Two-digit numbers in paired-associates learning¹

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Sixty Ss learned a paired-associates list in which two-digit numbers served as stimulus and response members. Nonrelated paired-numbers were most difficult to learn, pairs that contained zeros and fives were of intermediate difficulty, while pairs that contained stimulus and response reversals and pairs repeating one of the stimulus digits on the response side were easiest to learn. Suggestions were made for the construction of lists using two-digit numbers.

Investigators since Ebbinghaus (1885) have used various forms of nonsense syllable material. Most representative of this material are the consonant-vowel-consonant (CVC) combinations (see Noble, 1961; Underwood & Schulz, 1960). Besides determining the meaningfulness of CVC combinations, investigators have established association values for single-letters, two-letter combinations, monosyllables, bisyllables, trisyllables and words.

Less information is available to the investigator planning a study in which numbers are to be used as stimulus and response elements. Association values for the numbers 0-100 have been reported by Battig & Spera (1962). But guidelines to the preparation of paired S-R lists, of the kind Hilgard (1951) proposed for nonsense syllables, have not been devised for numbers. Silverstein & McCreary (1964), recognized the necessity for control of stimulus and response properties in a paired-associates (PA) study in which two-digit numbers served as stimuli and nonsense syllables served as responses. The following restrictions were made upon the numbers used; no first or second digits were repeated, no fives or zeros were used and no number was the reverse of any other number.

The present study tested the importance of the restrictions imposed by Silverstein and McCreary in the selection of two-digit numbers for use as both stimulus and response members of a PA list.

Method

Sixty undergraduates were tested as a group. Four paired-numbers were used in each of four treatment conditions: (1) the response number was a "reversal" of the stimulus number, namely, 54-45, 26-62, 43-34, 87-78; (2) the numbers included a "0 or 5" as the second digit of either number of the pair: 90-25, 85-30, 40-65, 70-95; (3) one of the stimulus "digits was repeated" on the response side: 53-13, 96-46, 21-27, 19-14, and (4) "no evident relation" existed between the stimulus and response members: 89-42, 86-93, 64-31, 18-37.

The numbers, chosen from Battig & Spera (1962), ranged from .72-3.06 association value. The mean

association values of both the stimulus items and the response items was 1.67. Association values for PA within each treatment and between each condition was controlled as closely as possible, the mean values for stimulus and response being: Reversals, 1.17-1.41; Zero and Five, 1.75-2.21; Digits Repeated, 1.93-1.99; and No Relation, 1.84-1.09.

The paired-numbers were presented aurally by a tape-recorder. The blocking method (Lockhead, 1961), was followed. There were six alternating study (both the stimulus and response members of the paired-numbers presented) and recall trials (stimulus members presented alone). Six randomizations of the position of items on both study and recall trials were made to prevent serial learning. The paired-numbers were read in a monotone approximately 2 sec. apart during the study periods while the stimulus words were spoken at 5 sec. intervals during recall trials. No intertrial interval was provided. Ss recorded their responses on a six page booklet; each page representing one trial. The letters, A-P, appeared in a column along the edge of each page indicating where responses were to be written. To aid the recording of responses the guide letter was read aloud immediately before the presentation of each stimulus during the recall trials.

Results and Discussion

The mean and standard deviation for each treatment is shown in Table 1. An analysis of variance for repeated measures indicated that Treatments had a significant effect ($F=61.47$, $df=3/177$, $p<.001$). The Newman-Keuls, a posteriori test of the difference between means (see Winer, 1962, p. 80), showed that the treatments, Reversals and Digits Repeated, did not differ from each other but did not differ from treatments, Zero and Five and No Relation. The latter two treatments also differed from each other ($p<.01$). In other words, each condition differed from every other with the exception of Reversals and Digits Repeated. The fact that Reversals and Digits Repeated did not differ may be explained by the similarity in structure between these two treatment condi-

Table 1. Mean Number of Correct Recalls for the Four Treatment Conditions

Treatments	Mean	SD
Reversals	13.5	5.07
Digits Repeated	13.9	4.59
Zero and Five	8.8	4.39
No Relation	6.5	3.56

tions. In both cases at least one number is identical on the stimulus and response sides of the PA which may arouse similar mediational processes and equate the ease in learning.

From an examination of these results it appears that the restrictions upon selection of numbers for PA tasks proposed by Silverstein & McCreary are good ones. If an investigator wishes to avoid inequalities of learning among paired-numbers he must avoid mixing these different conditions of pairing.

References

- Battig, W. F., & Spera, A. J. Rated association values of numbers from 0 - 100. *J. verbal Learn. verbal Behav.*, 1962, 1, 200-202.
- Ebbinghaus, H. *Ueber das Gedächtnis*. Leipzig: Duncker & Hum-bolt, 1885. (Trans. as *Memory: a contribution to experimental psychology* by H. A. Ruger and C. E. Bussenius. New York: Teachers College, Columbia University, 1913.)
- Hilgard, E. R. Methods and procedures in the study of learning. In S. S. Stevens (Ed.), *Handbook of experimental psychology*. New York: Wiley, 1951. Pp. 517-567.
- Lockhead, G. R. Methods of presenting paired associates. *J. verbal Learn. verbal Behav.*, 1962, 1, 62-65.
- Noble, C. E. Measurements of association value (*a*), rated associations (*a'*), and scaled meaningfulness (*m*) for the 2100 CVC combinations of the English alphabet. *Psychol. Rep.*, 1961, Monograph Supplement 3-V8.
- Silverstein, A., & McCreary, C. Acquired word value and verbal learning. *Psychol. Rep.*, 1964, 14, 499-504.
- Underwood, B. J., & Schulz, R. W. *Meaningfulness and verbal learning*. Chicago: Lippincott, 1960.
- Winer, B. J. *Statistical principles in experimental design*. New York: McGraw-Hill, 1962.

Note

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