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ABSTRACT

Theorists have argued that the relatedness of words depends upon the degree to which they are associatively connected. Hierarchies of association have been established using two experimental methods: (1) the procedural method, and (2) the repetitions method. Since the results of the two methods have proven to be somewhat inconsistent, a study was designed which examined the relationship between the two methods by presenting a list of 20 stimulus words three times in different random orders to 96 college student subjects. Tabulations were kept for the frequency with which associations given on the first trial were repeated in subsequent trials. It was hypothesized that the frequency would increase as the cultural frequency of the association increased. In general, it was found that cultural frequencies do predict the index of repetition of associates, and hence, they represent individual association hierarchies. (EMH)

The Prediction of Individual Association Hierarchies from Cultural Frequencies

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Pre-Publication Draft

Your comments would be very welcome

The Prediction of Individual Association Hierarchies from Cultural Frequencies

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Because of the importance of the concept of association in the history of psychology, the use of free association norms to describe verbal materials has enjoyed great popularity.[1] Among the more recent uses of such norms, one of the most important has been as an index of the "relatedness" of words. Several theorists[2] have argued that the relatedness or meaningful similarity between words depends upon the degree to which they are associatively connected. This argument is based upon the assumption that "the distribution of responses to any free association stimulus forms the associative meaning of the stimulus word and thus an associative concept named by the word."[3] The most obvious way of measuring the associative-relatedness of two words is by the relative frequency with which they evoke each other in cultural, free association norms. Deese[4] has also used this procedure to obtain a measure of the total relatedness of a list of words: interitem associative strength. A more complex approach to measuring associative-relatedness is that of assessing the degree to which two or more words produce common associates.[5] In all cases, the measures are based upon the frequency with which particular stimulus words yield particular associations.

The importance of the concept of associative relatedness lies in its widespread use as an independent variable in various problems of verbal behavior. It has been used to predict: performance in paired-associate learning,[6] interference and forgetting,[7] positive transfer in verbal learning,[8] clustering in free recall,[9] associational analyses of concept formation,[10] semantic generalization,[11] sequential contingencies in emitted speech,[12] and the effects of linguistic context on the production of speech.[13] The tacit assumption in all the above examples has been that the "distribution of responses taken one per

individual per stimulus word . . . is characteristic of the distribution of associations at different times in any one representative individual."[14] Perhaps because such an assumption appears to be so reasonable, relevant data are rare. However, the assumption has not gone completely unchallenged.[15] Indeed, the general use of averaged values to represent individual verbal processes has come in for some very heavy criticism during the course of the recent one-trial learning controversy.[16] For these reasons, a direct comparison of frequencies obtained on cultural association norms to response strengths in individual association hierarchies is badly needed.

There are two experimental designs which may be used to generate individual hierarchies of association. The first involves having S respond to each stimulus repeatedly during a specified periond of time. This may be called the production method because of its resemblance to Noble's[17] procedure for measuring meaningfulness. Here, Ss are instructed to give a sequence of different responses to each stimulus, so that the strength of any one response cannot be indexed by how often S repeats it. Instead, the serial order in which the response is given must be used to measure its strength. The response given most frequently in each serial position by a sample of Ss would then comprise the hierarchy of response strengths for a given stimulus. The second procedure involves testing each S for the entire list of stimuli on several different occasions. This may be called the independent repetitions method. In this method, the average frequency of repetition of a response would be used to index its strength in the average individual hierarchy.

There are difficulties inherent in each of these procedures, but those connected with the independent repetitions method seem less serious for the purpose of comparison with cultural frequency norms. The degree to which responses obtained by the independent repetitions method are actually independent is quite

difficult to assess, since S's memory for prior responses cannot be eliminated no matter what time intervals between tests are used. In addition, this method involves the problem of contextual determination of responses. That is, the immediately prior items on the list can influence the response to a particular stimulus.[18] However, the absolute independence of responses is not critical since the important comparison would be that between associations of different cultural frequencies, and their independences should not differ unless they also differ in response strength. Similarly, the associative strength of a response should determine its ability to withstand the effects of shifting context from test to test. For this reason, the best procedure would be to compare responses of differing cultural frequencies with regard to the frequency that they are repeated after having been given on the first trial of an independent repetitions experiment.

With regard to the difficulties of the production method, it must be noted that only order of response-emission can be obtained and that this is an indirect measure of associative strength. This difficulty is slightly mitigated by the well substantiated finding that cultural frequency is highly correlated with associative reaction time.[19] A more serious problem lies in the scorer's inability to eliminate associative chains from the data, which makes later associations given to a stimulus likely to be associates to prior responses.

