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To obtain an a priori estimate of natural language mediators (NLM's) 320 pairs of words with the consonant-vowel-consonant-pattern (CVC's) were broken into four series of 90 pairs and presented to 240 male and female undergraduates. Pairs were shown for 15 seconds while the subjects wrote down any associative device or NLM they could generate that would link both items in the pair. The association value (AV) of pairs varied between pairs. The proportion of subjects able to make an association was the associability value (AS). Results indicated that AS and AV were correlated although AS varied among pairs with items about equal in AV. Experiments run after the AS scale was obtained demonstrated that AS was valuable as a predictor of learning rate. In addition, AS values were highly correlated with the frequency of NLM's in the post-experiment reports. It was concluded that the AS measure represents a valuable addition to our understanding of the complexity of verbal learning. Seven tables provide data. (Author/RP)

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THE ASSOCIABILITY OF CVC PAIRS

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RESEARCH REPORT

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RESEARCH REPORT

ASSOCIABILITY OF CVC PAIRS

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Abstract

In prior experiments subject-generated associative devices or natural language mediators (NLMs) linking pairs of items have been shown to faciliate acquisition of paired associates. Since Ss are questioned about NLMs after learning, such reports may be a result of the questioning. Therefore, to obtain an a priori estimate of NLM probability this research was undertaken. Several hundred pairs, each composed of CVCs of about equal association value (AV), were shown for 15 sec. while Ss wrote down any NLM they could generate which linked both the stimulus and response. The AV level was varied between pairs. The proportion of Ss able to generate a NLM is the associability value (AS). As expected, AS and AV are correlated although AS varies considerably among pairs composed of items about equal in AV. Experiments run after the AS scale was obtained demonstrated that AS is valuable as a predictor of learning rate. In addition, AS values were highly correlated with the frequency of NLMs in post-experiment reports. It was concluded that the AS measure represents a valuable addition to our understanding of the complexity of verbal learning.

The Associability of CVC Pairs[1]

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Associability Norms

Meaningfulness of verbal material has been recognized as an important variable in paired-associate (PA) verbal learning and retention since Ebbinghaus' pioneering work in 1885. In fact, meaningfulness has been found to be the most powerful variable influencing speed of acquisition in verbal learning and has been the subject of a considerable amount of research in recent years. Simply, the effect of meaningfulness on learning rate can be seen in PA learning experiments where a pair like RIQ-KIV takes considerably longer to learn than a pair like TEL-COM. Since TEL and COM are items to which subjects (Ss) can give a relatively high number of associations we say they are more meaningful. Meaningfulness, or association value (AV), defined either in terms of the number of associations given in a limited time period, or the proportion of Ss giving an association to each verbal unit, has proved effective in influencing the rate of learning in many experiments (Goss and Nodine, 1965; Underwood and Schulz, 1960).

Although there is no doubt that meaningfulness is a major variable, a number of results indicate that it cannot account for all the important phenomena. For example, in a number of experiments involved in the recent controversy over "one-trial" or "all-or-none" learning, the rate of learning for pairs of equivalent meaningfulness differed considerably (Underwood and Keppel, 1962). This difference between pairs cannot be

based in any simple fashion upon meaningfulness since all pairs were originally equated on this dimension.

In several recent experiments, during post-experiment questioning, Ss reported using various means such as sentences or words to associate or link items together. The ubiquity of such reports by our Ss, and by other experimenters' Ss (e.g., Bugelski, 1962; Clark, Lansford and Dallenbach, 1960; Runquist and Farley, 1964; Underwood, 1964, 1965; Underwood and Schulz, 1960) points to the need for systematic investigation of this mediation. From the reports it can be seen that Ss use various means of learning the pairs, and in addition, certain pairings are easier because Ss find them easier to associate. A single word may be used to link two items, or a phrase or sentence may be generated which includes the items. At other times Ss may learn a pair by recognizing that the items sound alike when pronounced or they may encode (transform) the items into words. We refer to these techniques as natural language mediators (NLMs) and have found that they are important in learning and recall (Adams and Montague, 1967; Kiess and Montague, 1965; Montague, Adams and Kiess, 1966; Montague and Wearing, 1967a, 1967b). This research has shown that S-generated associations between items, not the meaningfulness of individual items per se, produce superior retention in comparison to instances where such associations are not present. Unfortunately, our knowledge about NLMs is generally by means of an interview or questionnaire given upon completion of the experiment, asking Ss how they went about learning each pair. Subjective reports of this kind are suspect. It is possible that Ss construct answers to "please" the experimenter in accord with the demand characteristics of the experiment (Orne, 1962) so that the NLMs reported

might not be accurate descriptions of what is learned. It is possible that some or all NLMs are not causal in learning, but may just be a correlate of the learning process (Adams, 1967). To ascertain their status in the associative process it is necessary that the probability of a NLM be manipulated independently of other variables known to affect learning rate. Therefore, some independent measure of the probability or likelihood of NLMs is necessary. Such a measure could be systematically manipulated to ascertain its relationship with other important variables and increase our understanding of verbal learning.

Undoubtedly, items high in AV should be easier to link than those of low AV. Richardson and Erlebacher (1958) hypothesized that items high in AV have more associations and these associations can be used somehow to facilitate linking such pairs compared to pairs of lower AV. Their Ss' ratings of pairs generally agreed with the hypothesis. However, it is our contention that AV and ease of linking or associability, although correlated, are conceptually different and that this difference needs examination. Pairs of items of a given level of AV are liable to differ considerably in associability, and thereby, in ease of learning. To support these contentions we obtained quantitative estimates of the ease of associating various types of item pairs. We first attempted to determine the frequency with which Ss form associative connections between item pairs of different AV levels. The proportion of Ss generating a NLM for each pair is the scale value of associability (AS). After the AS scale was obtained several experiments were undertaken to examine the effect of variation in AS on learning rate and retention. In addition, a subsequent scaling was undertaken to ascertain the role of stimulus and response AV in AS value, and to relate AS value to

the measures obtained by Richardson and Erlebacher (1958). In their study, Richardson and Erlebacher took pairs of words, CVCs, and consonant syllables of different levels of AV and had Ss rate them for ease of learning (EL, an estimate of how fast S could learn the pair) and common meaning (CM, degree to which pair items denoted the same meaning). These scale values should be related to the AS scale.

Three scalings of separate sets of items were done (designated AS-1, AS-2, AS-3), which differed only in the sets of items used. The scaling procedures described for AS-1 will apply also for AS-2 and AS-3.

Associability 1

Method

Materials. Three hundred and twenty pairs of CVCs were selected from Archer's norms (1960). Each pair was composed of items approximately equal in AV. Eighty pairs were constructed from the 160 lowest AV items on the norms. Similarly, eighty pairs were constructed from the 160 highest AV items, which are mostly three letter words. Two other blocks of 160 items from above and below the middle of the norms were used to form two more sets of 80 pairs yielding 320 pairs in all. Within each block of 160 items, 40 pairs were formed from the 80 items with the lower AV and 40 from the higher AV items to ensure that the AV of both items in the pair was approximately equal. Within these constraints the pairings were random. The AV ranges for the four sets of 80 pairs were: low = 2 - 13%; low-middle = 38 - 47%; high-middle = 66 - 76%; and high = 99 - 100%.

Four series of 80 pairs each were constructed. For each series an equal number of pairs (N = 20) were selected randomly from each of the four AV levels and dispersed at random throughout the series. These series

were used to counterbalance order effects in presentation. In addition, 40 pairs were selected at random (10 from each level of AV) to be used to check the reliability of the ratings. Ten of these pairs were added to each series rather than presenting them in a block. However, no pair appeared twice within a series. The final series used were thus 90 pairs long.

Subjects. The Ss were 240 male and female undergraduate volunteers from the University of Illinois who were paid for their participation. Equal numbers of males and females were run.

Procedure. Four different presentation orders of the four 90-pair series were given to subgroups of 30 Ss each by means of a 4 X 4 Latin square. The rows of a square were subgroups of Ss and the columns represent the order of presentation of the four series. Order of pairs within a series was the same for all Ss. The square was run twice, once for males and once for females. Each pair was presented by a projector for 15 seconds. Between the 1st and 2nd, and the 3rd and 4th series there was a short rest period of about 2 minutes, and at the end of the second series there was a 5-minute rest.

Subjects were asked to write the first associative device, if any, that a pair suggested to them in an answer booklet with numbered spaces for 10 responses on each page. Instructions gave examples of associations for both high and low AV pairs. Emphasis was placed on forming an association to both of the items in the pair, and not just one of the members. Subjects were informed that they were not expected to have associations for every pair and if they had no association to leave the response space blank. Following the instructions, a series of 10 practice slides composed of pairs of varying levels of AV was given. The Ss were permitted to ask questions

about the procedure after the practice series. In order to aid Ss in keeping their place in the booklet another slide projector showed the ordinal number of each pair in the series.

Associability 2

In this scaling the primary intent was to obtain a wider range of pairs which would be suitable for future experimentation. Therefore, rather than pairing items randomly, we constructed pairs with minimal inter-item similarity.

Method

Materials. Three hundred and twenty pairs of CVCs were constructed from Archer's norms (1960). As in AS-1, within-pair AV was approximately equal. Seventy pairs were constructed from CVCs at each of the same four levels of AV used in AS-1. However, the pairing of items was not random. Pairs were constructed with no consonants and wherever possible no vowels in common. In only two instances was it necessary to repeat a vowel. Ten pairs at each level of AV were taken from AS-1, added to the list, and were used to determine between groups reliability for the AS values. In addition, as in AS-1, 10 items were chosen from each AV level to be given twice to obtain test-retest reliability. Therefore, four series of 90 pairs were constructed in the same fashion as those in AS-1.

Subjects. The Ss were 120 male and 120 female undergraduates who were paid for their participation.

Procedure. The procedures used for counterbalancing the series and presenting the items were identical to those used in AS-1.

Associability 3

Several purposes motivated a third scaling. First, it seemed necessary to compare the AS scale with the Ease of Learning (EL) and Common Meaning (CM) scales developed by Richardson and Erlebacher (1958). Second, pairs were included with S-R order reversed to determine whether AS would change appreciably. This was an attempt to see if the AS values are bidirectional. Third, sets of pairs of unequal item AV were included to explore the importance of stimulus and response AV in determining AS.

Method

Materials. A total of 320 pairs of CVCs were selected from a variety of sources. The types and number of pairs for each type used are listed in Table 1.

Four series of 80 pairs were constructed with an equal number of pairs from each type included in each. In addition, 10 pairs from each series were selected and used to measure test-retest reliability. Ten of these were added to each series making each series 90 pairs long. No pair appeared twice within a series.

Insert Table 1 about here

Procedure. The procedure was identical with that for AS-1 and AS-2.

