Reciprocity between Shelter Width and Velocity in the Tunnel Effect

RECIPROCITY BETWEEN SHELTER WIDTH AND VELOCITY IN THE TUNNEL EFFECT

By

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In the previous study on tunnel effect (Maruyama & Iwasaki, 1973), it was inferred that CDW (critical delay width or subjective delayless time range) would be similar irrespective of the sheltering tape width or spot's velocity, when the spot's "passage time" (it means the time during which spots were disappearing behind the sheltering tape when there was objectively no delay in succession) falls below about 200msec. This inference was experimentally tested under higher velocity conditions than were used previously.

Each of 12 conditions which were the combinations of 3 spot's velocities (16.5, 25.2 and 54.2 cm/sec) to 4 different shelter widths of 0 cm, 1 cm, 2 cm, and 3 cm was presented to 8 *S*s. They were instructed to determine the thresholds for tunnel effect under these conditions, by their own adjustment of the delay time given to the travelling spot behind the shelter.

The main results are summarized as follows:

(1) The threshold of tunnel effect considerably unstable, though not to such degree as was reported previously.

(2) CDW increased as the tape width or the spot's velocity increased.

(3) It is with the "passage time" of 40msec or below and not of 200msec or below as inferred in the previous report that a constant CDW could be obtained irrespective of the difference in the experimental conditions.

(4) It was estimated that the reciprocity between shelter width and velocity held the conditions in which the spot's "passage time" was about 200 msec or below. This result supported the previously presented inference.

(5) As is stated above, CDW increased as the passage time increased, but the slope of this increment was quite gentle up to about 120msec of the "passage time", whereas it became steep beyond 200msec.

(6) Coupled with the results delineated in (4) and (5), it may be tentatively concluded that when the "passage time" is 120msec or below, CDW shows only a gentle increment and that the reciprocity law is discernible under these conditions. This, however, does not hold beyond the passage time of 200 msec, where CDW increases rather abruptly as the passage time increases.

The observed discontinuity of the slope obtained at the range from 120 to 200msec of the "passage time" may suggest the contribution of the two distinct mental processes in the two areas below and over that range to the perception of the tunnel effect.

Problem

In the previous report (Maruyama & Iwasaki, 1973), where the tunnel effect was experimentally investigated under 9 conditions (3 spot's velocities and 3 sheltering tape widths), it was inferred that if the spot's passage (concealment) time falls within 200msec or below, fundamentally equivalent prospective processing would be performed irrespective of the shelter width and the spot's velocity. Accordingly, it will be expected under these conditions that CDW (critical delay width or subjective delayless time range) as a measure of tunnel effect takes a constant value.

They pointed out, however, that it requires further experimentation to substantiate this conclusion. In the present study, higher velocities of travelling spot than were adopted in the previous study are examined in an attempt to test the influence mentioned above.

Method

Apparatus

The same apparatus as was used in the previous experiment was adopted again. That is, a display was made on a Braun tube of a traceless type oscilloscope which had a diameter of 5 in. Sawtooth-waves of a given voltage were fed into this oscilloscope which drove a spot across in a horizontal direction from the left edge against the *S* to the center of the screen and then it stopped its traveling there, and after a certain delay another spot which had stayed at the center started to run from there to the right edge where it disappeares. When the central portion of the screen was covered with a black sheltering tape, the event looked as if a single spot had travelled across the screen, momentarily disappearing in the center.

For detailed description of the apparatus, see Maruyama & Iwasaki (1973).

The delay time between the arrival of the first spot and the start of the second spot was adjusted by the *S* with a variable resistor at his hand and was measured by a digital time counter to the nearest msec.

The spots were reduced in brightness to be 0.8mm in diameter so that it produced no halo and left behind no visible trace in motion.

Procedure

Velocities of the spot were 16.5cm/sec, 25.2cm/sec, and 54.2cm/sec. Widths of the sheltering tape were 0cm, 1cm, 2cm, and 3cm. These conditions were combined to produce 12 experimental conditions. The tape width of 0cm means no sheltering that adhered to the center of the scope. In this condition when there was no delay i.e. when one spot was followed by the other without delay, it looked as if only one spot had travelled across the screen while another remaining in the center. This condition may be regarded as that of a minimum limit of the sheltering tape width.