Some evidence from the production method suggests that cultural frequencies do predict individual association strengths. Cofer[20] had Ss give associations to 25 stimuli from the Kent-Rosanoff[21] norms, and pooled the frequencies of all responses given to each stimulus. He found high agreement between the ranks of his frequencies and those obtained by Kent and Rosanoff. However, since Cofer did not consider the serial position of the responses he obtained, his data are not relevant to the problem of comparability between group and individual asso-

ciations hierarchies. Rosen and Russell[22] obtained two successive associations for 100 of the Kent-Rosanoff stimuli and found: (a) that the mean cultural frequencies of first associations were substantially higher than those of the second associations and (b) that for no response pair was the second response's cultural frequency higher than that of the first response. Garskoff[23] gave two independent groups of Ss either a single or a continuous association test for 20 words. The average order of emission of associations correlated with frequency of single associations between .52 and .94, with a median of .795.

Indirect evidence that cultural frequencies and production-method hierarchies are similar comes from several sources. First, Garskoff and Marshall[24] found that measures of the associative overlaps of 140 words obtained from single associations and from the production method were correlated .76. They also found, however, that the single-association measure of overlap was more sensitive to the degree of direct association between pairs of words. Similarly, the overlap coefficients between pairs of words on various semantic categories obtained by Laffal and Feldman[25] from single and continuous word associations correlated .88. Finally, it should be noted that the number of different responses obtained from the production method correlates highly with the number of Ss able to give a single association.[26]

There is very little evidence regarding the relation of cultural association frequencies to individual hierarchies obtained by the independent repetitions method. Laffal[27] has found that, in the clinical setting, Ss who failed to repeat an association to a stimulus were more likely to have given a response that had strong competitors on the cultural norms than were Ss who did repeat an association. The present study was designed to obtain more systematic information concerning this relation by presenting Ss a list of words three times, in dif-

ferent random orders, and calculating the frequency with which various associations given on the first trial were repated on subsequent trials. It was hypothesized that this frequency would increase as the cultural frequency of the association increased. Different groups of Ss were given lists of high and low frequency words. It was predicted that the High-F words would produce a higher level of repetition of associates, since associations to High-F words tend to show more communality than do associations to Low-F words. Separate analyses were made of the repetitions to cultural-frequency function for paradigmatic (same form class) and syntagmatic (different form class) associates. Since paradigmatic associates are presumed to be less dependent upon particular linguistic contexts,[28] it was hypothesized that they would be disturbed less by shifts in the items preceeding a stimulus word; and hence both be repeated more often than syntagmatic associates and show a clearer relation between repetition level and cultural frequency.

Method

Subjects and apparatus. The Ss were 96 college students from an introductory psychology course. Half randomly were assigned to each of two list-conditions: high frequency and low frequency. The Ss were run in small groups ranging in number from 1 to 6, with a mean of 3.4. A·Bell and Howell Robomatic slide projector with automatic timer showed each word for 5 seconds on a milk-glass screen.

Materials. Two lists of two-syllable nouns were used, one at each frequency level. Each list contained 20 words. The L count[29] for the High-F nouns ranged from 1000 to 3300 occurrences per million, while for the Low-F nouns it ranged from 10 to 33 occurrences. Familiarity, interitem associative strength and rated meaningfulness covaried with frequency, but the lists were equated for formal similarity. Association norms for these words had been obtained previously from

1000 Ss at the University of California.

Procedure. Both groups of Ss were shown their list for 3 trials. The intertrial interval was 25 seconds. All Ss were instructed that they were to participate in an experiment concerning the consistency of associations. They were told to cover each association given to a word before they saw the next stimulus word, and that the list of words would be shown in a different order on each presentation. They were asked not to try to recall previous associations, by simply to give the first word that came to mind regardless of what it was. Four different random orders of presentation were used for each of the lists. In each treatment group, 12 Ss received each of the orders first. Four Ss from the Low-F condition and two from the High-F condition were discarded because they had been recently in another verbal learning experiment.