Subjects. The 320 pairs were rated by 120 male and 120 female undergraduates from the University of Illinois who did not participate in the other scalings. They were paid for their time.

Results of AS-1 and AS-2

For each of the pairs of S's response was categorized as indicating that he generated a NLM for the pair or not. If S reported any device linking the items, such as noting letter or sound similarities, constructing single meaningful words by manipulating all or just a few of the letters, or using the items in a meaningful phrase or sentence, it was scored as a NLM. Reports of no associations, construction of nonsense polysyllables, and omissions were placed in the other category.

Before assessing the relationship between the scalings, and between AS and AV, it is necessary to examine the effect of two relevant variables: sex and sequence or practice effects. For each S the proportion of pairs on which associations were reported was calculated for each of the four series of 90 pairs. In analyzing data from both AS-1 and AS-2 these scores were entered into a Latin square analysis of variance (ANOVA) with sex, subgroup, ordinal position of the 90-pair series, and the different series themselves as factors (Winer, 1962, pp. 554-563). A pooled within-Ss error term was used. In both scalings females gave significantly more associations than males, AS-1: means of 59 and 54%; $F(1, 232) = 80.14$, and AS-2: means of 55 and 50%; $F(1, 232) = 66.18$. In AS-1 and AS-2 there was a significant decline in the proportion of associations given over the four series of 90 pairs, AS-1: $F(3, 708) = 56.01$, and AS-2: $F(3, 708) = 2.64$. The mean AS-1 scores as a function of the order of the series for males were .58, .54, .53, and .52 while those for females was .64, .60, .59 and .58. The AS-2 scores were very similar.

Intercorrelations between AS values of each item for males and females were high for both AS-1 and AS-2 as is shown in the lower right

cells of Table 2. The correlations between AS values for the sexes within

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Insert Table 2 about here

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levels of AV shown in Table 2 are somewhat lower.

Correlations between mean AV (i.e., average of stimulus and response AV), MAS, and FAS within levels of AV were low and insignificant for both AS-1 and AS-2. Table 2 shows the correlation coefficients between AV, MAS and FAS for pairs of different AV levels. Taken over all four levels of AV the correlation was significant both for MAS and FAS but accounted for only about 5-8% of the variance in AS-1. As can be seen in the table, the coefficients in AS-2 were considerably higher accounting for nearly 50% of the variance. The reason(s) for this difference is unknown.

The test-retest reliability coefficients obtained by repeating 40 pairs were high, $r_{12} = .98$ for both MAS and FAS in both AS-1 and AS-2. There were 40 pairs common to AS-1 and AS-2, their scale values correlated significantly ($r = .98$) for both MAS and FAS. Therefore, the scalings are quite comparable and the pairs from the two scalings were combined and are presented together with similar pairs from AS-3 in Table 3.

Table 3 contains the main results: the 320 pairs from AS-1, 280 different pairs from AS-2, and 129^3 pairs from AS-3. Table 3 is organized by increasing mean AS for 120 males and 120 females. For each pair, the scaling number (i.e., AS-1, AS-2 or AS-3), Archer's AV for both the stimulus and response, the MAS, FAS, and mean AS are shown. The AS scores are percentages of 120 Ss in the case of MAS and FAS, and 240 Ss

for the combined mean value. For those items from AS-1 repeated in the subsequent scalings the proportions are based on AS-1 Ss only. On 78%

Insert Table 3 here

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of the pairs in Table 3 FAS exceeds MAS and the mean difference is 4.9% (S.D. = 5.9%). Therefore, pairs where MAS scores are equal to (4%) or exceed (18%), FAS scores are unusual and should perhaps be avoided for use in groups mixed as to sex.

Results AS-3

The scoring of data for AS-3 was the same as that for the other scalings. Again, for each item an AS score was computed separately for males and females and for each S a mean AS score was calculated for each of the four series. These scores were entered into the Latin square ANOVA with sex, subgroups of Ss, sequence of series and the series as factors. Significant sex, $F(1, 232) = 32.95$; subgroups, $F(3, 232) = 49.70$; and sex by subgroup interaction, $F(3, 232) = 13.37$, effects were found. As had been the case in AS-1 and AS-2 females again gave more associations than males (means .55, .49). Although there was a trend toward fewer associations in the later series, it was insignificant, $F(3, 708) = 1.89$.

Over all types of items the intercorrelations of MAS and FAS were generally high, ranging between r = .74 and .96. The test-retest reliability was high for the items given twice in this scaling, r_{12} = .98 and .99 for MAS and FAS respectively.

The intercorrelation of AS values for the 40 pairs common to AS-1 and AS-3 were very high for both males and females, r = .97 and .96 respectively. The AS scores of the 40 common pairs were used in an ANOVA

for each sex separately. There was no significant difference between mean AS value for the items in AS-1 and AS-3 for MAS, $F(1, 78) = 1.32$, or FAS, $F < 1$. Therefore, the two scalings seem to be comparable. For this reason items composed of CVCs of about equal AV (i.e., types H-H and L-L) were included in Table 3 in the position determined by mean AS.

The 80 RS pairs were those scaled in AS-1, reversed in order, and rescaled in AS-3. Correlations of the AS-1 and AS-3 scales for these pairs for both MAS and FAS are high. For MAS the correlation was .94 and for FAS .93. ANOVAs comparing the AS-3 values against the corresponding AS-1 values showed for both males and females that the AS of a pair remained the same regardless of the order of the stimulus and response items, $F(1, 159) < 1$ for both FAS and MAS. Since the AS values are comparable from the two scalings these pairs have been included in Table 3 in their proper order according to mean AS.

The H-L and L-H pairs had unequal stimulus and response AV. However, the average AV (of the stimulus and response) for these pairs was about equal for both types. These items were scaled for AS to determine whether the stimulus or response is more important in forming an association. Table 4 shows these pairs, their AV, and MAS, and FAS values. ANOVA showed that although the mean AS value was higher for females, $F(1, 232) = 6.31$, it did not differ between the pair types, $F < 1$.

Insert Table 4 about here

For the H-L pairs AS was significantly ($p < .01$) although not strongly correlated with stimulus AV (.39 for MAS, .35 for FAS). Response AV was

not significantly related to AS value (.20 for MAS, .13 for FAS). On the other hand, for the L-H pairs response AV was significantly ($p < .05$) but not strongly related to AS ($r = .22$ and .25 for MAS and FAS) while the relation between stimulus AV and AS was approximately zero (.08 for MAS, .15 for FAS). The AS score is, therefore, more closely related to the item of a pair higher in AV, but this relationship does not account for a large part of the variance.

The RE pairs, taken from Richardson's and Erlebacher's lists (1958), their stimulus and response AV, their EL, CM, FAS, and MAS values are shown in Table 5. Goss and Nodine (1965, pp. 260-267) selected these items for an experiment. In their experiment the intent was to test

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Insert Table 5 about here

Richardson's and Erlebacher's proposal that learning rate for PAs might be due to the strength of association between pair items rather than the meaningfulness of the items per se. Pairs contained all combinations of either high or low stimulus or response AV and were of relatively low or high EL (ease of learning) or CM (common meaning) as scaled by Richardson and Erlebacher. Their results gave some support to Richardson's and Erlebacher's suggestion about the importance of the relationship between pairs in determining learning rate. The ANOVA showed a strong relationship between EL and performance but a subsequent correlational analysis, partialling out the effects of AV, EL, and CM, revealed AV to be more important. The correlation coefficients between our AS value, EL and CM values for the pairs are quite high (FAS vs EL: .83; FAS vs CM: .83; MAS vs EL:

.81; MAS vs CM: .86) leading to the conclusion that these scales measure very similar, if not the same, factors. Experiments to be described will explore the relationship between AS and performance further.

Discussion

The major results of the scalings are a pool of equal AV CVC pairs with a reliable difference in AS values between the sexes and a clearly defined relation between the AS scale and the EL and CM scale derived by Richardson and Erlebacher (1958).

The AS scale is reliable upon repeated measurements within (test-retest reliability) and between large groups of Ss. Although considerable variation in AS scores exists between pairs of given level of AV there is, as expected, a significant relationship between AV and AS. However, at best, this relationship accounts for only about 40%-50% of the variance. This finding indicates that considerable differences may be observed in learning rate between pairs of the same AV level and this factor may account for differences in interpair difficulty.

The AS-3 scaling produced results somewhat at variance with data from learning experiments (Ekstrand, 1966). It was found that AS values for items reversed in order from AS-1 correlated very highly with their AS-1 values. The AS measure is bidirectional for pairs of homogeneous AV. Since many verbal learning experiments have shown the importance of stimulus and/or response AV in directionality of association (Goss and Nodine, 1965), it is difficult to interpret the meaning of this finding for PA research. The result is probably due to the task requirements of the scaling where Ss had both items in front of them and 15 sec. in which to respond. This contrasts markedly with experimental conditions where a response must be retrieved

from memory upon presentation of its stimulus item within a few seconds.

Relation of AS to Performance

In order to demonstrate the usefulness of the AS measure several experiments were conducted. The main purpose of these studies was to demonstrate reliable differences in learning rate or in recall as a function of variations in AS value independently of stimulus-response AV. The primary problem in implementing this research was the presence of the correlation between AS and AV. Orthogonal manipulation of the two variables is not possible as the AS distributions of pairs at the various AV levels show only partial overlap. Therefore, less direct procedures were used to examine the relationship between AS and learning.

Experiment I

In this experiment four mixed lists varying in mean AS but of approximately constant mean AV were constructed, given to four independent groups to learn, and were tested after 24 hours.

Method

Materials. Four 12-pair lists were constructed from among items scaled in AS-1. Each list contained three pairs from each level of AV, but different lists were constructed of items taken from either the high, high-middle, low-middle or low parts of the FAS distribution at each level of AV. The lists with their mean AV and FAS values are shown in Table 6. The mean AV values for the lists were all approximately 55 while the mean AS values for the four lists are 43, 55, 63, and 77.

Insert Table 6 about here

Procedure. Four independent groups of 16 Ss each learned one of the lists by Battig's (1965) modification of the recall or study-test method which he calls a "correction-adjusted-learning" procedure. On any trial, after every pair has been presented, the stimuli are each presented alone during a test trial. Then pairs for which S had recalled the correct response are dropped temporarily, incorrect pairs are re-presented and re-tested, and so on until all items have been correctly recalled once. Then another trial begins with the presentation of all pairs and their testing. The Ss learned to a criterion of 11 out of 12 correct on an initial test when all stimuli were presented. Pairs were presented for 2-sec. during the learning and stimuli were presented alone for 6-sec. during testing. Different random orders were given during learning and testing for all Ss over all trials. The groups were run on the University of Illinois' PLATO system (Bitzer, Lyman, and Easley, 1966). Each S sat at a booth with a TV display on which the instructions and pairs were presented. The S typed his response using one finger on a typewriter and all responses were automatically recorded.

