Implied Motion Pattern and Speed Perception

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IMPLIED MOTION PATTERN AND SPEED PERCEPTION[1]

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Three investigations were done to inquire into how the implied motion pattern modified its apparent speed.

For equipment, Exp. 1 employed the speed anticipation reaction test (an aptitude test for motor driver in Japan), in which the speed of running target was extrapolated by *S*'s key-press reaction. Under the condition where a car target of forward moving style was used, 15 college students gave shorter reaction time for the speed extrapolation than a circular target, as if they felt faster the former than the later. This trend was discernible also in the condition of backward moving car administrated by the other 22 college students. The trend was noteworthy, however, at the forward moving car than the backward.

The identical *S*s to Exp. 1 participated in Exp. 2 where the successive comparison method of two velocities was performed under the constant method and ISI of these velocities set at 1 sec. They estimated the speed of car target faster than the forward moving style than the backward. No significant difference took place between two targets of the backward and circle. These results suggested that the locus being responsible for these effects was anchored to the perceptual process of speed about these implied motion patterns.

Exp. 3 was so designed that the change of successive speeds could be perceived more directly. Ratio of the judgment from 14 *S*s advanced that the car-styled targets were felt faster than the circle, and this trend was remarkable at the forward moving car than the backward.

These data arrived the conclusion that the effective locus of the implied motion pattern was anchored to its perceptual process and its outcome was reflected in the key-press reaction time of the speed anticipation reaction test.

Nothing of effective color difference was discernible between green and yellow.

Key words: implied motion pattern, speed anticipation reaction test, speed perception.

PROBLEM

Friedman and Stevenson (1975) called the moving impression that caused by addition of lines to 2-dimentional picture "the implied motion". Originating this connotation, we shall call the static pattern that has moving impression "the implied motion pattern". And, the task of this study was to examine whether the car target, would affect the subjects' estimation about its traveling speed as the implied motion pattern, when the moving target in the anticipation

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reaction test changed from the circle style to the car style.

EXPERIMENT 1

PURPOSE

The start of this research was a proposal from the National Organization of Automobile Safety and Victims' Aid (OSA) in Japan, that in the speed anticipation reaction test he would convert a circular motion target to a car style for his use. If this alteration of target would change the anticipation reaction time, its criterion for assessment should have to remake. Then, the first experiment investigated whether this implied motion pattern had its effective influence on this performance.

The *speed anticipation reaction test* (Maruyama & Kitamura, 1961-1962; Maruyama & Kitamura, 1965-1966; Takayama, Maruyama, Nomura, & Kitamura, 1972) is the one of six psychological driver's aptitude test used at OSA. in Japan. A panel of this test is displayed in CRT as shown Fig. 1, and Subject observes this panel at 50 cm distance. A circular target

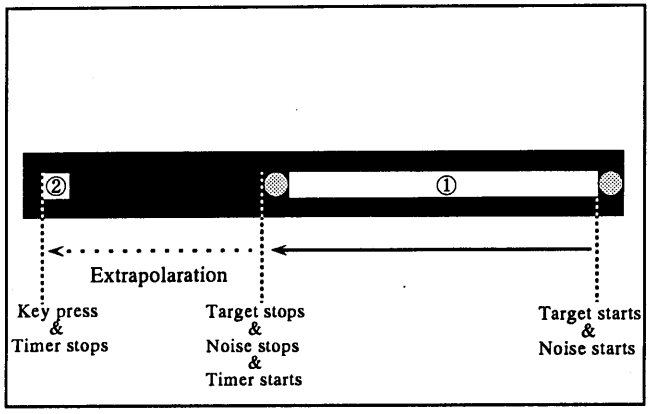
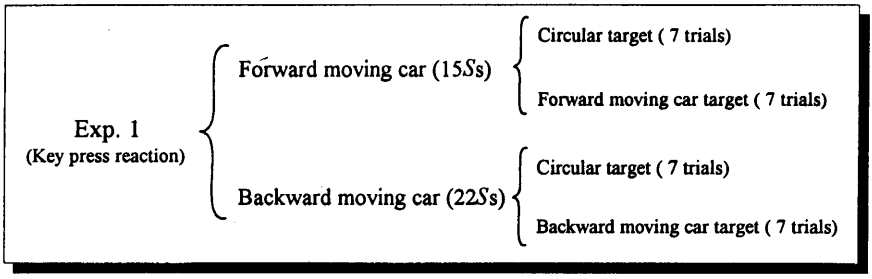


