MAGNITUDE ESTIMATION FOR THE METHOD OF LIMITS

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Abstract

A serial effect often reduces the PSE or the threshold on the ascending series and it raises them on the descending series of the method of limits. This effect has been usually explained as the error of expectation, which would occur in the process of reporting but not perception. However, as this effect appears so strongly, it seems to be reasonable to think it to be a perceptual phenomenon. I observed the successive changes of the underestimation during the ascending series and the overestimation during the descending series using the magnitude estimation in the length comparison of a pair of lines. These changes were explained as the microgenetic process of adaptation and aftereffect (Nakatani; 1995a.b).

A kind of serial effects occurs when we use the method of limits; underestimation appears on the ascending series of trials, and overestimation occurs on the descending series. For example, in the case of length comparison of two lines, the PSE of the comparison stimulus to the standard stimulus of the ascending series is shorter than the physical equivalent of length, and that of the descending series is longer than the physical equivalent. Similar effect occurs in the measurement of absolute threshold, as well. Moreover, the same effect is observed in the method of adjustment.

This effect in the classic methods of psychophysics is usually treated as one of constant errors, and it has been explained as the error of expectation: An observer may falsely anticipate the arrival of the stimulus at his threshold and prematurely report that the change has occurred before it really has. This error of expectation has an opposite effect to the error of habituation, which results in continuing to make the same response after the threshold has reached, and if each of these errors were of equal magnitude, they would cancel each other (Gescheider, 1997). However, is this serial effect just an error of the observer's reporting? Since this effect appears so constant, it would possibly occur as a perceptual effect.

Nakatani (1995a) reported that adaptation occurrs when a pair of lines of different length is presented briefly and repeatedly, and the perceived difference decreased with prolonged repetition. A negative aftereffect then appears on a pair of lines of the same length and the 'shorter' line as seen during the previous adaptation trials is now perceived to be longer. The same results were obtained when the stimuli were exposed persistently and the responses were made repeatedly during the adaptation (Nakatani, 1995b).

Although the stimuli are slightly changed at each trial, the method of limits mirrors the same process as above, and is thereby affected by both adaptation and aftereffect as well (Nakatani, 1995a). In the same way, although the stimulus is changed gradually, persistent exposure is involved with the method of adjustment, as well as persistent exposure resulted in adaptation and aftereffect (Nakatani, 1995b). The aim of this study was to measure the changes of perception at each exposure of the method of limits by using the magnitude estimation and to analyze the effect of adaptation and aftereffect.

Method

The task given to the subjects was to compare the length of a pair of lines and to make magnitude estimations in a series of trials of the method of limits and the aftereffect procedure. A pair of vertical lines was presented on a 14inches LCD monitor at a distance of 1m from the subject using SuperLab version 2.0.4. The lines were black on white background and 2pixels in width. 100pixels length was equivalent to 26.5mm. The middle points of both lines were 227 pixels apart and horizontal to each other. A black fixation point of 3 by 3pixels square was always exposed at the center. The subject made two responses at each trial: (1) a judgment of the longer line by use of one of two categories; either the left one was longer or the right one. (2) a magnitude estimation of the difference in length between the two lines, with the shorter one as a modulus with a value of 100. It should be noted that the standard stimulus was not always the modulus.

During the method of limits trials, each pair of lines was exposed for 500ms with the ISI of 5000ms. The aftereffect trials were started 5000ms after the method of limits trials with 10 exposures of 500ms and the ISIs of 5000ms. Before these procedures, the control trials were done with the same procedure as the aftereffect trials. While the standard stimulus seen on the right side was 150pixels in length, the comparison stimulus placed on the left side was varied by 4 pixels at each trial of the method of limits. There were six conditions in the variations of the comparison stimulus as shown in Table 1. Three of them formed ascending series and the other three formed descending series. The comparison stimulus of the aftereffect trials was designated to be the next step to last stimulus of the method of limits trials, and was not varied through out the aftereffect trials. Each subject participated in all of the six conditions, but the time order of conditions was randomized with every subject. The total number of trials was 174 for each subject.