Following criterion attainment, Ss were given a questionnaire in which each stimulus was presented alone for S to write the response and means of associating the pair. After this a final test was given and Ss were dismissed for 24 hours.

The recall session began with brief instructions reminding them of the testing procedures and then 5 test sequences were given in which each stimulus was presented for 6 seconds. Response items were never shown. After the 5th test sequence the questionnaire was given again and the Ss wrote the response, if they recalled it, and the means they had used to associate the pair, if they could recall that.

Subjects. The Ss were 64 paid volunteer undergraduates. Twelve females and four males were run in each group. Males were run in each group because females were not available.

Results

Acquisition. When using the corrected-adjusted-learning method a measure that most adequately reveals differences in rate of learning is the number of "exposures" to criterion averaged over pairs. An exposure is counted each time a pair is presented for learning. Different pairs may have differing numbers of exposures within a trial depending on how quickly the correct response is given within a trial. The number of exposures on Trial 1 and the total number of exposures to criterion for all groups are presented in Table 7. Means are shown for each AV level within each list. The expected difference in the number of exposures on Trial 1 or until criterion as a function of AS was not found by ANOVA. The AV, which was varied within each list and thereby within Ss, was inversely related to exposures on Trial 1, $F(3, 180) = 108.28$, and to criterion, $F(3, 180) = 82.48$.

Insert Table 7 about here

Table 7 shows that at all levels of AV, Group 4 has fewer exposures to criterion than any of the other groups. Groups 1, 2, and 3 overlap and do not differ. A post hoc comparison revealed that on the total number of exposures Group 4 differed reliably from Group 1, $F(1, 30) = 4.36$, $p < .05$. The groups did not differ on the number of trials to criterion, number correct on the criterion trial, or number correct on the post-questionnaire test. The questionnaire data taken at the conclusion of session 1 were divided into categories to ascertain if AS affected verbal reports given by Ss.

The categories employed were (a) natural language mediators (NLMs) defined as any learning method reported which transformed the pair into a word, phrase or sentence; (b) instances where the S reported he learned the pair by rote repetition or could report no associative device.

The proportion of NLMs per item given by each group out of the total possible is presented in Table 7. The proportion of NLMs given increased with both AS and AV, $F(3, 60) = 5.47$; $F(3, 180) = 31.67$, respectively, both $p < .01$.

Recall. There was a significant decrease in the number correct on the criterion trial and the number correct on the recall trial T_R, $F(1, 60) = 75.04$, but the groups did not differ ($F < 1$). Recall on the repeated test trials following T_R improved slightly but significantly, $F(4, 240) = 7.75$, $p < .01$, but again the groups did not differ ($F < 1$).

Discussion

The results provide only weak support for the validity of the AS scale. High and low AS groups (4 and 1) differed in number of exposures needed for acquisition but the difference was not large and the intermediate AS groups did not align themselves consistently as predicted. The finding concerning number of NLMs used is also anomalous, number of NLMs reported increased with AS but had no strong effect on acquisition rate.

The failure to find differences in recall among groups may be attributable to the use of the correction-adjusted-learning method. When employing a list criterion this procedure brings all items to about the same level of associative strength regardless of learning method reported (Montague and Kiess, 1966). Thus recall 24 hours after acquisition may be expected to be about equal for all groups.

Experiment 2

The primary purpose of this study was to obtain additional data from Ss run under the conditions of Groups 1 and 4 in the previous experiment. Since no differences in recall were found in Experiment 1, in this study only the acquisition data were obtained.

Method

Procedure. The procedures were the same as the acquisition phase of Experiment 1 except that Ss learned only the high or low AS lists. The two intermediate AS groups of Experiment 1 were not run.

Subjects. The Ss were 30 undergraduate females from the University of Illinois, naive to verbal learning experiments. Participation in the experiment was part of a course requirement and Ss were not paid. Fifteen Ss were run in each of the two groups.

Results

The mean total number of exposures to criterion, the mean number of exposures on Trial 1 and the mean number of NLMs per item are presented in Table 8. In the ANOVA, AS had no appreciable effect on Trial 1 or

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Insert Table 8 about here

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total number of exposures. Number of exposures did decrease, however, with increasing AV both on Trial 1 and to criterion, $F(3, 84) = 61.33$, $p < .01$; $F(3, 84) = 49.92$, $p < .01$, respectively. On Trial 1 there was also a significant AS by AV interaction, $F(3, 84) = 3.11$, $p < .05$. Number of NLMs given in the post-acquisition reports increased with both AS and AV, $F(1, 28) = 15.18$, $p < .01$; $F(3, 84) = 10.14$, $p < .01$ respectively.

Discussion

The significant difference in number of exposures to acquisition of low and high AS items found in Experiment 1 was not replicated in Experiment 2. The trend in both experiments follows that predicted by our hypothesis but the effect is not very strong. But in both experiments AS has a strong effect on number of NLMs given in the post-acquisition test. In view of other experimental evidence for performance variations due to NLMs (e. g., Dallett, 1964; Kiess and Montague, 1965; Underwood and Schulz, 1960, p. 297) why did we find AS effects only in reported NLMs and not in performance?

A plausible explanation of this difference between number of NLMs in Experiments 1 and 2, and rate of acquisition as a function of AS led to the third experiment. It is reasonable to assume that generation of a NLM in paired-associate learning is not instantaneous but requires a certain period of time. That is, time is required for the S to integrate the pairs into his established language structures (Mandler, 1967). It seems possible that the 2 sec. presentation interval employed was not long enough for the S to apply his language habits effectively to the materials to be learned on any one trial. It may have taken several trials for the S to form a NLM for a pair. Consequently, AS would have had little opportunity to affect rate of acquisition but may have influenced the number of NLMs reported at criterion. If this is the case, a longer presentation period should permit the S to effectively apply his language skills on the first trial and AS should affect rate of learning.

Experiment 3

The purpose of Experiment 3 was to investigate the effect of a lengthened presentation time on the speed of acquisition of low and high AS items. Experiment 3 was concerned only with acquisition and not with recall.

Method

Procedure. The method was the same as the acquisition phase of Experiment 1 and 2. Subjects were run only in the high and low AS groups and the pair presentation time was lengthened from 2 sec. to 5 sec. The recall time remained at 6 sec.

Materials. The items were the same as the low and high AS items of Experiment 1.

Subjects. The Ss were 54 undergraduate females who took part as a course requirement and Ss were not paid. Twenty-seven Ss were run in each of the two groups.

Results

The average total number of exposures to criterion, the average number of exposures on Trial 1, and the average number of NLMs per item are presented in Table 8. ANOVA revealed significant effects of both AS and AV on Trial 1 and total number of exposures. Number of exposures decreased with increasing AS both on Trial 1 and to criterion, $F(1, 52) = 9.27$, $p < .01$; $F(1, 52) = 5.17$, $p < .05$, respectively. Similar effects were found for increasing AV, $F(3, 156) = 93.73$, $p < .01$; $F(3, 156) = 89.54$, $p < .01$, respectively. The number of NLMs given increased with AS and AV, $F(1, 52) = 5.74$, $p < .05$; $F(3, 156) = 30.00$, $p < .01$, respectively.

Discussion

The results confirm the hypothesis that the generation and application of NLMs is a process which requires a certain period of time to operate. Bugelski (1960), Montague, Adams and Kiess (1966), and Kiess (in press) have found that time is an important variable in NLM formation. Rapid presentation rates may interfere with the encoding process so that the progress and process of learning is different from that for slower rates.

Experiment 4[4]

The purpose of this study was to examine the effect of AS on recall by partially replicating an experiment by Montague, Adams and Kiess (1966) using AS as an independent measure of NLM formation probability. In their study, pairs of high or low meaningfulness were presented to Ss once for a period of 15 or 30 sec. during which time S wrote down his NLM for the pair, if he had any. One day later, S was shown each stimulus and asked to recall the appropriate response and his NLM or other learning method. The reported use of NLMs was strongly associated with a high level of recall.

In the present study CVC pairs were either of high or relatively low AV and within each level of AV there were two levels of AS. It was expected that AS would be related to the number of NLMs used and thereby to the number of correct recalls independently of AV.

Method

Materials. Sixty pairs of CVCs were selected from Table 3. Thirty of the pairs contained items with a mean AV of 42 (range 38-47), while the other 30 items had a mean AV of 99 (range 99-100). Within each AV level were two levels of FAS, 15 pairs per level. Within low AV the FAS means were 37 (range 28-43) and 63 (range 52-78), and within high AV: 78 (range 61-86) and 96 (range 95-99). The 60 pairs were assigned randomly to 4 blocks of 15 with the restriction that no FAS level occurred more than 4 times per block. Sixteen different lists were constructed by varying the order of the blocks so that each block followed each other block exactly 4 times across lists. One novel sequence of blocks was used to test recall for all Ss.

Subjects. Forty-eight paid female undergraduates served as Ss.

Procedure. Groups of 10 to 16 Ss were run on the University's PLATO system (Bitzer et al, 1966). Subjects were instructed that 60 pairs would be presented once each for 15 sec., that they were to learn as many as possible during that trial and that their recall would be tested 24 hrs. later. A 5-cent bonus per correct recall was offered as an incentive to learn.

After a practice series (with letter pairs) used to familiarize them with computer controlled PA learning, the experimental list was presented. Subjects returned 24 hrs. later and recall was tested at the same presentation rate. To reduce variability in the data due to differences in typing skill, Ss were required to type with their preferred hand, hunt and peck fashion.

