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THE EFFECTS OF MEANINGFUL SIMILARITY AND PRACTICE
IN THE TRANSFER OF TRAINING

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ABSTRACT

This study investigated the effects of two variables within a transfer of training paradigm. The findings of this research are interpreted with a view to assessing Osgood's theory of transfer for Paradigm B, which predicts that the more nearly similar are two responses, the less would be the interference in learning. The two variables, Meaningful Similarity relations and amount of original list practice, were introduced in a transfer paradigm, Paradigm B, where the responses of two lists are varied and the stimuli are the same, i.e., Original list (OL): S_1--R_1 ; Transfer list (TL): S_1--R_2 . The stimuli were letter pairs, and the responses, adjectives, e.g., OL: w.k.--soft, TL: w.k.--relaxed.

Three levels of Meaningful Similarity relations between responses, similar (S), neutral or unrelated (N), and opposed (O) were presented. Each OL and TL list consisted of 15 items, 5 Ss, 5 Ns, and 5 Os all counterbalanced and mixed at random; thus, for the Meaningful Similarity variable, each subject was his own control. Each S learned, by the anticipation method, an OL to either a Low or High Practice criterion, and then a TL. There were 36 Ss in the Low Practice group and 36 in the High. All Ss were University of Hawaii students. Three dependent variables were scored on the TL trials: (1) (a) number of trials for each item to be obtained correct once, and (b) number of trials for each item to be obtained correct twice, (2) latency of correct responses, and (3) intrusions and blanks.

The statistical analyses performed on the data of the trials with the transfer list (TL) indicated no significant differences for any of the dependent variables with respect to Meaningful Similarity, i.e., significant differences between S, N, and O were not found with regard to trials-to-criterion, latency, or intrusions. Significant differences, however, were found on the TL trials between the Low and High practice groups with respect to some of the intrusion and blank measures.

An analysis was made to determine whether those items coded for the S, N, and O relations had been differentially learned on the OL trials. The finding of a non-significant Meaningful Similarity effect indicates that it is not likely that the findings of this study are biased as a result of initial inequities with respect to ease of learning on the original list.

Osgood has theorized that the more nearly similar are two responses, the less would be the interference in a Paradigm B transfer situation. He predicts an S N O order, where the S relation between responses (the most similar) results in the least amount of interference and the O relation (the least similar) results in the most amount of interference, i.e., $S < N < O$ interference. The results obtained in the present investigation, S N O, differences not significant, do not support Osgood's theory.

CHAPTER I
MEANINGFUL SIMILARITY, PRACTICE,
AND THE TRANSFER OF TRAINING

In an attempt to bind together a vast array of seemingly conflicting evidence with respect to transfer and retroaction phenomena into a coherent and integrated whole, Osgood (1946, 1949) analyzed the various materials and paradigms which previous investigations had employed. This endeavor culminated in the postulation of three empirical laws (Osgood, 1949), all based on the hypothetical role of the meaningful similarity variable in human learning. These laws were then incorporated in a three dimensional diagram which Osgood called the "transfer and retroaction surface." Both the laws and the surface were meant to account for the effects of previous learning in successive learning sessions, where the locus of similarities between stimulus members, response members, or both, is specifiable.

Focusing thus on specifiable stimulus and response components of paired-associates, three basic transfer paradigms were generated. These paradigms are shown in Fig. 1.

Insert Fig. 1 about here

Transfer paradigm A is that in which stimulus members are varied from list to list while the responses are kept identical. Paradigm B is that in which responses are varied but the stimulus members are held identical. C is the

Transfer Paradigms

Paradigm	Original Learning	Transfer Learning	Variation
Paradigm A	S_1--N_1	S_2--R_1	Stimuli
Example	<u>lucky--v.t.</u>	<u>formal--v.t.</u>	
Paradigm B	S_1--R_1	S_1--R_2	Responses
Example	<u>v.t.--elated</u>	<u>v.t.--high</u>	
Paradigm C	S_1--R_1	S_2--R_2	Both stimuli and responses
Example	<u>soft--elated</u>	<u>relaxed--high</u>	

Fig. 1. Paradigms indicating the locus of variation among successively practiced materials. (After Osgood, 1949).

paradigm in which both stimulus and response members are simultaneously varied.

This differentiation of various transfer paradigms, particularly B and C, led Osgood to a resolution of a major controversy which concerns the effects of similarity in the area of transfer and retroaction. In this controversy, one group of investigators maintained that "the greater the similarity, the greater the interference" (McGeoch, 1942, and others). A second group held just the reverse, "that increasing similarity (approaching identity) leads to decreasing interference" (Robinson, 1927, and others). Both views were supported by considerable experimental work. Osgood's resolution of this controversy was based on an analysis of the experimental paradigms used in those studies. From his analysis Osgood concluded that the two opposing groups had been using two different paradigms and it was due to their using different paradigms that varying results had been obtained. The Robinson group had been using paradigm B, and the McGeoch group, paradigm C. Osgood went on to formulate three laws which would incorporate the findings of these and other investigators. A brief discussion concerning the paradigms, Osgood's laws, and relevant literature follows.

Paradigm A: stimuli varied and responses identical.

This paradigm, is, in effect, a symbolic statement of stimulus generalization. Consequently, some facilitation from the original learning (OL) might be expected. Transfer and retroaction studies have generally revealed such facilitation.

Hovland (1937), for example, conditioned a galvanic skin response to a tone of a certain frequency (OL: S1--R1) and then presented a different test tone (TL: S2--R1). The extent to which the same response is made to the new stimulus is measured. Hovland found that the greater the similarity between practice and test stimuli, the greater the amount of positive transfer. Similar results were found by Hamilton (1943) in a retroaction study. She arranged three degrees of stimulus similarity--identical, similar, and neutral--to be associated with the same response in lists of paired-associates. Geometric forms were used as stimuli, and nonsense syllables as responses. Facilitation was found to decrease as similarity among the stimulus members decreased; zero transfer was obtained with the neutral stimuli. In view of the above and similar findings, Osgood (1949) formulated the law that, "where stimuli are varied and responses are functionally identical, positive transfer and retroactive facilitation are obtained, the magnitude of both increasing as the similarity among the stimulus members increases." The findings of a later study by Bugelski and Cadwallader (1956) also support this generalization. This law has not been disputed.

Paradigm B: responses varied, stimuli identical. This situation has been found to produce an interference effect in many experiments, e.g., Bruce (1933), Gibson (1941), Underwood (1945), and Osgood (1946). However, the degree of interference appears to be inversely related to the degree of

similarity between the original and new responses. In the Osgood (1946) experiment the original learning of a set of paired letters and meaningful adjectives such as c.m.--related was followed by one of three types of response relation, similar, neutral and opposed. It was found that although interference (as measured by latency of correct response) was obtained under all conditions, it was significantly less for the similar response relations group. Osgood (1949) expresses this view in his law for this paradigm, "where stimuli are functionally identical and responses are varied, negative transfer and retroactive interference are obtained, the magnitude of both decreasing as similarity between the responses increases."

Bugelski and Cadwallader (1956) reported an interesting reversal of this law. Neutral and similar relations showed more interference than opposed relations. Underwood (Cofer and Musgrave, 1963) has criticized the Bugelski and Cadwallader study on the grounds that visual forms, not verbal units, were employed as stimulus material. Hence, the possibility that the laws which govern the acquisition of tasks in which forms are stimuli may be different from those which govern the acquisition of a task in which verbal units are the stimuli. A recent study by Wimer (1964) similarly suggests that opposed responses show less interference than similar responses. Wimer, however, failed to obtain a statistically significant difference between any pair of the similarity conditions. On the other hand, Dallett (1962) found that performance was better with

similar than dissimilar responses, a finding which supports Osgood and contradicts the position of Bugelski & Cadwallader, and Wimer. However, Dallett, like Wimer, failed to obtain a statistically significant difference between the two similarity conditions used in the study. A summary table of the findings of these investigations, including Osgood's, is presented as Table 1.

Insert Table 1 about here

Paradigm C: both stimuli and responses simultaneously varied. Similarities here are between items having the same serial position on successive lists, i.e., stimulus and response similarities are simultaneously varied through the same degrees. Each item serves simultaneously as a response to the preceding item and a stimulus for the succeeding item. This paradigm was used extensively by the McGeoch group.

