DO THE ZEBRA STRIPES INTERFERE THE RECOGNITION OF TARGETS?

Shota Hatano

Graduate School of Human Sciences, Kanagawa University,
3-27-1 Rokkakubashi, Kanagawa-ku, Yokohama, 221-8686, Japan.

Corresponding author: Shota Hatano, r201270191og@kanagawa-u.ac.jp

Keywords: zebra pattern, recognition, reaction time, stripe, color

ABSTRACT

Some tropical fishes and also some wild animals and insects have strong stripe (zebra) patterns of vivid colors on their bodies. It is said those zebra stripes are so conspicuous that they conceal their body lines and consequently lower the probability for being caught by their predators. The aim of the present study was to verify the hypothesis that the zebra stripes really interferes the recognition of targets experimentally. A series of stimuli consisted of alphabets, “Hiragana (Japanese characters)", and figures, with and without zebra stripes (vertical or horizontal, and of three revels of spatial densities) of achromatic color were shortly presented one by one on the PC monitor and the reaction times for their recognition were obtained. The results are somewhat controversial, but generally tends to deny the above hypothesis, i.e. the targets with zebra stripes were easier to recognize than plain ones were.

INTRODUCTION

Some tropical fishes like *Amphiprion clarkii* and some wild animals like zebras, after which the title of this paper is named, have strong stripe(zebra) patterns of vivid colors on their bodies. The zebra patterns are so distinguished that they would divide the pattern of the body into several parts. This is why they are called "dividing color". They may make detection of the body by their predators difficult.

Pastoureau argued that the zebra pattern may make the human eye difficult to divide the plane between the figure (focal plane) and the ground (background plane) which is considered important to recognize the object [1][2].

If the above logic can be applied to human recognition, it may be hypothesized that we have difficulty in reading the characters with zebra patterns or take longer times to recognize them than the characters without zebra patterns.

In this study reaction times were obtained between the on-set when the stimulus is displayed and the on-set when the observer push the button recognizing the character.

METHOD

***Apparatus and Stimuli*:**

A PC tachistscope was used to present stimuli on the pc monitor and measure reaction times. The refresh rate of the monitor was 120Hz. So the recorded reaction times should be estimated with the errors of ±8 ms.

The three kinds of stimuli, alphabets (W, X, Y, Z), "Hiragana (Japanese characters)", and figures (○, □, △,▽) with and without zebra stripes. The stripes were achromatic and of two orientations, vertical or horizontal, and of three revels of spatial densities (0.27, 0.54, and 0.95 cpd) for each orientation. The average luminance of the bright part of each stimulus was 42.9

cd/㎡ and that of the immediate grey background 31.3 cd/㎡ (Fig.1).

A series of stimuli were composed of one hundred stimuli from each kind, half of which were with zebra stripes and the half were without stripes. Therefore in the series of alphabets, 25 "W" were with zebra stripes and 25 "W" were without ones, 25"X" were with stripe and 25"X" were without ones and so on. A series of stimuli were presented one by one at random on the center of the monitor 100 ms after the cessation of fixation points lasting for 100 ms (Fig, 2). The stimuli were observed at the distance of 72 cm forming the height of stimulus of 9.5° in visual angle.

The PC the experimenter was operating and the monitor the participant was observing were separated by the curtain making the ambient of the observer almost completely dark.

A session consisted of the completion of a series of stimuli out of three kinds. In each session, a target stimulus, for instance "W" with stripes, was fixed, and the observer was instructed to seek the target as soon as possible. Thus the candidates for targets were W, X, Y, Z, four "Hiragana (Japanese characters)", ○, □, △, ▽ with zebra stripes.

The participants used a chin rest to stabilize their fixation at rest. The stimuli were observed binocularly and naturally, with or without glasses.

