TIME ERROR IN REPEATED TRIALS AND A NEW AFTEREFFECT

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Abstract

Two experiments involving time error were conducted. In the first experiment, when the subject compared the size of a pair of equal circles presented successively, and this trial was repeated ten times, negative time error occurred even in the case in which the same circle was exposed twenty times with a constant time interval. This phenomenon cannot be explained according to the stimulus arrangement because no clue for segmentation of the pair of stimuli was included. In the second experiment, an aftereffect procedure was applied to this situation, i.e. before the repeated comparison of equal circles, two circles different in size were compared successively and repeatedly. This resulted in the appearance of a negative aftereffect, and this new aftereffect was named the "time order aftereffect". This aftereffect, as well, occurred when the interval was constant and when the stimulus arrangement was of no assistance in segmentation in the pair of stimuli. These results are explained by the function of set which involves the active process of the subject.

Time error can be observed in a very wide range of perceptual phenomena involving not only quantitative aspects of stimulus such as size, weight, sound, etc. but also qualitative aspects like aesthetic preference (Helström, 2001). In most of the studies, time error has been described by the structure of stimuli and their temporal arrangement of presentation. On the other hand, in these studies, factors involving subjects were insufficiently investigated or, at times, totally ignored.

Over the past years, research has been conducted on the subjective factors while mainly analyzing aftereffect phenomena (Nakatani, 1985; 1986; 1995; 2001). Most of the results showed the hypotheses, such as simple fatigue or inhibition of cells, are not sufficient to explain aftereffects, while the concept of set (Usnadze, 1931; Uznadze, 1966) is useful in this regard, especially when examining the microgenetic process of adaptation and aftereffect.

The aim of this study was to discover the crucial role of the subjective factor for time error, and to analyze the function of set in presenting a new aftereffect involved with time error.

Time error in repeated trials

A pair of equal stimuli was presented successively in the trial, and the same trial was repeated ten times with intervals of 5000 ms. The ISI, the interval between two presentations in the trial, was varied among seven conditions including the 5000 ms ISI. In the case of the 5000 ms ISI, the same stimulus was consequently presented twenty times with a constant ISI. The time error was not expected in such a stimulus arrangement according to the usual context of time error studies.

Method

A circle was drawn in the center of a sheet of white cardboard. The black contour was 0.5 mm in width, and the external diameter was 30 mm. The circle was exposed for 500 ms at a distance of 1000 mm by means of a tachistoscope (DP tachistoscope, Takei Kiki Co.). No fixation point was exposed.

The trial consisted of two presentations of the circle with the ISI, which was varied in seven conditions: 60 ms, 500 ms, 1000 ms, 2000 ms, 3000 ms, 4000 ms and 5000 ms. This trial was repeated ten times with intervals of 5000 ms. Before the first trial and after the last trail, during the ISIs, and in the intervals between trials, white cardboard was used as a background. The subject was instructed to judge the size of circles immediately after every second presentation, using one of two categories: either the first circle or the second circle was the larger of the two.

Ten university students with normal or corrected visual acuity participated in each condition. Each subject participated in only one condition.

Results and discussion

The responses that indicate the second circle was perceived as being larger were collected. Figure 1 shows the percentage of responses in the seven different conditions of the ISI. Regardless of the variable of ISI, “the second” responses appeared with over fifty percent probability. This result means the second circle was generally perceived to be larger than the first, i.e. negative time error occurred.

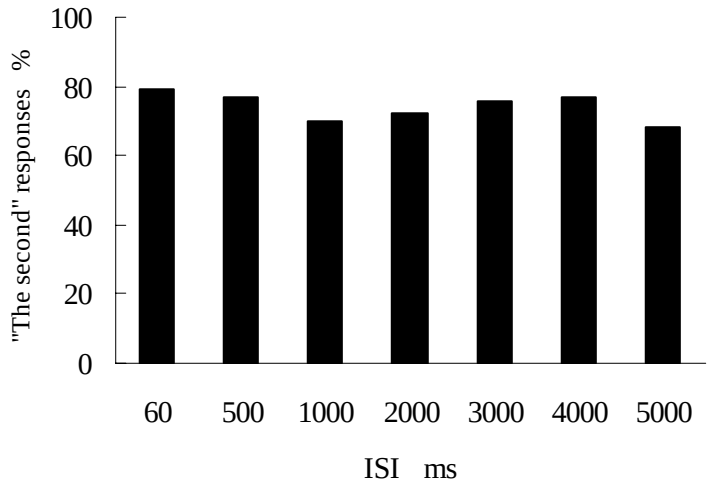

Figure 1. Percentage of the “the second circle was larger” responses.

Sometimes time errors appear in a positive direction, an overestimation of the first stimulus. For example, in a classic experiment by Köhler (1923), positive time error in the intensity of sound occurred when the ISI was short, i.e. 1500 ms. However, Karlin (1953) concluded in the case of visual size comparison of circles that positive time errors do not appear even if the ISI is short. In the present study, as well, the time error was positive in the short ISI conditions.