McGeoch and McDonald (1931) and Johnson (1933) employed this paradigm in a retroaction situation with meaningful materials and found retroactive interference to increase with degree of similarity. Melton and Von Lackum (1941) report similar findings for nonsense syllables. McGeoch and McGeoch (1937), Johnson (1933) and Gibson (1941) found the same result to hold for a transfer paradigm. Osgood's law for Paradigm C states, "when both stimulus and response members are simultaneously varied, negative transfer and retroactive interference are obtained, the magnitude of both increasing as the stimulus

Table 1
Some Experimental Findings in Transfer and Retroaction
regarding Meaningful Similarity Relations in Osgood's
Paradigm B.

Investigator	Findings ^a	Dependent Variable
Predicted by Osgood	Low...I S N O A..High	Interference
Osgood (1946)	Low..... <u>S N O</u>High Fast.....S <u>N O</u>Slow	No. trials to criterion Latency of responses
Osgood (1948) ^b	High..... <u>S O</u>Low Fast.....S O.....Slow	No. correct responses Latency of correct responses
Bugelski and Cadwallader (1956)	High....I O <u>N S</u> ..Low	No. correct words recalled
Dallett (1962) ^c	High..... <u>S N</u>Low	No. correct anticipations
Wimer (1964)	Low.... <u>I A O S N</u> ..High	No. trials to criterion

Note.--Those relations which are underscored by a common line are not significantly different from one another, while those relations which are not underscored by a common line are significantly different from one another.

^aDegrees of meaningful similarity relations between responses: I = identical, S = similar, N = neutral, O = opposed, and A = antonymous.

^bA neutral response condition was not included in the study.

^cAn opposed response condition was not included in the study.

similarity increases" (Osgood, 1949). Wimer (1964) reports contrary findings with respect to this law, but since he failed to obtain significant differences between any of the similarity conditions his findings are merely suggestive.

In addition to the above three laws, Osgood (1946, 1948) has outlined a special form of reciprocal inhibition which he presumes to be operating with regard to meaningfully opposed responses in the transfer situation. Osgood (1946) states, "that simultaneous with every increment of excitatory tendency, an equal inhibitory tendency is generated for that stimulus not to evoke the directly opposite meaning reaction." Thus, the meaningful similarity continuum according to Osgood would range in order from identical, similar, and neutral to opposed or antagonistic. The direct implication with respect to transfer under the conditions of paradigm B (stimuli identical, responses varied) would be that responses in an opposed relationship (elated: low) should produce even more interference than those responses in the neutral relationship. (Directly antagonistic responses, e.g. high-low, hard-soft, are difficult to work with experimentally because they usually have strong associative relations.) Evidence supporting Osgood's notion of response antagonism, or of his law regarding paradigm B is inconclusive.

Relatively few studies have been carried out with respect to transfer problems since Osgood's original formulations. It is evident from a brief study of the findings in Table 1 that more research is necessary before a considered evaluation

concerning the validity of Osgood's formulations can be made. In particular, significant differences among all response variations need to be established, if indeed they exist.

The present investigation attempts to test for the existence of significant differences among three response similarity conditions for the responses varied and stimuli identical paradigm (Paradigm B). A further aim is to determine the effect, if any, of varying the amount of original list learning. Learning to a high criterion may differentially affect the various conditions of meaningful similarity as compared with learning to a low criterion. Whether or not the relative order of various relationships would remain unchanged due to increased (or reduced) practice is of considerable theoretical import if valid general laws are to be established.

The past literature dealing with amount of original learning is not definitive with respect to the meaningful similarity variable. Bugelski (1956, p. 410) suggests in a brief review that performance improves in paradigm B with an increasing amount of original learning. The results of the experiments of Siipola and Israel (1933), Bruce (1933), and Bugelski (1942) appear to support this view, as do the findings of Postman (1964) in a more recent study. A general learning-to-learn effect appears to be operating under both conditions of response similarity and neutrality (stimuli identical). However, since none of the investigations cited had included an opposed response condition, the question of

the effects of amount of practice with regard to this meaningful condition is still an entirely open one. This study attempts to provide some definitive data with respect to this question.

Predictions.--Predictions regarding the effects of Meaningful Similarity during the test for transfer are described with respect to three dependent variables: (1) trials for an item to reach criterion, (2) latency of correct responses, and (3) intrusions, and blanks.

For trials-to-criterion, it is predicted that the Ss will more quickly learn i.e., obtain correct, those items which are meaningfully similar (S) than those which are neutral (N) or opposed (O). The O items will take longer to reach criterion than the N items. Thus, a sequence of S N O, with the S items reaching criterion faster than the O items is predicted.

These predictions are based on Osgood's law, "where stimuli are functionally identical and responses are varied (Paradigm B), negative transfer and retroactive interference are obtained, the magnitude of both decreasing as similarity between the responses increases" (Osgood, 1948), and on Osgood's postulated reciprocal inhibition mechanism (Osgood, 1946).

The analysis of latency scores is expected to yield a similar sequencing of relations, S N O. The shortest latencies are expected to be obtained with the S items, and the longest latencies with the O items. This prediction is based

on the assumption that latency is an index of response strength (Osgood, 1948), or an index of interference (Osgood, 1946). Thus, a short latency indicates a high response strength or low interference, while a long latency is indicative of low response strength or high interference.

Intrusions (incorrect responses uttered by the Ss) are expected to show an S N O sequence. The greatest number of intrusions are expected for the S items, and the smallest for the O items, $S > N > O$. Four types of intrusions will be categorized and tabulated as follows: (1) related inter-list: intrusion of a response from a previously learned list having the same stimulus member as the correct word. (2) unrelated interlist: intrusion of a word from a previously learned list not having the same stimulus member as the correct word. (3) intra-list: intrusion of a word from within the list being practiced. (4) extra-list: intrusion of a word not included in the lists practiced. Each intrusion is classified with respect to the meaningful similarity coding, S, N, or O, of the response which should have been given.

The $S > N > O$ outcome for intrusions is predicted for each type of intrusion and for their combined total as well. The basis for the intrusion predictions stems from Osgood's theoretical formulations (Osgood, 1946), (1) that, with every strengthening of a response on the transfer list that is in an S relation with a response on the original list there is generalized strengthening of other responses which are also similar to the OL response, and (2) that with every

strengthening of an O relation response on the TL, there is generalized inhibition developed toward other responses which are also opposed to the OL response. Hence, it is predicted that during the course of learning there will be a tendency for S intrusions to occur more frequently than O intrusions.

Blanks, i.e., when no response is given by the S, will also be tabulated. Osgood (1953) has hypothesized that generalized inhibitory tendencies result in a weakening of habit strength. On this, and on the basis that some failures of response are due to weakened habit strength, a greater number of blanks is predicted for the opposed materials than for the similar materials, i.e., $O > N > S$.

A summary of the above predictions concerned with the meaningful similarity variable is shown in Table 2.

Insert Table 2 about here

The conditions of Low and High amounts of practice with the original lists (OL) are not expected to change the ordering of the meaningful similarity relations as predicted above. However, it is predicted that for S and O, high OL practice would have an intensifying effect. That is, with increased practice (from Low to High) there would be a smaller number of trials to criterion and less interference for the S relation, while there would be a relatively larger number of trials to criterion and more interference for the O relation. This intensifying effect is deduced from the

Table 2

Summary of Predictions Concerning the Effect of Meaningful Similarity Relations with Respect to (1) Number of Trials to Criterion. (2) Latency of Correct Responses, and (3) Number of Intrusions and Blanks

(1) Number of Trials to Criterion

Low	S	N	O	High
-----	---	---	---	------

"Low" indicates fast rate of learning or low interference.

"High" indicates slow rate of learning or high interference.

(2) Latency of Correct Responses

Short	S	N	O	Long
-------	---	---	---	------

"Short" indicates high response strength or low interference.

"Long" indicates low response strength or high interference.

(3) Number of Intrusions

High	S	N	O	Low
------	---	---	---	-----

"High" indicates strengthening of generalized excitation.

"Low" indicates strengthening of generalized inhibition.

Number of Blanks

High	O	N	S	Low
------	---	---	---	-----

"High" indicates weakened habit strength.

"Low" indicates less weakened habit strength.

S - similar relation

N - neutral or unrelated relation

O - opposed relation

principles of Hull and Osgood (Osgood, 1946). The summation of excitatory habit strength is expected to lead to additional facilitation with increased practice for S, while the summation of inhibitory habit strength may be expected to lead to additional inhibition for O with increased practice. A similar intensifying effect is expected for the same reasons as learning trials progress.

