

STIMULUS PROBABILITY AND STIMULUS SET SIZE IN MEMORY SCANNING¹

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In many recent studies of speeded scanning of immediate memory, variations in the size of the positive set (s) were confounded with variations in the probability (P) of the individual items within the positive set: As s increased, P decreased. The present experiment sought to determine whether the effect on RT attributed to s could be accounted for by variations in P . This was accomplished by factorially varying both s and P . Probability effects were confined to items in the positive set and were insufficient to account for the effect of s . The results are discussed in terms of a model in which s and P affect different information-processing stages. The s affects the number of comparisons between the encoded item and the items stored in the memory of the positive set, as proposed by Sternberg. The P affects response selection—information as to the particular digit that was presented is available to the mechanisms for response selection along with the knowledge that there was or was not a match. The response selection mechanisms are assumed to be biased in tune with the P values of the items within the positive set.

The number of things that one has to think about and the expectancy as to the likelihood of occurrence of these things—stimulus number and stimulus probability—have long been regarded as fundamental variables in the study of cognition. The common finding that longer RTs would be produced by an increase in the number of possible stimuli or a decrease in stimulus probability was a result that was compatible with most theories of stimulus recognition. Discriminating among the various theoretical accounts for these effects has been a more elusive task.

One class of models holds that variations in stimulus probability and stimulus number affect only a single commodity such as information (in bits) or repetitions. Examples of such models are those that posit

a single decision maker which operates on stimulus information in bits (e.g., Briggs & Johnsen, 1973; Briggs & Swanson, 1970; Hick, 1952) or sequential position in a stack (Theios, Smith, Haviland, Traupmann, & Moy, 1973).

In contrast, Sternberg (1966, 1967) has advocated a model in which the time to scan immediate memory is affected by the number of possible items in memory—not by their probability of occurrence. In a series of character classification experiments, Sternberg (1966, 1967) found that the time to classify a character (e.g., a digit) as a member of an arbitrary subset of characters (the memory or positive set) was a linear increasing function of the number of items, s , in that subset. Moreover, the slopes for the positive (match) and negative (nonmatch) functions were identical. From these data, Sternberg postulated a high speed (25 items/sec), exhaustive, sequential scan of the items in the positive set. However, in Sternberg's experiments, the number of items in the positive (memory) set s was confounded with the probability (P) of the individual items in that set: As s increased, P decreased. By interpreting his results solely in terms of stimulus number, Sternberg was implicitly assuming that there was either

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no effect of P^3 or else that P affected some stage other than memory scanning. This confounding, which Sternberg explicitly acknowledged, was a necessary consequence of controlling for stimulus and response entropy and response probability. For example, in Sternberg's (1967) experiment, when $s = 1, 2,$ and $4,$ the individual items had P -values of $4/15, 2/15,$ and $1/15,$ respectively, so that the probability of a Yes response was always $4/15.$ Because of the confounding between s and $P,$ Biederman and Zachary (1970) suggested that the slower RTs to the larger set sizes might, in part, represent adjustments to stimulus probability within the positive set. (Sternberg, 1966, found no effect of increasing the number of negative set items from 2 to 15, with negative response probability held constant, so if probability adjustments were at play, they would have to be to positive set stimuli.) An effect of P had already been documented in other experiments (e.g., LaBerge & Tweedy, 1964), in that faster RTs were produced by more probable stimuli even when the different stimuli were assigned to the same response.

The present experiment was designed to reveal whether such probability adjustments would be found in the Sternberg memory-scanning task. Specifically, the probability of the items *within* a given positive set was varied. If it is assumed that P affects memorial comparisons and the memorial comparisons proceed at a fixed rate, then an exhaustive, sequential scanning theory would predict that such a probability imbalance would have no effect on RTs.

Recently, however, Klatzky and Smith (1972) argued that an exhaustive scanning theory could accommodate such a result by assuming that the adjustments to probability were made at some stage other than the comparison stage; viz., a stimulus encoding stage. The exhaustive scanning theory and the additive factors method (Sternberg, 1969) then predict that variations in P and s should produce additive effects on RT. Such a result was reported

by Klatzky and Smith in a letter classification task. Also compatible with an encoding effect of P is Miller and Pachella's (1973) finding that P and stimulus degradation (which would be expected to affect encoding) interact. The RTs to items of low probability of occurrence were more adversely affected by the presence of visual noise than high- P items. Since Sternberg (1967) found that degradation did not interact with variations in positive set size (i.e., memory scanning), the Klatzky and Smith (1972), Miller and Pachella (1973), and Sternberg (1967) experiments are all compatible with a two-stage theory, encoding and memory scanning, for the effects of P and $s,$ respectively.

