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EFFECT OF PRACTICE, MAPPING, STIMULUS AND SIZE ON STRING MATCHING[1]

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Summary.—The same-different discrepancy on a matching task on which the subject had to determine the number of common elements (physically identical and appearing in the same position) between two strings of size 1 to 4 was investigated. Manipulated also were the type of presentation (fixed or varied sets), amount of practice (four blocks), and type of stimulus (letters, words). Reaction times for pure positive responses (all same at each level) were faster than negative responses (all different), confirming the usual discrepancy shown in previous studies. The discrepancy was smaller for well-learned sets (fixed sets) and for words, indicating the development of a comparison process based on global characteristics of the stimulus.

On a matching task (Krueger, 1984) two stimuli are presented and the subject must judge whether they are *same* or *different*. Response time shows that *same* responses have shorter average latency than *different* responses. If the subject has to inspect both stimuli analytically, then the empirically obtained result runs against the expected one because inspection time should be inferior when both stimuli are *different*, given that the subject could adopt a self-termination strategy.

Experimental literature has focused recently on factors which can alter the balance towards an analytical or holistic way of processing the stimulus set. This difference in processing strategy is presumed to be the basis of the *same-different* discrepancy because a very schematic search of stimuli should be sufficient to say *same* (Taylor, 1976), meanwhile the response *different* must be based on a more analytical and costly inspection. Following this line of reasoning, several researchers (Proctor, 1981; Reed, 1973), predicting that sequential presentation should favor holistic processing, have shown a greater discrepancy with sequential versus simultaneous presentation. However, Krueger (1983) did not report an effect of letter size on the same-different discrepancy either with simultaneous or sequential presentations. If analytical processing is a significant factor, then the greater sizes should have favored the appearance of self-termination and consequently reverse the discrepancy.

Further research (Krueger, 1984) has shown that the discrepancy is reversed in matching long multiletter sequences (5 or 6 letters) when both memory and comparison sets are continuously present, suggesting the action of a self-termination factor in stimulus comparison. A previous investigation (Soler & Algarabel, in press) has shown that the discrepancy is also obtained in multiletter matching in absence of the global self-termination factor. The task con-

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sisted of the presentation of two stimulus sets whose letter elements, if alike, were also placed in identical positions. The subject's task was to choose the number of common elements between both sets.

The research presented here uses the paradigm just described to observe the effect of practice, type of stimulus (letters-words), and type of response mapping on the *same-different* discrepancy. Two sets of stimuli (memory and test) were presented, both having the same number of elements on each trial (1, 2, 3, or 4 items) in a varied or fixed arrangement (Sternberg, 1975). The subject's task was to report the number in common between both sets, considering identical items would only appear in the same positions in the set. This arrangement requires a subject exhaustively examine both sets before the response is given, because otherwise he would not be able to determine the exact number of common elements between both sets.

METHOD

Subjects

Subjects were 24 volunteers (17 women and 7 men), undergraduate students at the University of Valencia, Spain. They had normal or corrected-to-normal vision.

Materials and Design

The stimuli were words and consonant letters. The words were randomly chosen from the University of Valencia wordpool (Algarabel & Sanmartin, 1985). These were nouns selected from Juilland and Chang-Rodriguez's frequency dictionary of Spanish words (1964), chosen with the further restrictions of their being common names of four to seven letters. The letters were consonants from the Spanish alphabet, excluding the "ñ" and "ll".

The subject's task was to identify the number of common elements between a fixed or varied set of stimuli (comparison set) and a test set. An experimental session was divided in four blocks according to the stimulus-set size (1, 2, 3, or 4), with 60 trials for each block, except Block 4 with 63. Within a block, comparison and test sets were random samples of words or letters in which every match appeared an exact number of times according to position in both sets. The sequences were constructed in such a way that no stimulus repetition was allowed within a trial unless required letters were at the same position in the comparison and test sets.

After a practice session to familiarize subjects with the task, subjects received eight experimental series at a rate of two per day.

Procedure

The experiment was conducted individually under the control of an Apple IIe microcomputer. The microcomputer was programmed to randomize a different sequence for each subject to time responses and stimulus presentation.

A first set trial began with the display of a memory set. The subject viewed this set for as long as he wished, then hit a key, causing the test set to be displayed in addition to the memory set. Memory set was identical for all trials of the same set. The subject pressed the key corresponding to the number of common elements between memory and test set (0 or 1 for block 1; 0, 1, or 2 for Block 2; 0, 1, 2, or 3 for Block 3; 0, 1, 2, 3, or 4 for Block 4). After a 2-sec. intertrial interval the next test set appeared and the subject had to respond. The computer provided response feedback and printed the reaction time after the subject's response.

In a varied set trial a different comparison set was presented sequentially (character by character). Each character was displayed for 1 sec. After a 2-sec. interstimulus interval, the test set appeared simultaneously. The remaining details were exactly the same as in the fixed procedure. Instructions given to the subjects emphasized accuracy and speed.