In brief, this study investigates the effects of two variables within a particular transfer of training paradigm. The variables, meaningful similarity and amount of original learning, were introduced in a transfer paradigm where responses are varied and the stimuli are identical. The findings of this research are to be interpreted with a view to assessing Osgood's theory of transfer.

CHAPTER II

METHOD

Subjects.--Seventy-two Ss were obtained from introductory psychology courses at the University of Hawaii. They were volunteers who were given extra course credit for participating.

Experimenters.--Three Es, one the writer, participated in the experiment. The writer operated the necessary electronic equipment while the two other Es recorded Ss responses. The two Es were unaware of the hypotheses under investigation.

Observation Complex and Apparatus.--The complex consisted of a large rectangular room (E-room) and six adjacent separate soundtreated rooms (S-rooms), three on each side of the E-room). One-way mirrors along the side of the E-room permitted E visually to observe Ss in all S-rooms. There was a ceiling microphone and a high quality speaker with baffle in each S-room as well as a table and chair. In the E-room there was a set of headphones which monitored the sounds picked up by the ceiling microphone in S-room. The master electronic control unit in the E-room included a high fidelity triple tape-deck unit. The writer played tapes which were heard by Ss via the speakers in their S-rooms.

Materials.--Each S learned two different lists, an original list (OL) and then a transfer list (TL), by the anticipation method. The lists were composed of 15 items, each item with a stimulus and a response element. The

stimulus elements were always pairs of letters e.g., w.k., g.b., c.z., while the response elements were always words (adjectives) e.g., soft, hard, basic, relaxed. The elements employed in the construction of all the lists are presented in Tables 3 and 4. One column of stimuli (letter pairs) and

Insert Table 3 about here

Insert Table 4 about here

four columns of responses (three OLs and one TL) are shown in each table. Five different lists of S-R items, 3 OLs (OL 1--OL 4, OL 2--OL 5, and OL 3--OL 6) and 2 TLs, were constructed. With these five lists, six sets of transfer materials (OL 1--TL 1, OL 2--TL 1, OL 3--TL 1, OL 4--TL 2, OL 5--TL 2, and OL 6--TL 2) were formed.

The various meaningful relationships between the responses of each OL with each TL are indicated in Tables 3 and 4 by the letters S for similar, N for neutral, and O for opposed. Each OL or TL may be described as mixed, since within each list three types of meaningful similarity relations are included. There are five instances of each of the three similarity relations, S, N, and O, resulting in a total of 15 items per list.

Most of the response words of this experiment and their

Table 3
 Elements Employed in the Study of the Effects
 of Meaningful Similarity and Practice
 Sets 1, 2, and 3

STIMULI	RESPONSES			
	Original List			Transfer List
	OL 1	OL 2	OL 3	TL 1
w.k.	S soft	O hard	N basic	relaxed
q.f.	N sour	S slow	O fast	awkward
c.z.	O sickly	N similar	S healthy	true
j.q.	S calm	O excited	N equal	cool
g.b.	N daily	S clumsy	O graceful	angular
v.t.	O smooth	N near	S rough	rude
f.s.	S humorous	O serious	N common	light
y.l.	N left	S low	O high	dejected
t.g.	O blunt	N curious	S sharp	clear
d.w.	S crooked	O straight	N long	messy
h.v.	N numb	S clean	O dirty	open
n.y.	O flimsy	N formal	S solid	rugged
r.j.	S sleepy	O wakeful	N necessary	dead
z.p.	N lucky	S young	O old	wet
k.m.	O strange	N pious	S familiar	easy

Note: The subscripts S, N, O indicate the similarity relation between the OL and TL responses.

Table 4
 Elements Employed in the Study of the Effects
 of Meaningful Similarity and Practice
 Sets 4, 5, and 6

STIMULI	RESPONSES			
	Original List			Transfer List
	OL 4	OL 5	OL 6	TL 2
w.k.	O soft	S hard	N basic	tense
q.f.	N sour	O slow	S fast	skillful
c.z.	S sickly	N similar	O healthy	false
j.q.	O calm	S excited	N equal	warm
g.b.	N daily	O clumsy	S graceful	rounded
v.t.	S smooth	N near	O rough	polite
f.s.	O humorous	S serious	N common	heavy
y.l.	N left	O low	S high	elated
t.g.	S blunt	N curious	O sharp	hazy
d.w.	O crooked	S straight	N long	neat
h.v.	N numb	O clean	S dirty	closed
n.y.	S flimsy	N formal	O solid	delicate
r.j.	O sleepy	S wakeful	N necessary	alive
z.p.	N lucky	O young	S old	dry
k.m.	S strange	N pious	O familiar	difficult

Note: The subscripts S, N, O indicate the similarity relation between the OL and TL responses.

relationship are those which were used in earlier experiments by Osgood (1946, 1948). Additional items were kindly provided by Dr. Osgood for this particular experiment. Osgood's original procedure in constructing the adjective sets was to select familiar words from dictionaries of synonyms and antonyms. Judges then ranked the items in these sets for similarity or opposition, and only sets for which a high degree of agreement occurred were used. This procedure resulted in 15 selected familiar adjectives for each of which there existed other adjectives similar, neutral, and opposed in meaning.

As was mentioned previously, with reference to Tables 3 and 4, the words of OLs 1, 2, and 3 are the same as those of OLs 4, 5 and 6, respectively. The words of the OLs function therefore, in both similar and opposed relations. Soft, for example is an S item in OL 1, but an O item in OL 4. Such a design offers some measure of control over the possible effects of word particularity.

In order to determine the associative strength between OL and TL responses so as to be able to select materials and thereby reduce the effect of this variable as much as possible, the 15 words in each of the three different OLs were presented as stimuli in a word association test. Three different freshman classes were used as Ss and tested during their regular instruction period. OL 1 was administered to the first class (N = 156), OL 2 to the second class (N = 131) and OL 3 to the third class (N = 158). The Ss were provided with a sheet

of paper on which 15 lines were ruled. The instructions and 15 stimulus items were presented by means of a tape recorder. The same announcer who made the experimental tapes recorded this material. The presentation was designed to simulate, as closely as possible, the experimental situation that would later be used.

The following instructions were presented:

"Listen to the words spoken. Without hesitation after each word, print the first other word that comes to your mind. Do not write down the word you hear."

All answers were checked to see if either of the related TL responses occurred. For example, with soft (OL 1 and 4) as a stimulus, the Ss' responses were checked for relaxed (TL 1) and tense (TL 2). For the materials used in this experiment 43 out of the 45 OL words yielded a frequency of zero with respect to their related TL 1 and TL 2 responses. The word wakeful (OL 2 and 5) elicited the "correct" response alive (TL 2) 3 times out of the 131 Ss' responses; the word calm elicited the "correct" response of hot (TL 2) 1 time from the 156 Ss. The wakeful--alive relation is similar, while the calm--hot is an opposed one. Since very low frequencies were involved (3 and 1) as well as different similarity relations (S and 0), the two items were retained as experiment materials.

Three trials with a list that was composed of letters with number pairs were presented prior to the experimental lists in order to orient Ss to the anticipation method. The

list was composed of 15 items, the response elements consisting of digits ranging from 1 to 15. Table 4 shows the three different orders in which the list was presented. The order of items was varied at random.

Insert Table 5 about here

All lists with attendant instructions were recorded on magnetic tape by a male announcer. There were three OL master tapes, one for each OL. Each tape had instructions, three preliminary number trials and 14 OL trials recorded on it. The instructions and preliminary number trials were identical for all three tapes. All reoccurring instructions and trials were reproduced electronically from the original master. Each of the two TLs with their eight trials were recorded on separate masters.

There was a three second interval between the stimulus and response members of each associate pair and a two second interval between the response of one pair and the stimulus of the following pair. The stimulus and response members of each paired-associate were presented with a slight rising and a slight falling intonation, respectively.

Design.---The six different sets of transfer materials were presented to 12 groups of Ss. Six Ss comprised each group, a total of 72 Ss in all. One half of the Ss received the low practice condition (LP), the other half the high

Table 5

Three Trials of Letter with Number Pairs

Trial 1	Trial 2	Trial 3
S---R	S---R	S---R
a.g.---15	x.i.---13	c.i.--- 3
c.i.--- 3	c.m.---14	e.r.---10
e.r.---10	s.o.--- 2	s.o.--- 2
w.i.---13	s.g.---15	m.o.--- 8
s.o.--- 2	e.r.---10	l.e.---11
u.b.--- 6	m.o.--- 8	c.p.--- 5
m.c.--- 8	f.l.--- 7	s.m.--- 4
l.e.---11	d.i.--- 1	c.m.---14
t.l.---12	c.p.--- 5	d.i.--- 1
c.p.--- 5	q.a.--- 9	u.b.--- 6
s.m.--- 4	l.e.---11	q.a.--- 9
d.i.--- 1	c.i.--- 3	t.i.---12
q.a.--- 9	u.b.--- 6	f.l.--- 7
c.m.---14	t.i.---12	a.g.---15
f.l.--- 7	s.m.--- 4	x.i.---13

practice condition (HP).

