Memory search of simple sentences using unequal probe frequencies*

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Simple sentences in memory were to be searched for the word following a probe. An attempt was made to influence the starting point of the memory search by presenting the first word of the sentence as a probe more often than the other words. The manipulation resulted in significantly faster reaction times for this probe, but the other probes did not differ from their controls.

Sternberg (1969) draws a distinction between scanning memory for presence of a probe item and scanning to retrieve the item following a probe. This paper is concerned with the latter process, which Sternberg argues is self-terminating (S searches no further after reaching the correct response). Evidence for this claim comes from examination of serial position curves (SPC). According to Sternberg's analysis, a self-terminating search process can lead to two types of SPC. If the search process always begins with the first item in the list, the SPC should increase linearly and SPCs for varying set sizes should be superimposed. If the memory scan begins at a random point, then no position should enjoy an advantage; consequently, the SPCs should be flat, with their y-intercepts increasing by a constant amount for each additional item in the list.

Sternberg observed generally linear SPCs, but they were not superimposed. On the basis of individual SPCs, he attributed this result to variability of starting strategies; some Ss apparently used a fixed starting point, others apparently used a random one.

The present paper reports an attempt to standardize selection of a starting point in a retrieval task where simple sentences were the contents of memory. Potentially, inter-S variability of starting-point strategies can be reduced through the use of unequal probe frequencies; presenting the first word as probe more often should induce Ss to begin their search with that word. Extrapolating from Sternberg, a control group (with equal probe frequencies) should contain some Ss who use a random starting

point. The more of these Ss there are in the control group, the more often words other than the first will serve as the initial word in the search; hence, the flatter the SPC should be. Therefore, it was expected that the SPC for the control group would converge with the SPC for the fixed starting-point group.

MATERIALS

Eighty sentences of the form adjective-noun-verb-adjective-noun ($A_1-N_1-V-A_2-N_2$) were constructed using words with a frequency (Kučera & Francis, 1967) of between 10 and 45 per million (e.g., Handy fathers repair broken gadgets.). A random presentation order of the 80 sentences was derived, and all Ss received the sentences in that order. Thirty-two of the sentences were designated randomly as filler sentences, the remainder serving as test sentences.

PROCEDURE

Forty undergraduates were assigned randomly either to an equal-frequency control group (Group E) or to an unequal-frequency group (Group U). Each sentence was read to S with normal intonation. After approximately 2 sec, E presented the probe word on a small tachistoscope, at the same time activating a timer. Ss responded by saying the word following the probe, closing a voice-activated relay which terminated stimulus exposure and stopped the timer. Reaction time (RT) was not recorded for filler sentences.

Each S was tested only once on each sentence. For the 48 test sentences, both groups received 12 tests on each type of probe (A_1 , N_1 , V , A_2). Across Ss, all four probes for each sentence were tested equally often. For Group U, A_1 was the probe

for all filler sentences; for Group E, A_1 , N_1 , V , and A_2 were used as probes the same number of times. Over the experiment, then, the probability that the first word would be a probe was .25 for Group E and .55 for Group U. The instructions given to both groups differed only in that they contained mention of the respective probe frequencies. Both speed and accuracy were stressed to both groups. Twelve practice trials were given to Ss before the experiment began, the probe frequencies roughly corresponding to those in the experiment.

RESULTS AND DISCUSSION

Each S's mean RT was computed for each of the four probes (see Table 1); these means do not include RTs from trials on which S responded incorrectly. Reaction time varied significantly as a function of probe [$F(3,114) = 32.41$, $p < .01$]. As has been reported elsewhere (cf. Kennedy & Wilkes, 1969; Wilkes & Kennedy, 1969), RT does not increase linearly as a function of probe position in the sentence. The bowed shape of the function obtained here can be reconciled with Sternberg's data if one is willing to assume that, whereas transitions between numbers are of approximately uniform difficulty, transitions between words in a sentence are not (cf. Johnson, 1966). Then, suppose that responding in this situation involves finding the probe word in memory and then retrieving the word which followed it. This is essentially the assumption made by the model of Kennedy & Wilkes (1969): "...the retrieval latency measure compounds two operations: the time to locate the stimulus word and the time to locate and utter the response [p. 396]." To illustrate, Table 2 presents a hypothetical breakdown of the mean RT for Group E into a serial search component and a response-retrieval component. The search process is represented as linearly increasing with a slope of 23 msec per word. The hypothetical response-retrieval times listed are consistent with other studies (cf. Johnson, 1966) in that the noun-verb transition is more difficult than that between adjective and noun. Reaction times would reflect the linearity of the search process if each response-retrieval was of

Table 1
Mean Reaction Time (in Msec) as a Function of Probe

Group	Probe							
	A_1		N_1		V		A_2	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Unequal Frequency	801	145	1132	190	1108	214	1054	148
Equal Frequency	1028	134	1187	173	1140	212	1097	158

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Table 2
Analysis of Mean RT for Group E into Hypothetical Search and Retrieval Components

	Probe			
	A ₁	N ₁	V	A ₂
Search	900	923	946	969
Retrieval	128	264	194	128
Total	1028	1187	1140	1097

approximately equal difficulty, an assumption which seems more defensible with lists of numbers than with sentences. Consequently, it can be argued that search of simple sentences in memory proceeds serially from a fixed starting point. If Groups E and U contain differing numbers of Ss using a fixed starting point, then the differing slopes of the search process should be reflected by an interaction between groups and probe position.

There was a reliable overall difference in RT for the two groups [$F(1,38) = 4.15$, $p < .05$], and an interaction was obtained [$F(3,114) = 5.91$, $p < .01$]. Simple main effects were calculated for the two conditions across the four probes. Ss in Group U had reliably faster RTs only when A₁ was the probe [$F(1,152) = 17.19$, $p < .01$]; no other comparison produced an $F > 1.00$. The significance of the A₁ comparison is consistent with Keele's (1969) conclusions about the effect of an

expectancy on choice reaction time. Keele suggested that the anticipation of a certain stimulus (A₁ here) results in partial retrieval of the appropriate response (N₁), leading to faster RTs when the anticipated stimulus is presented.

It was expected that inducing Ss to use the fixed starting-point strategy would result in a linearly decreasing advantage across the sentence. However, the significant interaction was due solely to the marked facilitation occurring for the first probe. It seems clear that Ss in Group U were biased towards the use of a fixed starting point, and the consistency of the difference between SPCs across the final three probes suggests that Ss in Group E uniformly began their memory search with the first word. Perhaps a random starting-point strategy is more likely to be adopted with longer sentences or with a (relatively unordered) list of digits.

Although the present results have

been presented in the framework of Sternberg's (1969) theorizing, it is quite likely that some other model (cf. Wilkes & Kennedy, 1969), explicitly embodying syntactic and semantic features, would be more appropriate. Actually, the paucity of published data on sentence search does not allow firm conclusions about models; the purpose of this paper is not so much to argue for one particular model, but rather to present evidence which might potentially influence a choice among candidates.

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