Fig. 1. CRT exhibition of the speed anticipation reaction test.
Target moved from the right end to the left through the horizontal ditch ① at the uniform velocity (4.40 deg/sec), then it disappeared the wall, and stopped its movement. The task of subject was extrapolate the arrival time by means of his key press reaction supposing the target would appear at the arrival area ②, keeping the same speed as in the area 1.

moves from the right to the left through a horizontal ditch with a noise "boo" at uniform velocity (4.40 deg/sec). Then it hides behind the wall area, and stops its traveling with noise stop. Task of Subject is to extrapolate the arrival time of this target by means of his key-press reaction supposing the target will appear in a arrival point at the left end of wall, keeping the same speed as in the ditch. This extrapolated time is the measure value as anticipation reaction time. If the anticipation time is 2080 msec, it corresponds with the real moving velocity. The purpose of this research was that when the moving target converted its style to the car, whether the test performance would change or not.

METHOD

Experimental series: The series of the speed anticipation reaction experiment was planed as below.



Between the two car target series, different subjects were employed. A reason for this complex procedure adopted was that the backward moving car series was added after the forward moving series. Therefore, A difference between the circle and car had to be compared in each series.

Apparatus: A panel of speed anticipation reaction test was presented on NEC PC-KD853n display (14-inch), and all the experimental conditions were controlled by NEC PC-9801RX. Moving targets had three kinds of shapes (Fig. 2). Color of the circle was green same as the

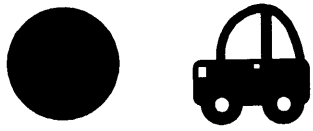


Fig. 2. Target patterns employed in the exporiments. The left stimulus is CIRCLE, which is green with 40 min. (visual angle). The right is CAR, which is yellow, having the same size as CIRCLE.

usual method of OSA. The other ones of two cars decided yellow because of its loudness. Size of the patterns was about 40 min.. The observation distance was 50 cm. A noise of "boo", which was presented in the test at OSA, was deleted. This absence of the noise had no problem, because the purpose of this study was to compare only shape difference.

Subjects: Fifteen college students and the other twenty-two college students were participated in the experiment. The former for the series of forward moving car, the later for the backward. They had normal vision and no knowledge of this experiment.

Procedure: Subjects sat on a chair and fixed their head on a chinrest, and were instructed as below. Instruction: Along the horizontal lane, a target runs from the right to the left. It will hide behind a wall and stop. You suppose, however, that the target will move with an

equal velocity through behind the wall, and when you think the target will arrive at a left hole of the wall, you push a key. Then the target will appear at this hole. Your task is to pursuit the target and to estimate the time moving through the wall.

After two practice trials, seven regular trials were done. Trial order for the three target shapes was counterbalanced.

Results and Discussion

The results of the Exp. 1 are indicated at Table 1 and Fig. 3.

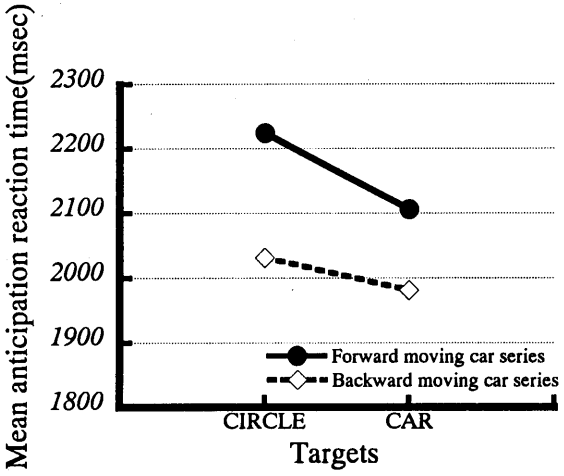


Fig. 3. Results of Exp. 1.
Solid line and dotted line show the differences of mean anticipation reaction time of forward moving car series and of the backward moving car series, respectively. Analysis of covariance was adopted, because there was difference between the results of both group's circles, which have the roles of the control.

