Serial CVC learning with varied $\underline{m}'$ but equal $\underline{a}$ values¹

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Two investigations were conducted on 140 Ss from widely-separated college populations to test the hypothesis that speed of acquisition in the serial verbal learning of consonant-vowel-consonant (CVC) material is a positive function of scaled meaningfulness ($\underline{m}'$), even when the association values ($\underline{a}$) of the lists are held constant. Appropriate norms for the relevant scale values were drawn independently from the two geographical regions. Contrary to popular belief that $\underline{m}'$ and $\underline{a}$ are either identical or proportional measures, both experiments were consistent with the hypothesis as derived from Noble's curvilinear principle. It is thus a replicable fact that the memorization of CVCs selected from the high ends of the two scales depends more upon $\underline{m}'$ than upon $\underline{a}$.

The history of research on the roles of meaningfulness, association value, and related variables in verbal learning is available elsewhere (Noble, 1952; Noble, 1961a; Noble, 1963; Underwood & Schulz, 1960) so it need not be summarized here. Suffice it to say that, although the problem of controlling sources of variance among verbal stimuli began with Ebbinghaus, it is still very much with us. The task of discovering the basic laws of verbal learning and performance requires careful analysis of the quantitative properties of the independent variables. Yet there are those who disregard the operational distinctions between $\underline{m}'$ -value (standard-score transformation of 5-category comparative judgments of Ss' number of associations to a given CVC) and $\underline{a}$ -value (relative frequency of Ss who report at least one association to the CVC). In spite of two independent studies which demonstrated that $\underline{a}$ and $\underline{m}'$ are neither equivalent by definition nor linear in regression (Noble, Stockwell, & Pryer, 1957; Noble, 1961a), there still exists a common opinion among psychologists that these two concepts are interchangeable. Nor is the misunderstanding confined to introductory textbooks. It has even clouded the writings of research specialists (Underwood & Schulz, 1960; Archer, 1961), as one of us has occasionally remarked (Noble, 1961a; Noble, 1961b; Noble, 1962; Noble, 1963). Indeed, the senior author has consistently argued for the superiority of meaningfulness scales over association-value indices, and has hypothesized that learning scores depend more on $\underline{m}'$ than on $\underline{a}$.

History aside, perhaps the old-fashioned *experimentum crucis* approach will clear the air. Specifically, from the empirical fact that $\underline{a}$ is a sigmoidal function of $\underline{m}'$, which for the full range of CVCs is essentially flat in the upper register (cf. Noble, 1961a, p. 510), it follows that a certain range of $\underline{m}'$ -values may be

selected whose $\underline{a}$ -values are approximately equal. By judiciously varying $\underline{m}'$ for different groups while holding $\underline{a}$ constant, we reasoned that a critical test of the following hypothesis should be possible; viz., that rate of acquisition in serial CVC learning is a positive function of $\underline{m}'$ even when $\underline{a}$, its normal correlate, is experimentally neutralized. Two experiments were designed to determine the truth or falsity of this hypothesis.

Method

In Experiment I 50 University of Montana Ss were assigned equally and without bias to 5 lists of 10 CVCs each. Based on the Montana norms (Noble, 1961a), the mean $\underline{m}'$ -values were 3.31, 3.59, 3.84, 4.09, and 4.37; mean $\underline{a}=1.00$. Item order was random except that no letter was used more than 5 times in any list, no letter appeared more than 3 times in adjacent items in any list, no adjacent items formed a familiar phrase or hyphenated word, and each item occurred once in every serial position. Following standard instructions pertaining to the pronunciation-anticipation technique, all Ss received 20 trials by the correction method. Trial 1 was for familiarization; Ss began anticipating on Trial 2. The apparatus was a Patterson memory drum which exposed each item for 1 sec., followed by a shutter closure of 1 sec. The intertrial interval was 5 sec., measured between offset of the last item to onset of the cue symbol.

In Experiment II 90 University of Georgia Ss were assigned equally and without bias to 3 lists of 10 CVCs each. Based upon unpublished Georgia norms drawn from 200 different Ss, the mean $\underline{m}'$ -values were 2.33, 2.79, and 3.36; mean $\underline{a}=.997$. All other procedural details of Experiment II were exactly the same as Experiment I, except that a Stowe memory drum was used.

Fig. 1. Acquisition curves for 5 lists of CVCs in Exp. I as a function of $\underline{m}'$. Each curve contains 10 Ss.

Fig. 2. Acquisition curves for 3 lists of CVCs in Exp. II as a function of $\bar{m}'$. Each curve contains 30 Ss.

Results

The data of Experiment I are presented in Fig. 1, where it can be seen that there is a clear rank-order agreement between rate of acquisition and $\bar{m}'$ -value for the 5 groups. The data of Experiment II are shown in Fig. 2, confirming the first study for 3 groups drawn from a geographically disparate population with different norms.

Considering the preexperimental hypothesis under evaluation and the metrical nature of the data in Experiments I and II, an appropriate statistical test is that of Jonckheere (1954). In the usual analysis-of-variance test for 3 or more groups, the F-ratio is not sensitive to the rank order of the group means. Furthermore, the unit of measurement may not be constant throughout the scale of the dependent variable. What is needed in the present study is a distribution-free or nonparametric comparison of (1) our positive hypothesis that various levels of $\bar{m}'$ will produce a particular ordering of the groups' frequency distributions for total correct responses with (2) the null hypothesis that such distributions will differ only randomly; i.e., that the several groups within each experiment might have been drawn from the same population as far as their cumulative acquisition scores are concerned.

Applying Jonckheere's Test to the data of Experiment I, we computed an S-statistic of 322, which is sufficient to reject the null hypothesis ($p < .01$). Similarly, the data of Experiment II yielded an S-statistic of 980, which is also significant ($p < .01$). The rank-difference correlation coefficient (ρ) between predicted and obtained performances was 1.00 in both experiments.

Discussion

It is evident from the graphical analyses (Figs. 1 & 2) and the two statistical tests that speed of acquisition in the serial verbal learning of CVC material is a positive function of $\bar{m}'$. With respect to control variables,

we held constant the mean $\bar{a}$ -value of all lists in each experiment, so association value cannot be used in lieu of scaled meaningfulness to forecast the learnability of CVCs within this range. The suggestion has also been made (Underwood & Schulz, 1960) that rated pronounciability may be a more fundamental variable than $\bar{m}'$, but it is now known that pronounciability can statistically be removed from certain interrelationships by partial correlation methods without affecting the $\bar{m}'$ contribution (Noble, 1962; Noble, 1963). Just to make sure, we drew independent samples of 100 Ss each from the Montana and Georgia populations and administered the pronounciability schedule for 100 full-range CVCs according to the Underwood-Schulz procedure (1960, pp. 23-24). Despite high intergroup reliability coefficients ($\geq .98$), mean rated pronounciability for the relevant items correlated less strongly with the ranked acquisition data than did $\bar{m}'$. For Experiment I, $\rho = -.90$; for Experiment II, $\rho = -.50$. Since higher proportions of variance were accounted for by $\bar{m}'$ in all cases, we conclude that neither pronounciability nor association value is more effective in predicting ease of memorization than is scaled meaningfulness. Our hypothesis is sustained.

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Note

1. This report was prepared by the senior author with support from the Office of Naval Research under Contracts Nonr-2960(01) and 3677(02). Reproduction in whole or in part is permitted for any purpose of the United States Government. Experiment I is based on a master's thesis performed by F. A. S. under the guidance of C. E. N. at the University of Montana in 1964. Experiment II was conducted by H. R. J. and C. E. N. at the University of Georgia in 1965.