TIME ESTIMATION OF COMPOSITE STIMULI

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Abstract

It has been reported that the durations of moving objects, such as a set of moving dots circulating around a spot on a computer display, when shown for various intervals, appeared to last longer than its non-moving counterpart. In this study, the objects were of a different kind, i.e. in one condition, they were sinusoidally modulated luminance gratings moving downward, and in another, the amplitude of the same moving gratings were temporally modulated sinusoidally at a given frequency. As a control, durations of a stationary and fixed-luminance patch, which was of the same size as the other targets, were also judged. Five women and two men took part as observers. Instead of the usual magnitude estimation, the method of converging limits was used for the estimation of the durations of the targets. The results indicated that the more complex were the targets, the longer were they judged in duration. The exponents for the function relating the real to the estimated durations, were somewhat higher for the steady luminance stimuli.

There are no known sensory organs capable of capturing temporal information directly. Hence, we are led to believe that our time perception or time estimation is only inferred from various types of sensory inputs. In this sense, it is no wonder why various physical attributes of the events about which we make temporal judgment should have large influence upon our time judgement. We think that by analysing the relation between the physical aspects of the environmental events and mode of time estimation thereof, we could approach the functioning of our temporal estimation mechanism. How the attributes of external stimuli affect the mode of our time estimation has been studied by many workers, but their studies were mainly focused upon the spatial characteristics (the extent) of the stimuli, as well as upon the dynamic characteristics of the movement they are in (or the changes they are undergoing). Some believe that both these characteristics are subsumed under the same thing, i.e. amount of stimulus information. In the present study we were chiefly concerned on the latter aspect of the stimuli, i.e .the motion and the changes.

Method

Stimulus configurations were generated on a color display (Model 10.3CM2085M made by HITACHI Co.) under control of a stimulus generator (VENUS Model 1020 made by NEURO Scientific Corp.). which itself was under control of an independent personal computer, which was also used for collection of the data (subjects' responses) and their statistical analyses. An area of the display was delimited in a rectangular form 9.9 x 10.3 degs. in va , its luminance being 42.7 cd/ m^2 ,which was considerable brighter than the outer area of the display. There was a fixation point in the center of the rectangular area. Coincident with the fixation point, there was an elliptical area whose vertical axis was 2.7 degs. in va , and horizontal axis 3.1 degs. in va. Its luminances were the independent variables of this study as will be explained later.

There were three main conditions for the presentation of the stimuli:

I. Luminance condition, in which a steady luminance patch of a fixed luminance of 69.2 cd/ m^2 was presented for 10 prescribed durations: 1, 1.25, 1.5, 2, 2.5 3, 4, 5, 6, 7 sec. Ⅱ. Drifting Grating condition, in which a sinusoidal grating of 2.0c/degs with the mean luminance of 52.9 cd/ m^2 was moved downward at a speed of 1.0 deg/sec. The presenting durations were the same as in I.

III. Flickering grating condition in which the same sinusoidal grating stimuli as those used in Ⅱ were used again, but their overall luminances were modulated sinusoidally at the rate of 1.67 cycle/sec., so that the stimuli appeared to be breathing with its whole body while moving downward. In this way, the luminance of the moving grating reached the peak value of 93.8 cd/ m^2 at one time, and at another reached the trough (the lowest point).of 42.69 cd/ m^2. The presenting durations were the same as in the other 2 conditions.

The participants were 2 men and 5 women (3 college students ,2 teachers and 2 office workers).. The average age for them was 29.1

The participants each made judgment of the durations of the presented stimuli. Instead of the more usual magnitude estimation, where the modulus stimulus was first set, we used the Method of Converging Limits (Guirao, 1991). In this method, prior to the presentation of the stimulus series in each experimental condition, the participants were shown the 'longest' and 'shortest' stimulus durations in the on-going series, and were told to give numbers which they think would be proportional to the length (duration) of those stimuli that they were just given. This way the participants were freed of some of the stress inherent in the experiment. Usual precautions for any time-estimation experiment were taken such as depriving them of watches.

Results and Discussion

Table 1. Participants' numerical estimations of the duration of the stimuli, under the three conditions (Luminance, Drifting Grating and Flickering Grating) are shown. They were first converted to common logarithm numbers and their means (i.e. geometrical means) and the standard deviations were then calculated.