Subjects were 31 university students with normal or corrected visual acuity. Practice with 5 free view trials and 8 tachistoscopic view were done before the experiment.

Table 1. Length of the comparison line (pixels). A: ascending series D: descending series

Condition	The method of limits														Aftereffect
Trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A-114	102	106	110												114
A-130	102	106	110	114	118	122	126								130
A-158	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158
D-186	198	194	190												186
D-170	198	194	190	186	182	178	174								170
D-142	198	194	190	186	182	178	174	170	166	162	158	154	150	146	142

Results and Discussion

The PSE of each subject was identified when the magnitude estimation exceeded 100 in the ascending series and receded from 100 in the descending series. It was shorter than 150pixels in 22 of 31 subjects on the ascending series, and was longer in 21 subjects on the descending series. The average PSE was 147.0 pixels in the ascending series and 151.9 pixels in the descending series. These results are consistent with the serial effect; underestimation on the ascending series and overestimation on the descending series.

Figure1 presents the average of the magnitude estimation. Each of the ascending series and the descending series resulted in symmetrical figures with each other. Now, it should be remembered that the comparison stimulus placed on the left side was shorter than the standard stimulus on the right side in the ascending series, and it was longer in the descending series. At the first trial, the shorter one of a pair of lines was estimated to be equal or shorter than the physical length in the ascending series, and the longer one was estimated to be much longer in the descending series. This is consistent with Nakatani (1995a)'s results of perceptual microgenesis that single exposure of a pair of lines of different length resulted in contrast perception when the exposure was around 1s, and the shorter line was perceived much shorter and the longer one was perceived much longer.

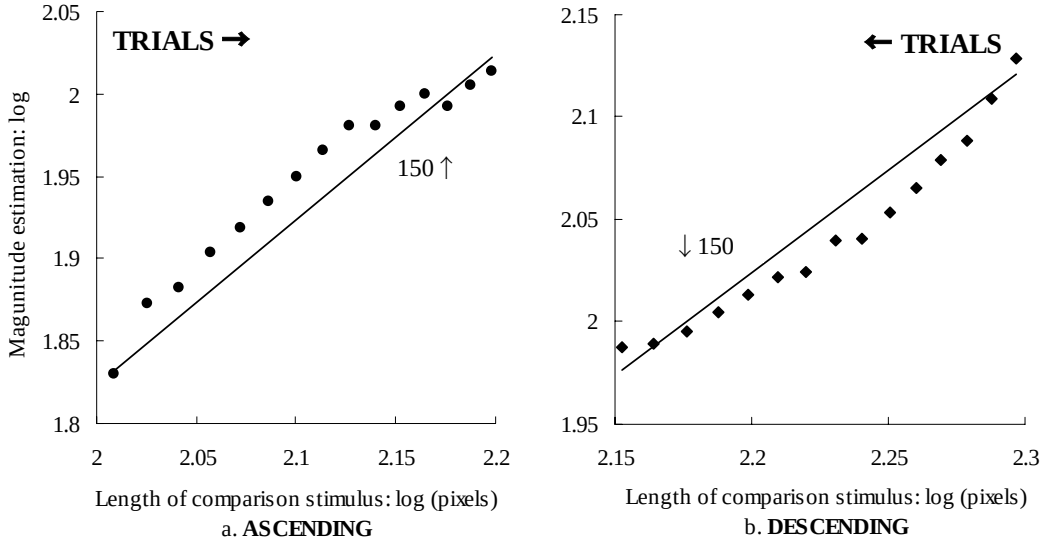

Figure1. The average of the magnitude estimation of each comparison stimulus in the ascending series (a) and the descending series (b). The trials were started from the left side of the figure on the ascending series, but they were started from the right side on the descending series. The last trial was the first trial of the aftereffect trials. "150" indicates the equilibrium with the standard stimulus; 150pixels. The slant line shows the physical equivalence of the comparison stimulus in relation to the standard stimulus.