Results

Representativeness of sample. Since the California association norms were used as the frequency values for predicting probability of repetition in this experiment, a comparison was made between the first associations given by the present sample of Ss and the associations given by the 1000 Ss in the California sample. Table 1 shows, for each list, the percentage of responses that fall

Insert Table 1 about here

in each of the first 5 California ranks, both for the present sample and for the larger, California sample. It can be seen that the distributions according to ranks are roughly similar in the two cases, and that the major differences come from the present sample of Ss giving a greater percentage of California-norm primary responses than did the Ss from whom those norms were obtained. This difference may be expected on the basis of the smaller sample used in the present study, and the fact that the Ss in the California sample were associating to a substan-

tially longer list. A specific comparison was made of the five responses given most frequently by both samples to each of the 40 stimulus words. The primary response given by the California sample for 31 of the stimuli was also the primary for the present sample; for 5 of the stimuli the California primary was the secondary response given in this experiment. In only 80 instances of a possible 400 did any word appear in the first five ranks of one sample, but not the other. In all, the present sample of Ss seems quite representative of the larger one.

Probability of repetition and cultural frequency. Each association given on the first trial of this experiment was first classified according to whether it fell in one of the first five frequency ranks of the California norms, in ranks greater than five, or was idiosyncratic. Next, the associations were assigned to one of three repetition categories: (1) repeated on both subsequent trials, (2) repeated on one of the subsequent trials,[30] (3) repeated on neither of the subsequent trials. The percentage of responses from each of the seven cultural-frequency categories that were repeated twice, once, and not at all was then calculated. Table 2A presents these data for the pooled responses from both lists, along with the number of responses obtained at each frequency level.

Insert Table 2 about here

It is apparent that the probability of obtaining two repetitions increases directly with the relative frequency of the association, while the probability of obtaining no repetitions increases inversely with relative frequency. The probability of obtaining one repetition does not vary in any systematic way. There appear to be five discrete categories (with ranks 3, 4, and 5 forming a single category) so far as probability of repetition is concerned. Chi-square tests were performed on the separate distributions obtained from the high and low frequency lists to test the hypothesis that the cultural frequency of the

responses did not change the distributions across the three repetition categories. The expected values used for these tests were calculated by taking the percentage of all responses to a list that fell in each of the repetition categories and multiplying it by the number of responses at each cultural-frequency rank. The values obtained were 101.29 and 71.51 for the High-F and Low-F lists, respectively ($df=20$, $p<.001$, for both).

The first associations given were also classified into seven percentages of absolute cultural frequency in order to see whether probability of repetition is more sensitive to this variable than to relative frequency (i.e., ranks).[31] The distribution of repetitions, however, was substantially the same as that using ranks. (See table 2B.) Again, five discrete categories were found: over 25.0%, 5.0%, 24.9%, 0.6%-4.9%, 0.2%-0.5%, and idiosyncratic.

To further investigate the respective influences on probability of repetition of absolute and relative frequency, an index of repetition was calculated for: the five primary associates in each list with the lowest absolute frequencies, five rank-3 associates in each list with matching absolute frequencies, and the five primary associates with the highest absolute frequencies, and the five primary associates with the highest absolute frequencies. The index of repetition (IR) represents the total number of times that an associate is repeated over the 2nd and 3rd trial divided by the total number of opportunities. Table 3 presents the means for IR and cultural frequency (CF) for these 30 associations.

Insert Table 3 about here

The most common primary responses were repeated more often than the least common primaries ($t=1.75$, $df=19$, $.05<p<.10$), while the IR for primaries and secondaries of matched absolute frequency did not substantially differ ($t<1$).

High vs low frequency lists. The hypothesis that high frequency stimuli would produce greater associative repetition than low frequency stimuli was not-

confirmed, despite the fact that the high frequency list did yield far greater commonality of responses (see table 4). Overall indices of repetition for the High-F and Low-F lists, respectively, were 52.1% and 51.7%. The reason for this lack of difference may be observed in table 4, which displays the IR values across frequency ranks for the two lists. The idiosyncratic responses given

Insert Table 4 about here

to the Low-F stimuli are repeated substantially more often than those given to the High-F stimuli. In fact, it appears that the High-F list produces a generally steeper function relating cultural frequency and probability of repetition. However, a chi-square test of the assumption that the two distributions do not differ yielded a value of only 6.29 (df=13, $p.>.90$). It should also be noted that the secondary responses given to the Low-F stimuli produce an IR that resembles that for the primaries, while the secondary responses given to the High-F stimuli produce an IR similar to that for ranks 3, 4, and 5. This difference cannot be accounted for by the fact that the absolute frequencies of primary and secondary responses are slightly more similar in the Low-F list, since replacing frequency ranks with absolute frequencies does not eliminate the difference.