The design of the present experiment compared the effect of P on positive RTs with the effect on negative RTs. An encoding theory of P -effects would predict that response type would not interact with $P.$ Theios et al. (1973), Krueger (1970), and Miller and Pachella (1973), in fact, reported such a result. However, these investigators all employed positive and negative sets that were of equal size. Such a procedure might well lead to S 's functional (i.e., positive) set not being the one specified by $E.$ When sets are of equal size, there is little utility for S to confine his scanning to the set which E designated as positive. Under such conditions, S might reasonably be expected to sometimes scan one and sometimes scan the other set. Or else, S could scan an amalgamation of sets (Hawkins & Hosking, 1969) by combining the high- P items from the negative set with the positive set. The design of the present experiment employed a positive set that was smaller than the negative set hence, less scanning would be required if S confined his scanning to the positive set.

METHOD

Subjects. Forty-eight undergraduate students at the State University of New York at Buffalo participated in the experiment as part of their course requirement in introductory psychology.

Stimuli and apparatus. The stimuli were the 10 digits, 0, 1, . . . , 9, generated by an IEEE in-line display (Model 10-0K21-1820-L) set in a 3×3 ft. gray frame. The background, pre- and postexpo-

³ As defined here, P is the probability of occurrence of a particular stimulus.

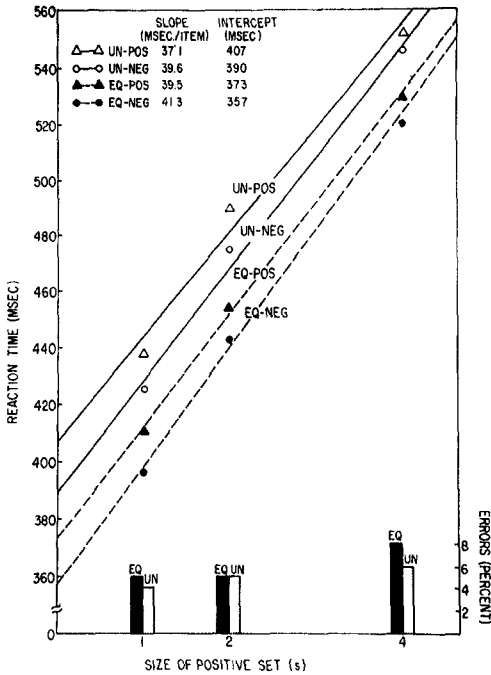


FIGURE 1. Mean correct reaction time as a function of group (EQ vs. UN), response (POS vs. NEG), and set size. (Slopes and intercept constants shown on figure represent best least squares fit. Lower bars represent error rates as shown on scale on the right of the figure.)

sure fields were black. The *S*'s index fingers rested on plastic keys which, when depressed, activated a microswitch which stopped a timer that was started by the onset of the digit. A warning buzzer of .5-sec. duration sounded 1 sec. before each stimulus presentation of .5 sec. The interstimulus interval was 5 sec. After each response, *E* verbally provided error and speed feedback (to the nearest .01 sec.). Approximately 2 min. intervened between blocks of trials.

Design and procedure. Each *S* was fully instructed about the nature of the task and the relative fre-

quencies of each of the 10 digits. A bar graph display of these relative frequencies remained in *S*'s view throughout the experiment. Left and right keys were assigned to Yes and No responses according to *S*'s preference.

