects with low reversal rates. The results are discussed in terms of a general factor regulating the rate of decay of cognitive/motoric residual activity after the completion of the first response.

In experimental psychology, the figure reversal phenomenon has generated extensive research and theoretical speculation. In general, the tendency has been to account for the phenomenon in terms of either neural fatigue mechanisms (Attneave, 1971; Howard, 1961; Kohler, 1960; Long & Toppino, 1981) or attentional and decisional factors (Ammons, 1954; Gregory, 1970, 1974; Rock, 1975; Smith, Imparato, & Exner, 1968). According to the latter conception, the reversal rates are contingent on higher level cognitive functions and are thus sensitive to such modifying factors as instructions and mental orientation.

Given evidence in support of both standpoints, there seems to be some basis for the conciliatory conception of a combined system involving a satiation mechanism modulated to some extent by higher level cognitive factors.

In recent studies, indications have been found of a positive relationship between ambiguous figure reversal rate and creativity (B. O. Bergum & J. E. Bergum, 1979; J. E. Bergum & B. O. Bergum, 1979) or original thinking (Klintman, 1984). Klintman (1978) also found subjects with high reversal rates in the Necker cube to display more frequent shifts of attention between the stimulus alternatives in a serial reaction time (RT) task than did a contrasting group with low reversal rates. On the whole, such findings support the hypothesis that the ambiguous figure reversal rate reflects the individual's general capacity for switching from one perceptual/cognitive act to another. With the aim of further exploring this hypothesis, the present study centers on the question of whether the type of differential behavior implied by interindividual variation in figure reversal rates might also be a critical factor in the performance of sequential two-choice RT tasks.

In a serial two-choice self-paced RT task using a repetition(REP)/non-repetition(N-Rep) response model, the subject was asked to respond as quickly as possible to each of two successive signals (for instance, by naming the stimulus or by pressing a key). Typically, under these conditions the RT to the second stimulus (S2) is differentially affected by the previous response to the first stimuli (S1): In general, human subjects respond faster if the two signals (and thus responses) are identical than if S1 is followed by a signal calling for a different response. This "repetition effect" is well documented in the literature, most of the work dating back to the 1950s and 1960s (see Rabbitt & Vyas, 1973). Whereas most studies report positive repetition effects ($RT_{N\text{-}Rep} > RT_{Rep}$) at response-stimulus (R-S) intervals of 0.2 to 4 sec, the results for intervals of greater length are less consonant and include reports of positive as well as negative effects (Kornblum, 1973).

In the present experiment, the repetition effect was assessed at three R-S intervals (3, 6, and 10 sec) for two groups of subjects differing in terms of figure reversal rates. The hypothesis was tested that the selective preparedness for a second identical response set up by the first response would be maintained for a longer period in subjects with low reversal rates than in those with high ones, that is, that the former would display more consistent repetition effects than the latter.

This study was supported by a grant from the Swedish Humanistic and Social Science Research Council. The author's mailing address is: Department of Psychology, Lund University, 221 01 Lund, Sweden.

METHOD

Subjects

Forty-two (20 male and 22 female) undergraduate students, ranging in age from 18 to 25 years, served as the subjects.

Apparatus

A Necker cube was presented in the form of a line figure drawn in black on white cardboard, and it was viewed by the subject from a distance of 50 cm. The side dimensions of both the front and back faces of the cube were 28 mm, with the back face above and 7 mm to the right of the front face.

The figure, covered with a sheet of paper, was placed on the table in front of the subject and uncovered by the experimenter at the start of the viewing period.

In the RT part of the experiment, two slide projectors controlled by an electronic timer produced the stimulus sequences S1-S2. Each stimulus was exposed for .1 sec on a ground-glass screen placed 1 m in front of the subject. The time (in milliseconds) between the onset of S2 and the subject's verbal response to that stimulus was measured with a digital chronometer. The timer was programmed for R-S intervals of 3, 6, and 10 sec, balanced with regard to serial position and with an intertrial interval of 15 sec.

Stimuli

The S1-S2 sequences consisted of the printed names of two numbers (S1 and S2) between 0 and 9. As projected onto the screen, the stimuli were 15 mm tall and the words about 50 mm wide.