In order to reduce the possibility of a response set occurring with respect to a particular meaningful relation, a counterbalancing design was utilized. An SNO 3 x 6 counterbalancing design is arranged in Table 3 and is repeated every three items across the six OLS, i.e., OL 1 has an S N O sequence, OL 2 an O S N sequence, OL 3 an N O S sequence, OL 4 an O N S sequence, OL 5 an S O N sequence, and OL 6 an N S O sequence. The same sequences were repeated for each trial. The counterbalancing of the three types of relations is designed to minimize the likelihood of Ss developing a set for any one type of relation since such an eventuality might result in differential facilitation in the learning of the various relations. For instance, if an S were presented with a list in which all response relationships were opposed, he might develop the concept that the responses were always in such a relationship and consequently restrict his answers on the TL to those which were opposed in meaningful similarity to those responses of the OL list. Perhaps he may even be able to generate the correct answer with the application of this opposition principle. The counterbalancing of relations would tend to prevent such a situation from occurring. The Bugelski & Cadwallader (1956) and the Wimer (1964) studies (see page 4) did not exercise this control, since they used lists in which only a single relation was present.

Various orders of the S-R pairs in each list were

presented from trial to trial in order to prevent S learning response chains instead of paired associates to a stimulus, as well as to avoid serial position learning effects. A rotational system of items was employed. The rotational system was integrated with the counterbalancing arrangement of meaningful relations (described in the previous paragraph). To obtain the total of 14 trials, six orders were repeated for another six trials (trials 7 to 12); the first two orders were then repeated for the last two trials (trials 13 and 14). A random sampling procedure established the various serial positions of the items within the counterbalancing constraint. Similarly, for the TL trials, the first six trials had six different orders while trials 7 and 8 were repeats of the same orders of trials 1 and 2.

Procedure.--As required by the transfer paradigm, each A first learned an original list (OL) and then a transfer list (TL). Each S learned one of six different OLs to one of two criteria, low practice (LP) and high practice (HP). Both the LP and HP criteria required that each S obtain a total of 10 or more items correct on a single trial before the termination of OL trial number ten. Any S who did not reach this LP criterion was discarded. As soon as any of the Ss in the LP condition obtained 10 or more items correct on a single trial, their OL trials were terminated, and the TL trials were then presented. The Ss in the HP condition were presented all 14 OL trials unless they obtained a total

of 14 items correct for two consecutive trials. The TL trials were terminated when S either obtained two errorless trials in succession or had been presented the maximum number of eight trials.

The paired-associates were learned by the anticipation method. The S was presented with an auditory stimulus and was requested to anticipate the correct response by saying it out loud before the E (on tape) did so.

An E greeted Ss (usually two) in a waiting room and then showed each of them into a separate S-room. No mention was made to S about the nature of the experiment other than it was concerned with verbal learning. When S was seated, the writer selected at random and presented on tape one of the six transfer sets. Both Ss were thus tested simultaneously. Each of the other Es listened in to one of the S-rooms and recorded the responses made by S on a response sheet. The S listened to the following on tape:

Thank you for coming today and offering your services for our study. We are interested in the problem of verbal learning and we would like you to help us. All you need to do is learn words from a list. When you are finished you will be given a full hour of experimental credit, even though this experiment will take up only part of that time. So just sit back and relax, but listen closely to every word that I say.

Before we begin let me say that this entire experiment is automated and that you will not see the

experimenter until it is all over. Although we can hear everything that you say, we cannot answer any questions. But you won't need to ask any questions if you listen closely.

Here's what we are going to do. I will read a list of paired items to you. Here is an example, a.b.--red. Here is another, c.d.--fresh. These examples are from the same list. Your task is to memorize these pairs so that when I say the first member of the pair, for example, a.b., you will be able to say out loud, the second member of the pair, red. When I say c.d. you should be able to say out loud, fresh. I will give you a few seconds to say the word before I say it out loud myself.

For practice let us do the a.b.--red item. When I say a.b., you must say out loud, red, as quickly as you can. Ready? Remember, when I say a.b., you must say out loud, red. a.b......red.

You will be presented a list of different items such as these, and your task will be to memorize and say each of the words that go with particular letter-combinations.

Perhaps it might be a good idea if we did a list for practice, just to get the feel of it. Instead of words we will use numbers. You may not get many items correct, but don't worry about it. This is just a warm-up. You will be given the list three times. Each

time you will find the order of items varied.

Listen carefully to the following list of items and try to memorize the pairs. You will be tested on the trial after this one. I repeat, for this trial only just listen to the following list of items.

/Trial 1 of the number list is presented./

That is the end of the list.

Now when I say the letters I want you to say, out loud, the numbers which go with them. You should always say your response as quickly as you can because I am also measuring how fast you can make your response. If you are not sure about the accuracy of your response, you may guess. There is no penalty for guessing.

/Trial 2 of the number list is presented./

That is the end of the list.

Here is another trial.

/Trial 3 of the number list is presented./

That is the end of the list.

That's all we'll be doing with the practice list. Let's do our experiment lists, now. The procedure will be exactly the same, except this time you will have words to learn.

Listen carefully to the following list of items and try to memorize the pairs. You will be tested on the trial after this one. I repeat, for this trial only, just listen to the following list of items.

/Trial 1 of OL will be presented./

That is the end of the list.

Now when I say the letters I want you to say, out loud, the words which go with them. You should always say your response as quickly as you can because I am also measuring how fast you make your response. If you are not sure about the accuracy of your response, you may guess. There is no penalty for guessing.

/Trial 2 of OL will be presented./

That is the end of the list.

Here is another trial.

/More OL trials follow. The only instruction between trials is, 'That is the end of the list. Here is another trial.' When the S reached LP or HP criterion he was presented with the TL trials. The TL trials were presented immediately after S reached criterion, i.e., each subject at his own pace. (The E had the TL tapes set up and ready to play on two other tape decks.) The instructions which preceded the TL trials were as follows:/

That is all we will be doing with that list.

Now we would like you to learn a different list. The procedure will be the same as before. Listen to the following list. You will be tested on the trial after this one.

/Trial 1 of the TL is presented./

That is the end of the list.

Now when I say the letters I want you to say, out loud, the words which go with them. You should

always say your response as quickly as you can because I am also measuring how fast you make your response. If you are not sure about the accuracy of your response, you may guess. There is no penalty for guessing.

/Trial 2 of TL is presented./

That is the end of the list.

Here is another trial.

More TL trials follow. The only instruction between trials is 'That is the end of the list. Here is another trial.' At the conclusion of the final TL trial, E appeared and showed the S out.

The maximum length of time possible for the testing of each S was approximately 45 minutes. A breakdown of this period is as follows: greeting and seating S: 3 minutes; introductory instructions and practice trials: 10 minutes; 14 OL and 8 TL trials: 36 minutes. Total trial time varied, depending on when S reached the criterion on his OL and TL trials.

Scoring.--The Ss' performance on TL trials was scored with respect to the three dependent variables: (1) number of trials for each item to reach criterion. There are two variations of this criterion, A and B. (2) latency of correct responses, and (3) intrusions, and blanks.

1a. Number of trials to criterion, Variation A: Each item was scored on the basis of S obtaining that item correct on one trial. The number of the trial on which the

first correct response was given was the score assigned for that item. For example, if S obtained the item correct on trial 5, he was given a score of 5. If S did not obtain a correct response by the end of the last trial (trial 8) he was given a score of 9.

1b. Number of trials to criterion, Variation B: Each item was scored on the basis of S obtaining that item correct on two separate trials. The number of the trial on which the second correct response was given, was the score assigned for that item. For example, if S obtained the item correct on trials 5 and 6, he was given a score of 6. If S did not obtain one correct response by the end of the last trial (trial 8), he was assigned a score of 10. If S had obtained one response correct by the end of the last trial, he was given a score of 9.

Variation A may be regarded as a measure more sensitive to change than Variation B since it is based on that trial on which an item is obtained correct for the first time. On the other hand, the Variation B may be viewed as a more stable one since it is based on two correct responses for an item.