The design closely followed that of the first session in Sternberg's (1967) experiment. The first block for all *S*s always consisted of 45 trials with a positive memory-set size of three digits. The second through fourth blocks each consisted of 90 trials with memory set sizes of one, two, or four digits in counter-balanced order. Half of the *S*s were run in a condition (UN) where, for memory sets of Size 2 and 4, one of the digits in that set was more probable than the other digit(s). The remaining *S*s, like those in Sternberg's experiment, had memory sets where the positive digits were equiprobable (EQ). The stimulus sets and probabilities are shown in Table 1. For Set Size 2 in the EQ condition, both digits had a probability of 2/15. In the UN condition, one of the digits had a probability of 3/15 and the other digit had a probability of 1/15. For Set Size 4 in the EQ condition, each of the four digits had probabilities of 1/15. In the UN condition, one of the four digits had a probability of 2/15 and the remaining three digits each had a probability of 2/45. For Set Sizes 1, 2, and 4 the probability of a positive response was 4/15. For *s* = 3, all *S*s had an equiprobable condition where the probability of a positive response was 3/15. (Therefore, the probability for any one digit when *s* = 3 was 1/15.) For EQ *S*s, therefore, 1 of the 10 digits had a probability of 4/15, 2 had probabilities of 2/15, and the remaining 7 had probabilities of 1/15. In the UN condition, 1 digit had a probability of 4/15, 1 had a probability of 3/15, 1 had a probability of 2/15, 4 had probabilities of 1/15, and 3 had probabilities of 2/45.

Each *S*'s positive sets were selected from one of the three groupings used in the Sternberg (1967) experiment. The high and low *P*s were balanced over the different digits. Thus, for example, one-third of the *S*s had a grouping that when *s* = 1, the positive digit was "5"; when *s* = 2, the positive digits were 4 and 9; and when *s* = 4, the positive digits were 0, 1, 3, and 7. In the UN condition, each digit in *s* = 2 and 4 occurred as the more probable digit an equal number of times. For example, for eight of the *S*s in the UN condition, when *s* = 2 the more probable (*P* = 3/15) digit for four of these *S*s was "4" and for the remaining four *S*s the more probable digit was "9." The assignment of *P*s to digits remained constant throughout *S*'s session. Before each block, markers were placed on the bars of *S*'s display designating the positive digits.

RESULTS

Figure 1 shows the overall Yes-No RT and error functions for both EQ and UN conditions. The slopes for the EQ functions average 40.4 msec/item which is

TABLE 1

PROBABILITIES OF STIMULUS DIGITS IN THE POSITIVE SETS FOR THE EQUAL AND UNEQUAL PROBABILITY GROUPS

Size of positive set	Group	
	Equal	Unequal
<i>s</i> = 1	4/15	4/15
<i>s</i> = 2	2/15, 2/15	3/15, 1/15
(<i>s</i> = 3)	(1/15, 1/15, 1/15)	(1/15, 1/15, 1/15)
<i>s</i> = 4	1/15, 1/15, 1/15, 1/15	2/15, 2/45, 2/45, 2/45

almost identical to the UN functions which average 38.4 msec/item, and these, in turn, are similar to those reported by Sternberg in his (1967) experiment (mean slope = 35.6 msec/item). Thus, instructing *S* about the probability variations and explicitly manipulating *P*s within the positive set had little effect on the rate and nature of processing. The 30-msec. average difference in intercepts between the EQ and UN groups most likely represents individual differences in the groups: the EQ group was 43 msec. faster at the outset of the experiment, in the $s = 3$ condition, and 26 msec. faster in the $s = 1$ condition. Differences in RTs among the three digit groupings were negligible, $F < 1.00$.

The data for probability adjustments within the positive set are shown in Table 2. An analysis of variance of the positive stimuli of the $s = 2$ and 4 condition of the UN group revealed that the main effects of s (2 vs. 4) and P (high vs. low) were significant, $F(1, 23) = 19.40$, $p < .001$, and $F(1, 23) = 11.85$, $p < .01$, respectively. The $s \times P$ interaction was highly variable from subject to subject and was not significant, $F(1, 23) = 1.42$. Table 2 shows that the effect of s on Yes RTs is too large to be completely attributable to P . Three comparisons are relevant here: (a) The differences in P -values between $s = 2$ and $s = 4$ in the EQ condition was only half the difference between high and low P s in the $s = 2$ UN condition (.133-.067 = .061 vs. .200-.067 = .133). Yet the former yielded an effect on RT of 77 msec. which was more than twice the effect on

RT produced by the latter P difference (28 msec.). (b) A similar case can be made for the $s = 4$ UN condition. Here the difference in P values was .089 (.133-.044) —slightly greater than the difference in P values in the EQ condition. Yet, again, the 48-msec. UN difference was less than the effect of s in the EQ condition. (c) Within the UN conditions, the effect of s was clearly greater than the effect of P . The RTs to the .133 stimulus in the $s = 4$ condition were slower than the .067 stimulus in the $s = 2$ condition. Thus when s and P were directly pitted against each other, s was the more potent variable.