Paradigmatic vs syntagmatic associates. Each association given to a stimulus word was classified by two judges as paradigmatic, syntagmatic, or clang. The basic conceptual distinction between the first two categories is that of whether the associate is substitutable for the stimulus in sentence positions, or the associate occurs contiguously to the stimulus in sentence positions. Usually, but not always, the substitutability (paradigmatic) criterion is met when stimulus and response are of the same grammatical form class and the contiguity (syntagmatic) criterion is met when they are of different form classes. In many cases both criteria may be fulfilled, in which case (if the contiguity is in S-R direction) the association was classed as syntagmatic. In 25 doubtful

cases, 10 additional Ss were asked whether the S-R sequences were ones which actually occur in the English language. In only two cases was there less than 7/10 agreement, and these were eliminated.

Contrary to the hypothesis, the overall IR was slightly (but not reliably) lower for the paradigmatic associates: 51.3% vs 52.8%. Nor do the paradigmatic associates show any trend toward a steeper function relating IR to frequency rank. A chi-square test of the hypothesis that the two distributions do not differ yielded a value of 4.17 (df=13, $p > .95$).

The percentage of syntagmatic responses obtained on the first trial for the two lists is roughly comparable with that obtained by Deese,[32] though slightly higher. Unlike adjectives, where he found lower percentages of syntagmatic responses with increasing frequency, Deese found no relation between frequency and percent-syntagmatic associates for nouns. In the present study, the High-F nouns have a somewhat higher percentage of syntagmatic responses (36.9% vs 26.5%) but this difference is not reliable ($t=1.21$, $p > .20$). The reason for this difference seems to be that 7 of the 20 High-F nouns used may also be used as other form classes (i.e. verb or adjective), while only 2 of the Low-F nouns have such dual function. Having included within the criterion of syntagmatic response any associate which shows both substitution and contiguity characteristics, one would expect these dual function words to yield greater syntagmatic percentages; which, indeed, they do.

Discussion

The major finding of the present experiment is that cultural free association norms do reflect individual association hierarchies, as measured by probability of repeating an associate. It appears, however, that the association strengths obtained from the single associations of a large number of subjects yield a finer gradation than those obtained from probability of repetition within subjects.

This fact is in accord with some recent data showing that weaker cultural associations may produce as speedy direct and mediated paired-associate learning as do stronger cultural associations.[33] Perhaps cultural free association norms produce a spurious fineness of gradation in associative strength. Storms,[34] however, has suggested an alternative interpretation: that "recency" operated to temporarily strengthen weaker associations. He showed that if Ss are given a list of words to recall prior to an association task, that the words on the list become more likely to appear on the association protocols. It would be useful to see if the gradation in probability of recall could be sharpened by using very long intervals between trials.

The present data strongly suggest that absolute cultural frequencies are more reliable indices of intrasubject association strengths than are cultural-frequency ranks. Primary and rank-3 responses of equal absolute frequency showed equivalent IR values, while those same primary responses were repeated 12.3% less often than more commonly given primaries. It is possible that some other factor than absolute associative frequency was responsible for this difference. For example, primary associates of greater frequency have greater superiority over their nearest competitor than primary associates of lower frequency. Also, more common primaries might be more likely to occur to stimuli that produce a smaller total number of different associations, or to stimuli that produce more associations that are related to the primary associate. Although it is not possible to select among these alternatives with the small number of stimuli used in this experiment, it would seem preferable to use the frequencies rather than the ranks from cultural association norms for diagnostic purposes.

Despite finding the expected larger number of primary responses and smaller number of idiosyncratic responses with the High-F list than with the Low-F list, no overall difference was found in the level of repetition for the two lists.

It was shown that this was mainly the result of a significantly higher repetition level for idiosyncratic responses in the Low-F list. It may well be that this phenomenon is the result of idiosyncratic responses representing different things for frequent and infrequent stimuli. For one thing, High-F words are likely to have been experienced in a wider variety of linguistic contexts than have Low-F words, for any one individual. But the dominant linguistic context for Low-F words should be more variable between individuals. Thus, an idiosyncratic response to a High-F stimulus may represent the influence of some transient feature of the momentary context, while an idiosyncratic response to a Low-F stimulus may be a truly strong associate for that individual which he does not share with other individuals. For these same reasons, one would expect idiosyncratic responses to High-F stimuli to be subject to a greater number of competing associations than are idiosyncratic responses to Low-F stimuli. Such an interpretation is supported by the fact that High-F words yield a greater number of different associations per person in the production method,[34] despite showing less associative variety in single-response hierarchies. It is thus quite possible that cultural association norms give a somewhat inaccurate picture of the individual response hierarchies of extremely unfamiliar words.