All fifteen items were scored for each S. The scores for the five S items were summed, as were the scores for the five N and five O items. These three scores were then regarded as that S's raw scores for the S, N, and O conditions.

2. Latency of correct responses: The S was given three seconds in which to respond to the stimulus. If, by Es'

estimation, Ss' response was given within the first $1\frac{1}{2}$ seconds, and "F" for fast was recorded for that response. If the response was given in the last $1\frac{1}{2}$ seconds, and "S" for slow was recorded. The two Es were instructed to record the latency of all responses uttered although only the TL data concerning correct response were utilized. Such a procedure was intended to simplify the Es' recording task as well as to deter them from focusing particularly on the latency of correct responses on the TL trials.

A reliability check on the Es indicated very high agreement between them. The data of one S who responded to 18 trials (11 OL trials and 7 TL trials) were recorded by both Es. Disagreement in latency occurred on 20 out of a total of 270 responses, i.e., they agreed on 92%.

For every TL trial that had been presented to each S, the total number of "fast" and "slow" correct responses was tabulated for the five items for each of the S, N, and O conditions. A single raw score for each of the three conditions was calculated according to the following formula:

$$\frac{F}{F + S} \times 100$$

where F = frequency of fast correct responses, and where S = frequency of slow correct responses. This formula is designed to yield an average rate of responding for Ss with respect to correct responses.

3. Intrusions: An intrusion is defined as any incorrect response which the subject utters. Four types of intrusions were identifiable (see Page 9 for a description of each); (a) related interlist, (b) unrelated interlist,

(c) intralist, and (d) extralist. These along with blanks (failures to make any response) were classified with respect to the meaningful similarity relation of the response which should have been given. For example, if an S had been presented the following materials, OL: w.k.--soft and TL: w.k.--relaxed, and the relation between soft and relaxed is similar (S), the intrusion (or blank) which occurred would be classified as S, regardless of its type. The frequency of intrusions, according to type and meaningful similarity relation, was tabulated for each S for all TL trials presented to him, along with frequencies of blanks.

CHAPTER III

RESULTS

The scores on the transfer list (TL) trials on the three dependent variables, number of trials to criterion, latency and intrusions, were analyzed independently. The results with respect to each of these variables will be presented separately and then later compared.

As a prelude to this description, the results of two sets of analyses concerning the performance of the subjects on the original lists (OL) are presented here. The first set of analyses is concerned with determining the level of difficulty with respect to S, N, and O type items. The second is designed to determine whether, on the basis of OL performance, the Low and High groups had actually received differential treatment.

Level of S, N, O difficulty on OLs.--The question may be raised as to whether the findings to be reported in this study are biased as a result of initial inequities between the S, N, and O type items with respect to ease of learning, i.e., the S, N, and O coded items on the OLs may not have been equal in difficulty before the TLs were learned. The same trials-to-criterion per item measure as that used in the TL analysis was employed. Both variation A (first correct response) and variation B (second correct response) of the trials-to-criterion measure (see pages 23, 24) were used. All 14 OL trials were used for the scoring of items.

A two-way analysis of variance was made on the scores

for each of the variation measures. The two factors were Amount of Practice (Low and High) and Meaningful Similarity Relations (S, N, and O). The Meaningful Similarity Relations variable involves correlated observations. The frequency distributions, means and standard deviations for each of the S, N, and O levels under the Low and High practice conditions for Variation A are shown in Tables 6 and 7. The results of

Insert Table 6 about here

Insert Table 7 about here

the analysis of variance for Variation A is shown in Table 8.

Insert Table 8 about here

The F ratios for Meaningful Similarity, $F(2,140) = 0.11$; OL Practice, $F(1,70) = 2.27$; and Similarity by Practice Interaction, $F(2,140) = 1.24$, are not significant, i.e., $p > .05$ in all cases. For $\alpha = .05$ the critical values for $F(2,140)$ is 3.05, and for $F(1,70)$ it is 3.98. The frequency distributions, means and standard deviations for each of the S, N, and O levels under the Low and High practice conditions for Variation B are shown in Tables 9 and 10. The results of

Insert Table 9 about here

Table 6

Trials to Criterion, Variation A, for OL Trials; Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and Low OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	40-44	1	1	3
Low	35-39	3	2	0
Practice	30-34	7	10	8
N = 36	25-29	11	7	14
	20-24	10	9	7
	15-19	2	7	3
	10-14	2	0	1
	n	36	36	36
	Mean	26.39	25.83	26.78
	S.D.	6.65	6.37	6.62

Table 7

Trials to Criterion, Variation A, for OL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and High OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	50-54	0	1	0
High	45-49	2	2	1
Practice	40-44	1	4	5
N = 36	35-39	4	3	2
	30-34	10	8	6
	25-29	5	7	9
	20-24	9	4	3
	15-19	5	6	8
	10-14	0	1	2
	n	36	36	36
	Mean	28.42	29.56	27.67
	S.D.	7.90	9.82	9.24

Table 8

Trials to Criterion, Variation A, on OL Trials:

Summary of Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	8435.22	71		
OL Practice	264.45	1	264.45	2.27
Subjects Within Groups	8170.77	70	116.73	
Within Subjects	5326.00	144		
Meaningful Similarity	8.18	2	4.09	0.11
Practice x Similarity	73.18	2	36.59	0.98
B x Subjects Within Groups	5244.65	140	37.46	

Table 9

Trials to Criterion, Variation B, for OL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and Low OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	50-54	0	1	1
Low	45-49	3	2	2
Practice	40-44	4	2	3
N = 36	35-39	11	10	12
	30-34	9	8	10
	25-29	7	11	6
	20-24	1	2	1
	15-19	1	0	1
	n	36	36	36
	Mean	34.11	33.36	34.25
	S.D.	6.93	6.81	6.44

Insert Table 10 about here

the analysis of variance for Variation B is shown in Table 11. The F ratios for Meaningful Similarity, $F(2,140) = 0.14$, and for Similarity by Practice Interaction, $F(2,140)$

Insert Table 11 about here

$= 0.98$, are not significant, i.e., $p > .05$ in both cases. For OL practice $F(1,70) = 5.65$ and is significant, $p < .05$.

Low vs. High Practice.--To determine whether the Low and High groups had actually received differential practice on the OL trials, analyses were made on (1) the number of OL trials presented to each subject and (2) the number of correct items obtained by subjects on their last OL trial. The mean number of OL trials presented to the Low group was 7.81 and to the High group 13.05, a difference of 5.24 trials. The frequency distributions, means and standard deviations for the two groups are shown in Table 12.

Insert Table 12 about here

A t -test for independent measures to determine the significance of the difference between the two means yielded a $t = 13.75$. With $df = 70$ the difference is significant, $p < .001$. The mean number of items obtained correct by the Low group

Table 10

Trials to Criterion, Variation B, for OL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and High OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	65-69	0	1	0
	60-64	1	0	0
High	55-59	0	2	1
Practice	50-54	3	4	4
N = 36	45-49	1	4	4
	40-44	8	6	5
	35-39	7	7	6
	30-34	7	4	4
	25-29	9	4	9
	20-24	0	3	3
	15-19	0	1	0
	n	36	36	36
	Mean	37.08	38.92	37.25
	S. D.	8.32	11.25	10.00

Table 11
 Trials to Criterion, Variation B, On OL Trials:
 Summary of Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	10679.33	71		
OL Practice	797.34	1	797.34	5.65*
Subjects Within Groups	9881.99	70	141.17	
Within Subjects	5745.34	144		
Meaningful Similarity	11.23	2	5.62	0.14
Practice x Similarity	79.23	2	39.62	0.98
B x Subjects Within Groups	5654.88	140	40.39	

* $p < .05$

Table 12

Number of OL Trials Presented to the Low and High Practice
Groups: Frequency Distributions, Means, and
Standard Deviations

No. OL Trials Presented	Frequency for \underline{S} s in Low	Frequency for \underline{S} s in High
14		25
13		0
12		4
11	3	4
10	4	2
9	4	0
8	10	1
7	6	
6	7	
5	1	
4	0	
3	1	
N	36	36
Mean	7.81	13.05
S.D.	1.78	1.56

on their last OL trial is 11.06; the mean of the High group is 13.27. The frequency distribution, means, and standard deviations for the two groups are shown in Table 13. The

Insert Table 13 about here

difference of 2.21 items is significant ($p < .001$), $t = 6.06$, $df=70$.