Results

Since AS and AV are correlated it was not possible to cross completely levels of both factors. Therefore, we used a Ss X levels ANOVA with repeated measures on the number of correct recalls for all four AS level means, and planned comparisons providing specific tests of the effect of AS with AV controlled. From the lowest AS level to the highest the mean number of recalls were .94, 1.77, 3.79 and 7.48. The overall effect was highly significant, $F(3, 141) = 119.74$, $p < .01$. The planned comparison between AS level means within low AV was significant also, $F(3, 47) = 4.93$, $p < .01$, as was the comparison of AS level means within high AV, $F(3, 47) = 96.71$, $p < .01$. A third orthogonal comparison provided a test of the interaction of AS and AV. The differences between the AS means for low and high AV were taken and tested (7.48 - 3.79) - (1.77 - .94). The difference between the AS level means was significantly larger at high AV than at low, $F(3, 47) = 29.0$, $p < .01$.[5]

Discussion

Not only was recall shown to be a function of AS value, but more importantly, recall varied as AS value within AV level. However, the significant interaction between AS and AV indicates that the relationship is not simple. The magnitude of the effect of AS seems to be dependent upon the level of AV. Other data from our laboratory (including Experiment 2 above) and those reported by Montague et al (1966) have shown similar trends. At low AV levels the effect of AS differences is much less than it is at high AV levels. The reason(s) for this finding are unknown. It seems likely that it may arise in the need for Ss to integrate the items into their verbal repertoires (Mandler, 1954). This process may involve considerable complexity in the form of transformations or encoding pair items before they can be associated. For low AV items many transformations or letter additions, etc., are necessary to make a meaningful word. Within a list of such pairs a large set of encoding rules might be used by a S. Therefore, for each pair at recall, S must remember how a response was encoded and how it was associated with the stimulus. It seems likely that the complexity of such encoding would differ only slightly between lists of pairs of low AV items differing in AS value. On the other hand, the much larger effect due to AS differences among pairs composed of high AV items may be produced by a relatively much larger difference in encoding complexity. For high AS pairs a single (or a very few) rule for generating NLMs may be used reducing the need to remember a rule for each pair. More rules for generating NLMs may be needed for the low AS pairs thereby raising the amount to be retained. Although we have no data bearing directly on the validity of this idea, recent research on encoding in free recall lends some support. Mueller, Edmonds and Evans (1967) report that the number of trigrams recalled by Ss is inversely related to the number of encoding rules used in learning.

Summary and Conclusions

The main objectives of the research were achieved. A reliable measure of the probability of NLM formation, AS, was scaled and it was found to be related both to learning rate and to the frequency of NLMs in post-acquisition reports.

In PA learning research it has long been fashionable to regard pair learning as a complicated analogue of conditioning where specifiable stimuli become discriminative cues for particular responses. The S is generally considered to be a passive vehicle for the demonstration of interference or transfer effects due to manipulations of stimulus and response similarity or meaningfulness. However, the fact that S searches his past language associations, transforms the items whenever necessary, and generates appropriate NLMs to link them may mask or confound variables of interest. For example, the relatively unique NLM formed for letter pairs may attenuate or eliminate interference from extra-experimental associations (Montague and Wearing, 1967b). Similarly, NLMs formed for pairs in an original list may protect those pairs from interference from an interpolated list (Adams and Montague, 1967).

A concerted, systematic attack on the problems posed by the ways in which Ss organize, structure or conceptualize the paired-associate task is long overdue. The present research, along with some discussed by Mandler (1967), has made a modest beginning in illuminating certain aspects of techniques Ss use to encode paired-associates. Furthermore, although a NLM may represent a S's unique encoding for a pair, the present data demonstrate that there is consistency across Ss in the likelihood of forming a NLM. It remains for further investigation to uncover variables determining this commonality among Ss and to investigate the full range of complexity of Ss' transformations of paired-associate lists.

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Footnotes

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3. One pair too few was included.

4. Alexander Wearing and Clinton Walker executed this study.

5. Recently, this experiment was replicated using an independent group of 61 Ss. Mean recall for the four AS levels was .85, 2.09, 5.82, and 9.21, values quite close to those obtained in experiment 4. Once again ANOVA revealed highly significant effects of AS within AV levels and a significant interaction between AV and AS.

Table 1

Types and Numbers of Pairs Used in AS-3

Code	N	Type of Pair
AS-1	40	Equal number of pairs were taken from each AV level used in AS-1 to be used to test inter-group reliability.
RE	28[1]	These pairs were scaled by Richardson & Erlebacher (1958).
RS	80	These were pairs scaled in AS-1 but with S and R terms reversed here to examine bidirectionality. Twenty pairs were selected from each AV level.
HL	60	Pairs with high stimulus AV (96-100) and low AV (13-22) response.
LH	59[1]	Pairs with low stimulus AV (13-22) and high AV (96-100) response.
H-H	25	Pairs with high AV stimuli and responses
L-L	24[1]	Pairs with low AV stimuli and responses

[1] pairs were lost because of clerical errors discovered after scaling.

Table 2

Correlations of Mean AV for the Pairs from AS-1 and AS-2 with MAS and FAS Values

Correlation	AV level: low	low-mid	high-mid	high	over all pairs
AS-1 AV-MAS	.17	.01	.01	.05	.23
AS-2 AV-MAS	.06	.09	-.04	.29	.69
AS-1 AV-FAS	.10	.10	.04	.04	.28
AS-2 AV-FAS	-.02	.06	.04	.17	.68
AS-1 MAS-FAS	.79	.85	.86	.88	.97
AS-2 MAS-FAS	.74	.85	.88	.89	.98

Table 3

Associability Value of Pairs of CVCs of Approximately Equal Association Value from Three Scalings Arranged in Terms of Increasing Mean AS Value

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
YUX	QEH	2	14	13	8	14	11
FEP	YOQ	3	14	14	10	13	11
GEX	ZIJ	2	9	4	8	16	12
YIV	QUW	2	7	13	9	16	13
XAF	JIH	2	8	13	8	18	13
ZIY	XIB	1	8	6	13	14	13
YIJ	XIH	1	3	2	10	17	13
YAV	ZUQ	2	9	12	13	14	13
XEQ	KUJ	2	6	7	12	15	13
YIX	HUJ	2	9	14	7	22	14
QOJ	ZUV	2	4	13	12	17	14
XAJ	VUQ	2	5	6	11	18	15
XUT	NEJ	2	8	15	11	18	15
GUC	PEV	2	47	46	5	23	15
XIJ	XUY	3	2	3	15	14	15
ZIY	TEJ	2	8	9	15	15	15
YIB	FEJ	2	16	11	12	18	15
XAL	FEP	2	12	14	13	18	15
ZEG	YIG	2	6	10	10	21	15
YOF	QAV	2	10	14	10	21	15
XOG	YUJ	3	9	9	13	18	15

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
XUJ	YEV	1	3	5	13	18	15
ZUJ	XAH	1	5	5	12	19	15
VIJ	QUG	2	9	14	11	21	16
YEV	XUJ	3	5	3	16	16	16
QEF	WUG	1	8	8	16	16	16
ZIJ	XIY	1	4	4	15	17	16
CIJ	XOH	1	8	7	16	17	16
XEM	QOV	2	11	14	17	16	16
QUX	RIW	2	9	15	11	22	16
XON	GUQ	2	9	11	8	24	16
VUQ	YEJ	1	6	4	11	22	16
VUB	VEF	1	12	12	11	22	16
VUP	NEJ	3	14	15	13	20	17
XIB	FAJ	2	6	10	15	18	17
YEF	XIG	1	11	11	13	30	17
YUF	XOL	1	9	9	14	19	17
ZEH	QOK	2	14	15	15	19	17
ZUY	QUX	1	8	9	18	17	17
ZUX	POJ	2	14	15	17	18	16
JOF	BUV	3	19	15	19	16	18
BUV	ZEQ	2	15	15	18	18	18
VUB	JIQ	2	12	13	16	20	18
ZOF	QIH	2	11	6	15	21	18
QAZ	YAJ	1	10	9	18	18	18

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
XUB	ZUF	1	8	8	23	13	18
XEQ	XAJ	1	6	5	19	17	18
YIW	XEV	2	14	6	12	24	18
YAF	CEJ	3	19	17	16	21	18
KOJ	CIW	2	12	13	20.	17	18
YEQ	XUV	1	4	4	15	22	18
ZOQ	YUB	2	10	14	17	21	19
QEV	JIY	2	12	14	14	23	19
XUK	XAZ	1	5	2	21	18	19
TIJ	XAD	2	13	7	16	23	19
XOL	QEC	2	9	16	14	24	19
NOJ	QUH	3	12	12	18	21	20
DUJ	XEP	2	13	13	18	21	20
YEV	GAQ	2	5	11	20	19	20
XIY	ZIJ	3	4	4	17	23	20
XUY	XIJ	1	3	2	20	19	20
XUW	XEG	1	5	5	19	20	20
CIQ	ZOV	2	15	15	18	22	20
YOX	NIJ	2	16	7	17	23	20
KEJ	QEB	2	16	16	13	27	20
VAJ	GEQ	3	12	11	20	20	20
XOC	VOF	1	9	10	22	18	20
FEJ	VOJ	1	11	11	18	23	20
XOJ	QIJ	1	2	5	13	27	20

Table 3

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
TEJ	QIW	3	9	10	20	21	20
XIY	QOH	2	4	8	15	26	20
QEF	BOJ	2	8	16	19	22	20
KUQ	ZAJ	2	11	8	19	22	20
GIW	FEQ	2	16	11	19	22	20
XOD	ZUQ	1	12	12	21	21	21
QEB	DIJ	3	16	16	20	22	21
YAV	XAQ	1	9	10	20	22	21
YEQ	XIL	2	4	13	20	22	21
JIH	YEB	3	13	13	22	21	21
XUG	KUJ	3	6	7	20	23	21
WUQ	QEF	3	8	8	18	24	21
YIV	WUJ	1	7	8	16	27	21
WOJ	QAH	2	13	14	18	25	21
MOJ	YIQ	2	13	11	17	26	21
GEQ	XOT	2	11	9	15	28	21
FOJ	GUQ	3	11	11	18	25	22
XIG	YEF	3	11	11	18	25	22
CUQ	QIF	1	12	12	18	26	22
GAQ	DUJ	1	11	13	18	26	22
KEV	GOC	2	46	46	18	27	22
QAM	JAH	3	44	44	18	27	22
KUJ	XUG	1	7	6	20	24	22

Table 3 (continued

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
ZIH	XEY	1	6	6	24	21	23
QEJ	QUJ	1	6	3	17	28	23
ZUF	XEC	2	8	9	18	28	23
CUJ	ZIW	2	15	5	18	28	23
YIW	POJ	3	14	15	23	22	23
PUV	YIH	3	22	13	22	23	23
XUZ	XUF	3	5	3	20	25	23
XOM	VUF	3	10	67	19	26	23
YEF	XOC	2	11	9	18	28	23
MOF	WEJ	2	40	42	15	31	23
QUH	NOJ	1	12	12	20	26	23
KIF	XAC	3	17	18	24	22	23
HAJ	NUQ	3	18	13	22	24	23
GEQ	VAJ	1	11	12	19	27	23
LUJ	XAH	2	10	15	21	26	23
XOZ	XUQ	1	5	3	18	28	23
QOS	XEB	3	19	17	23	23	23
XIQ	XEJ	1	5	3	23	23	23
VOQ	TIW	3	15	18	19	28	23
QEV	ZOF	1	12	11	23	24	23
YIG	LUJ	1	10	10	25	22	23
SIJ	YOQ	2	14	14	23	24	23
XOL	YUF	3	9	9	23	25	24

