c2

TRANSFER IN SERIAL LEARNING AS A
FUNCTION OF
INTERLIST POSITIONAL RELATIONS

by

SALLY JEAN WHITMORE
B.A., University of British Columbia, 1971

A THESIS SUBMITTED IN PARTIAL
FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF ARTS
in the Department
of
Psychology

We accept this thesis as conforming to
the required standard

The University of British Columbia
April, 1973

Department of Psychology

The University of British Columbia
Vancouver 8, Canada

Date April 21, 1973.

Abstract

Transfer in serial learning as a function of inter-list positional relations was examined in a serial to serial transfer paradigm. After learning a 16-adjective serial list to a criterion of two consecutive perfect recitations, 128 _S_s were given ten trials on a 16-adjective transfer task. There were four conditions of transfer defined by the positional relationship of items between successive lists. First-, second-, and fourth-order derived list conditions and a control condition were used. Half of the experimental _S_s were instructed as to the positional relationship between the lists while the remaining _S_s were given no positional information. The results indicated significant positive transfer in the DL_1 and DL_4 groups when compared to the control group. DL_2 performance was slightly superior to performance of the control group but this difference did not approach significance. Performance of instructed _S_s was found to be significantly better than performance of non-instructed _S_s. The instructions variable was not found to have a differential effect among conditions. The results were interpreted as being incompatible with either the sequential or the ordinal-position hypothesis of serial learning, but as evidence in support of a relative ordinal-position hypothesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENT

The author would like to particularly acknowledge the advice and the encouragement of Dr. G.J. Johnson throughout all phases of this research. Thanks are also due to Dr. D. Foth who read and critically evaluated the writing of the thesis as a member of the Thesis Committee.

Transfer in Serial Learning as a Function of Interlist Positional Relations

Sally Jean Whitmore

University of British Columbia

Since their inception in 1885, the connectionist views of the German psychologist, Ebbinghaus, have played an important role in the shaping of the explanations proposed by modern psychologists for many verbal learning phenomena. His classic monograph on rote verbal learning and retention (1885) has been accorded widespread recognition for its role in the establishment of the concept of remote associations in serial learning. Ebbinghaus used derived-list experiments to study the remote associations which he assumed were formed during serial learning. Ebbinghaus was his own subject in these early experiments. His method was to learn an original list of nonsense syllables to a criterion of one perfect recitation. The following day, Ebbinghaus memorized a second serial list composed of the same items as those he had learned the previous day. He re-arranged the order of the items in the second list according to the paradigm he wished to represent. A first-order derived list (DL_1) was one in which items separated by one item in the first list were adjacent to one another in the second list. A second-order derived list (DL_2) was one in which items separated by two words in the original list were adjacent to one another in the second list.

In his derived-list experiments, Ebbinghaus used the method of whole-list presentation where the complete list was always in view. He would learn an original list, symbolized A, B, C, D, etc., and then, if the derived-list condition was one of one-degree remoteness, he would learn a second list composed of alternate first-list items. Thus the second list would be A, C, E,...B, D, F,...etc. If the desired paradigm was a list of two degrees of remoteness, then the second list was constructed by skipping two first-list items, A, D, G,...B, E, H,...etc. By studying several derived lists of varying orders (first, second, third, seventh and random), Ebbinghaus acquired data which supported his hypothesis that the percentage savings in learning time of the second list was greatest for the first-order condition and that the percentage savings in learning time of the list decreased as the order of the second-list derivation increased. On the basis of these results and the results of an experiment in which the second list was the reverse of the first (a backward derivation), Ebbinghaus proposed that during serial learning, associative strength accrues not only between adjacent items, but also, and at the same time, between items farther separated in the list in both the forward and backward directions. The strength of a given remote association was inferred to decrease as the degree of remoteness increased. Backward associations were assumed to be much weaker than forward associations.

Largely on the basis of the results of the derived-list studies, Ebbinghaus (1913) formulated what has come to be known as the "chaining" or "sequential association" conception of the serial learning process. According to this view, the serial list is a highly organized group of items which are related to or associated with each other. It is implied that the functional stimulus operating in serial learning is the preceding word in the list. Thus, after a subject has learned a serial list symbolized A, B, C, D, etc., when A is presented in the transfer task, the response most likely to be emitted by the subject to this stimulus is the response B.

The derived-list studies performed by Ebbinghaus provided impetus for further experimentation, and in the fifty years following the publication of his work, considerable research in serial learning was conducted.

The concept of remote associations was used by investigators to explain other phenomena observed in serial learning. Lepley (1934) used the Ebbinghaus concept to account for the commonly observed bowed serial-learning curve. He assumed that every item in a serial list is associated with every other item in the list during serial learning and that all but the correct associations interfere with learning. The Lepley hypothesis, however, predicted a symmetrical serial-position curve with the most difficult items at the middle of the list. Hull (1935) extended the Lepley hypothesis to account for the greater difficulty of learning syllables in the middle of a serial list compared to those at either end of a list. His deduction was based on the assumption that each item in a serial list becomes associated, through stimulus trace conditioning, with each of the succeeding items in the list. These trace conditioned responses were supposed to be held in check by an assumed "inhibition of delay". Hull counted the number of remote associations for each item in a serial list and calculated the alleged amount of inhibition preventing the occurrence of each response. He plotted the values and predicted a symmetrical curve with a peak in the middle and zero values at either end. However, data show a curve that is non-symmetrical with the largest number of correct responses occurring at the first few positions, the next largest number of correct responses at the end positions, and the most difficult items, not in the middle of the list, but somewhat beyond the middle.