Trials-to-criterion on TL trials.--An analysis of variance utilizing a two factor design with repeated measures on one factor was done for each of the variations on the trials-to-criterion measure. The first factor, Amount of OL Practice, involves two levels of independent observations, Low and High. The second factor, Meaningful Similarity Relations, has three levels S, N, O, and involves correlated observations.

Variation A: The frequency distributions, means, and standard deviations for each of the S, N, and O levels under Low and High practice are shown in Tables 14 and 15. The

Insert Table 14 about here

Insert Table 15 about here

results of the analysis of variance is shown in Table 16.

Table 13

Number of Items Obtained Correct by Ss on their Last OL Trial
for the Low and High Practice Group: Frequency Distributions,
Means, and Standard Deviations

No. Items Correct	Frequency for <u>Ss</u> in Low	Frequency for <u>Ss</u> in High
15	1	10
14	1	12
13	3	4
12	5	2
11	9	6
10	17	1
9	0	0
8	0	1
N	36	36
Mean	11.06	13.28
S.D.	1.29	1.74

Table 14

Trials to Criterion, Variation A, on TL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and Low OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	40-44	0	1	1
Low	35-39	3	4	0
Practice	30-34	5	6	5
N = 36	25-29	6	5	9
	20-24	12	9	9
	15-19	6	8	9
	10-14	4	3	3
	n	36	36	36
	Mean	23.42	24.67	23.44
	S.D.	7.36	8.08	6.58

Table 15

Trials to Criterion, Variation A, on TL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and High OL Practice

		Meaningful Similarity Relation		
		S	N	O
	<u>Score</u>	<u>f</u>	<u>f</u>	<u>f</u>
	45-49	0	0	1
High	40-44	0	1	1
Practice	35-39	6	3	3
N = 36	30-34	5	4	7
	25-29	5	8	7
	20-24	9	7	9
	15-19	8	10	6
	10-14	3	3	2
	n	36	36	36
	Mean	24.28	23.92	25.97
	S.D.	7.49	7.21	7.78

Insert Table 16 about here

The F ratios for: Meaningful Similarity Relations, $F(2,140) = 0.56$; OL Practice, $F(1,70) = 0.34$; and the Similarity by Practice Interaction, $F(2,140) = 2.01$, were not significant, i.e., $p > .05$ in all cases.

Variation B: The frequency distributions, means, and standard deviations for each of the S, N, and O levels under Low and High practice are shown in Tables 17 and 18. The

Insert Table 17 about here

Insert Table 18 about here

results of the analysis of variance is shown in Table 19.

Insert Table 19 about here

The F ratios for: Meaningful Similarity, $F(2,140) = 0.41$; OL Practice, $F(1,70) = 0.15$; and the Similarity by Practice Interaction, $F(2,140) = 1.40$, were not significant, i.e., $p > .05$ in all cases.

Variation B, \log_{10} : Since the distributions of raw scores were slightly positively skewed, a \log_{10} transformation was applied. For convenience, the characteristic of 1 and the

Table 16

Trials to Criterion, Variation A, on TL Trials:

Summary of Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	8601.77	71		
OL Practice	41.78	1	41.78	0.34
Subjects Within Groups	8559.99	70	122.29	
Within Subjects	3490.00	144		
Meaningful Similarity	26.70	2	13.35	0.56
Practice x Similarity	96.70	2	48.35	2.01
B x Subjects Within Groups	3366.59	140	24.05	

Table 17

Trials to Criterion, Variation B, on TL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and Low OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	45-49	5	2	1
Low	40-44	0	6	3
Practice	35-39	6	6	8
N = 36	30-34	7	5	6
	25-29	9	10	12
	20-24	5	5	4
	15-19	4	2	2
	n	36	36	36
	Mean	30.67	31.72	30.56
	S.D.	8.20	7.98	6.87

Table 18

Trials to Criterion, Variation B, on TL Trials: Frequency Distributions, Means and Standard Deviations for Levels of Meaningful Similarity Relations and High OL Practice

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	50-54	0	0	1
High	45-49	0	1	1
Practice	40-44	9	6	6
N = 36	35-39	5	5	8
	30-34	4	6	5
	25-29	10	9	8
	20-24	6	7	5
	15-19	2	2	2
	n	36	36	36
	Mean	31.06	31.03	32.67
	S.D.	7.87	7.88	7.73

Table 19

Trials to Criterion, Variation B, on TL Trials:

Summary of Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	9445.77	71		
OL Practice	19.56	1	19.56	0.15
Subjects Within Groups	9426.21	70	134.66	
Within Subjects	3698.00	144		
Meaningful Similarity	21.18	2	10.59	0.41
Practice x Similarity	72.07	2	36.03	1.40
B x Subjects Within Groups	3604.76	140	25.75	

decimal point were dropped from each log score.

The frequency distributions, means, and standard deviations for each of the S, N, and O levels under both the Low and High practice conditions are shown in Tables 20 and 21.

Insert Table 20 about here

Insert Table 21 about here

The results of the analysis of variance on the log scores is shown in Table 22. The F ratios for the effects of

Insert Table 22 about here

of Meaningful Similarity Relations, $F(2,140) = 0.63$; OL Practice, $F(1,70) = 0.11$; and the Similarity by Practice interaction $F(2,140) = 1.24$, were not significant, i.e., $p > .05$ in all cases.

A summary of the results for the trials-to-criterion measures on the OL and TL trials is shown in Table 23.

Insert Table 23 about here

Latency of Correct Responses.--An analysis of variance utilizing a three factor design with repeated measures on two factors was performed on these data. There were two

Table 20

Trials to Criterion, Variation B, \log_{10} , on TL Trials:
 Frequency Distributions, Means and Standard Deviations for
 Levels of Meaningful Similarity Relations and Low OL Practice.

(The characteristic of 1 and the decimal point have been
 dropped from each log score.)

		Meaningful Similarity Relation		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	65-74	5	2	1
Low	55-64	4	11	10
Practice	45-54	13	13	12
N = 36	35-44	9	4	8
	25-34	4	5	5
	15-24	1	1	0
	n	36	36	36
	Mean	47.00	48.64	47.19
	S.D.	11.67	11.38	10.02

Table 21

Trials to Criterion, Variation B, \log_{10} , on TL Trials:
 Frequency Distributions, Means and Standard Deviations for
 Levels of Meaningful Similarity Relations and High OL Practice.

(The characteristic of 1 and the decimal point have been
 dropped from each log score.)

		Meaningful Similarity Relation		
		S	N	N
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	65-74	0	1	2
High	55-64	13	11	11
Practice	45-54	8	9	14
N = 36	35-44	8	10	6
	25-34	6	5	2
	15-24	1	0	1
	n	36	36	36
	Mean	47.53	47.67	49.94
	S.D.	11.63	11.21	10.85

Table 22

Trials to Criterion, Variation B, Log_{10} , on TL Trials:
 Summary of Analysis of Variance.

(The characteristic of 1 and the decimal point have been
 dropped from each log score.)

Source of Variation	SS	df	MS	F
Between Subjects	19729.66	71		
OL Practice	31.89	1	31.89	0.11
Subjects Within Groups	19697.77	70	281.40	
Within Subjects	7293.34	144		
Meaningful Similarity	64.04	2	32.02	0.63
Practice x Similarity	126.26	2	63.13	1.24
B x Subjects Within Groups	7103.04	140	50.74	

Table 23

Summary of Results: Trials to Criterion on OL and TL Trials.
Analyses of Variance

Analysis	Practice $F(1,70)$	Similarity $F(2,140)$	Similarity x Practice $F(2,140)$	Table No.
Variation A, OL trials	2.27	0.11	0.98	8
Variation B, OL trials	5.65*	0.14	0.98	11
Variation A, TL trials	0.34	0.56	2.01	16
Variation B, TL trials	0.15	0.41	1.40	19
Variation B, \log_{10} , TL trials	0.11	0.63	1.24	22

* $p < .05$

levels of OL practice, three levels of Meaningful Similarity Relations, and two levels of Trials (see following paragraph). The latter two factors involve repeated measures.

For the Trial factor, the middle and last TL trials of each S were selected for analysis. For most Ss the middle trial was trial 5, and the last trial was trial 8. For the Ss who reached the criterion early and did not complete all eight trials, their middle and last trials--whatever the trial numbers--were used. The reason early trials were not selected for analysis is that Ss obtained few correct responses during those trials. Also, trial 1 was merely a familiarization trial.