Table 1. Mean anticipate reaction times (msec)

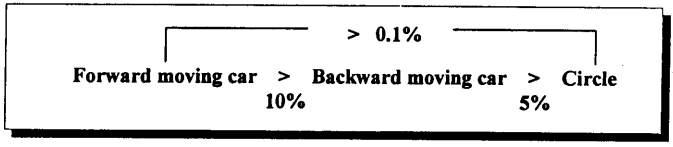
	Targets	n	MeanRT	*SD*
CAR	CIRCLE	105	2,224	461.2
(Forward)	CAR(f)	105	2,106	472.4
CAR	CIRCLE	154	2,031	472.4
(Backward)	CAR(b)	154	1,981	496.8

n = 7RTs × *Ss*'s number

In both the series, the mean estimation reaction time on the circular target was longer than

that of both the forward and backward car; i.e., 2224 msec (circle) − 2106 msec (forward car) =118 msec, 2031 msec (circle)−1981 msec (backward car) =50 msec. There was a significant difference between these reaction times (between circle and forward car: t (104) =3.71, $p<.01$; between circle car and backward car: t (153)=2.43, $p<.05$). In both cases, the results indicated that the estimation reaction time on car target was shorter than that on circle.

However, a significant difference took place between reaction times in the circular series, which participated the control group ($t(258)=2.96$, $p<.01$). So, it could not directly compare between the car targets. To solve this problem, we applied the analysis of covariance. By this analysis, the tendency was indicated that the RT of the forward moving car was shorter than that of the backward (F (1, 299)=2.95, $p<.10$). Therefore, it is said that the difference of the shape affected the estimation reaction time in the speed anticipation reaction test. Differences among the shapes are summarized as below.



From the results, a conclusion was induced as that the car patterns were estimated faster in their movement than the circular one, —— thus the effect of the implied motion pattern was discernible.

Then, in this test performance, what kind of task processing was the implied motion pattern affected. We could not replay this question now, because the speed anticipation reaction test was constructed by compound processing steps; i.e., at least three steps-----(1) observation of the moving target, (2) extrapolation throughout the wall area, (3) key-press performance. If the implied motion pattern affected the 1st step, its effect concerned in the speed perception itself. The one of 2nd step was in the extrapolation process. The one of 3rd step was in the readiness to key-press reaction.

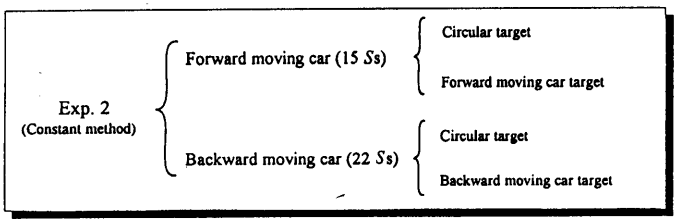
Experiment 2

Purpose

An aim of this experiment was to inquire into whether the implied motion pattern bears on perceptual process (the 1st step) of speed estimation in the test, using the constant method that is the one of means for exploration of perceptual process.

Method

Experimental series: The experiment for speed comparison had two series in like fashion to Exp. 1, as follows.



This unusual design was a consequence of that the series for backward moving car added afterward to the forward series. The apparatuses as well as the targets were the same as Exp. 1.

Procedure: Successive comparison method was employed for speed estimation. The first (standard) stimulus was circular target, with the velocity of 4.40 deg/sec. It was identical with the CRT testing at OSA. After ISI of 1 sec., the second (comparison) stimulus was exhibited of circular or car target. Velocities of these comparison stimuli distributed over five kinds of 5.72, 5.06, 4.40, 3.74, and 3.08 deg/sec. This second stimulus was paired with the first, and presented 5 times per each pair, resulting 50 comparison trials in all. Subjects were asked to compare the velocity of second stimulus to the first of circular target and answer his/her judgment in terms of "faster", "slower", "same". Fig. 4 shows the block diagram of this procedure.

