The Effects of Social Environment on Paired-Associate Learning and Retention in Normal Elementary School Children

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THE EFFECTS OF SOCIAL ENVIRONMENT ON PAIRED-ASSOCIATE LEARNING AND RETENTION IN NORMAL ELEMENTARY SCHOOL CHILDREN*

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For many years, psychologists have showed considerable interest in the relationship between ability and verbal learning and retention. In general, the research evidence is consistent with the common belief: rate of acquisition of a verbal task is a positive function of initial level of ability (6, 7, 8, 19, 21, 22). Data of this type suggest that verbal learning is a fertile field for research on learning and individual difference in intelligence.

This generalization, however, does not hold in the forgetting phenomenon. Although an early study by Gillette (9) indicated that fast learners retained more than slow learners, the data of recent studies (12, 26, 27, 28) indicated that the individual differences presented in forgetting do not follow the same pattern as those in learning. That is, there is no evidence that the rate of forgetting differs significantly between fast and slow learners.

Group differences in learning and forgetting based on independent variables other than intelligence have not yet been investigated. The present study represents an attempt to investigate the effects of social environment on paired-associate learning and retention in two groups of normal elementary school children.

The major theoretical position from the experimental point of view with respect to forgetting places great emphasis upon interference as a critical factor (24, 29). The interference is said to stem from the learning of other tasks following the learning of the task to be recalled (retroactive inhibition) and from tasks acquired prior to the learning of the task to be recalled (proactive inhibition). There has been a shift in the relative importance assigned to these two sources of interference. In earlier years, retroactive inhibition was assumed to be the major source of interference in producing forgetting. Recently, however, Underwood (29), Underwood and Postman (32) and Postman (24) have assigned the major role to proactive inhibition. The reason for this switch in emphasis comes mainly from the concept of spontaneous recovery of old habit being temporarily suppressed during the learning of a new habit. Thus spontaneous recovery of prior learning producing proactive inhibition is assumed to be an important variable in long-term memory. This assumption has been supported by research evidences (2, 1,

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25, 15). This concept has been widely accepted (14, p. 501) and been extended by Underwood and Postman (32) and McGovern (20) in terms of ordinary language habits (letter-sequence interference and unit-sequence interference) and multidirection associations (S-R and R-S, etc.).

This development has brought about a fundamental change in the interference theory and has stimulated a new direction of research. Several hypotheses have been developed based on the concept. Klausmeier et al. (16), for example, hypothesized: (1) high IQ children would learn rapidly and forget rapidly whereas low IQ children would learn slowly and forget slowly; and (2) retention would be the same among children of low, average, and high intelligence when the tasks are learned to the same criterion. Underwood (31) hypothesized: (1) very young children would show less rapid forgetting of a verbal task than college students because of the fewer conflicting associations in children's repertoire to cause proactive inhibition; and (2) if an imbecile were given enough trials on a verbal task to reach the same degree as that attained by a genius, the genius would show more rapid forgetting because he has learned more things and will subsequently learn more things that will interfere.

These kinds of hypotheses have been tested by a number of studies in the last decade, but the results are conflicting. Some findings indicated no difference among groups with different IQ levels either on original learning or on retention (5, 13, 18,). Some studies found differences on rate of learning, but not on retention (3, 16, 17). Still others indicated no differences among ability levels on learning, but significant differences on retention (23, 33).

In general, the previous studies have three similarities: (1) verbal tasks were used as learning material and the single paired-associate learning technique was employed; (2) measures of long-term memory were used as criterion of retention; and (3) two (or more) IQ groups, principally normal and mentally reatarded children, were used as subjects. Based on the original hypotheses proposed by Klausmeier (16) and Underwood (31), and according to the current version of the interference theory, it seems logical to assume that the degree of proactive and retroactive interference is greater for normal children than for retardates because of their more diverse verbal experience. From the methodological and theoretical points of view, however, it is difficult to generalize the results because extraneous variables have not been consistent among the treatment groups. In other words, the previous studies were possibly contaminated because their designs did not take into account other sources of differences.

If other variables rather than verbal experience were equal, the less intelligent children might forget less rapidly because of less interference. Unfortunately, the experiments comparing normals and retardates on learning and retention permit no degree of experimental control over the related variables. Underwood (30, p. 123), for example, suggested that if we separate subjects on the basis of a particular characteristic (e.g., intelligence) and then test them on an aspect of behavior not used in the

original separation, the groups should be equated on all other variables other than those used to effect separation. More recently, Goulet (10) pointed out that mentally retarded subjects may have an additional variable of structural memory deficiency. If this is the case, the course of forgetting over time in the normals and in the retardates would be different. Verbal forgetting in normal children might be attributable to only two variables, namely, proactive and retroactive interference. In the retardate group, however, the course of forgetting must be considered to be a joint function of three variables, proactive and retroactive interferences and the structural deficiency.