Is the effect of s independent of the effect of P ? The data were more equivocal on this point but certainly did not provide strong evidence for an interaction between s and P . Although not statistically reliable, the within-subjects effect of P was greater in the $s = 4$ condition than in the $s = 2$ condition, even though the difference (but not the ratio) in P -values was greater in the $s = 4$ condition. However, before this suggestion of an interaction between s and P is given much weight (which would be evidence against a two-stage theory), one must first consider how the interaction could be affected by rescaling the probability variable since the differences in P -values for the different set sizes were not taken at the same points on the P scale. The variation in P for $s = 4$ occupied a lower range of the scale (.044 to .133) than did the variation in P for $s = 2$ (.067 to .200). Hence, if one wished to assume a transform between objective and subjective

TABLE 2
MEAN CORRECT REACTION TIMES (RTs) FOR YES RESPONSES AS A FUNCTION
OF GROUP, SET SIZE (s), AND PROBABILITY (P)

Set size	Group						<i>P</i> -effect (Low <i>P</i> minus high <i>P</i>)
	Equal		Unequal				
	<i>P</i>	RT (msec.)	High <i>P</i>	RT (msec.)	Low <i>P</i>	RT (msec.)	
2	.133	454	.200	484	.067	512	28
4	.067	531	.133	528	.044	576	48
<i>s</i> effect (4 minus 2)		77		44		64	

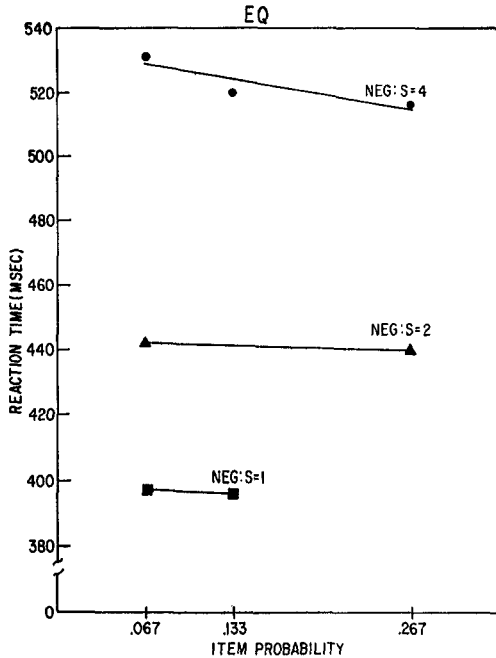


FIGURE 2. Mean negative correct reaction time as a function of probability for the EQ condition.

tive P that expanded the smaller values of the P scale, the interaction between s and P could be eliminated. Such an assumption could be justified on the basis of studies (e.g., Hohle & Gholson, 1968; Miller & Pachella, 1973) that have demonstrated that differences between small P -values produce larger effects on RT than equal differences in larger P -values. It is possible to construct a between-subjects test of the $P \times s$ interaction—which avoids the scaling problem—by comparing the data from the EQ and UN groups. This

TABLE 3

MEAN CORRECT REACTION TIMES (RTs) FOR YES RESPONSES AS A FUNCTION OF SET SIZE (s) AND PROBABILITY (P) WITH CORRECTION FOR GROUP DIFFERENCES

Set size	Probability		P-effect (.133 minus .067)
	.133	.067	
2	480(Equal)	512(Unequal)	32
4	528(Unequal)	557(Equal)	29

Note. A total value of 26 msec., the difference between the equal and unequal groups in the $s = 1$ condition, has been added to the equal RTs.

can be done by equating for the between-group differences on the basis of the common $s = 1$ condition which was 26 msec. faster in the EQ group. Thus if 26 msec. is added to the EQ values as shown in Table 3, then the larger P -effect found in the $s = 4$ group for the within-s analysis is eliminated.