As the series of trials proceeded, the shorter lines were estimated to be longer than the physical equivalence on the ascending series and the longer lines were much shorter on the descending series. Nakatani (1985) observed a strong negative aftereffect on a pair of stimuli of different size presented in the aftereffect phase. In the same way, a negative aftereffect should have lengthened the perceptual length of the shorter line after an exposure of the shorter one of a pair of lines on the same place at the previous trial in the ascending series, and *vice versa* in the descending series. This effect became weaker as the comparison stimulus approached to the PSE, around 150pixels, probably because the previous pair of lines had small difference of length with each other and accordingly the aftereffect was weak.

The results of the aftereffect trials and the control trials in two of six conditions are presented in Figure2. In the ascending series (A-114), where the comparison stimulus was 114pixels and the standard was 150pixels, the comparison stimulus of the control trials gradually increased its perceptual length and this assimilative change in perceptual length presents the adaptation as reported by Nakatani (1995a). In the first trial, the

comparison stimulus was estimated longer in the aftereffect trials rather than in the control. This clearly presents the negative aftereffect mentioned above. This aftereffect persisted until the fourth trial and then began to decay. A similar but reversal phenomenon can be observed in the descending series (D-186). The same but weaker effect occurred in the conditions of A-130 and D-170, and an opposite effect appeared very weakly in the conditions of A-158 and D-142.

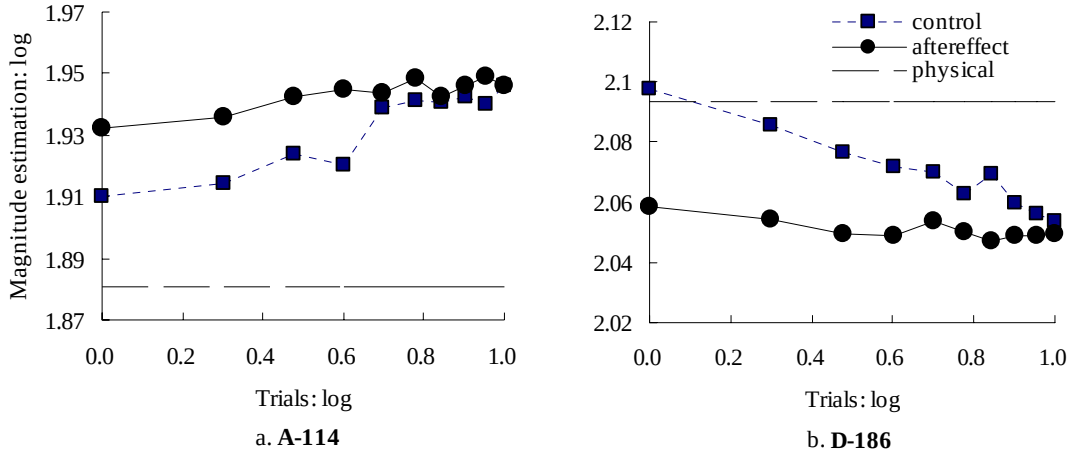

Figure2. The average of the magnitude estimation during the aftereffect trials and the control trials of two conditions, A-114 (a) and D-186 (b). The broken line indicates the physical equivalence of the comparison stimulus in relation to the standard stimulus.

The serial effect can be concluded to be the aftereffect from previous exposures. This effect occurs from the earlier stage of the method of limits with higher intensity than it appears at the last stage, around the PSE. A microgenetic perspective (Nakatani, 1995a,b) should be useful for such a phenomenon with gradual changes of perception. While both the adaptation and the aftereffect lengthen the shorter one and shorten the longer one of a pair of lines, Nakatani (1995a,b) has discussed the differentiation of set (Uznadze, 1966) as the underlying mechanism of these phenomena. These discussions on the perceptual microgenesis and the differentiation of set may be important not only for the method of limits but also the other classic methods of psychophysics.

References

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