RESULTS

No evidence was found of speed-accuracy tradeoff in error rates. Mean reaction time,[2] excluding errors, for condition in which the comparison and test sets were either *same* or *different* were submitted to a 2 (type of procedure) × 2 (stimulus type) × 8 (practice) × 4 (set size) × 2 (response type) analysis of variance (see Table 1). The analysis indicated that mean reaction for *same* judgments was faster than *different*, this discrepancy being more evident for letters (699 vs 895 msec.) than words (736 vs 828 msec.). Reaction time for fixed-sets was lower than for varied-sets, increasing this difference with set size. Moreover, the discrepancy between *same-different* judgments for fixed-sets (507 vs 552 msec.) was lower than varied sets (591 vs 659 msec.). As would be expected the effect of practice was significant, although the interaction of type of procedure × practice showed that extensive training reduced the reaction time of fixed sets only. Finally, as string-length increased reaction time was greater; this increase was more evident for *same* judgments than *different* ones.

TABLE 1

SIGNIFICANT EFFECTS IN ANALYSIS OF VARIANCE ON MEAN REACTION TIMES FOR PROCEDURE OF PRESENTATION (FIXED, VARIED), PRACTICE, STIMULUS SIZE, AND TYPE OF RESPONSE (SAME OR DIFFERENT)

Source	*df*	*MS*	*F*
Between Subjects	23		
Procedure	1	1109.89	11.02*
Error	20	100.75	
Within Subjects	1512		
Practice	7	114.04	48.69*
Procedure × Practice	7	16.31	6.96*
Error	140	2.34	
Size	3	3664.99	460.25*
Procedure × Size	3	107.87	13.55*
Error	60	7.96	
Practice × Size	21	6.38	6.14*
Procedure × Practice × Size	21	2.71	2.61*
Error	420	1.04	
Response	1	794.68	132.58*
Procedure × Response	1	34.45	5.75†
Stimulus × Response	1	102.56	17.11*
	20	5.99	
Size × Response	3	78.85	47.41*
Stimulus × Size × Response	3	31.21	18.77*
Error	60	1.66	

*$p < .001$. †$p < .05$.

[2]Data are on file in Document NAPS-04560. Remit $7.75 for photocopy or $4.00 for fiche to Microfiche Publications, POB 3513, Grand Central Station, New York, NY 10017.

DISCUSSION

The present experiment shows the usual finding of faster reaction times for *same* than *different* responses. Whereas Krueger (1984) attributed the discrepancy to a self-termination factor, the present experimental arrangement forced the subject toward an exhaustive matching of memory and comparison sets. That is, self-termination need not be a determining factor at a micro-molecular level of analysis, at least in normal matching situations.

On the other hand, the interaction between type of stimulus and type of response should probably be interpreted as the result of the different codes brought into play for the comparison process. Whereas letter items are compared on the bases of physical and/or phonological characteristics, words add meaning to these two dimensions. Meaning allows matching to be carried out more on a global basis than do stimuli lacking meaning, such as letters. The smaller discrepancy associated with well learned sets (fixed-set procedure) in comparison with changing trial-by-trial sets (varied-set procedure) should be interpreted along similar lines. This difference has to do with learning and the automatization of the comparison code which allows the subject at the fixed-set procedure to carry out global comparisons on both kinds of trials (Yes-No) more efficiently.

Data on mixed trials suggest a rechecking mechanism (Krueger, 1984). Given that at set sizes 3 and 4, trials with mixed "yes" and "no" comparisons are slower than trials in which all comparisons are 'same' or 'different,' this difference must be interpreted as the attempt on the part of the subject to make sure that he has adequately counted the number of common elements as required by the task in spite of instruction not to do so.

REFERENCES

ALGARABEL, S., & SANMARTIN, J. (1985) Baspal: descripción de la base computarizada de palabras de la Universidad de Valencia. *Psicológica*, 6, 189-200.

JUILLAND, A., & CHANG-RODGIGUEZ, E. (1964) *Frequency dictionary of Spanish words.* London: Mouton.

KRUEGER, L. E. (1983) Probing Proctor's priming principle: the effect of simultaneous and sequential presentation on *same-different* judgments. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 9, 511-523.

KRUEGER, L. E. (1984) Self-termination in same-different judgments: multiletter comparison with simultaneous and sequential presentation. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 10, 271-284.

PROCTOR, R. W. (1981) A unified theory for matching-task phenomena. *Psychological Review*, 88, 291-326.

REED, S. K. (1973) *Psychological process in pattern recognition.* New York: Academic Press.

SOLER, M. J., & ALGARABEL, S. (in press) Same-different discrepancy in an exhaustive matching task. *Bulletin of Psychonomic Society.*

STERNBERG, S. (1975) Memory scanning: new findings and current controversies. *Quarterly Journal of Experimental Psychology*, 27, 1-32.

TAYLOR, D. A. (1976) Effect of identity in the multiletter matching task. *Journal of Experimental Psychology: Human Perception and Performance*, 2, 417-428.

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