As is shown by the p-function (Needham, 1934), negative time errors usually increase with the ISI increases. Karlin’s (1953) results mentioned above show the same

increase of negative time error. However, this kind of tendency was not observed in the present study.

Significantly, the most important result in this experiment appeared in the ISI condition of 5000 ms. In this condition, the same circle was presented twenty times with a constant ISI. When considered only by the aspect of stimulus arrangement, such a procedure cannot be termed a true time error experiment. In actuality, similar results of negative time error in the other six conditions were obtained. This can not be explained simply by the interaction among twenty stimuli. However, the subject was given the task of comparing two circles exposed successively which must have been a crucial factor in achieving the negative time error result.

The subject should have segmented the two successive stimuli among the twenty monotonously exposed stimuli. This segmentation was not caused by physical stimulus arrangement, what Gestalt Psychologists call the factor of proximity; in this case, such proximity was temporal. Some other active function of the subject was necessary for the segmentation. According to the task of comparison, the subject should have prepared him/herself to perceive and compare the two circles which would appear in succession. The same active process should have worked in the other six conditions as well. Thus, the crucial factor in the appearance of time error depended not on the physical stimulus arrangement but on the active process of subjects who were instructed to compare the first circle and the second.

Uznadze (1966) hypothesized that an unconscious state of preparing for behavior is activated when the subject meets the object to be perceived, and he called this state of preparation “set”. Subsequently, he verified the role of set and surveyed the function and structure of set mainly by using the method of fixed set (Usnadze, 1931). Along with a repeated perception of the same object, the set proceeds with differentiation and fixation. The fixed set consequently brings about a set illusion, which is the same as aftereffect phenomena. In the next experiment, the function of comparison was surveyed focusing on the function of set.

Aftereffect on time error

When two stimuli are compared successively, some aftereffect usually occurs. In the case of simultaneous size comparison, for example, when two different circles are presented before comparing two equal circles, a successive size contrast normally appears, i.e. if the previously presented circle on the right side was larger than the one on the left side, the following circle on the right side is perceived as smaller than the one on the left side.

This is known as the figural aftereffect, and Uznadze (1966) called this set illusion. In Uznadze’s fixed set experiment, both the different pair of circles and the following equal pair were usually presented tachistoscopically and repeatedly. For example, identical pairs of circles different in size were presented ten times in the set fixing (adaptation) phase, and then equal pairs were presented ten times in the critical (aftereffect) phase.

While such an experimental design is based on simultaneous comparison, a new design based on successive comparison can be applied to the time error experiment with repeated trials.

Method

The stimulus material and the apparatus were the same as the previous time error experiment.

A pairs of circles of different size was successively presented repeatedly for adaptation, and then the aftereffect was observed as in the time error procedure above.

Adaptation phase: The first circle was 20 mm in external diameter and the second was 40 mm. This pair of circles was exposed ten times.

Aftereffect phase: Both the first circle and the second were 30 mm in external diameter. The first trial was started 5000 ms after the last trial of the adaptation phase.

The ISI was varied in the same way as the time error experiment above: 60 ms, 500 ms, 1000 ms, 2000 ms, 3000 ms, 4000 ms, and 5000 ms. The interval between trials was constantly 5000 ms. From the standpoint of the subject, twenty trials, forty exposures, were continuously repeated, and a distinction could not be made between the adaptation phase and the aftereffect phase with such a temporal condition.

The subject judged the size at each trial including those during the adaptation phase. The other conditions were the same as the previous time error experiment. The ten subjects were the same as well. This experiment was done after the time error experiment.

Results and discussion

The responses that indicate the second circle was larger were collected. The number of these responses in the aftereffect phase was smaller than that in the previous time error experiment. The range of this number was between 47 and 63, indicating that the negative time error was weakened or diminished. The difference, i.e. the decrease from the previous time error results, in the percentage of responses is shown in Figure 2.

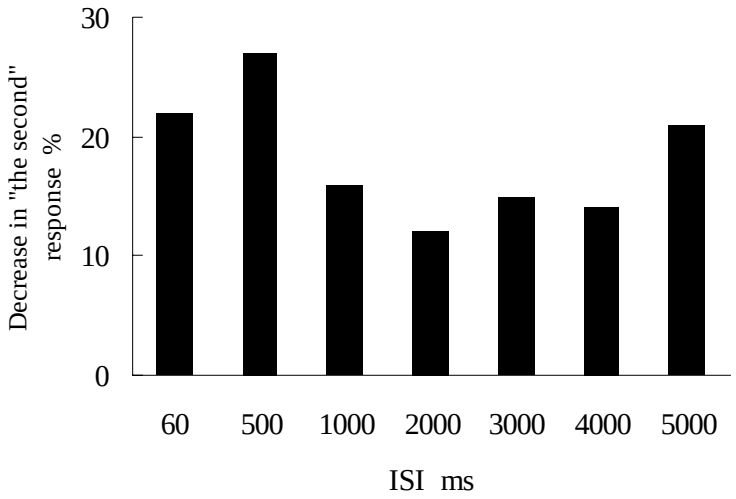

Figure 2. Decrease of the “the second circle was larger” from the time error experiment.