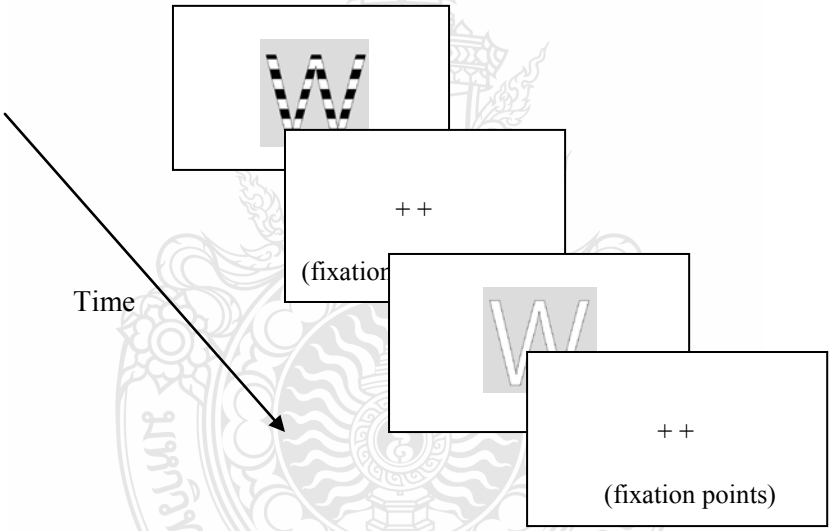

Fig.1 The spatio-temporal configuration of stimuli

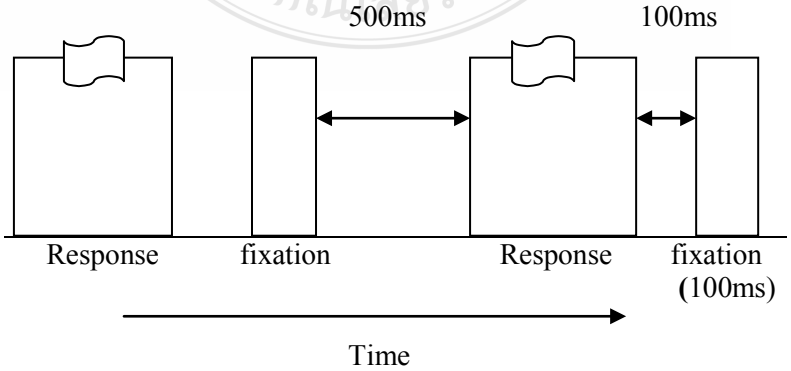

Fig. 2 Temporal configuration of stimuli

Participants:

Around twenty participants were recruited. All of them were students of Kanagawa University at ages ranging from 19 to 21. They were paid. All of them did not participate in all of 36 sessions. They were all naive to this kind of experiment.

Procedure

The observer was instructed to respond as soon as possible and as correct as possible by pressing one of two buttons when the stimulus he/she recognized was the target and by pressing other button when he/she recognized was whatever of non targets . Three sessions for three series of stimuli were conducted in a day and the session was repeated other day exchanging the buttons which the participant has to press for the target stimulus.

Prior the session, the participant was dark adapted for several minutes. Data in the first several trials were discarded for practice.

RESULTS AND DISCUSSION

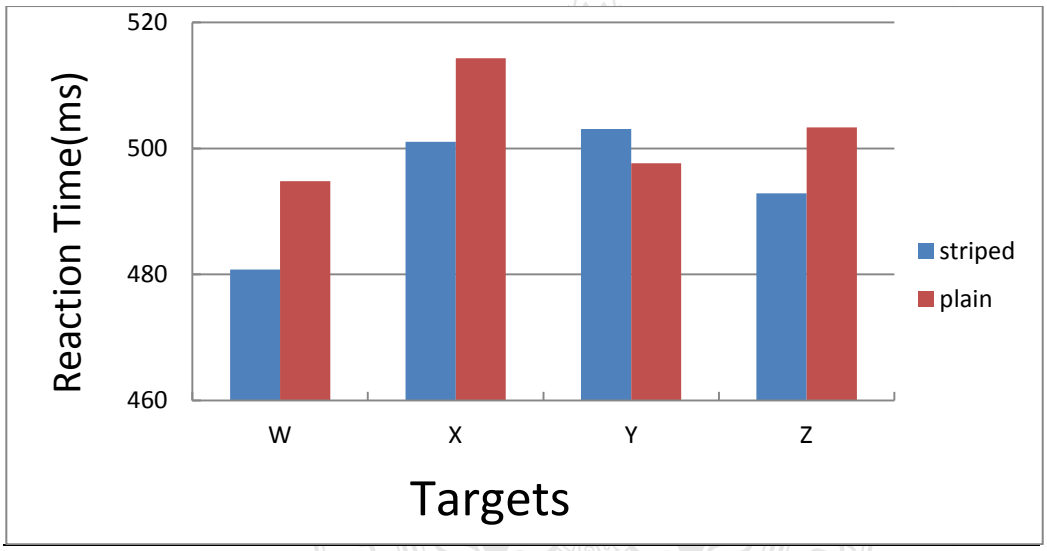

Fig. 1 Average reaction time (ms) for targets of W, X, Y, Z.