Luminance Condition

Stimulus (sec.)	1	1,25	1.5	2	2.5	3	4	5	6	7	means
Response (gm)	0.056	0.181	0.221	0.344	0.457	0..514	0.687	0.783	0.823	0.88	0.494
SD	0.178	0.12	0.133	0.151	0.109	0.169	0.24	0.195	0.203	0.18	0.168

Drifting Grating Condition

Stimulus (sec)	1	1.25	1.5	2	2.5	3	4	5	6	7	means
Response (gm)	0.078	0.171	0.288	0.419	0.498	0.569	0.684	0.739	0.82	0.87	0.514
SD	0.164	0.134	0.112	0.169	0.208	0.206	0.183	0.215	0.165	0.22	0.178

Flickering Grating Condition

Stimulus (sec.)	1	1.25	1.5	2	2.5	3	4	5	6	7	means
Response (gm)	0.22	0.225	0.331	0.446	0.529	0.604	0.677	0.804	0.863	0.94	0.564
SD	0.118	0.108	0.042	0.134	0.13	0.131	0.135	0.135	0.135	0.14	0.135

The results are summarised in Tabel 1, as well as in Figures 1 and 2 (next page)
We carried out an ANOVA on these results with the stimulus conditions and the duratioure ns as the main effects. It turned out that both these main effects were statistically significant. They were, in that order, $F(2,12)=5.09$ and $F(9,54)=108.03$, $p<.05$.
Then, the difference between the means for the participants' responses in each condition were analysed with Tukey's HSD test. It turned out that the difference between the values in the Luminance Condition and Flickering Grating Condition was siginificant (Mse=0.018, p,.059). The difference between the values in Luminance and Drifting Grating conditions were not siginificant,. However there was a tendency that the values of Drifting Grating Condtion were greater than those in the Luminance Condition. Figure 1 demonstrates these tendencies.
At what duration were these differences more apparent? To show this, we checked the differences among the three conditions for each of the 10 durations of the experiment. Figure 2 shows this. It seems that the tendencies described above are more apparent in the relatively short durations (1～4 seconds), so that the experimental effects of the mode of presentation upon the participants response in this study are mainly in shorter durations. However, in the FG condition, the effect persists in the longer durations, too.

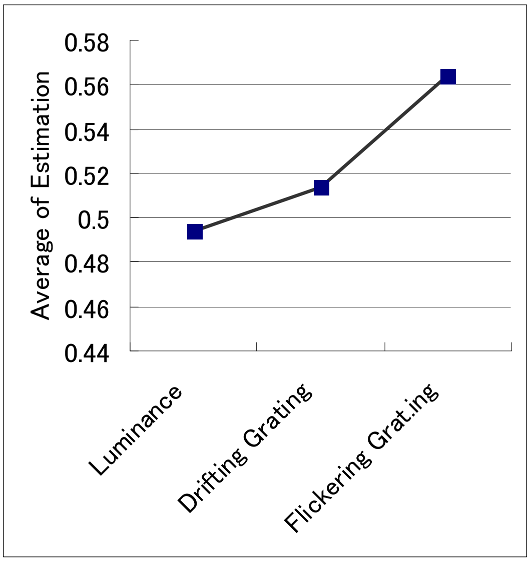

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Fig.1.. Participants' average responses in each of the three experimental conditions.

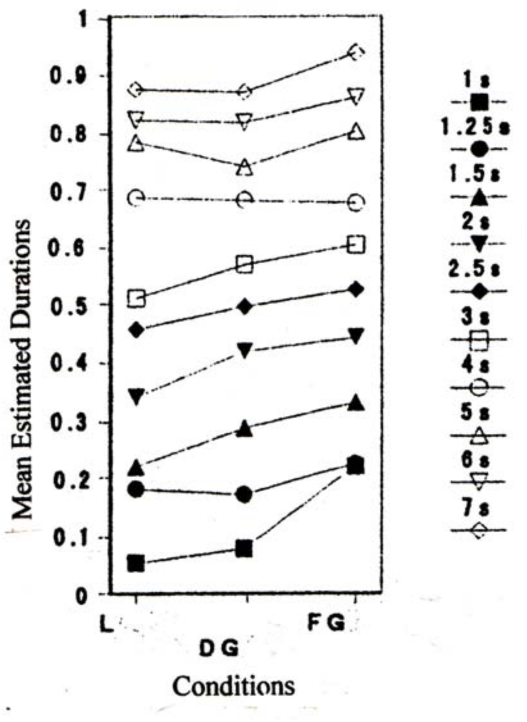

Fig.2.. Mean responses in the three conditions in the respective duration.