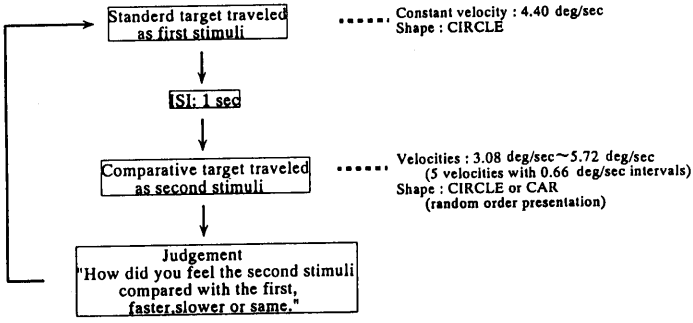


Fig. 4. Time cours of stimulus presentation in Exp. 2.

The identical *Ss* to Exp. 1 volunteered in this experiment, i.e., 15 college students for the series of forward car, 22 students for the backward.

Results and Discussion

The measure of this constant method was D% indicated below.

$$D\% = \frac{\text{Number of faster judgements} - \text{Number of slower judgements}}{\text{Total 25 judgements}} \times 100$$

(The judgements of same was added to faster or slower, respectively, based on the ratio of them.)

Table 2 and Fig. 5 show the mean D% in each of the targets. In the condition of circular target, the difference between forward and backward moving cars had no statistical

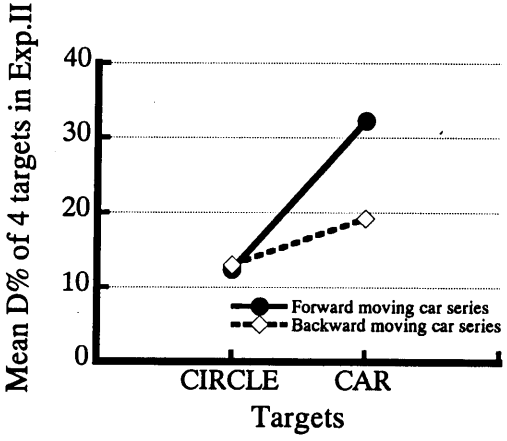


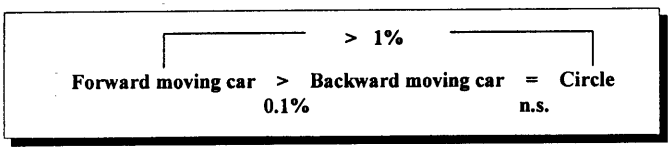
Fig. 5. Results of Exp. 2.

significance not same as that of Exp. 1. So, it might be possible to compare directly between the two car conditions. However the subjects participated at Exp. 2 was identical to Exp. 1, so it seemed to be better to apply the same way with Exp. 1. Thus the analysis of the covariance was adopted same as Exp. 1. As the results, the significance between these conditions of the forward and backward moving cars could be recognized at 0.1% level (F (1, 33) $=7.908$, $p<.001$), and between the forward car and the circle at 1% level, but there did not find the significance between the backward moving car and circle, not same as Exp. 1.

Table 2. Results of mean D%s and their SDs for the 4 targets in Exp. 2.

	Comparative Targets	n	Mean D%	*SD*
CAR (Forward)	CIRCLE	15	12.4	21.7
	CAR(f)	15	32.2	15.1
CAR (backward)	CIRCLE	22	13.9	20.5
	CAR(b)	22	19.2	18.7

These results can be illustrated as below.



In summary, the forward moving car was perceived its movement faster than that of the backward as well as circular target even if they had equal velocity. D% indicated positive value at all the targets. This means that the speed of the second stimulus was perceived faster than that of the first, showing "negative time order error". The short term memory made the speed of first stimulus fading during ISI of 1 sec., and this faded memory was compared with vivid impression on the second stimulus, in consequence the faster estimation about the second might be induced, offering the strongest at the forward moving car. And this is accepted the effect of the implied motion pattern, here.