Figures 2 and 3 show the effect on RTs of variations in item probability, set size, and response. Variations of P within the positive set had a considerably greater effect than variations of P within the negative set. The average slope of the functions relating RT to P within the positive set, are 14 times as steep as the corresponding negative functions: -48 msec. per .1 increase in P for the positive slope and -3.4 msec. per .1 increase in P for the negative slope. (By comparison, if the effect of s is described in terms of P , then the resulting slope, -60 msec. per .1 increase in P , is steeper than the function relating RT to P within a given sized positive set.) Probability thus had only a negligible effect on RTs to items within the negative set. In five of the six negative set probability functions, the F ratio for the effect of P was less than 1.00. In the UN group, $s = 2$ condition, there was a significant effect of P : $F(3, 69) = 4.91$, $p < .01$. However, the function for that condition is nonmonotonic and the effect is primarily attributable to the point at $P = .067$ which is slower than the point at $P = .044$.

Repetition effects were examined as a function of response type, probability, set size, and group. (Since a number of S s did not have any entries for repetitions for some of the low probability stimuli in some conditions, the nonrepetition RTs for the corresponding cells for these S s were not included in the analyses.) Stimulus repetition effects were larger than response repetition effects. Trials in which the stimulus was repeated from the preceding trials resulted in RTs that averaged 25 msec. less than RTs from trials in which the successive stimuli were different but the response was the same. When a different response was required, RTs were 6

msec. longer than when the response was repeated but different stimuli were presented. Table 4 shows that larger stimulus repetition effects were associated with larger set sizes. Response type, *P*, and groups did not yield a consistent effect on the magnitude of the stimulus repetition effect. The magnitude of the response repetition effect did not vary systematically with any of the major experimental variables. Since there were relatively few repetition trials the results shown in Figures 1, 2, and 3 would be only negligibly affected if only nonrepetition trials were used.

Table 5 shows the correct RTs, error RTs, and error rates for the major experimental conditions. Yellot's (1971) correction for fast guessing and the speed-accuracy trade-off applied to these data had only a negligible effect on the comparisons described above.

DISCUSSION

Variations in *P* produced by variations in *s* led to considerably greater effects on RT than identical variations in *P* with *s* held constant. Thus it is clear that not all the effect of *s* can be attributed to *P*. The results of this memory scanning experiment are thus consistent with the information conservation studies of Hyman (1963) and Hohle and Gholson (1968) in showing that the effect on RTs of variations in set size of equiprobable stimuli is greater than the effect which is produced by variations of *P* within a given set size. The interaction between *s* and *P* was not significant although there was a trend, within-*s*, for larger *P* effects to be present in the larger positive sets (although this was not the case in the between-*S* comparison).

In the present experiment, if it is assumed that *P* effects reflect the functional set (i.e., the set which is scanned), then the lack of such effects in the negative set would indicate that the negative set was rarely functional (or scanned). What might have occurred in the Kreuger (1970), Theios et al. (1973), and Miller and Pachella (1973) experiments, was that their *S*s, faced with positive and negative sets of equal size, varied the set which they scanned from trial to trial. What determines which set gets scanned? What does the *S* treat as positive? This decision could not primarily be based on response probabilities

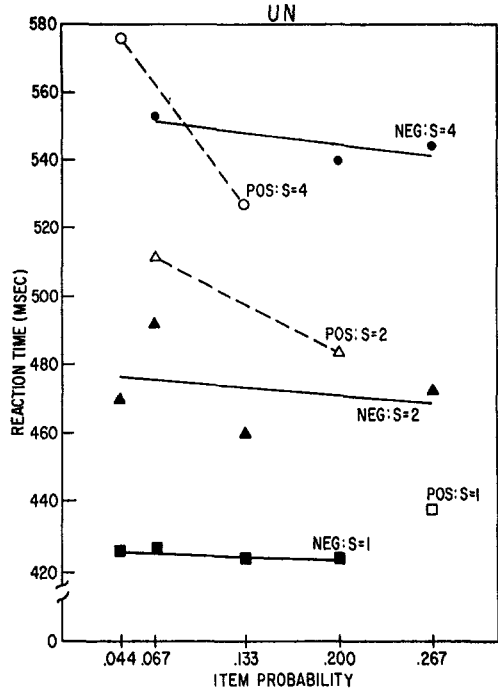


FIGURE 3. Mean correct reaction times as a function of probability and response in the UN condition.