Procedure

Each subject was given a 2-min trial with the Necker cube. The subject was instructed to fixate a black dot in the center of the cube and to say "now" when, and only when, he or she clearly perceived an apparent change in the orientation of the cube. Using a digital chronometer, the experimenter scored the cumulated time at each reversal.

In the RT part of the experiment, the subject was instructed to respond as quickly as possible by naming each stimulus in terms of odd or even. Thus, in a sequence, there were four possible responses ("odd-odd," "even-even," "odd-even," and "even-odd"). The task was self-paced; that is, the R-S interval (3, 6, or 10 sec) was initiated by the subject's verbal response to S1. Also, a warning signal was given 1.5 sec before the exposure of S1. The RT to S2 was scored by the experimenter after each trial.

The stimulus series consisted of 12 sequences and was so designed that S2 would yield a repetition of the response ("odd-odd" or "even-even") to S1 in half of the sequences and a nonrepeated response in the other half. The repetition condition and the R-S interval length were balanced with regard to position in the series. Within these constraints, the distribution of the sequences was randomized.

RESULTS

The 42 subjects were split into two subgroups on the basis of the total number of reversals experienced in the Necker cube: one high-reversal (HR) group (reversal rates above the group median), and one low-reversal (LR) group (reversal rates on or below the group median, the median rate being seven reversals in the 2-min inspection period). For each subject, the mean RT was calculated for all combinations of R-S intervals and repetition contingencies. From these data, group means were then formed.

Table 1 summarizes mean RTs for the HR and the LR groups under all conditions. Standard deviations are also given. As indicated, longer RTs were consistently obtained under the Rep condition. The overall mean RTs were 775 msec for repeated responses and 896 msec for nonrepeated responses. In terms of time gain, the magnitude of the repetition effect was somewhat above 100 msec for both groups at the R-S intervals of 3 and 6 sec, whereas at the 10-sec interval, the effect was reduced in the HR group (41 msec) and increased in the LR group (206 msec).

A mixed-design three-way analysis of variance with two independent groups and repeated measures on the R-S interval and repetition-condition variables demonstrated highly significant differences in RT between repeated and nonrepeated responses [$F(1,40) = 48.11$, $p < .001$]. In addition, a significant triple interaction effect was found to exist among this difference, reversal rate level, and R-S interval [$F(2,80) = 3.83$, $p < .05$]. T tests between R-S intervals revealed a highly significant difference in repetition effect magnitude between the two groups at the 10-sec interval [$t(40) = 3.27$, $p < .005$]. For the high group, the reduction in the repetition effect observed at the transition from the 6- to the 10-sec R-S interval is also statistically significant [$t(20) = 2.74$, $p < .01$]. In this group, no significant difference was found between N-Reps and Reps at the 10-sec interval.

DISCUSSION

As expected, the results revealed a positive repetition effect when undifferentiated means were used as a basis for the evaluation. This is in general agreement with several earlier studies (e.g., Kornblum, 1973; Rabbitt & Vyas, 1973). Thus, in the present experiment, the execution of the verbal response—"odd" or "even"—to S1 tended to facilitate the repetition of this same response at the R-S intervals of 3 to 10 sec. We may think of this effect as resulting from a combination of cognitive and

Table 1
Mean RTs and Standard Deviations

Reversal Rates		R-S Interval: 3 sec N-Rep	Rep	D	6 sec N-Rep	Rep	D	10 sec N-Rep	Rep	D	Mean
High (N = 20)	Mean	899	792	107	861	738	123	846	804	42	823
	SD	243	133	110	111	123	−12	173	179	−6	
Low (N = 22)	Mean	910	788	122	874	758	116	978	772	206	847
	SD	242	120	218	140	135	5	200	133	67	
	Mean	905	790	115	868	749	119	915	787	128	
	SD	343	179	164	179	183	−4	264	223	41	

Note—D = difference.