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
QIF	CUQ	3	12	12	21	27	24
QIH	XIW	1	6	3	23	25	24
XUP	QIY	1	7	8	25	23	24
XIC	QEX	1	10	10	24	23	24
XUF	XUZ	1	3	5	23	25	24
LAJ	VUP	2	14	14	22	26	24
YAJ	VEF	2	7	12	20	28	24
GEJ	QAZ	2	9	10	18	29	24
QUC	YIH	2	15	13	23	25	24
XUL	HIJ	2	7	10	22	27	24
VOQ	XUD	2	15	6	19	29	24
ZIF	PEJ	3	20	17	22	27	24
XEZ	XAB	1	7	8	25	24	25
HAQ	ZIV	2	45	39	19	31	25
WUQ	XIR	2	13	12	18	32	25
QUF	XOR	3	19	19	20	30	25
XET	QAJ	1	11	11	20	30	25
GUQ	FOJ	1	11	11	20	30	25
XER	QAJ	2	11	12	20	31	25
NIJ	ZEJ	1	7	6	23	28	25
YOF	YIX	1	10	9	24	27	25
VUF	XOM	1	10	10	24	27	25
RAX	YOC	1	47	44	22	29	25

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
XAW	DIJ	2	8	16	18	33	26
XER	YIQ	1	12	11	22	30	26
XIM	YEB	2	11	13	22	30	26
YUJ	XOG	1	9	9	23	30	26
KUQ	FEQ	1	11	11	28	25	27
QIG	ZOS	2	14	13	25	28	27
FAP	PUW	1	44	43	26	28	27
CUW	VOK	2	38	42	25	29	27
KEX	LUQ	2	39	42	19	35	27
VOH	RUJ	3	16	18	30	24	27
CIB	MOY	3	47	45	23	32	27
XOV	XUH	1	3	4	24	31	28
YUS	MIP	2	38	42	26	30	28
XEW	QOH	3	7	8	29	27	28
LIY	ZEP	2	46	46	28	28	28
ZEV	GAX	3	19	19	28	29	28
XAG	BOJ	3	19	16	25	32	28
XUL	XEV	1	7	6	30	27	28
GEJ	VUJ	1	9	9	23	34	28
YUF	GIX	2	9	11	25	32	28
XUR	FOJ	2	9	11	23	34	28
XOP	XOK	1	7	7	25	32	28

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
XID	XUC	1	9	10	27	31	29
VIB	PAF	1	40	40	24	33	29
XIF	XEF	1	5	3	23	34	29
KIH	QUV	2	15	9	25	33	29
XOP	MUJ	2	7	10	21	37	29
PAF	NUJ	2	40	44	20	38	29
HIB	ZAN	1	44	43	33	26	29
QOH	XEW	1	8	7	28	31	29
XAL	GIJ	1	12	13	28	31	30
GOX	NUV	2	12	15	26	33	30
KOJ	XIR	1	12	12	33	27	30
QOJ	ZOJ	1	4	3	28	32	30
WEX	QAY	2	38	41	31	29	30
GOK	BEH	2	40	44	28	33	30
GEX	QUV	1	9	9	33	28	30
DEJ	XEM	1	13	11	31	29	30
XOB	GIX	1	12	11	28	33	30
RUV	QOF	3	16	20	31	30	30
QIW	TEJ	1	10	9	23	38	30
FAJ	XOT	1	10	9	27	34	30
ZUT	REJ	1	38	39	33	28	31
PEV	HAQ	1	46	45	31	31	31

Table 3 (continued

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
XEH	XOY	1	5	4	33	29	31
XOS	XOQ	1	6	6	24	38	31
QUJ	QEJ	3	3	6	27	36	31
FUB	KEX	1	40	39	25	38	31
VAJ	XIS	2	12	14	30	33	31
GOQ	XUM	2	13	13	25	38	31
BIW	VOF	2	15	10	23	40	31
TOJ	GAC	3	17	17	28	36	32
GOC	YOS	1	39	38	28	36	32
PEX	DUT	2	40	44	28	36	32
KEJ	MIV	3	16	17	30	34	32
TEV	DOQ	2	40	44	28	37	32
VEM	LIG	1	46	46	31	33	33
WUM	FIP	2	38	42	30	35	33
GUB	WEH	2	40	41	29	36	33
YAQ	TOF	2	47	47	33	33	33
ZAN	HIB	3	43	44	32	34	33
XUT	XIK	3	8	6	33	33	33
QEP	TUV	3	13	16	33	34	33
GUJ	GOX	1	11	12	42	25	33
TIQ	GEP	1	41	41	32	35	33
FUB	WIX	2	40	44	33	34	33
YOS	PUQ	2	38	42	30	37	33

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
KUB	NOP	2	70	72	29	38	33
KIJ	XAD	1	8	7	30	38	34
TOZ	TEV	1	40	40	27	41	34
HEQ	ZAN	2	38	43	28	40	34
XUM	CIW	3	13	15	31	38	34
MOY	CIB	1	45	47	33	35	34
WAB	GOK	1	39	40	30	38	34
YOP	ZAD	1	38	38	31	38	35
HUJ	XAN	3	14	14	28	42	35
TIQ	VAY	2	41	43	35	35	35
GOJ	ZOQ	1	11	10	31	39	35
ZAJ	XIZ	1	8	6	29	41	35
HEG	TUD	2	45	47	31	40	35
BEW	GEB	1	42	42	35	36	35
JUK	QAM	2	40	44	29	42	35
HEG	SUG	1	45	47	35	37	36
NIR	GEP	2	38	41	35	37	36
GOZ	MUQ	2	45	38	34	38	36
GOQ	XIM	1	13	11	32	41	36
NEQ	KIB	1	42	44	32	41	36
TOZ	RUC	2	40	47	35	38	36
YOT	PUH	2	38	42	33	39	36

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
JAH	QAM	1	44	44	30	43	37
XEK	XUS	1	8	6	37	37	37
SOZ	NID	2	38	44	38	36	37
WOG	SUY	2	38	41	34	40	37
DOY	QAC	2	39	47	32	43	37
CIP	HUX	3	75	75	38	37	37
WOG	CEK	3	38	40	38	37	37
XIS	JUF	3	14	18	32	43	37
PUQ	FUJ	1	42	43	29	45	37
BAZ	FOH	2	38	43	33	44	37
NUJ	WIY	1	44	42	38	37	38
RUK	DOQ	1	44	44	38	37	38
CEK	WOG	1	40	38	35	40	38
KAZ	GUV	2	39	42	39	36	38
WAB	ZIN	2	39	47	37	38	38
VOX	ZEP	1	46	46	37	38	38
GEB	BEW	3	42	42	35	40	38
XAM	GEB	2	38	42	40	36	38
CEK	RAJ	2	40	44	33	43	38
HUK	VOT	2	67	72	36	40	38
XUC	XID	3	10	9	40	36	38
XUS	XEK	3	6	8	37	39	38
BEH	PEQ	1	44	44	32	44	38
TEZ	KAG	2	38	41	33	43	38

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AS
ZON	YAN	1	43	43	38	39	38
BIM	FEY	1	68	68	32	45	38
REZ	WIY	2	38	42	35	42	38
ZIH	XOG	2	6	9	33	44	38
XIK	XUT	1	6	8	40	38	39
HIY	QEL	1	43	43	36	42	39
FIP	POQ	1	42	41	34	43	39
RIQ	JAT	2	38	41	36	42	39
SEF	MOF	3	41	40	39	40	39
QEL	HIY	3	43	43	36	43	39
RIX	VAZ	1	43	42	38	41	39
HIJ	MUJ	1	10	10	33	45	39
TUP	SEF	2	38	41	38	41	39
RUC	GUC	1	47	47	36	43	40
WEC	VAZ	2	38	42	32	48	40
JOW	JEK	3	39	39	38	43	40
VOC	ZAP	2	66	70	41	40	40
DIQ	JIR	1	41	41	38	43	40
KAG	PEX	1	41	40	34	47	40
FUW	DAQ	2	38	38	37	44	40
SIB	MAH	2	74	76	37	44	40

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	S AV	MAS	FAS	Mean AV
XUD	XAW	1	6	8	38	43	41
MOF	SEF	1	40	41	38	44	41
KEV	GOZ	1	46	45	33	49	41
FIC	WEY	2	68	72	36	47	41
CEV	HIY	2	38	43	41	42	42
VAD	JOR	2	39	44	41	43	42
VUN	DIQ	2	40	41	40	43	42
BIM	DOK	2	68	72	38	46	42
MOG	QIC	3	45	45	47	37	42
LOZ	PIV	2	40	44	38	47	42
REJ	HIB	2	39	44	42	43	42
MIP	PIV	1	42	44	44	40	42
LIG	VOX	2	46	46	38	47	43
TAF	NOD	1	71	72	33	52	43
VOK	GOY	3	42	43	44	41	43
BEQ	HUN	1	41	41	36	49	43
ZEN	VAX	2	38	41	41	43	43
NUH	PEQ	2	38	44	43	43	43
KUB	RIL	3	70	69	43	43	43
YUK	FOS	1	67	68	37	49	43
QEP	XAS	2	13	14	43	43	43
GUB	DOY	1	40	39	38	49	43
WOZ	SIV	2	68	73	39	48	43

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
XOF	XAF	1	6	8	38	50	44
VAM	RUL	2	68	76	43	45	44
BIP	VON	1	71	70	42	47	44
LIY	JOX	1	46	45	42	48	45
SUT	HUC	3	70	69	43	47	45
CIY	RUK	2	40	44	46	44	45
TIY	BEZ	2	40	44	39	51	45
JUK	VAD	3	40	39	42	48	45
XEC	XUN	1	9	9	44	46	45
JAT	GOW	1	41	42	40	50	45
PAG	FEY	2	74	68	40	51	45
GUD	HIG	1	42	41	41	50	45
ZIV	TUP	1	39	39	39	52	45
VIB	ZON	2	40	43	44	47	45
LOQ	RIX	2	38	43	47	44	45
NUG	HOF	2	66	74	43	48	46
KOR	YAW	2	75	76	41	51	46
CAY	HEK	1	74	74	41	51	46
BIP	CED	2	71	73	45	47	46
BEQ	JOX	2	41	45	42	50	46
WIY	NUJ	3	16	44	43	49	46
YOG	KAZ	1	38	39	40	53	46
XUR	XIN	1	9	10	48	45	46
GEZ	WOB	2	42	45	43	49	46