Because of the methodological weakness, the results of the studies comparing normals and retardates are subject to difficulty in interpretation. This led Baumeister (3) to conclude "To understand the behavior of retardates one must study the behavior of retardates. The study of normal behavior is quite irrelevant to this purpose." To the same effect, to understand the behavior of normal one must study the behavior of normals.

For this reason, the present study instead of comparing normals and retardates in learning and retention, two normal groups drawn from different social environments employed as subjects. According to the current version of the interference theory, it is reasonable to assume that individuals living in a complex and enriched social environment would have more verbal stimulations than that of living in a simple and deprived social environment. These differences may influence children's verbal experience in producing different effects upon their learning and retention. The present study was designed to investigate the effects different verbal environment on children's paired-associate learning and retention.

In viewing of our language habits in terms of the concepts of unit-sequence interference (32) and multi-direction associations (20), they seem to be more relevant to Chinese than to English. The basic expressions in the Chinese language are not single words (characters) but terms, which are combinations of two or more single words. Chinese children have to learn the meanings of the single words as well as the derived new meanings of the terms. In considering the variety of Chinese language, two features, at least, of the basic unit of Chinese language should be identified: (1) the original meaning of a single word may be changed completely when it is combined with other words; and (2) the single words can be in different positions with different functions (S or R) and meanings in different combinations. According to the current interference theory, the complex associative interferences must be apparent in Chinese language learning. Based on these phenomena, it would be logical to assume that Chinese children who have more diverse verbal experiences would have more associative interferences which would produce forgetting.

Within the frameword of the general problem and theoretical consideration above, the following two hypotheses were postulated:

1. There is no significant difference between the two groups in the measures of learning based on the trials to criterion of original learning.
2. There is no significant difference between the two groups in the measures of

retention of learned material based on the number of correct responses obtained after different time intervals.

METHOD

Subjects Fifty normal children (25 boys and 25 girls, IQ range 90 to 115), who were enrolled in elementary public school fourth grade classes in an urban area (Taipei City) were selected as subjects for the urban normal group (UNG). In addition to the variable of intelligence determined by a standardized non-verbal intelligence test, the UNG subjects were selected on the basis of the following criteria. All of the children had attended kindergartens at least one year. Their parents had at least high school educations. They had lived in the same environment since birth. Most of their families provided reading materials above and beyond school textbooks.

Another fifty normal children (25 boys and 25 girls, IQ range 90 to 115), who were enrolled in elementary public school fourth grade classes in a rural area were selected as subjects for the rural normal group (RNG). The selection of this group was based on the following criteria. None of the children had preschool education. Their parents' education did not extend elementary school. They had lived in the same environment since birth. Most of their homes did not provide reading materials other than school textkooks.

Materials The learning materials for this experiment consisted of 12 paired-associate verbal tasks (unrelated pairs of Chinese characters). Each of the paired-associate words was printed in black ink on a $4'' \times 6''$ white card. These words were selected on the basis of two criteria: (1) all words had to be known by the subjects; the subjects' task was to learn the associations of the paired words, not the separate words themselves; and (2) according to the textbooks previously used by the subjects and the Chinese language used daily, none of the paired-associates could be a meaningful term; that is, the learning task had to be new to the subjects and the pairedassociate words had to be unrelated.

Procedure Since one of the purposes of the study was to investigate the relationship between subjects' verbal experiences and their learning environments, it was necessary to devise a technique for measuring verbal complexity. Therefore, a free-recall test was given to the subjects before experiment. A list of 15 Chineses words drawn from textbooks used previously by the subjects was given to the subjects, and they were required to use them as cues for making word-combination terms. In other words, the subjects were asked to recall freely the words associated with the 15 words on the list. In responding, the subjects could either use Chinese characters or national phonetic symbols which they learned in first grade. Within the time limitation, which was two minutes for each word, no restriction was placed on the kind or number of terms the subjects were to make. The only restriction was that each-combination term should contain one, but only one, word from the list. The total

number of the terms an individual recalled represented his verbal complexity, which was used as an index of the level of language development.