What about the exponent for psychophyscal function relating the actual duration to estimated duration? Figure 3 shows that relation. The function for the FG (Flickering Grating)appears to have the lowest exponent to be followed by the DG (Drifting Grating) and the L(Luminance). This last one has the largest exponent. Perhaps this coincides with the fact already referred to: namely the difference in the estimated durations among the three different conditions is more marked in the shorter duration range. In any case, a three factor ANOVA proved that none of the differences among the exponents are statistically significant.

There has been a debate concerning what causes changes in the exponent in the psychophysical functions. Stevens (1975) maintained that shorter range of stimuli always leads to a steeper exponent. According to him, this an empirical fact, but he does not offer any convincing explanation for this effect. On the other hand, Stevens and Guirao(1972) maintained that inhibition or noise on the stimulus range would lead to steeper exponent.. Whatever is their contention, in our studies we always used the same range of stimuli, and there is no reason to believe that any of our stimuli is any noisier than others. So there is no convincing explanation that they could offer for the effect that we have discovered.

On the other hand, there is a possibility that the activity or motion within the stimulus itself might have effect on our physiological clock. As briefly mentioned in the abstract of this paper, Tayama , Nakamura and Aiba. (1987) found that only moving some dots on a computer display had effects of lengthening its subjective duration. More recently, Tayama (2002) found that temporal modulation of sound in terms of loudness and pitch (amplitude and frequency) resulted in duration estimation proportional to the modulation frequency. So the activity of external stimuli seem to have some effects on our timing mechanism.

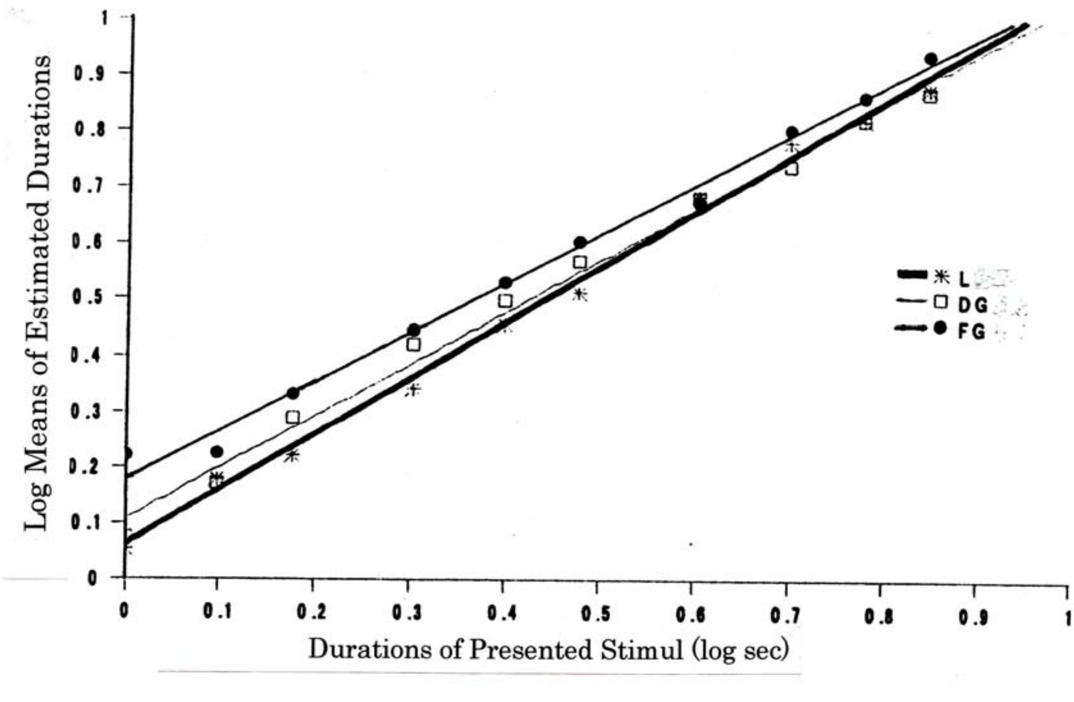

Fig. 3 Psychophysical functions relating the estimated durations to the presented durations. The exponent is highest for the Luminance Condition, lowest for the FG condition.

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