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
LUW	HEZ	2	39	41	43	50	47
JEK	FIM	2	39	42	43	50	47
CIZ	GOM	2	39	47	42	52	47
WIQ	ZEN	3	38	38	43	51	47
LUB	FES	1	69	69	46	48	47
LIX	YAT	2	46	46	43	51	47
TIZ	VAG	2	75	75	43	51	47
NEM	FIM	1	41	42	43	52	47
NAC	DAS	1	72	72	39	55	47
CIZ	CAH	3	39	40	48	47	47
VON	RIL	2	70	69	53	43	48
CIY	NEZ	1	40	39	44	51	48
ZEN	WIQ	1	38	38	44	51	48
HUP	VIK	3	75	74	51	44	48
NOF	WIV	2	38	43	43	53	48
DEG	SIQ	1	45	47	46	50	48
JUP	HUW	2	39	41	38	58	48
GOM	POW	1	47	45	48	48	48
VAX	SUY	1	41	41	50	47	48
JAQ	HUK	1	68	67	48	50	49
GOY	VOK	1	43	42	43	54	49
HOK	NUF	2	75	69	43	54	49

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
VAD	JUK	1	39	40	45	53	49
PUH	WEJ	1	42	42	45	53	49
CEN	YOW	2	75	73	48	51	49
TUW	NEM	2	38	41	44	54	49
HUC	SUT	1	69	70	49	49	49
WIK	HES	2	67	71	46	54	50
DAP	WIK	1	67	67	44	56	50
HOF	FOP	3	74	75	53	48	50
TUJ	YOJ	1	10	9	48	53	51
VAG	DOB	1	75	75	42	60	51
HEZ	QAY	1	41	41	49	53	51
HOX	TEW	2	74	76	52	50	51
LUQ	TIY	3	42	40	47	56	51
HUX	CIP	1	75	75	49	53	51
NAK	HOX	1	74	74	54	48	51
BIS	WUF	2	72	67	48	55	51
TEP	WIX	1	45	44	45	3	51
DUT	QID	1	44	42	42	61	51
FOS	MEC	2	68	67	47	57	52
VIS	KOG	2	75	76	47	57	52
VOY	WUT	2	68	69	44	59	52

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
HIQ	TOH	1	47	46	54	49	52
CIP	NES	2	75	72	48	56	52
BEK	SOT	2	66	69	46	58	52
RAL	TID	2	67	72	47	58	52
JOS	NUR	1	68	67	45	59	52
VIJ	XON	1	9	9	48	57	52
DIR	NAC	2	68	72	50	55	53
LAN	TIF	2	75	76	49	56	53
FOP	HOF	1	75	74	45	60	53
GIS	PIY	1	39	39	51	54	53
JEK	JOW	1	39	39	51	55	53
VUN	GUV	3	40	42	53	53	53
HUY	BEW	2	39	42	44	62	53
WOB	QAC	1	45	47	41	66	53
SUG	HEG	3	47	45	54	53	54
BEY	MAJ	1	75	74	49	58	54
DET	MAJ	2	69	74	50	58	54
WEY	LUM	1	72	73	45	63	54
YUK	LAZ	2	66	68	50	58	54
FUM	WAP	2	67	74	47	62	54
CAH	CIZ	1	40	39	49	59	54

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
VAY	QIS	1	43	44	48	61	55
JUP	WEZ	1	39	39	51	58	55
NEG	DUP	2	69	74	55	54	55
MAQ	JIR	2	38	41	53	58	55
DAS	NAC	3	72	72	59	51	55
BIS	LAV	3	72	72	58	53	55
RIZ	WOD	2	66	70	54	57	55
CAK	NEB	2	67	71	54	57	55
RAJ	WIV	1	44	43	49	62	55
KOF	TID	1	71	72	53	59	56
TOB	HIZ	2	66	75	50	63	56
MUY	LIX	1	45	46	53	60	57
SAR	HEV	2	68	70	61	53	57
TIY	LUQ	1	40	42	53	61	57
WEH	GEZ	1	41	42	51	63	57
KOM	NEG	1	69	69	50	63	57
RAL	VOC	1	67	66	50	63	57
DAP	LOF	2	67	70	52	62	57
FOZ	FEX	1	41	42	52	62	57
LIR	DAF	1	71	74	49	64	57
WAP	PAG	1	74	74	57	58	57
WEX	WUM	1	38	38	49	65	57

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
SEG	RUD	2	68	73	53	62	58
JOH	PEM	1	45	45	63	52	58
SEQ	DEH	1	44	44	57	58	58
CAH	QIS	2	40	44	55	61	58
VER	LUM	2	67	73	53	63	58
FIC	FUM	3	68	67	58	58	58
PIR	HOK	1	74	75	51	65	58
SIY	GOW	2	38	42	57	59	58
SIB	KOR	1	74	75	52	65	58
WIR	ZAP	1	69	70	55	62	58
NEB	NAV	1	71	72	53	64	58
YUH	HUZ	1	45	46	57	61	59
TAV	HOD	1	70	69	53	64	59
HUS	PEY	2	70	67	53	65	59
YAT	QIZ	1	46	47	52	67	59
TIZ	DES	1	75	75	53	66	60
FEZ	CIL	2	71	72	58	62	60
LIB	VAS	2	75	76	57	63	60
CEN	BIF	1	75	76	54	65	60
QUT	YOT	1	39	38	53	67	60
VOY	HEV	1	68	70	53	67	60
GOH	QAN	3	41	40	51	70	60
VAM	KEP	1	68	70	57	64	60
JOH	TUL	2	45	47	58	65	61

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
COS	CED	1	74	73	56	67	61
CIK	MEC	1	67	67	58	66	61
YIR	NEP	1	44	46	58	66	62
FOH	BEZ	1	43	44	48	76	62
WOM	TIR	2	67	67	53	72	62
QIC	MOG	1	45	45	65	59	62
JOR	NID	1	44	44	55	69	62
CUN	DOK	1	73	72	57	68	63
KOR	SIB	3	75	74	63	63	63
GOW	JAT	3	42	41	63	62	63
KOG	JUS	1	76	76	62	63	63
WEP	YIR	3	60	44	63	63	63
DUR	GUR	1	67	68	58	68	63
FAS	WOZ	1	71	68	51	75	63
TAV	NUR	2	70	67	62	64	63
KAS	HEK	2	67	74	59	67	63
REK	SUZ	2	73	68	58	69	63
DAL	YOW	1	74	73	62	65	63
SAR	CUL	1	68	68	59	68	63
TOB	MEX	1	66	67	63	65	64
PAG	WAP	3	74	74	63	66	64
RIV	COS	2	69	74	58	70	64
CUL	MAZ	2	68	72	66	63	65
YUH	NIS	2	45	41	58	71	65

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
PEL	FAK	2	75	76	59	70	65
BEY	MOS	2	75	75	59	70	65
DES	TOK	2	75	69	65	64	65
LAV	BIS	1	72	72	64	65	65
XAM	LOZ	1	38	40	60	70	65
FUM	FIC	1	67	68	68	62	65
RIL	KUB	1	69	70	61	69	65
VIK	HUP	1	74	75	63	68	65
CER	CIV	1	71	71	61	71	66
NES	REK	1	72	73	64	68	66
TOG	BUN	3	97	100	72	61	66
COZ	REL	1	74	72	62	72	67
FEN	COV	1	74	73	64	70	67
NAM	DUP	1	73	74	63	73	68
PAZ	QEL	2	38	43	67	68	68
PES	MUL	2	68	44	62	73	68
WUR	CET	2	69	69	68	68	68
MUY	SIQ	2	45	47	70	66	68
YUS	NIS	1	40	41	61	75	68
CET	VEW	1	69	68	56	80	68
HUY	LUW	1	39	39	64	72	68
YAK	TUM	3	97	98	69	67	68
DUG	ZIP	1	100	100	62	74	68
PES	DAW	1	68	67	66	71	68

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
PAR	DAB	1	99	99	64	73	68
LIB	MOS	1	75	75	59	78	69
JOS	BIF	2	68	76	64	73	69
FOD	FEZ	1	69	71	61	78	69
KOL	RAB	2	74	76	68	71	69
JAD	BOK	2	66	69	60	78	69
KER	NOK	1	76	75	68	70	69
QAN	GOH	1	40	41	61	78	69
YUM	PAD	3	90	100	69	69	69
NUR	JOS	3	67	68	68	72	70
HES	KOD	1	71	73	63	77	70
VOT	DUX	1	72	74	62	78	70
DUP	NAM	3	74	73	68	73	70
SOT	WUT	1	70	69	68	72	70
WOM	VER	1	67	67	63	77	70
MUL	VIS	1	74	75	64	76	70
FAK	HIZ	1	76	75	58	83	71
VEW	LAV	2	68	72	64	78	71
CIL	SIV	1	72	73	68	75	71
LEF	ROF	3	67	67	68	74	71
BUT	VAN	2	99	100	67	76	71
ROF	LEF	1	67	67	68	74	71
LAN	KOL	1	75	74	66	78	72

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
MOY	GUD	2	45	42	71	74	73
CAS	ROP	2	75	76	73	73	73
DAW	LIQ	2	67	71	66	80	73
HIC	POW	2	99	100	74	72	73
FIV	KEP	2	66	70	72	74	73
RET	SEG	1	68	68	72	74	73
RUD	JUN	1	73	73	69	77	73
TAM	SID	3	98	98	69	78	73
COT	FAY	3	98	98	68	79	73
TEK	MAH	1	75	74	70	77	73
KOM	VIK	2	69	74	73	74	74
FES	JUN	2	69	73	66	82	74
VAN	PIN	1	100	100	68	80	74
DUZ	LOG	2	99	100	76	73	74
MUN	CER	2	67	71	68	80	74
MIX	LAG	2	99	100	74	74	74
TUG	BIN	2	99	100	74	76	76
MEX	PIR	2	67	74	70	80	75
SUZ	PEY	1	68	67	73	78	75
WIR	DUS	2	69	73	71	79	75
LAR	DAZ	1	76	76	73	78	75
MUN	TIR	1	67	67	68	84	76
DUS	MAZ	1	73	72	75	78	76
COD	HIC	1	99	99	73	80	76
TOK	HUS	1	69	70	73	80	76

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
TIL	BOW	3	97	99	77	76	76
KIM	YET	3	98	97	78	76	77
RIM	BUN	2	99	100	73	80	77
JAQ	CUN	2	68	73	73	81	77
DIR	WUF	1	68	67	74	80	77
YER	WUR	1	70	69	71	86	78
CIK	FAS	2	67	71	79	78	78
KAS	CAK	1	67	67	77	81	79
BEL	MAC	1	99	99	76	82	79
NUF	LOF	1	69	70	75	83	79
MAZ	DUS	3	72	73	73	85	79
SOF	TEK	2	69	74	73	85	79
WAC	BEN	1	99	99	74	84	79
TAG	DIP	1	100	100	73	86	80
QIT	YER	2	66	70	81	78	80
TAP	WIG	1	100	100	75	84	80
BOK	DET	1	69	69	74	85	80
CAB	DIP	2	100	100	77	83	80
LEG	RIM	1	99	99	78	83	80
GUV	VUN	1	42	40	75	86	80
SAF	DUX	2	69	74	82	79	80
POT	DUZ	3	99	99	78	84	81
RIV	SAF	1	69	69	78	84	81
BOX	WEB	2	99	100	84	78	81