since in the present experiment as well as Sternberg's (1967, 1969) experiments the probability of a positive response was only 4/15. Moreover, variations of response probability independent of stimulus probability have only

TABLE 4
STIMULUS REPETITION EFFECTS (IN MSEC.) AS A FUNCTION OF RESPONSE (POSITIVE OR NEGATIVE), SET SIZE (*s*), AND STIMULUS PROBABILITY

Set	Stimulus probability					<i>M</i>
	.044	.067	.133	.200	.267	
Positive						
<i>s</i> = 1					5 ^a	5
<i>s</i> = 2		b	13	41		27
<i>s</i> = 4	9	93	71			58
Negative						
<i>s</i> = 1	-12	0	12	-6		-2
<i>s</i> = 2	23	8	21		3	14
<i>s</i> = 4		54	12	50	36	38
<i>M</i>	7	39	26	28	15	

Note. Entries are the difference, in msec., between mean RTs for response nonrepetition and stimulus repetition trials. Positive entries indicate that the repetition trials were of shorter latencies.
^a Includes both stimulus and response repetition effects.
^b Insufficient data.

TABLE 5

MEAN CORRECT REACTION TIME (MSEC.), ERROR REACTION TIME (UNDERLINED, IN MSEC.), AND ERROR RATE (IN PARENTHESES) AS A FUNCTION OF GROUP, SET SIZE, AND RESPONSE AND STIMULUS PROBABILITY

Probabil- ity	Positive response						Negative response					
	Group equal			Group unequal			Group equal			Group unequal		
	<i>s</i> = 1	<i>s</i> = 2	<i>s</i> = 4	<i>s</i> = 1	<i>s</i> = 2	<i>s</i> = 4	<i>s</i> = 1	<i>s</i> = 2	<i>s</i> = 4	<i>s</i> = 1	<i>s</i> = 2	<i>s</i> = 4
.267	412 <u>324</u> (.089)			438 <u>364</u> (.076)				442 <u>456</u> (.021)	516 <u>586</u> (.023)		471 <u>525</u> (.012)	544 <u>508</u> (.042)
.200				484 <u>408</u> (.113)						424 <u>548</u> (.009)		540 <u>637</u> (.016)
.133		454 <u>410</u> (.078)			528 <u>584</u> (.052)		396 <u>490</u> (.007)		520 <u>521</u> (.030)	424 <u>400</u> (.003)	460 <u>471</u> (.024)	
.067			531 <u>498</u> (.078)	512 <u>524</u> (.132)			397 <u>389</u> (.009)	444 <u>482</u> (.015)	531 <u>622</u> (.078)	427 <u>609</u> (.014)	492 <u>508</u> (.028)	551 <u>587</u> (.013)
.044					576 <u>511</u> (.142)					426 <u>500</u> (.003)	470 <u>490</u> (.017)	

slight effects on RT (Biederman & Zachary, 1970). It would appear that the number of items is the most potent determinant of what gets scanned in memory: Left to his own devices, *S* scans the set with the smaller number of items.⁴ It seems reasonable to assume, however, that when positive and negative sets are of equal size, other variables (e.g., probability, repetition, value) would determine which stimuli are scanned on a given trial. Also, if *S* had insufficient time or memory to determine the complement of a positive set, he might scan the positive set even though it was larger than the negative set.

The interaction between *P* and Response Type observed in this experiment is contrary to what would have been expected from an encoding theory of stimulus probability as advanced by Klatzky and Smith (1972) and Miller and Pachella (1973). These investigators reported that *P* did not interact with memory set size but did interact with stimulus degradation. An encoding theory of probability effects might be reconciled with the above findings if it is assumed that prior to the presentation of the probe, *S* "prepares" only for the positive set items, and the effect of this preparation is on the encoding stage.

⁴ Perhaps it is for this reason that it is so difficult to follow the instruction, "Don't think about alligators."

If the amount of preparation was related to *P* then larger *P* effects in the positive than in the negative set might be expected. However, such a theory is inconsistent with the complete absence of any interaction between degradation and response type in the Sternberg (1967) experiment.