In these results, however, an effect of color difference had not to leave out of consideration. That is, the circular target was green, but the car target was yellow. Because the yellow was louder than the green, they might have different character for their speed perception. Actually, some subjects reported that the yellow was felt faster because of its loudness. So this color effect should be inspected in the next experiment.

EXPERIMENT 3

PURPOSE

1) The first problem of this experiment was to obtain a further confirmation for the perceptual effect of implied motion pattern, by the method that the ISI between successive velocity was so arranged as short as possible that Subjects could get a clear change of perceptual speed. 2) Another problem was to examine whether a differential effect of colors appeared between the yellow and green targets in their speed perception.

METHOD

Display for the speed comparison: A CRT display was divided vertically to three areas as shown in Fig. 6. Its middle area was moving area for the comparison target, and both its sides were for the standard. Each border between these areas was interpolated by vertical stripes with the width subtending the visual angle of 40′ and a target traveled behind these stripes. The target as standard stimulus started to move from the right end in the right side area along a horizontal center in the CRT, and transformed its pattern or color during the passage behind the stripe to the comparison stimulus, that ran through the middle area. The last running was done at the left side area as a standard stimulus again, after the same fashion of transformation behind the second stripe. Behind both the vertical stripes, the target was arrested for 500 msec in order not to be judged only by the momentary speed change at here.

This arrest time did not impair the perceptual comparison of successive two velocities but fairly relevant to purpose.

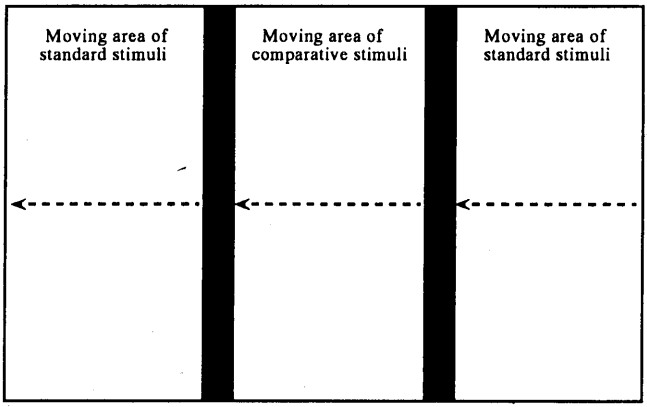


Fig. 6. CRT exhibition in Exp. 3.
CRT display is divided vertically into 3 areas, where a stimulus target traveled from the right end to the left as a dotted line. Targets in both the right and left areas served as standard stimuli with a constant velocity of 4.40 deg/sec. The middle area's target was comparative stimulus with every one of 5 velocities distributed above and bellow the standard. Behind two vertical stripes, target was arrested for 500msec in area not to be judged by a momentary speed change at that border.

As of Exp. 2, the standard stimulus was a circular target in all the trials with green color, which traveled at the velocity of 4.40 deg/sec. The comparison targets, on the other hand, had four kinds of styles as shown in Table 3, i.e., forward moving car (yellow), backward moving car (yellow), circle (yellow), circle (green). The circle (yellow) among these served as the examination of color effect. Five levels of velocities were set for each of these comparison targets as of Exp. 2: 5.72, 5.06, 4.40, 3, 74, and 3.08 deg/sec.

All possible 60 combinations between these four targets and five levels of velocities were presented three times in each, moreover one more presentation of the standard velocity (4.40 deg/sec) was appended in each of the four target conditions, thus the total 64 combinations were offered in random order.

Subject pursued with his eye the running sequence of the targets from his chin-rest position, and answered how did he/she feel the speed of the comparison target compared with that of the standard in terms of three categories of "faster", "slower", or "same".

Subjects: Fourteen college students volunteered for the experiment.

Results and Discussion

For the measure of this experiment, D% was calculated in each target condition same as Exp. 2. Table 3 as well as Fig. 7 to 8 shows these results.