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
WAG	LAY	1	99	99	80	83	82
KIN	MAT	2	99	100	79	84	82
RAW	HIT	2	99	100	81	83	82
BOW	VET	2	99	100	77	88	82
BEG	FAD	2	100	100	80	84	82
DEY	LAZ	1	68	68	81	85	83
SIP	FAN	1	99	99	80	86	83
POW	NOD	1	100	100	79	87	83
BUZ	TIP	2	99	100	84	82	83
GAL	MID	1	99	99	81	86	83
MIX	GOT	1	99	99	81	86	83
VIS	MUL	3	75	74	82	85	83
KEG	PAD	2	99	100	84	83	83
RUT	HIM	2	99	100	84	83	83
KIN	LUG	3	99	98	85	83	84
PIT	LAB	2	99	100	82	86	84
CUB	TEX	2	99	100	82	86	84
CUB	JAN	1	99	99	78	90	84
BEL	JUG	2	99	100	84	84	84
MUG	LET	2	99	100	83	87	85
RAH	FEW	1	99	99	82	88	85
MAC	HER	2	99	100	84	85	85
PEN	RIG	3	99	99	84	85	85
SOW	JET	2	99	100	85	85	85
TIC	FUN	2	99	100	79	91	85

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
CON	RIB	3	100	100	86	84	85
SIN	DOG	2	99	100	86	85	85
JUG	MAY	1	100	100	86	85	85
RAP	COW	2	99	100	87	84	85
CAS	PEL	1	75	75	82	90	86
JAP	NOT	2	99	100	83	89	86
ROY	FOR	1	100	100	85	88	86
KEG	BUS	3	99	99	93	80	87
RAW	PUT	3	99	99	91	82	86
RAN	NAG	1	99	99	88	86	87
SEG	RET	3	68	68	90	83	87
LOW	JAM	2	99	100	88	86	87
CIV	JUS	2	71	76	86	88	87
BAG	WIT	2	99	100	86	88	87
FUR	SAG	2	99	100	87	87	87
SUN	TUG	1	99	99	89	84	87
SEW	CAN	2	99	100	86	88	87
KEN	RUB	3	100	99	84	90	87
PAY	BUT	1	99	99	88	87	88
BUS	KEG	1	99	99	87	88	88
LEG	MAP	2	99	100	88	88	88
BED	CUT	2	100	100	88	88	88
LOT	RIP	2	100	100	88	88	88
FAN	SIP	3	99	99	86	90	88

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
PUT	RAW	1	99	99	86	90	88
MAC	BEL	3	99	99	88	88	88
BAN	DOT	2	100	100	88	89	88
LOT	SAG	1	100	100	89	88	89
GUM	PIG	1	99	99	83	95	89
CIV	CER	3	71	71	89	88	89
TUG	SUN	3	99	99	89	88	89
PAT	RIB	2	99	100	90	88	89
HAG	PUB	2	99	100	88	89	89
HEP	RAY	2	99	100	87	91	89
DUZ	POT	1	99	99	90	88	89
GAY	LID	1	99	99	88	91	89
POT	MAD	2	99	100	85	93	89
KEY	GAP	1	99	99	87	92	89
WAD	SOD	1	99	99	84	94	89
NAP	NET	1	100	100	86	93	90
SEW	FIG	3	99	99	91	88	90
GOT	SAD	2	99	100	87	93	90
GUT	JAR	1	99	99	89	90	90
SAK	SIN	3	94	99	90	89	90
DIM	TEL	1	99	99	90	89	90
BED	LAG	1	100	100	89	90	90
SOW	BUZ	1	99	99	89	90	90
BIT	LIZ	1	100	100	88	92	90

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
RUG	DOT	1	100	100	88	92	90
KEY	NUT	2	99	100	92	88	90
RID	HUT	2	99	100	89	91	90
JAN	MET	2	99	100	88	92	90
PIC	KAY	2	99	100	88	93	90
SAF	RIV	3	69	69	90	90	90
MID	GAL	3	99	99	87	93	90
HOW	MAP	1	100	100	88	92	90
NED	MAY	2	99	100	90	91	90
MAY	JUG	3	100	100	88	93	90
JEW	FAR	1	100	100	90	91	90
DON	SIR	1	100	100	88	93	90
FUR	RUT	1	99	99	88	93	90
CAB	PET	1	100	100	92	89	90
PUT	HOG	2	99	100	89	92	90
MOB	FIX	2	99	100	89	92	90
PUB	TAB	1	100	100	89	93	91
SAP	TOM	3	100	99	90	92	91
ROW	DUG	2	99	100	89	93	91
WAD	BOY	2	99	100	89	93	91
BIG	PUG	1	99	99	90	93	91
HAL	TEN	1	99	99	89	93	91
JON	DEW	1	99	99	89	93	91
FIT	HAM	1	100	100	90	93	91
SAD	BIN	3	100	100	91	92	91

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
GUN	TIM	3	100	99	90	93	91
JAM	BAY	1	100	100	91	92	91
MAX	GUN	2	99	100	93	89	91
SIX	HAT	2	99	100	92	91	91
LIP	MUD	2	99	100	92	91	91
TOY	DEN	2	99	100	89	93	91
REX	WAS	3	98	97	91	93	92
TUB	FED	3	100	99	88	96	92
SAT	HIP	2	99	100	93	91	92
COD	TIN	2	99	100	91	93	92
FIG	SAW	2	99	100	89	94	92
REL	COZ	3	72	74	92	92	92
GUT	JIM	2	99	100	91	93	92
GUM	ROB	2	99	100	88	96	92
RID	PAT	1	99	99	89	95	92
WIT	LAB	3	100	100	98	88	93
GEM	WAX	3	100	100	93	93	93
ROB	KIT	1	100	100	92	94	93
WAR	HIP	1	100	100	92	94	93
CUT	TAR	1	100	100	92	94	93
NOW	LIZ	2	99	100	92	94	93
YES	BIT	2	99	100	91	96	93
RAP	SIX	1	99	99	93	93	93
SIT	CAR	1	99	99	92	95	93
FIB	SEX	2	99	100	93	94	93

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
COW	CAN	1	100	100	95	93	94
LAB	WIT	1	100	100	93	95	94
BUM	CAT	1	100	100	92	96	94
LAY	BAT	1	100	100	93	95	94
VET	FOX	3	100	100	94	93	94
WAY	JET	3	99	100	94	93	94
FOR	ROY	3	100	100	93	95	94
BUG	WAX	2	99	100	93	95	94
BIN	SAD	1	100	100	95	93	94
HOG	SOB	1	100	100	93	95	94
DAM	CUP	3	100	100	95	93	94
LIT	SON	3	96	100	93	96	94
TAN	FOX	2	99	100	95	93	94
HID	PET	2	99	100	93	95	94
BUZ	SOW	3	99	99	94	94	94
ROD	BOX	1	99	99	92	97	94
MOB	MUG	1	99	99	93	96	95
TIN	NUT	1	100	100	93	96	95
MAR	LAD	1	99	99	96	93	95
BAR	FIT	2	100	100	94	95	95
GOD	NED	3	99	99	97	93	95
CAR	SIT	3	99	99	93	97	95
BOY	MEN	1	100	100	95	95	95
SOF	WOD	1	69	70	94	95	95
HOP	NOT	1	100	100	94	95	95

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
GAS	BAN	1	100	100	94	95	95
LAZ	DEY	3	68	68	93	97	95
NED	GOD	1	99	99	95	95	95
WAX	GEM	1	100	100	95	95	95
BUD	HAS	1	100	100	94	96	95
TOY	MAX	1	99	99	94	96	95
SAG	LOT	3	100	100	95	96	95
SIR	DON	3	100	100	95	96	95
HAY	HOT	1	100	100	98	93	95
TOP	LOG	1	100	100	95	96	95
TAN	HID	1	99	99	94	97	95
JOB	SAW	1	100	100	97	94	95
FAT	SON	2	99	100	93	98	96
SUM	COP	1	100	100	97	95	96
MUD	WET	3	100	100	95	97	96
HID	TAN	3	99	99	94	98	96
PAR	KIT	2	99	100	95	97	96
PIG	KEN	2	99	100	95	97	96
FOG	BAD	1	99	99	94	98	96
DOC	BET	3	98	100	98	94	96
PEN	WIN	2	99	100	96	97	96
DOG	BAR	1	100	100	96	98	97
LIZ	BIT	3	100	100	96	98	97
JON	PAL	2	99	100	95	98	97

Table 3 (continued)

CVC Pair S	R	AS No. of Scaling	S AV	R AV	MAS	FAS	Mean AV
BEG	GIN	1	100	100	96	98	97
DOT	RUG	3	100	100	98	96	97
BAD	ZIP	2	99	100	96	98	97
BUY	WON	3	99	97	98	97	97
WIN	FAT	3	100	99	97	98	97
MAN	RUN	1	99	99	95	99	97
LOW	SAT	1	99	99	98	98	98
BIG	WED	2	99	100	98	99	98

Table 4

Associability of Pairs of Mixed Stimulus and Response AV

Scaled in AS-3 Ordered by Increasing MAS

(a) High stimulus AV, low response AV (HL)

CVC pair S	R	S AV	R AV	MAS	FAS
POD	VUW	97	19	25	30
PUS	QOB	97	17	25	35
HEM	GIQ	98	15	28	30
YEN	TIJ	97	13	28	43
YAP	GUX	95	19	30	39
TOD	VIH	98	20	32	36
NIL	QEZ	98	17	33	39
SUB	YIF	98	16	33	40
NOB	WEQ	98	20	36	55
DEB	FUV	97	17	38	50
HUG	ZIW	97	13	38	47
MOP	QAV	99	14	38	47
MEL	VUY	97	18	39	46
LAW	QUG	100	14	40	45
CAD	JIQ	97	13	41	47
DUB	KEH	96	22	41	44
JAW	ZEQ	98	15	42	48
PEW	JIY	97	14	42	51
JAY	NUV	98	15	43	48
GIT	VAF	97	22	43	45

Table 4 (continued)

(a) High stimulus AV, low response AV (HL)

CVC pair S	R	S AV	R AV	MAS	FAS
JAG	QOX	99	19	43	52
LAP	WUX	100	18	43	35
HUT	RIW	100	15	45	61
WED	QUG	100	18	45	42
PAN	SIJ	99	14	46	56
FUN	VAW	100	16	47	55
BOP	JIC	98	20	48	48
FIB	WOJ	99	13	48	55
WIL	QAX	97	22	48	53
JIG	QEC	98	16	49	49
PAL	YUB	100	14	49	63
SET	WIJ	99	13	49	60
JOY	GEC	100	17	50	48
HUB	QEK	98	17	53	56
ROW	QAS	99	17	53	63
HIM	QUC	100	15	53	64
RAT	NIY	100	22	54	59
FIX	QAG	100	17	56	55
SUP	MIW	96	22	56	64
HIS	QOL	98	19	58	63
PAM	YEC	97	13	58	63
TOW	XAS	97	14	58	58