The *S*s were instructed to fix their head on a chin-rest and to gaze at the center of o sheltering tape (fixation of the glance). They were asked to observe a recurrently appearing spot travelling across the screen of a Braun tube in this state. Their task was to adjust a variable registor at their hands in order that a spot might pass through a sheltering tape without delay or not too quickly, giving an impression of smooth passage across shelter (the tunnel effect). A delay time was thus obtained with a digital counter.

There were two series, one of which began at a point where the spot gave too late an impression of reappearance to the *S* (thus called too late reappearance or TLR series). The other series started from a point where it gave too early an impression of reappearance (TER series). These were alternately performed giving a respective threshold of delay time. This method of measurement of threshold may be called a kind of the method of limits by subject's abjustment.

Five to fifteen repetitions of stimulus display were needed to get one threshold. At least five measurements were taken for each series under 12 different experimental conditions.

Subjects

6 undergradates (MiK and AH were female students) and both of the authors served as the subjects.

Results and Discussion

The fifth statement of the summarized reports from the *S*s' impressions in Maruyama & Iwasaki (1973): "the displacement of the sweep line before and after tape passage" was turned out to be directly related to a slight head tilting of the observer to one side. A right side tilting of head caused an upward displacement of sweep line after the tape passage, and a left side tilting brought about a reversed displacement.

Besides those presented in the previous paper, the following impressions were reported from the *S*s.

(1) It was sometimes observed that just when the spot hid behind the tape or came out of it the trace of spot irradated into the tape. This was not effected by the light shining through the tape because a stationary spot behind the tape was completely invisible.

(2) Something like "launching effect" (Michotte, 1963) was appeared just before smooth succession of the two spots in the condition of 0 cm tape width.

(3) Generally speaking, the determination of a threshold of the tunnel effect was reported to be difficult, though not to such a degree as was reported before. This difficulty was reflected in the wide variance of the data obtained in the

present experiment.

Fig.1 shows the mean values and *SD*s of TLR and TER series for each *S* with means and *SD*s over 8 *S*s under each experimental condition, respectively.

The absolute differences between the thresholds of TLR and TER series were computed and called a critical delay width (CDW) or subjective delayless time range. These values were averaged as to the 8 *S*s and shown with *SD*s in Fig.2 and 3. In Fig.2 CDWs were plotted against velocity for each tape width. In contrast, they were plotted against tape width in Fig. 3. At the same time, the previously obtained data were reproduced here in these figures.

By taking previous results into consideration, the following conclusion were drawn.

(1) An objectively delayless point (which is shown in Fig.1 as the zero level) was covered with the CDW under most conditions.

(2) There was much difference in CDW among the *S*s.

(3) As is read from Fig.2, CDW rapidly approached to a constant value as stimulus velocity increased.

(4) As is shown in Fig.3, the tendency of increasing CDW that resulted from increasing tape width was distinctly seen in the two lower velocity conditions. On