As the first circle had been smaller than the second in the adaptation phase, the perceived size of the first circle was enlarged and second circle shrank in the aftereffect phase. That is, a negative aftereffect appeared. This is a new type of aftereffect different from either the figural aftereffect or any other simple type aftereffect. This aftereffect is termed “the time order aftereffect”.

Uznadze (1966) reported some similar aftereffects in the strength of tactile pressure, loudness of sound and brightness of circles. However, the time error was not taken into account in these experiments, and their results are not clear.

While the figural aftereffect occurs when two stimuli are presented simultaneously, the time order aftereffect occurs when two stimuli are presented successively. When presented simultaneously, the two stimuli are strongly segmented in the same space and at the same time. On the other hand, when presented successively and repeatedly, the two stimuli should be segmented along with the temporal process. For such segmentation, some active function of the subject is substantiated, as was the case of the time error in repeated trials.

Only in the ISI condition of 60 ms can an exception be assumed. With this ISI, apparent motion can occur and it may impress the expansion of a circle for the subject. This motion could result in the motion aftereffect, and an impression of a shrinking circle can be assumed in the aftereffect phase. Actually, the result of the 60 ms ISI condition shows a comparatively greater decrease. This is possibly the motion aftereffect itself, or the motion aftereffect might have enhanced the time order aftereffect.

However, the ISI condition of 500 ms produced a greater aftereffect than the 60 ms condition. As no apparent motion can be expected, in this case the time order aftereffect was strong in itself. Moreover, the aftereffect was strongest in the 500 ms condition. Probably the segmentation of two circles was easier in the 500 ms condition than the longer ISI conditions. When considering the duration of 500 ms, it almost coincides with the duration of iconic memory. It is possible that the iconic memory of the first circle has helped the segmentation of two circles. Although the aftereffect was weakened in the ISI condition over 1000 ms, it occurred in every condition. The iconic memory of the first circle was of no assistance for the segmentation.

In this case, the ISI condition of 5000 ms was as unique as that in the previous time error experiment. Both in the adaptation phase and aftereffect phase, the twenty presentations were conducted with a constant ISI. There was no temporal proximity between the first circle and the second. Their segmentation was totally dependent on the subjects who were instructed to make a comparison.

General Discussion

Both in the repeated trials of time error and in the aftereffect experiment, without having the task of comparison it should have been impossible for the subject to segment the pair of circles correctly. Therefore, neither the negative time error nor the time order aftereffect could have appeared only by the stimulus arrangement. However, when the task of comparison was applied, both the time error and the aftereffect appeared even in the 5000 ms ISI condition where each stimulus was presented with a constant interval.

In the case of simultaneous comparison, the segmentation of two stimuli may be quick and easy as they occur in the same space and at the same time. When the comparison is successive and repeated, the segmentation might be rather difficult. But the results show the subjects correctly segmented the two circles presented successively in the trial, and the aftereffect occurred consistently with this segmentation.

The present study suggests that the figural aftereffects with the simultaneous comparison and the time order after effect with successive comparison appear analogous with each other, with the only difference being that the presentations are either simultaneous or successive. Therefore, there must be some underlying common mechanism for both of the aftereffects, and this mechanism cannot be determined by the stimulus arrangement. The set for perceiving a pair of stimuli should play its role in this situation.

Uznadze (1966) stated that repetition of the same trial promotes differentiation

and fixation of set. When the subject encounters a similar situation to the set fixing situation, the fixed set is activated and causes the illusion. Nakatani (1985, 1989) concluded both size weight illusion and the lightness size illusion are caused by the set fixed through the developmental process. On the other hand, aftereffects appear along with the microgentic process under some experimental situation (Nakatani, 1995).

While the figural aftereffect is categorized as one of the simple type aftereffects, the time order aftereffect may be one of the contingent type aftereffects (Scowbo, Gentry, Timney & Morant, 1974) since the aftereffect of size was contingent with time order. However, Nakatani (1985, 1989) stated that when observing the aftereffect involving the size weight illusion and the lightness size illusion, such a categorization is not reasonable because each of aftereffects can be described as the differentiation, the fixation and the activation of set.

In all probability, the set was differentiated for the perception of the two circles according to the task of size comparison. Nakatani (1995) observed the adaptation during this process, i.e. the perceived difference of length of a pair of lines decreased with the repetition of trial. It could be likely that the difference in size was decreased during the adaptation phase of the present study. As a consequence of this process, the aftereffect occurred due to the activation of the fixed set. In such a case, neither simple fatigue nor inhibition of cells can explain the aftereffect.

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