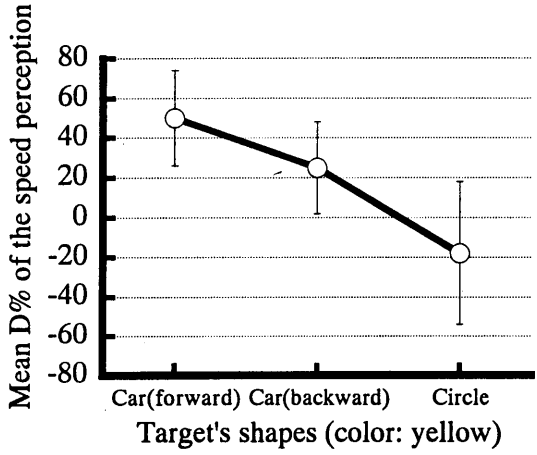


Fig. 7. Shape effect on the apparent speed.

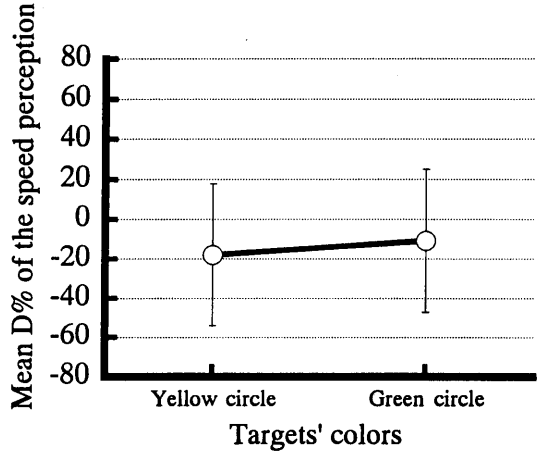
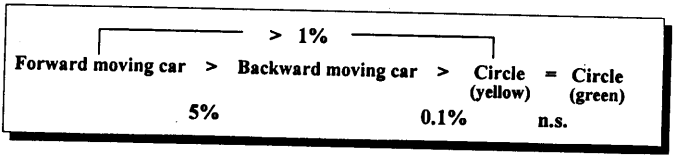


Fig. 8. Color effect on the apparent speed.

Table 3. Results of mean D%s of Exp. 3 on the speed perception.

Shape	Direction	Color	n	Mean D%	*SD*
CAR	Forward	Yellow	14	50.0	24.0
CAR	Backward	Yellow	14	25.0	23.0
CIRCLE	–	Yellow	14	−18.0	36.0
CIRCLE	–	Green	14	−11.0	36.0

From the result of t-test no significant difference was found between the yellow and green circle ($t(13)=0.48$). So, it seems to be introduced that these differential colors did not affect the speed perception. The results of analysis of variance, on the other hand, showed clear significant difference among the three shapes of yellow targets (F (2, 42) $=20.03$, $p<.001$). Furthermore, every possible pair of these had significant difference by the Fisher's LSD test.



Hereupon, the differences among these targets are indicated below.

In the car type targets, a clear perceptual change of the speed was observed under this short ISI experiment. Therefore, it can be concluded that the implied motion pattern affects the speed perception itself.

Summary of Main Results and Conclusion

(1) The effects of implied motion pattern came into being in the speed anticipation reaction test, in which the speed of target was extrapolated by S's key-press. Under the condition traveling the car-style targets, shorter reaction times resulted as compared to the circular target, as if the speeds of car-styled targets were perceived faster. This effect was dominant at the forward moving car than the backward.-----Exp. 1.

(2) In the experiment being employed the successive comparison of two velocities under the constant method where ISI of these velocities held at 1 sec, the speed of target was estimated faster at the forward moving car than the backward. No significant difference gave away between the two targets of backward and circle. These results suggested that the locus being responsible for these effects was anchored to the perceptual process of speed on these implied motion pattern.-----Exp. 2.

(3) In the experiment where the change of successive speeds could be perceived directly, the ratio of judgment advanced that the car styled targets were felt faster than the circle, and this trend was remarkable at the forward moving car than the backward.-----Exp. 3.

(4) These data arrived at the conclusion that the locus of effects of the implied motion pattern was anchored to its perceptual process and its outcomes were reflected in the key-press reaction time of the speed anticipation reaction test.

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