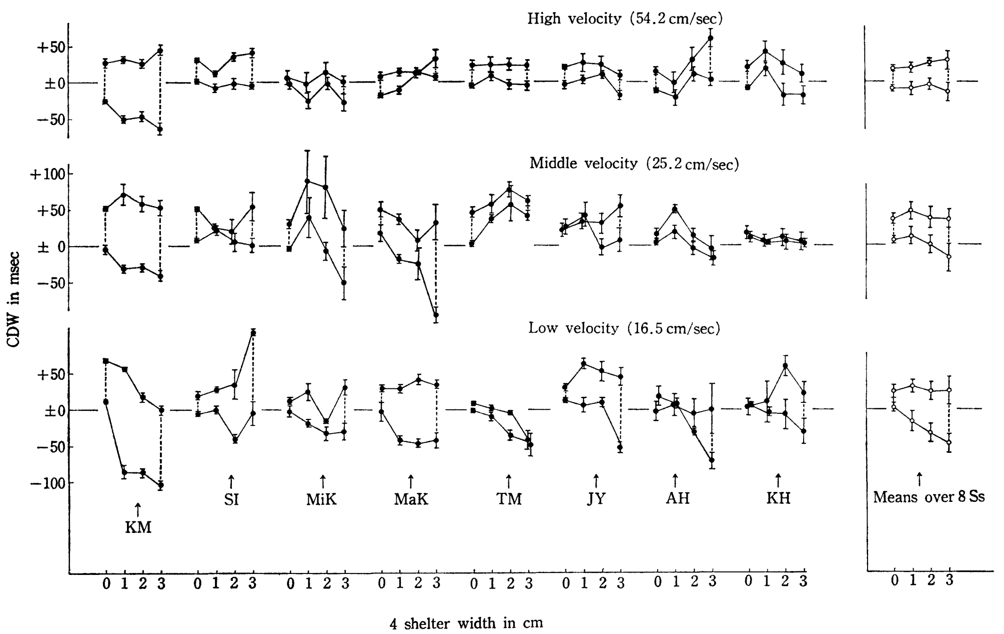

Fig. 1. Means and *SD*s of threshold in TLR and TER series under 12 conditions for each *S* with means for 8 *S*s. The absolute difference between the thresholds of two series was called CDW.

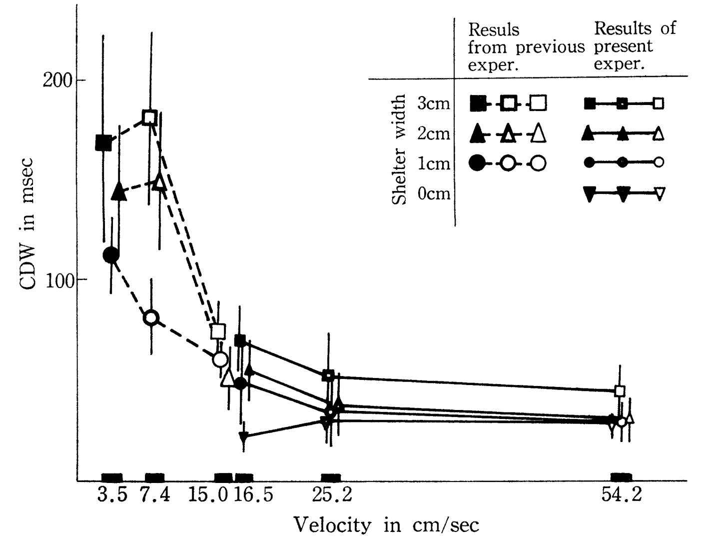

Fig. 2. CDW with *SD* for each of shelter widths as a function of spot's velocity.

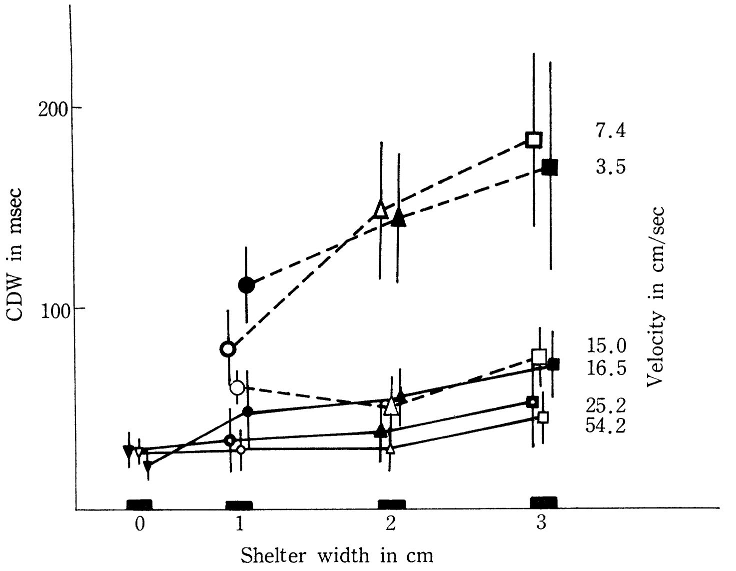

Fig. 3. CDW with *SD* for each of spot s velocities as a function of shelter width.

the other hand, the shelter width had little effect on CDW under the highest velocity conditions.