The experiment was conducted in a small room in the school. The experimenter (*E*) worked with subjects (*S*) individually. The subjects was seated at a small table facing *E*. After *E* recorded the name and birth date, the following instructions were given:

> We are going to play a game with these cards. I want you to read each of the two words on the card (*E* points to the card). Try to remember that the two words go together, because later I am going to show you just one word (*E* shows him the stimulus word on the back of the card) and ask you to tell me which word goes with it. Do you know how we play? (if *S* indicates understanding) OK, let's begin now.

E then manually presented each card to *S* at a rate of approximately five seconds per card, with *S* saying the words aloud. After one trial, exposing all 12 cards to *S*, *E* shuffled the cards and said:

> Now I am going to show you only one word on the opposite side of the card. Would you please tell me which word goes with it?

The cards were presented at a rate of approximately 5 seconds per card, with 15-second intertrial interval. At the end of each trial the cards were shuffled during the 15-second interval in order to control for possible serial effect. If *S* made an incorrect response to the stimulus word, *E* turned the card and *S* verbally corrected his response to the stimulus. Following a correct response, *E* responded with "good," "that's fine," or other expressions of approval and refrained from the card.

The material was learned by the adjusted-learning method originated by Woodworth (35) and adapted and refined by Gillette (9). By this method the cards in the deck were dropped out after *S* correctly responses. Again, when the number of cards in the deck reached zero, the deck was reassembed a third time and readministered to *S*. Thus, each subject made three correct responses to each of the stimulus words.

Subsequent to the attainment of the criterion, retention was measured by presenting *S* with only the stimulus words and recording correct responses. The time interval between termination of learning and the first retention test was one hour. When retention was measured, incorrect responses were not corrected by turning cards These procedures were repeated one day (± 2 hours), and 15 days (± 4 hours) after initial training session.

RESULTS

Original Learning The means and standard deviations of trials to criterion as well as the mean number of trials needed to reach the point of errorless response at different time of learning practice for the two groups are presented in Table 1. Since the main purpose of the study was to investigate the effect of social learning environ-

ments on pairedassociate verbal learning, the difference in the measures of learning of UNG and RNG should be tested first. Test of significance (t-test) applied to these data indicated that the difference between these two groups was not statistically significant.

To analyze the effect of interaction of social groups and the measures of learning, a 2×3 complete factorial analysis of variance with repeated on one factor (34) was used. The groups (UNG and RNG) and the three times of learning practice to reach the points of errorless response served as the independent variable, and mean numbers of trials needed for reaching the points served as a dependent variable. The results are shown in Table 2. The data indicated that the main effect of subject classification (UNG and RNG) was not significant. There were no effects attributable to the interaction between the subject classification and the mean numbers of trial needed to reach the points of errorless response for each time of learning practice. The data show clearly that both of the groups improved significantly ($F=173.90$, $p<.01$) through the three time of learning practice. The first hypothesis of the present study, therefore, was not rejected.

To provide more information concerning paired-associate verbal learning as related to environmental and sex factors, a 2×2 complete factorial analysis of variance was used to further analyze the data. The results are presented in Table 3, and the summary of the analysis of variance is shown in Table 4. As indicated in Table 4, the differences between boys and girls and between UNG and RNG were not significant. The effects of interaction of these two variables were also not significant.

Verbal Complexity The means and standard deviations of measures of subjects' verbal complexity two groups obtained by the method of free recall are presented in Table 5. Tests of significance (t-test) applied to these data indicated that the RNG Ss were significantly inferior to UNG ($t=4.51$, $p<.01$). This result indicated that the verbal development was a function of social learning environment.

Table 1 Means and Standard Deviations of Trials to the Point of Errorless Response and to Criterion

Group	N	First Time Reaching the Point of Errorless Response		Second Time Reaching the Point of Errorless Response		Third Time Reaching the Point of Errorless Response		Total Number of Trials to Criterion	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
UNG	50	7.78	2.98	4.76	1.92	3.48	1.38	16.02	5.44
RNG	50	8.04	3.77	5.42	2.20	4.16	1.87	17.62	7.08

Table 2 Summary of the Analysis of Variance of Trials Needed for Reaching the Point of Errorless Response

Source	df	SS	MS	F
Between Subjects	99	1348.26		
Between Groups	1	21.34	21.34	1.58
Subjects within Groups	98	1326.92	13.54	
Within Subjects	200	1373.33		
Between Times	2	876.45	438.23	172.90**
Interaction (Groups × Times)	2	2.80	1.40	.56
Times × Subjects within Groups	196	494.08	2.52	
Total	299	2723.59		

**p<0.01

Table 3 Means of Trials to Criterion of Paired-associate Learning as Related to Environmental and Sex Factors