Fig. 1 shows the average reaction times for alphabets, with stripes of two orientations and of three spatial densities included all together. The difference in reaction time among 4 kinds of alphabets is irrelevant with the present study. The analysis of variance (ANOVA 4) showed no significant interactions between all kinds of targets and the effect of stripe.

The statistical t-test showed that the reaction time for W were significantly smaller for the one with zebra stripe than the plain one ($t(21)=--3.75$, $p<.01$). The results for other targets were all statistically n.s., although the probability ($P(T<=t)$) was 0.06 for Z!

Fig. 2 shows the average reaction times for 4 figures. The results were statistically all n.s. The results for Japanese characters are not illustrated in this paper, because Japanese characters might not be available in Thailand. Reaction times were significantly shorter for three of four Japanese characters with stripes than those without stripes ($P(T<=t)$ were 0.01, 0.05, 0.01), with one n.s.

Thus the results were somewhat controversial. It seems difficult at this stage to explain how such discrepancies occurred among the targets. There seems no clear geometrical or cognitive difference among the targets.

In spite of that, the targets with zebra stripes were generally easier to recognize than those without stripes. How could the present results be compromised with what is happening in natural

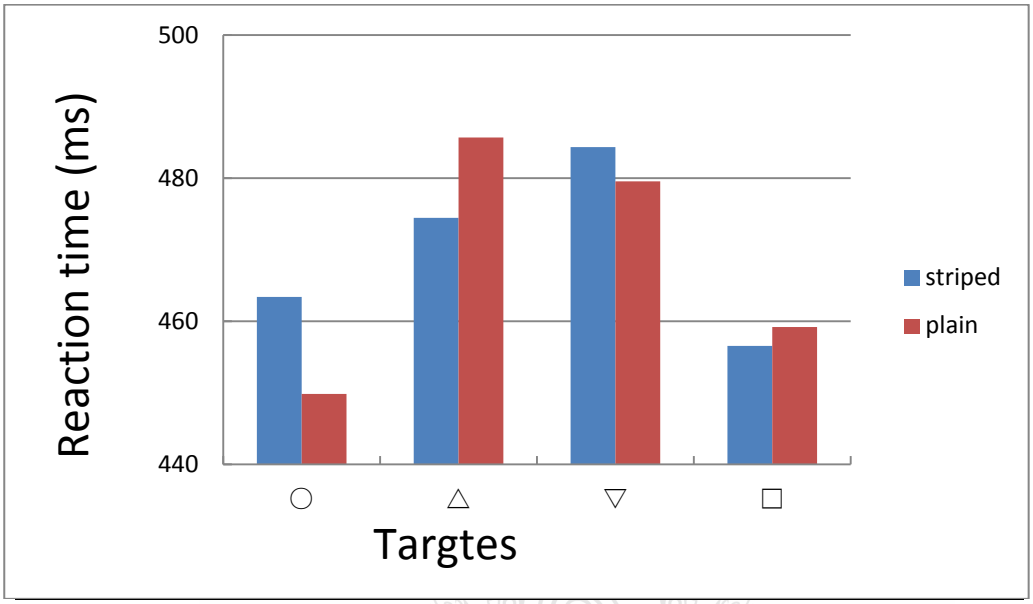

Fig. 2 Average reaction time (ms) for targets of ○, △, ▽, □.

environment? One possible factor to explain the difference is color. Many tropical fishes are quite colorful. So it is worth to conduct experiments with the targets of colors.

Noguchi demonstrated that the targets with "hatching", thin stripes, were useful for the color deficient to recognize them [3]. The present results turned to support it as a result.

REFERENCES

1. Metzger W. (1953) Gesetze des Sehens, Verlag von Waldemar Kramer, Frankfurt am Main (Japanese translation by S. Morinaga, 1968, Iwanami Publishing Co. Ltd.)
2. Pastoureau M. (1991) L'Etoffe du diable. Une histoire des rayures et des tissus rayes, Paris, Editions du Seuil (Japanese translation by T. Matsumura & E. Matsumura, 2004, Hakusuisha Publishing Co. Ltd.)
3. Noguchi Y. (2013) The effect of hatching on the word recognition of the color deficients using reaction time. Annual Review of Human Sciences, Kanagawa University, 7, 5-17. (in Japanese)