Now, the time required for the spot to pass a tape when it was objectively delayless, was computed for each condition in order to investigate the possibilities of the reciprocity between shelter width and spot's velocity, which was one of the main purposes of this study. If two conditions have equivalent passage time, even though they are different in tape width and velocity, then they can be considered to be equivalent in this respect. Therefore an equivalency of CDW under these conditions suggest that the perception of tunnel effect is solely dertermined by the passage time (the time during which a spot was disappearing behind a tape), rather than by both the tape width and the velocity. This is the reciplocity law between shelter width and velocity. From these considerations, CDWs were plotted in Fig.4

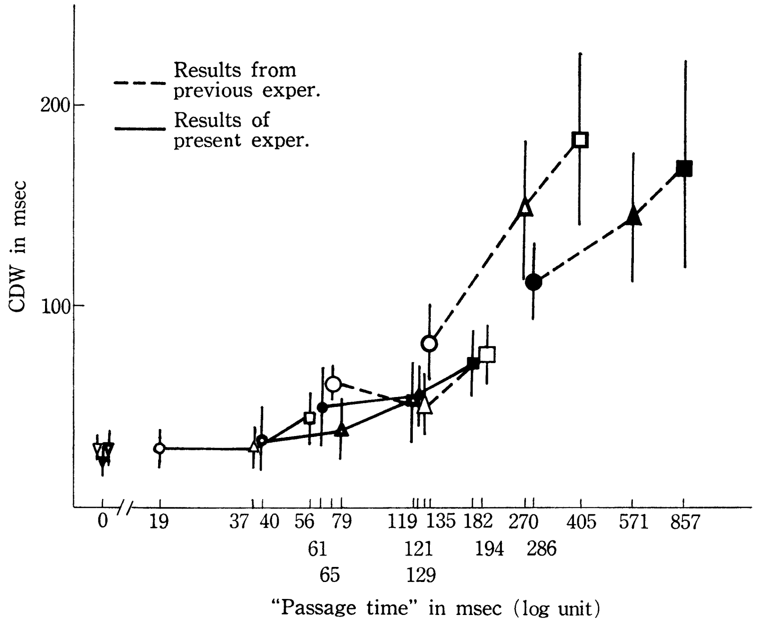

Fig. 4. CDW as a function of "passage time" across shelter.

as a function of "passage time"* in log unit in addition to the results obtained before.

There were no significant difference in CDWs among the members of the following four groups which have the almost equivalent "passage time". They were (1) 37msec vs 40msec, (2) 56, 61, and 79msec, (3) 119 vs 121msec. Similar comparisons in the previous report revealed that there was no statistically significant difference in CDWs between two conditions in which the "passage times" were 129 and

* All the "passage times" given in the paper were computed from spot's velocity and shelter width under the condition that the succession of the two spots was smooth or without delay.

135msec, while CDWs of 270 and 286msec "passage times", though they still missed a conventionally required statistical level, yielded a t value which reached the 20% level of significance. Consequently it was not positively supposed that two CDWs of the latter case made no difference.

It may be concluded from these statistical results that the reciprocity law holds in the conditions where the "passage time" is about 200msec or below, while we leave some doubt on the tenability of such a law if the "passage time" is beyond that point.

Further inspection of the Fig.4 reveals that CDW increases as the "passage time" increases, and that this tendency is abruptly magnified when the "passage time" approaches 120msec.

It may be maintained as a comprehensive conclusion that CDW shows only a gentle increment over the range about 120msec or below the "passage time", with the reciprocity between shelter width and velocity, and that it starts to increase rapidly when the passage time exceeds 200msec, making the reciprocal law untenable.

The observed discontinuity in the slope between 120msec and 200msec may be suggestive of the contribution of two distinctive psychological processes for the perception of tunnel effect. Over the range of 120msec or below at the "passage time", the perception might be under the control of the processes that are considered within the context of the short-term information storage or the like, because of the perception of tunnel effect is solely determined by the "passage time". Beyond 200msec of the "passage time", the reciprocity between shelter width and velocity does not hold and inferential nature seems to be added to the perception.

The inference previously made that equivalent CDWs would be obtained below 200msec at the "passage time" where prospective perception would be working was not supported by a close survey of the values obtained in the present experiment. Statistical testing of the difference in the CDWs values among 19msec, 56msec, and 61msec of the "passage time" showed that the former condition was significantly different from the latter two at the 5% level of significance. Accordingly it may be more appropriate to suppose that CDW shows a gentle increment instead of a flat line. If forcibly conjectured, equivalency of CDW holds at the range of about 40msec or below.

The perception of tunnel effect at this range may be explained within the context of psychological moment (Stroud, 1955).

References

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