motor factors, so that at the time of S2 the subject is both mentally prepared for the reactualization of the concept signaled by S1 and motorically prepared for its reverbalization. The experiment tested the hypothesis that, in a random sample of students, there would be systematic differences in the strength and consistency of this effect. It was predicted that students characterized by a high degree of perceptual/cognitive mobility would display less pronounced positive repetition effects than a contrasting group. The results support this hypothesis, in that a significant difference appeared between subjects with high reversal rates in the Necker cube test and those with low ones. At the 10-sec interval, a marked reduction in the difference in RTs between N-Reps and Reps was observed in the HR group ($p < .005$). A moderate, but not significant ($p > .05$), corresponding increase in the LR group was also noted. Thus, whereas a positive repetition effect was indicated for both groups at the 3- and 6-sec intervals, this effect virtually disappeared in the HR group at the 10-sec interval. This virtually total reduction suggests that, after this time, the HR group no longer upheld any selective preparedness to respond to a repeated S1. In contrast, the LR group tended toward the reverse, that is, a strengthening of the repetition effect at this interval.

There are two main conclusions to be drawn from these results. First, the data support the view that at least part of the intersubject variability observed in ambiguous figure reversal rates is linked with a factor in the cognitive system that in general influences the duration of preparedness for a reactivation of a given cognitive/motoric act after the completion of the first. Thus, in the subjects at one extreme, a Necker cube perspective, once established, is quickly restructured and another is formed. Likewise, in sequential stimulation, the readiness for a second identical response is maintained for only a relatively short time after the first. As mentioned, these subjects also tend to score comparatively high on creativity and originality, which further suggests the involvement of cognitive functions.

In contrast, the subjects at the other extreme tend to "hold on to" a given Necker cube perspective and, in sequential stimulation, to maintain–or even strengthen–their preparation for a second identical response beyond a 10-sec interval. Also in contrast, such subjects score relatively low on creativity and originality.

Second, the source of variance identified in the experiment would probably be present in any ordinary nonselected sample of students. Therefore, its differential effects would be well worth considering in the design of experiments or work tasks involving repeated and nonrepeated responses.

REFERENCES

AMMONS, R. B. (1954). Experiential factors in visual form perception: I. Review and formulation of problems. *Journal of Genetic Psychology*, **84**, 3-25.

ATTNEAVE, F. (1971). Multistability in perception. *Scientific American*, **225(6)**, 62-71.

BERGUM, B. O., & BERGUM, J. E. (1979). Creativity, perceptual stability, and self-perception. *Bulletin of the Psychonomic Society*, **14**, 61-63.

BERGUM, J. E., & BERGUM, B. O. (1979). Self-perceived creativity and ambiguous figure reversal rates. *Bulletin of the Psychonomic Society*, **14**, 373-374.

HOWARD, I. P. (1961). An investigation of a satiation process in the reversible perspective of revolving skeletal shapes. *Quarterly Journal of Experimental Psychology*, **13**, 19-33.

GREGORY, R. L. (1970). *The intelligent eye*. New York: McGraw-Hill.

GREGORY, R. L. (1974). Choosing a paradigm for perception. In E. C. Carterette & M. P. Friedman (Eds.), *Handbook of perception* (Vol. 1). New York: Academic Press.

KLINTMAN, H. (1978). A comparison of figural reversal patterns with periodic changes in responsiveness in a serial naming task. *Psychological Research Bulletin*, **18**, 1-10.

KLINTMAN, H. (1981). Original thinking and ambiguous figure reversal rates. *Bulletin of the Psychonomic Society*, **22**, 129-131.

KOHLER, W. (1960). *Dynamics in psychology*. New York: Grove Press.

KORNBLUM, S. (1973). Sequential effects in choice reaction time: A tutorial review. In S. Kornblum (Ed.), *Attention and performance IV*. New York: Academic Press.

LONG, G. M., & TOPPINO, T. C. (1981). Multiple representations of the same reversible figure: Implications for cognitive decisional interpretations. *Perception*, **10**, 231-234.

RABBITT, P. M., & VYAS, S. (1973). What is repeated in the "repetition effect"? In S. Kornblum (Ed.), *Attention and performance IV*. New York: Academic Press.

ROCK, I. (1975). *An introduction to perception*. New York: MacMillan.

SMITH, O. W., IMPARATO, N., & EXNER, J. E., JR. (1968). Effects of practice on reversals of incomplete Necker cubes. *Perceptual and Motor Skills*, **27**, 951-954.

(Manuscript received for publication July 25, 1983.)