Group	Boys	Girls
UNG	16.16 (n=25)	15.88 (n=25)
RNG	15.60 (n=25)	19.72 (n=25)

Table 4 Summary Analysis of Variance of Trials to Criterion of Paired-associate Learning as Related to Environmental and Sex Factors

Source	df	SS	MS	F
Between (Boys and Girls)	1	92.16	92.16	2.37
Between (UNG and RNG)	1	67.24	67.24	1.74
Interaction (Sex Groups × Social Groups)	1	121	121	3.14
Within	96	3697.04	38.51	
Total	99	3977.44		

Table 5 Means and Standard Deviations of Measures of Verbal Complexity

Group	N	Mean	SD
UNG	50	125.74	19.05
RNG	50	106.92	22.54

Retention The means and standard deviations of the correct responses of different groups on the tests of retention of learned material at different time intervals are presented in Table 6. A 2×3 complete factorial analysis of variance with repeated measures on one factor was used to analyze the retention data, and the results are presented in Table 7. These tables indicated, as expected, that the mean numbers of correct responses measured at different intervals were significantly different ($F=222.42$, $p<.01$). That is, the recall of the learned material was significatly reduced as time passed. Inspection of Table 7 indicated that differences between groups were also significant ($F=16.92$, $p<.01$). In order to determine which comparisons among the three means were significant, t-test was applied, and the results are shown Table 6. The results indicated that the retention scores of RNG were significantly superior to UNG at all three tests of retention obtained at different time intervals after original learning. The effect of interaction of groups and intervals was also significant.

Based on the results analyzed the second hypothesis that there is no significant difference between groups in the measures of retention was, therefore, rejected.

The measures of retention as related to environmental and sex factors were analyzed. The difference between boys and girls was not significant.

Table 6 Means and Standard Deviations of the Correct Responses of two Groups on Tests of Retention of Learned Material

		Retention Interval					
		1 hour		1 day		15 days	
Group	N	Mean	SD	Mean	SD	Mean	SD
UNG	50	8.14	1.86	6.90	1.73	4.94	2.09
RNG	50	9.72	2.18	8.02	2.08	6.78	2.15
t		3.90**		2.93**		4.34**	

**p<0.01

Table 7 Summary of the Analysis of Variance of Scores of Two Groups on Tests of Retention of Learned Material

Source	df	SS	MS	F
Between Subjects	99	1166.92		
Between Groups	1	171.77	171.77	16.92**
Subjects within Groups	98	995.15	10.15	
Within Subjects	200	686.00		
Between Intervals	2	471.53	235.77	222.42**
Interaction (Groups × Intervals)	2	6.64	3.32	3.13*
Intervals × Subjects within Groups	196	207.83	1.06	
Total	299	1852.92		

**p<0.01 *p<0.05

DISCUSSION

According to the interference theory and based on the facts that the children from culturally deprived environment were retarded in verbal development, it would be reasonable to assume that the subjects in RNG would have fewer old associations with the familiar stimulus words to be extinguished during the acquisitions of new associations. This might reduce the proactive inhibition produced by previous associations and consequently result in faster learning. In other words, the group which had lower verbal complexity would need fewer trials to criterion. The results of the present study, however, did not support this assumption. Contrary to expectations, when two groups were combined and mixed up without regard for social classification, a negative correlation ($r=-.23$, $p<.05$) was found between the measures of learning and the measures of verbal complexity. That is, the subjects who had more complex language habits learned faster than those who had simpler language habits. Based on the concept of interference, this rather tangled problem could not be readily answered. This phenomena might be explained in terms of extraexperimental transfer proposed by Goulet (11).

Fundamentally, there are two paired-associate transfer paradigms: A-B, A-C; and A-B, C-B. The designation implies that subjects learn two consecutive paired-associate lists. The A-B, A-C paradigm, involving identical stimuli and unrelated responses on the two lists, typically results in negative transfer. This negative transfer is attributed to interference where the first-list association (A-B) inhibits the new associations of the second-list (A-C). In the A-B, C-B paradigm, involving unrelated stimuli and identical or similar responses, a positive transfer is expected. This positive transfer

stem from the transfer of response learning from the first-list to the second-list. In the two-list experiment these types of transfer can readily be identified. Now could we use these concepts to interpret the peculiar phenomena of the obtained data?

