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Minimum duration necessary for integration of briefly presented letters

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Minimum duration and ISI necessary for the perceptual integration of letters presented over a brief temporal interval were measured. Time per each letter necessary for the integration was found to be about .25 sec, which is close to the iconic storage duration.

It has been found that a visual persistence remains still available for several hundred milliseconds after the stimulus has disappeared. A brief visual display presented at one moment is retained in iconic storage or short-term visual storage so that it can be integrated with a display presented at a slightly later moment. Several different paradigms (Averbach & Coriell, 1961; Eriksen & Collins, 1967; Parks, 1965; Sperling, 1960; Osaka & Osaka, Note 1) have been employed to demonstrate the existence of iconic storage, although the locus of the storage is not clear at present (Dick, 1974; McCloskey & Watkins, 1978; Sakitt, 1975).

The following experiments were made to measure iconic storage duration by using a minimum time paradigm: The time necessary for temporal organization in letter recognition was measured by varying the duration and interstimulus interval (ISI) between the successively presented letters. Integration of a letter string appears easy when the duration of each letter is long enough, but difficult to read out when it is too brief: Letters can be seen superimposed on each other when the duration is too short.

EXPERIMENT 1

Method

Stimuli. Five Japanese "kana" letters were presented successively on the CRT (P23 phosphor) driven by a Commodore PET-2001 microcomputer. Each "kana" letter consists of an 8 by 8 dot matrix. The stimulus subtended a visual angle of 3.5 deg when observed from a 30-cm viewing distance. The duration was changed from 17 to 510 msec in steps of 17 msec with ascending series. The luminance of the target was 116 cd/m^2, and the adapting field was kept at 12 cd/m^2, which was not sufficiently bright to keep the rods saturated (Adelson, 1980).

Procedure. Fifteen undergraduate psychology students with normal or corrected-to-normal vision were tested individually. The subjects were told that their task was to watch letters presented successively on the same location of the CRT and to read what they saw: They were told to report when they perceived the string "as a whole." The stimuli were presented successively, and a sample letter string is shown in Figure 1: The "kana" letter string " アカイハナ " means "red flower" in English. The letters were presented successively immediately after the fixation cross disappeared. The duration of the fixation was kept constant at 2 sec. The following two conditions were introduced: in the noninstructed condition, subjects were not informed what letter string would appear; in the instructed condition, subjects were informed what letter string would appear.

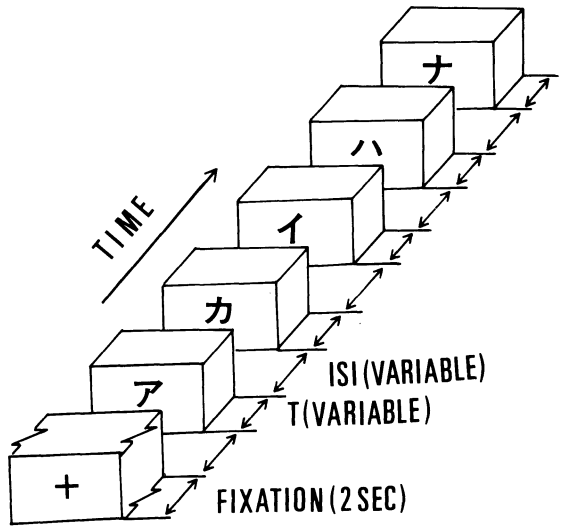

Figure 1. Time sequence to measure minimum duration (T) and ISI necessary for integration. Japanese "kana" letters were successively presented immediately after the initial fixation.

Results and Discussion

The results are shown in Table 1. The values indicate the time per each letter necessary for integration. The mean minimum duration for the noninstructed condition was found to be approximately 230 msec. This value appears close to the iconic storage duration, which deteriorates over 250 msec and has essentially faded away after this time. It is likely that the subjects could not reasonably integrate the string in less than about 200 msec due to backward masking (Felsten & Wasserman, 1980) by the letter presented at a slightly later moment. Further testing would be necessary to investigate the masking effect: This can be done by introducing a variable ISI between the letter presentations (see Experiment 2).

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Table 1
Minimum Duration and ISI Necessary for the Perceptual Integration of Letters Presented Over a Brief Temporal Interval

	Time per Each Letter Necessary for the Integration (in Milliseconds)		
	Experiment 1*		Experiment 2†
	Noninstructed	Instructed	(Noninstructed)
Mean	227.60	141.07	128.05
SD	35.35	40.37	32.50

Note–For Experiment 1, N = 15; for Experiment 2, N = 8.
**Stimulus duration without ISI.*
†*Stimulus duration (85 msec fixed) with ISI.*

It should be noted that the instructed condition was faster than the noninstructed condition. The difference was about 90 msec and was statistically significant [$t(14) = 6.62$, $p < .01$]. This can partly be explained in terms of a maintenance rehearsal effect from short-term memory: The effect may facilitate faster integration.

EXPERIMENT 2

Method

The procedure was the same as that used in Experiment 1, with the following differences. A blank ISI was introduced between stimulus presentations. The stimulus duration was fixed at 85 msec, and the ISI was varied from 17 to 510 msec in steps of 17 msec with ascending series. Eight students served as subjects. They were not informed about the stimulus. See Figure 1 for the sequence.

Results and Discussion

As Table 1 indicates, the minimum ISI was about 128 msec. However, the total time necessary for the integration (85 + 128 = 213 msec) remained about the same as the iconic storage duration. This suggests that ISI had little effect on minimum duration. It is likely that the iconic duration is closely related to the periodicity of saccadic eye movements during reading: During the fixation between saccades (i.e., a minimum of 250 msec), the content of the iconic storage could be registered.

REFERENCE NOTE

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