The frequency distributions, means and standard deviations obtained for each of the S, N, and O levels under both Low and High Practice for the Middle and Last trials are shown in Tables 24 and 25.

Insert Table 24 about here

Insert Table 25 about here

Five Ss in each of the Practice groups were not included in the analysis because they did not obtain at least one correct response in all of the S, N, and O cells. Without a sample of at least one correct response, it is not possible to estimate an S's average rate of responding.

Table 24

Latency: Frequency Distributions, Means and Standard Deviations
for Levels of Meaningful Similarity Relations and OL Practice
on the Middle Trial

		Middle Trial		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	100	17	19	17
Low	80-99	1	2	1
Practice	60-79	5	4	7
N = 31	40-59	5	3	4
	20-39	0	2	2
	0-19	3	1	0
	Mean	76.32	81.84	80.35
	S.D.	31.63	27.00	23.53
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	100	19	14	18
High	80-99	0	2	0
Practice	60-79	7	6	7
N = 31	40-59	0	6	3
	20-39	1	2	0
	0-19	4	1	3
	Mean	77.77	74.71	78.61
	S.D.	34.57	27.50	31.17

Table 25

Latency: Frequency Distributions, Means and Standard Deviations
for Levels of Meaningful Similarity Relations and OL Practice
on the Last Trial

		Last Trial		
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	100	16	23	24
	80-99	6	4	2
Low	60-79	5	4	3
Practice	40-59	4	0	2
N = 31	20-39	0	0	0
	0-19	0	0	0
	Mean	83.61	93.45	92.06
	S.D.	19.48	11.65	15.68
		S	N	O
<u>Score</u>		<u>f</u>	<u>f</u>	<u>f</u>
	100	20	19	21
	80-99	3	7	2
High	60-79	7	4	5
Practice	40-59	0	1	2
N = 31	20-39	1	0	0
	0-19	0	0	1
	Mean	89.23	90.16	86.97
	S.D.	16.38	13.65	22.74

The S's scores tend to show relatively little variability. The median for 11 of the 12 cells was 100. A score of 100 indicates that all of the responses which the S gave were "fast". Although the distribution of scores were greatly skewed, an analysis of variance was made. (The study of Norton (1952) suggests that the analysis of variance model is sufficiently "robust" to withstand departures from a normal distribution.) A transformation was not attempted, since the skewness due to the high frequency of one particular score (100) would not alter the situation. The results of the analysis of variance are shown in Table 26. Only the

Insert Table 26 about here

F ratio for Trials was found to be significant, $F(1,60) = 20.77$; $p < .001$.

Intrusions.--The four types of intrusions, related interlist, unrelated interlist, intralist and extralist were analyzed separately and in combination. Blanks were also analyzed. The frequency tables for these classes according to levels of Meaningful Similarity, OL Practice, and two levels of Trials, Middle and Last (see page 33 for definitions of Middle and Last) are shown in Tables 27, 28, 29, 30, 31, 32, and 33.

Insert Tables 27, 28, 29, 30,
31, 32, and 33 about here

Table 26

Latency: Summary of Analysis of Variance

Source of Variation	SS	df	MS	F
Between Subjects	46,159.91	61		
A OL Practice	268.44	1	268.44	0.35
Subjects within Groups	45,891.47	60	764.86	
Within Subjects	183,160.34	310		
B Trials	11,209.06	1	11,209.06	21.92*
A x B	55.69	1	55.69	0.11
B x Subject within Groups	30,680.91	60	511.35	
C Meaningful Similarity	780.19	2	390.09	0.67
A x C	1,322.16	2	661.08	1.14
C x Subject within Groups	69,432.00	120	578.60	
B x C	310.06	2	155.03	0.27
A x B x C	279.94	2	139.97	0.24
BC x Subject within Groups	69,090.38	120	575.75	

* $p < .001$

Table 27

Related Interlist Intrusions: Observed Frequencies Classified
According to Meaningful Similarity Relations,
OL Practice and Trials.

Middle Trial				
Meaningful Similarity Relations				
Practice	S	N	O	Total
Low	2	4	1	7
High	0	1	1	2
Total	2	5	2	9

Tests not performed

Last Trial				
Meaningful Similarity Relations				
Practice	S	N	O	Total
Low	0	0	0	0
High	2	0	0	2
Total	2	0	0	2

Tests not performed

Table 28

Unrelated Interlist Intrusions: Observed Frequencies Classified
According to Meaningful Similarity Relations,
OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	2	6	4	12
High	2	1	2	5
Total	4	7	6	17

Similarity x Practice: test not performed

Similarity Totals: test not performed

Practice Totals: Binomial, $p = .14$

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	2	1	2	5
High	0	1	0	1
Total	2	2	2	6

Tests not performed

Table 29

Intralist Intrusions: Observed Frequencies Classified
According to Meaningful Similarity Relations,
OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	26	36	32	94
High	21	17	18	56
Total	47	53	50	150

Similarity x Practice: $\chi^2 = 1.79$ df = 2

Similarity Totals: $\chi^2 = 0.36$ df = 2

Practice Totals: $z = 3.02$ p < .001

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	21	31	21	73
High	9	14	12	35
Total	30	45	33	108

Similarity x Practice: $\chi^2 = 0.35$ df = 2

Similarity Totals: $\chi^2 = 3.50$ df = 2

Practice Totals: $z = 3.56$ p < .0002

Table 30

Extralist Intrusions: Observed Frequencies Classified
According to Meaningful Similarity Relations,
OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	4	4	3	11
High	1	2	0	3
Total	5	6	3	14

Similarity x Practice: test not performed

Similarity Totals: test not performed

Practice Totals: Binomial, $p < .06$

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	0	1	2	3
High	1	0	2	3
Total	1	1	4	6

Tests not performed

Table 31

Combined Intrusions for Related Interlist, Unrelated Interlist,
 Intralist, and Extralist: Observed Frequencies Classified
 According to Meaningful Similarity Relations,
 OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	34	50	40	124
High	24	21	21	66
Total	58	71	61	190

Similarity x Practice: $\chi^2 = 2.21$ df = 2

Similarity Totals: $\chi^2 = 1.46$ df = 2

Practice Totals: $z = 4.13$ p < .00006

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	23	33	25	81
High	12	15	14	41
Total	35	48	39	122

Similarity x Practice: $\chi^2 = 0.21$ df = 2

Similarity Totals: $\chi^2 = 2.18$ df = 2

Practice Totals: $z = 3.53$ p < .006

Table 32

Blanks: Observed Frequencies Classified
According to Meaningful Similarity Relations,
OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	48	40	34	122
High	56	63	70	189
Total	104	103	104	311

Similarity x Practice: $\chi^2 = 3.96$ df = 2

Similarity Totals: test not performed

Practice Totals: $z = 3.74$ $p < .0002$

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	27	27	25	79
High	30	23	48	101
Total	57	50	73	180

Similarity x Practice: $\chi^2 = 5.07$ df = 2

Similarity Totals: $\chi^2 = 4.63$ df = 2

Practice Totals: $z = 1.56$

Table 33

All Incorrect Responses, Intrusions and Blanks:
 Observed Frequencies Classified According to Meaningful
 Similarity Relations, OL Practice and Trials

Middle Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	82	90	74	246
High	80	84	91	255
Total	162	174	165	501

Similarity x Practice: $X^2 = 1.86$ df = 2

Similarity Totals: $X^2 = 0.47$ df = 2

Practice Totals: $z = .36$

Last Trial

Meaningful Similarity Relations

Practice	S	N	O	Total
Low	50	60	50	160
High	42	38	62	142
Total	92	98	112	302

Similarity x Practice: $X^2 = 5.57$ df = 2

Similarity Totals: $X^2 = 2.09$ df = 2

Practice Totals: $z = .98$

The intrusion frequencies for the related interlists type are presented in Table 27, for unrelated interlist in Table 28, for intralist in Table 29, for extralist in Table 30, for the four types combined in Table 31, for blanks (no response given) in Table 32, and for all incorrect responses (intrusions and blanks) in Table 33.

Chi-square tests of independence were applied to each of the frequency tables in order to determine whether the two variables, Meaningful Similarity and OL Practice are independent of each other or associated. A chi-square analysis was performed where frequencies were sufficiently large. None of the χ^2 values were found to be significant. There are no grounds for rejecting the hypothesis of independence between Meaningful Similarity and Practice. Apparently there is no relationship between these two variables.