In this experiment, instead of a two-list design, a single paired-associate task was employed. And particulary, both the stimulus and response items were meaningful Chinese words known previously by the subjects. These words, although unrelated in the designated pairs, were apparently associated with other words in the subjects natural language habits (word-combinationterms). If we take the learned single paired-associate task as A-C, and assume the stimulus item "A" had a number of preexperimental learned associations such as A-B, A-D, A-E, ...; the higher the verbal complexity, the more preexperimental associations. If this is the case, extraexperimental transfer would be negative (since the conceptualized paradigm is A-B, A-C).

However, the single paired-associate A-C should be considered as a multireaction association (20). Since both "A" (the stimulus item) and "C" (the response item) are meaningful words, they would not only have their own preexperimental associations, but also be associated in different ways. The following paradigm could be conceptualized:

B-C	A-C
(Preexperimental association)	(The single paired-associate)

If this is the case, the extraexperimental transfer would result in a positive effect. Furthermore, the preexperimental associations could be in various forms such as B-C, D-C, E-C, ... , with identical responses and unrelated stimuli. It follows from this paradigm that the higher verbal complexity and the more preexperimental associations, the better facilitation learning condition would be.

With these conceptual analyses above, the extraexperimental transfer might be either positive or negative in nature. The findings in the present study that the higher verbal complexity, the faster the learning to criterion, might be attributable to the positive extraexperimental transfer.

SUMMARY

Based on the current version of the interference theory, the effects of children's verbal learning environment on paired-associate learning and retention was examined. Two groups, UNG (n=50) and RNG (n=50), with equal IQ levels were drawn, based on defined selected criteria, from two social environments. The learning material was 24 unrelated Chinese characters, and the single paired-association technique was used. The results indicated: (1) The difference of measures of learning to criterion between two groups was not significant. (2) The difference of measures of verbal complexity measured by free recall revealed that the RNG Ss were significantly inferior to Ss in UNG. (3) RNG Ss retained significantly superior to Ss in UNG. (4) No significant difference between boys and girls was found either in learning or in retention. (5) The interference theory was partially supported by the findings of the present study.

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兒童語文學習環境對其聯對學習與遺忘之影響

張 春 興

摘 要

從實驗心理學的觀點看，干擾論（Interference Theory）素爲解釋語文學習後遺忘現象的主要理論。以往干擾論者咸認倒攝抑制（Rotroactive Inhibition，以後學得的習慣抑制舊有習慣的記憶）爲構成遺忘的主要原因。但近十幾年來，非但理論的觀點業已改變，而且也獲得實驗結果的證實，學習心理學者多以爲順攝抑制（Proactive Inhibition,舊經驗的干擾抑制了新學習的記憶）乃是構成遺忘現象的主要原因。此一觀點對語文學習後的長程記憶(Long-Term Memory)的解釋，尤其在舊新兩種學習中刺激相同而所需反應相異的情形下，具有甚大的價值。此一新干擾論的基本觀念有四：（1）學習任何事物都不是孤立的，在個體的生活中，學習總是連續的產生；（2）在個體從事某一項特定事物學習時，舊習慣中與新學習有關但却不適於新學習的反應，必得暫時棄置而產生一種「反學習」（Unlearning）現象；（3）等新學習過後，因「反學習」而暫時壓制之舊習慣，將會產生「自發性恢復」（Spontaneous Recovery）現象；（4）當個體需要回憶新學習的反應時，舊經驗的自發性恢復又將干擾其對新學習的記憶。

基於上述理論，本研究提出以下四個假設，並試經實驗方法以考驗之：（1）兒童之語文經驗較複雜者，在從事一項以舊經驗爲基礎的新語文經驗的學習時，將有較多且具干擾性的舊經驗需「反學習」；（2）語文經驗複雜者，新學習過後也將會產生較多的「自發性恢復」；（3）在語文刺激豐富環境中兒童語文習慣的複雜度應較同智力階層但語文刺激貧乏環境中兒童者爲高；（4）在以兒童熟知單字但無邏輯意義的聯對學習時，語文刺激豐富組的兒童其學習速度將較語文刺激貧乏組兒童爲慢，但學後的遺忘速度反而較快。

本研究之受試者爲小學四年級兒童，分爲城市（50人，男女各半）與鄉村（50人，男女各半）兩組；前者均曾接受學前教育，其父母教育程度較高，家境較富裕，課外閱讀機會較多。以下爲本研究獲得的重要結果：（1）城市組兒童的語文複雜度（以定時造詞量爲準）遠較鄉村組兒童爲高；（2）在學習速度方面，兩組無顯著差異；（3）在遺忘速度方面，城市組在習後各次測驗上都顯示比鄉村組遺忘者較多；（4）未發現性別上的差異。本研究結果大體上支持新干擾論者的看法。