Table 4 (continued)

(a) High stimulus AV, low response AV (HL)

CVC pair S	R	S AV	R AV	MAS	FAS
NEW	QOV	99	14	58	64
HEY	JUQ	97	17	59	61
RIP	YOZ	100	18	59	52
LET	SUJ	100	16	61	67
HAG	YIL	99	21	62	73
DAY	QOP	100	21	63	73
LAX	YOB	98	17	63	73
BAG	QED	99	20	64	66
HIT	VUG	100	17	66	65
TAX	VUK	97	19	66	63
GET	BIW	100	15	67	67
RAM	ZIX	100	21	69	72
RAY	QEM	100	21	69	73
FIN	XES	99	14	71	68
SAM	BIH	100	21	71	72
HEN	XAY	98	17	73	69
MIS	KUY	97	19	73	73

Table 4 (continued)

Associability of Pairs of Mixed Stimulus and Response AV

Scaled in AS-3 Ordered by Increasing MAS

(b) Low stimulus AV, high response AV (LH)

CVC pair S	CVC pair R	S AV	R AV	MAS	FAS
ZUV	TAD	13	97	28	35
VOB	NIP	19	98	33	38
MOJ	WEB	13	100	37	43
QUW	MIT	13	100	38	37
ZUH	VIC	20	97	38	35
JIK	GAB	21	98	38	43
LIJ	TUX	17	97	38	45
SOJ	TIC	19	99	38	43
BUW	SOC	21	97	39	48
QOZ	RED	19	99	39	61
XED	JOT	13	98	41	43
DAJ	SOY	22	96	43	43
FIQ	VEL	20	96	43	51
JEQ	SAL	14	98	43	51
MEJ	DOZ	17	98	43	57
CUJ	DAN	15	99	44	49
HOJ	NIX	22	97	45	38
NAJ	BID	18	99	45	48
XEL	NAY	21	98	46	44
YUQ	HOT	16	100	46	51
WUB	MON	21	97	48	48
XAV	TON	16	98	48	55

Table 4 (continued)

(b) Low stimulus AV, high response AV (HL)

CVC pair S	CVC pair R	S AV	R AV	MAS	FAS
YIB	NOW	16	99	48	55
ZIQ	MET	17	100	48	53
XOW	TED	19	100	50	53
KIW	MED	10	100	51	51
ZUX	JAP	14	99	51	48
QAH	GUY	14	99	52	56
ZEC	SAY	17	99	53	66
MEF	RON	22	99	53	62
QOC	FAD	21	100	53	57
QOK	CAP	15	100	53	56
RIH	SAX	22	98	53	55
VEQ	BUG	17	99	53	51
CEQ	JIM	19	100	54	68
XIL	RAG	13	99	54	50
ZOS	PIT	13	99	54	55
YOX	MAT	16	100	55	49
XIV	PUN	18	98	56	43
YOV	NAB	22	96	56	58
CAQ	FIR	22	96	58	58
HIW	LED	19	98	59	70
XEN	PIC	15	99	59	59
YEX	DIG	19	100	59	61

Table 4 (continued)

(b) Low stimulus AV, high response AV (LH)

CVC pair S	R	S AV	R AV	MAS	FAS
COJ	LES	16	98	61	57
JEV	HAD	21	100	61	77
QIG	YES	14	99	61	53
WOY	CAL	22	96	61	61
ZEH	ROT	14	100	62	58
LIW	RUM	19	100	63	75
QEH	TIP	13	100	63	62
FIW	HEP	22	99	64	67
VUH	DEN	16	100	64	64
XAT	PEG	14	99	65	72
QUK	HER	19	100	66	68
YUX	MAD	14	100	71	66
GIW	SEX	16	100	73	66
PIJ	HUM	21	97	84	78
WEF	SOX	20	98	84	88

Table 5

Items Previously Scaled by Richardson and Erlebacher (1958) and Used in an Experiment by Goss and Nodine (1965) Ordered in Terms of Increasing MAS

CVC	CVC	S	AV R	EL*	CM*	MAS	FAS
XEJ	FON	3	65	4.33	3.11	21	19
VAF	QAP	22	24	5.87	3.85	24	30
LAJ	VUX	14	18	4.77	3.24	26	16
JAT	LEQ	41	28	5.98	3.91	28	30
TEV	XEF	40	3	5.02	2.68	28	27
XEQ	GID	6	63	4.44	2.61	29	28
YEG	MEC	31	67	5.63	3.70	29	32
BIP	QES	71	26	5.81	3.07	30	33
KEX	BEH	39	44	6.53	3.59	30	33
HOD	BOF	69	31	6.75	4.96	37	48
TES	JIQ	80	13	5.26	3.19	37	43
PAC	QIH	93	6	5.74	2.96	38	54
LAN	KUC	75	32	6.80	3.85	40	54
GIC	WIP	19	86	7.11	4.25	42	44
VAK	JEN	37	88	6.47	3.98	42	43
CIJ	DUL	8	91	5.07	3.39	43	53
BES	CEH	85	25	5.91	4.43	43	48
BEP	LIS	58	83	7.16	4.54	45	59
REG	KIH	91	15	5.59	4.17	47	48
BEL	VIF	99	21	6.99	3.75	48	58
GOV	NUB	95	76	6.68	4.24	58	62
NAV	RUQ	72	24	6.45	4.75	58	72
POH	SAV	52	86	7.03	4.42	62	68
VOL	DET	82	69	7.96	5.20	65	66
PAV	KOF	76	71	7.59	4.28	70	73
WIZ	SEC	83	88	6.99	5.94	80	82
TEL	CUM	99	92	8.89	6.39	92	97
FEM	HOS	90	81	8.22	6.47	93	93

*Ease of Learning (EL) and Common Meaning (CM) values from Richardson and Erlebacher (1958).

Table 6

Pairs Used in Experiments 1, 2, and 3, Their Mean AV and FAS Values

		Mean AV	FAS
Group 1 (Lowest AS)			
QEF	WUQ	8	16
ZIJ	XIY	4	17
XUB	ZUF	8	13
HIB	ZAN	43.5	26
RAX	YOC	45.5	29
MOY	CIB	46	35
CAY	HEK	74	51
YUK	FOS	67.5	49
BIM	FEY	68	45
PAR	DAB	99	73
VAN	PIN	100	80
BEL	MAC	99	82
Mean		55.2	43
Group 2 (Low-Middle AS)			
YIG	LUJ	10	22
XUP	QIY	7.5	23
QEV	ZOF	11.5	24
DIQ	JIR	41	43
JAH	QAM	44	43
BEH	PEQ	44	44
DAL	YOW	73.5	65
TAV	HOD	69.5	64
LIQ	DAF	72.5	64
DIM	TEL	99	89
PUT	RAW	99	90
SOW	BUZ	99	90
Mean		55.9	55

Table 6 (continued)

		Mean AV	FAS
Group 3 (High-Middle AS)			
GUQ	FOJ	11	30
XET	QAJ	11	30
YUJ	XOG	9	30
VAD	JUK	39.5	53
TEP	WIX	44.5	58
PUH	WEJ	42	53
PES	DAW	67.5	71
NAM	DUP	73.5	73
ROF	LEF	67	74
RAP	SIX	99	93
JOB	SAW	100	94
ROB	KIT	100	94
Mean		55.3	63
Group 4 (High AS)			
VIJ	XON	9	57
ZAJ	XIZ	7	41
TUJ	YOJ	9.5	53
YUS	NIS	40.5	75
QAN	GOH	40.5	78
XAM	LOZ	39	70
CAS	PEL	75	90
RIV	SAF	69	84
BOK	DET	69	85
DOG	BAR	100	98
TAN	HID	99	97
MAN	RUN	99	99
Mean		54.7	77

Table 7

Average Number of Exposures per Item on Trial 1 and To Criterion, and Proportion of NLMs Reported per Item in Experiment 1

AV Levels Within Lists		Lists Learned by Independent Groups 1 (43)*	2 (55)*	3 (63)*	4 (77)*	Means
Low	Trial 1	6.10	6.46	7.10	5.77	6.36
	To Criterion	12.31	13.38	15.73	11.21	13.16
	Prop. NLMs	.06	.21	.29	.33	.22
Low-Middle	Trial 1	5.48	6.00	5.14	4.98	5.40
	To Criterion	11.15	12.08	11.81	9.06	11.03
	Prop. NLMs	.25	.48	.35	.58	.42
High-Middle	Trial 1	4.31	4.77	3.29	3.10	3.87
	To Criterion	9.35	10.40	8.60	6.33	8.67
	Prop. NLMs	.35	.56	.58	.63	.53
High	Trial 1	2.56	2.73	2.19	1.81	2.32
	To Criterion	6.75	7.27	7.21	5.04	6.57
	Prop. NLMs	.42	.67	.79	.81	.67
Means	Trial 1	4.61	4.99	4.43	3.92	
	To Criterion	9.89	10.78	10.84	7.91	
	Prop. NLMs	.27	.48	.51	.59	

*Mean AS

Table 8

Average Number of Exposures per Item on Trial 1 and To Criterion, and Proportion of NLMs Reported per Item in Experiments 2 and 3

AV Levels Within Lists		Experiment 2			Experiment 3		
		List 1 (43)*	List 4 (77)*	Means	List 1 (43)*	List 4 (77)*	Means
Low	Trial 1	7.36	7.51	7.43	4.84	4.28	4.56
	To Criterion	16.09	14.98	15.54	9.01	7.69	8.35
	Prop. NLMs	.02	.20	.11	.09	.26	.17
Low-Middle	Trial 1	5.73	5.31	5.52	3.95	3.28	3.61
	To Criterion	13.31	10.42	11.87	8.21	6.20	7.20
	Prop. NLMs	.16	.29	.23	.32	.54	.43
High-Middle	Trial 1	5.22	3.13	4.18	3.44	2.32	2.88
	To Criterion	11.91	7.42	9.67	7.00	4.91	5.95
	Prop. NLMs	.16	.47	.32	.49	.67	.58
High	Trial 1	2.67	2.13	2.40	1.96	1.42	1.69
	To Criterion	7.87	6.33	7.10	5.04	3.93	4.48
	Prop. NLMs	.27	.60	.44	.56	.59	.57
Means	Trial 1	5.25	4.52		3.54	2.82	
	To Criterion	12.30	9.79		7.31	5.68	
	Prop. NLMs	.15	.39		.36	.51	

*Mean AS