The separate effects of Meaningful Similarity and Practice were then analyzed. Only analyses on the marginal totals were made. A breakdown to the various levels of a single variable is not warranted from a probability standpoint since the above chi-square tests of independence indicated that the two variables did not interact significantly.

A χ^2 analysis was performed on the S, N, O frequency totals for the Meaningful Similarity variable. None of χ^2 values were significant ($p > .05$)

A binomial test was performed on the Low and High frequency totals for the OL Practice variables. Five of the z values were found to be significant. Both the Middle and

Last trials for Intralist intrusions (Table 29) and combined intrusions (Table 31) showed significant differences between the Low and High totals. The Middle trial for Blanks (Table 32) also showed a significant difference.

A summary of the results for intrusions and blanks are shown in Table 34.

Insert Table 34 about here

Table 34

Summary of Results: Intrusions and Blanks

Type	Analysis Trial	Practice	Similarity $\underline{df} = 2$	Similarity x Practice $\underline{df} = 2$	Table No.
Related Interlist	Middle	no test	no test	no test	26
	Last	no test	no test	no test	26
Unrelated Interlist	Middle	Binomial	no test	no test	27
	Last	no test	no test	no test	27
Intralist	Middle	$z = 3.02***$	$\chi^2 = 0.36$	$\chi^2 = 1.79$	28
	Last	$z = 3.56***$	$\chi^2 = 3.50$	$\chi^2 = 0.35$	28
Extralist	Middle	Binomial	no test	no test	29
	Last	no test	no test	no test	29
Combined Intrusions	Middle	$z = 4.13***$	$\chi^2 = 1.46$	$\chi^2 = 2.21$	30
	Last	$z = 3.53**$	$\chi^2 = 2.18$	$\chi^2 = 0.21$	30
Blanks	Middle	$z = 3.74***$	no test	$\chi^2 = 3.96$	31
	Last	$z = 1.56$	$\chi^2 = 4.63$	$\chi^2 = 5.07$	31
Intrusions and Blanks	Middle	$z = 0.36$	$\chi^2 = 0.47$	$\chi^2 = 1.86$	32
	Last	$z = 0.98$	$\chi^2 = 2.09$	$\chi^2 = 5.57$	32

**p < .01

***p < .001

CHAPTER IV

DISCUSSION

Level of S, N, O difficulty on OLs.--The non-significant F s for the effects of Similarity and the Similarity x Practice interaction (see Tables 8 and 11) indicated that the items coded for the S, N, and O relations on the OL trials were not differentially learned. The rather similar means and the large standard deviations (see Tables 6, 7, 9 and 10) further support this view. It is likely, then, that the findings of this study are not biased with respect to a differential ease of learning of the S, N, and O type items on the original lists (OL).

The finding of a significant F of 5.65 ($p < .05$) for Practice on the Variation B analysis (see Table 11) is probably an artifact of the scoring system employed. Since the High Practice group had been presented more OL trials than the Low Practice group, on difficult to learn items the subjects in the High Practice group were thus permitted to obtain higher scores than the Low group. The median number of OL trials presented to the Low Group was 8.0; to the High group it was 14.0.

Effects of OL Practice.--On the OL trials the two levels of OL Practice, Low and High, were significantly different with respect to (1) the mean number of OL trials presented to each group, and to (2) the mean number of correct items obtained by subjects on their last OL trial. ($p < .001$ in both cases; see Tables 12 and 13). These findings suggest that the differing

amounts of OL practice presented to the groups were sufficiently diverse. However, on the TL trials, significant differences between the Low and High groups were found only with respect to some of the Intrusion and the Blank measures. It is not immediately apparent why the analyses made with the trials-to-criterion and latency measures did not result in significant differences between the two groups on the TL trials. Perhaps the amounts of practice were not varied to a sufficient degree. Or, it may be that trials-to-criterion and latency were insensitive measures. An assessment of these dependent variables will be presented in the following section.

The mean number of intrusions for the Low group was significantly greater than the mean of the High group, on both the Middle and Last Trials for the Intralist and Combined Types of Intrusions (see Tables 29 and 31). It is likely that the increased amount of practice which the High group received increased the ability of that group to distinguish the OL from the TL materials. Thus, the subjects in the High group might well be expected to produce fewer intrusions than those in the Low group. Consequently, those in the High group would be expected to produce more blanks than those in the Low. The finding of a significant difference ($p < .0002$) between the mean number of blanks for Low and High groups on the Middle Trials (see Table 30) supports this interpretation.

Effects of Meaningful Similarity.--The results of the statistical analyses indicate that the S, N, and O levels of the Meaningful Similarity Relations variable had no

differential effects upon the measures of trials-to-criterion, latency, and intrusions in the "responses varied" transfer situation. Nor did the Meaningful Similarity variable interact in any significant way with amount of OL practice. The variable of Meaningful Similarity does not appear to be a major factor affecting degree of transfer.

The question may be posed as to whether the three dependent variables used in this study were sufficiently sensitive to detect such effects. An assessment of each of these variables follows.

(1) Trials-to-criterion per item may be regarded as a sensitive and important measure for it traces the progress in learning for each of the 15 items in the transfer list across trials. It is sensitive because it records the exact trial on which a subject obtains an item correct for the first time (Variation A). It is also a stable measure because it records the trial on which the item is obtained correct for the second time (Variation B). The measure is exceedingly important since it is directly involved with determining when and if an item is learned correctly.

(2) The Latency measure was undoubtedly restricted in the present study. The extremely skewed frequency distributions were the result of an inordinately high number of "Fast" (short) latencies (see Tables 24 and 25). Consequently, finer latency discriminations, which the E-raters did not provide, may have been necessary. A mechanical measuring device or aid of some sort would possibly be required. Nevertheless, rough

as it was, this measure did significantly differentiate to a high degree between something, the rate of responding between the Middle and Last Trials (see Table 26). The difference indicates that, in general, the subjects' average speed of responding increased over trials. That is, when the subjects gave correct responses on the Last trial those responses tended to be given with shorter latency than those responses given on the earlier Middle trials. Such a difference is likely due to the effect of practice on correct items over trials. The typical finding of investigators is that latency is inversely related to response strength or to freedom of conflicting tendencies (Woodworth and Schlosberg, 1954, p. 41). However, whatever the adequacy of this formulation might be, it would appear that the sort of interpretation which would likely be placed on this finding would not be relevant to the purposes of this investigation. The finding would be one of particular importance had some significant effect involving either Meaningful Similarity or level of Practice also been found.

(3) The intrusion measure is one that is closely related to the trials-to-criterion per item measure. The former is concerned with incorrect responses, the latter with correct responses. A problem which may occur with the intrusion measure is that subjects may prefer to say nothing (blanks) rather than utter an incorrect response. Consequently, the frequency of intrusions in some particular categories may be insufficient for statistical analysis. This situation occurred in this investigation for certain types of intrusions, Related

Interlist, Unrelated Interlist, and Extralist, and thus greatly reduced the effectiveness of the intrusion measure.

In summary, it appears that the most sensitive measure in the experiment was trials-to-criterion; latency and intrusions were weak ones, although not entirely without power. In all, one would expect that such measures would be sufficiently sensitive to detect any differences which may exist to an important degree regarding the effects of the Meaningful Similarity variable.

The number of studies which have employed the variable of Meaningful Similarity is relatively small, and their results are conflicting and inconclusive (see Table 1, and pages 3-5). The finding of Osgood and Steinberg (1965) that Meaningful Similarity is a factor affecting rate of acquisition in paired-associate learning, seems to suggest that it would also be one in a transfer situation. In that study it was found that, generally, S items were learned significantly faster than N or O items. There was little differentiation between N and O items. The subjects in their study were tested with materials and procedures that were similar, and in a situation that was identical with that employed in the present investigation. Further, the dependent variable of trials-to-criterion per item used by Osgood and Steinberg was the same as that used in the present study. That the Meaningful Similarity variable affected learning in that study, but failed to affect transfer in the present study is thus somewhat baffling. However, since the Osgood and Steinberg study varied similarity

relations between stimulus and response elements in paired-associate learning, rather than the similarity relations between response elements in transfer as in the present study, any implications from the Osgood and Steinberg study for the present one must be quite tenuous.

Conclusion.--Osgood (1953) has theorized that the more nearly similar are two responses, the less would be the interference in a paradigm B transfer situation. He predicts an S N O order, where the S relation between responses (the most similar) results in the smallest amount of interference and the O relation (the least similar) results in the largest amount of interference, i.e., S < N < O interference. The results obtained in the present investigation, S N O, differences not significant, do not support Osgood's theory.

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