If *P* does not affect encoding, then where does it have its effect? One possibility might be at the response selection stage following memory scanning. If positive set matches are signaled not simply by a match signal but by the digit itself along with a match signal, then response selection could be biased in tune with the probabilities of the positive set stimuli. After all, *S* knows what the digit was that provided the match. Such a theory would be consistent with the finding that the effects of *P* and *S*-*R* compatibility interact (Sanders, 1970). In fact, with naming tasks (which are of very high compatibility), there is little or no effect of probability (Miller & Pachella, 1973; Theios, 1974). Of the studies discussed above, the only finding that is apparently incompatible with this view is the interaction between *P* and degradation reported by Miller and Pachella. In that experiment, degradation was produced by the presentation of a light field immediately prior to the presentation of the digits of a CRT display. The field, which reduced the contrast between the digits and background, decayed over time. That is,

if *S* waited, the digits became clearer. It is possible that such a discriminability manipulation could have induced a response selection strategy which was biased in favor of high-*P* stimuli (assuming that response selection is achieved by a combination of digits and match signals). But even if another method of producing degradation revealed an interaction between *P* and degradation, *P* effects could still be localized at the response selection stage if it was assumed that the *P* bias was to a visual representation of the digit.

REFERENCES

- BIEDERMAN, I., & ZACHARY, R. A. Stimulus versus response probability effects in choice reaction time. *Perception & Psychophysics*, 1970, **7**, 189-192.
- BRIGGS, C. E., & JOHNSEN, A. M. On the nature of central processing in choice reactions. *Memory & Cognition*, 1973, **1**, 91-100.
- BRIGGS, G. E., & SWANSON, J. M. Encoding, decoding, and central functions in human information processing. *Journal of Experimental Psychology*, 1970, **86**, 296-308.
- HAWKINS, H. L., & HOSKING, K. Stimulus probability as a determinant of discrete choice reaction time. *Journal of Experimental Psychology*, 1969, **82**, 435-440.
- HICK, W. E. On the rate of gain of information. *Quarterly Journal of Experimental Psychology*, 1952, **4**, 11-26.
- HOHLE, R. H., & GHOLSON, B. Choice reaction times with equally and unequally probable alternatives. *Journal of Experimental Psychology*, 1968, **78**, 95-98.
- HYMAN, R. Stimulus information as a determinant of reaction time. *Journal of Experimental Psychology*, 1953, **45**, 186-196.
- KLATZKY, R. L., & SMITH, E. E. Stimulus expectancy and retrieval from short-term memory. *Journal of Experimental Psychology*, 1972, **94**, 101-107.
- KRUEGER, L. E. Effect of stimulus probability on two-choice reaction time. *Journal of Experimental Psychology*, 1970, **84**, 377-379.
- LABERGE, D., & TWEEDY, J. R. Presentation probability and choice time. *Journal of Experimental Psychology*, 1964, **68**, 477-481.
- MILLER, J. O., & PACHELLA, R. G. Locus of the stimulus probability effect. *Journal of Experimental Psychology*, 1973, **101**, 227-231.
- SANDERS, A. F. Some variables affecting the relation between relative stimulus frequency and choice reaction time. *Acta Psychologica*, 1970, **33**, 45-55.
- STERNBERG, S. High-speed scanning in human memory. *Science*, 1966, **153**, 652-654.
- STERNBERG, S. Two operations in character recognition: Some evidence from reaction-time measurements. *Perception & Psychophysics*, 1967, **2**, 45-53.
- STERNBERG, S. The discovery of processing stages: Extensions of Donder's method. *Acta Psychologica*, 1969, **30**, 276-315.
- THEIOS, J. Reaction time measurements in the study of memory processes: Theory and data. In G. H. Bower (Ed.), *The psychology of learning and motivation*. Vol. 7. New York: Academic Press, 1974.
- THEIOS, J., SMITH, P. G., HAVILAND, S. E., TRAUPEMANN, J., & MOY, M. C. Memory scanning as a serial, self-terminating process. *Journal of Experimental Psychology*, 1973, **97**, 323-336.
- YELLOTT, J. I., JR. Correction for fast guessing and the speed-accuracy tradeoff in choice reaction time. *Journal of Mathematical Psychology*, 1971, **8**, 159-199.

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