It is also possible that the repetition level for more common associates of the High-F list was depressed by a general tendency to inhibit repetition of a response to successive stimuli. Thus, S has just said "man" to the stimulus "doctor," he may inhibit saying it again if "woman" is the next stimulus. The overlap in associative hierarchies is much greater for High-F words than for Low-F words, so it is possible that a reliable difference between IR values for the two lists would have been obtained if they had been mixed into a single list.

The failure to find either a difference in overall level of repetition or a difference in the sharpness of the frequency-IR function between the paradig-

matic and syntagmatic associations is truly puzzling. There are two general possibilities open as an explanation. Either the effect of shifting the linguistic context from trial to trial was minimal, or else syntagmatic associates have some special way of resisting such contextual shifts. The former alternative could be investigated by introducing more radical contextual shifts from test to test and noting whether differences between paradigmatic and syntagmatic associations appear.

Summary

Ss were given three successive free-association tests to a list of 20 stimulus words of either high or low frequency. The index of repetition (IR) of associations was analyzed as a function of their commonness on cultural association norms. In general, it was found that cultural frequencies do predict IR of associations, and hence they represent individual association hierarchies. The only difference found between IR for High-F and Low-F lists was a higher value for idiosyncratic responses in the Low-F case. No differences in IR values was found between paradigmatic and syntagmatic associations.

Footnotes

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[30] This category was originally divided into: (1) repeated on trial 2, and (2) repeated on trial 3. Since the frequencies in these two categories were nearly identical in all cases, they were merged.

[31] These frequency categories were empirically derived from "natural" cut-off

points in the frequencies with which different frequency-values were obtained.

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Table 1

Per Cent Responses Falling in Different Frequency-Ranks of the California Association Norms

	California Norms		Present Sample	
Rank	High-F	Low-F	High-F	Low-F
1	28.3	24.9	33.0	27.9
2	10.9	11.5	10.6	13.4
3	6.0	6.8	7.4	7.6
4	5.1	4.6	7.1	4.8
5	4.1	3.5	3.5	3.2
>5	36.4	34.9	31.3	25.5
Idio-syncratic	9.2	13.8	7.1	17.6

Table 2

Per Cent Associations Repeated in Both Lists as a Function of Cultural Frequency

A. By Frequency-Rank

Rank	No. Rs	%2 Repeat	%1 Repeat	%0 Repeat
1	543	53.6	24.7	21.7
2	213	44.1	28.7	27.2
3	133	39.8	24.1	36.1
4	107	36.5	32.7	30.8
5	60	40.0	23.3	36.7
>5	506	29.0	28.1	42.9
Idio-syncratic	217	19.4	19.4	61.3

B. By Frequency-Percentage

Frequency	No. Rs	%2 Repeat	%1 Repeat	%0 Repeat
25.0	356	58.4	24.2	17.4
12.0-24.9	323	44.3	27.9	27.9
5.0-11.9	271	42.4	27.7	29.9
2.0- 4.9	249	31.7	26.9	41.8
0.6- 1.9	218	33.0	26.1	40.8
0.2- 0.5	145	24.8	26.3	48.9
Idio-syncratic	217	19.4	19.4	61.3

Table 3

Mean Cultural Frequency and Index of Repetition for Selected Associations

	High-F		Low-F		Combined	
	% CF	IR (%)	% CF	IR (%)	% CF	IR (%)
High Primary	55.1	73.1	44.4	69.9	49.8	71.6
Low Primary	10.5	56.7	10.1	61.9	10.3	59.3
Matching Rank-3	8.8	55.8	9.5	63.7	9.2	59.8

Table 4

Index of Repetition of High and Low Frequency Lists

	High-F		Low-F		Combined	
Rank	No. Rs	IR (%)	No. Rs	IR (%)	No. Rs	IR (%)
1	301	67.8	242	63.6	543	65.9
2	97	53.6	116	62.5	213	58.5
3	67	52.2	66	51.5	133	51.9
4	65	54.6	42	50.0	107	52.8
5	32	51.6	28	51.8	60	51.7
> 5	285	41.2	221	45.5	506	43.1
Idio-syncratic	64	21.9	153	32.0	217	29.0