Bugelski (1950) used the remote association concept in an attempt to modify the Lepley-Hull hypothesis to provide a more adequate fit of the symmetrical theoretical curve to the assymetrical data. Theoretical remote associations spanning each serial position in an eight-item list are shown in Table 1. In this table, X refers to the starting symbol in the list. The numbers refer to the other items in the list.

Bugelski suggested that Hull's system could approximate experimental data most closely if his stimulus trace and afferent neural interaction postulates were more completely exploited. Bugelski hypothesized that the remote associations alleged to be responsible for the prevention of correct responses vary not only in number,

Table 1

Hypothetical Remote Associations Assumed to be Established during the Acquisition of an 8-item Serial List

	X	1	2	3	4	5	6	7	8
	0	X-2	X-3	X-4	X-5	X-6	X-7	X-8	0
		X-3	X-4	X-5	X-6	X-7	X-8	1-8	
		X-4	X-5	X-6	X-7	X-8	1-7	2-8	
		X-5	X-6	X-7	X-8	1-6	1-8	3-8	
		X-6	X-7	X-8	1-5	1-7	2-7	4-8	
		X-7	X-8	1-4	1-6	1-8	2-8	5-8	
		X-8	1-3	1-5	1-7	2-6	3-7	6-8	
			1-4	1-6	1-8	2-7	3-8		
			1-5	1-7	2-5	2-8	4-7		
			1-6	1-8	2-6	3-6	4-8		
			1-7	2-4	2-7	3-7	5-7		
			1-8	2-5	2-8	3-8	5-8		
				2-6	3-5	4-6			
				2-7	3-6	4-7			
				2-8	3-7	4-8			
					3-8				
TOTAL	0	35	66	90	104	105	90	56	0

but also in strength. He attempted to determine how variations in total remote association strength arise at different positions in a serial list.

According to Bugelski, the strength of remote associations is a function of two factors. The first of these factors is the point in time at which a response occurs when a stimulus trace is present. He assumed that the strength of a remote association decreased as a function of degree of remoteness, that is, if the starting point is symbolized as X, then X-1 is stronger than X-2; X-2 is stronger than X-3, etc. Hull assumed generally that stimulus traces are active for about 30 secs. In an eight-item list the first stimulus (X) will be active throughout the presentation of the entire series if the items appear at a 3-sec. rate as the last item will appear 24 secs. after the presentation of the initial stimulus. However, since 24 secs. have elapsed, the trace is not likely to be very strong and the last remote association should be correspondingly weak. Similarly, for all other items in the list, each item serves as a stimulus, resulting in a stimulus trace of diminishing intensity.

The second factor assumed to affect the strength of remote associations is the number of additional responses occurring while a trace is active. For remote associations of any _given_ degree, the strength of that association will increase from the beginning of the list to the end of the list, that is, X-2 < 1-3 < 2-4, etc. In this manner, not only the _number_ of associations at each point in the list, but also the _strength_ of each remote association was considered.

On the basis of the above assumptions, Bugelski calculated weighted frequencies to provide a theoretical curve which showed the greatest effect of the remote associations occurring just beyond the middle of the list. Hypothetical strengths of remote associations assumed to be established during the acquisition of an eight-item list are represented in Table 2. Each of the remote associations appropriate to an eight-item list according to Hull's (1935) conceptualization appears in Table 2 in columns labelled (a). The value of each remote association according to Bugelski's analysis is shown in column (b). An increment of one unit of associative strength with each successive decrease in degree of remoteness is added, starting with the association between the first stimulus and the last response. Progressively higher values are assigned to the associations of the same degree of remoteness. That is,

Table 2

Hypothetical Strength of Remote Associations
Assumed to be Established During The
Acquisition of an 8-item Serial List
(Bugelski, 1950)

Position X	1		2		3		4		5		6		7		8
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	
0	X-2	(7)	x-3	(6)	x-4	(5)	x-5	(4)	x-6	(3)	x-7	(2)	x-8	(1)	0
	X-3	(6)	x-4	(5)	x-5	(4)	x-6	(3)	x-7	(2)	x-8	(1)	1-8	(3)	
	x-4	(5)	x-5	(4)	x-6	(3)	x-7	(2)	x-8	(1)	1-7	(4)	2-8	(5)	
	x-5	(4)	x-6	(3)	x-7	(2)	x-8	(1)	1-6	(5)	1-8	(3)	3-8	(7)	
	x-6	(3)	x-7	(2)	x-8	(1)	1-5	(6)	1-7	(4)	2-7	(6)	4-8	(9)	
	x-7	(2)	x-8	(1)	1-4	(7)	1-6	(5)	1-8	(3)	2-8	(5)	5-8	(11)	
	x-8	(1)	1-3	(8)	1-5	(6)	1-7	(4)	2-6	(7)	3-7	(8)	6-8	(13)	
			1-4	(7)	1-6	(5)	1-8	(3)	2-7	(6)	3-8	(7)			
			1-5	(6)	1-7	(4)	2-5	(8)	2-8	(5)	4-7	(10)			
			1-6	(5)	1-8	(3)	2-6	(7)	3-6	(9)	4-8	(9)			
			1-7	(4)	2-4	(9)	2-7	(6)	3-7	(8)	5-7	(12)			
			1-8	(3)	2-5	(8)	2-8	(5)	3-8	(7)	5-8	(11)			
					2-6	(7)	3-5	(10)	4-6	(11)					
					2-7	(6)	3-6	(9)	4-7	(10)					
					2-8	(5)	3-7	(8)	4-8	(9)					
							3-8	(7)							
0	7	28	12	54	15	75	16	88	15	90	12	78	7	49	0

although the associations between stimulus 1 and response 3 and stimulus 6 and response 8 are both of one degree of remoteness, Bugelski does not value them equally. He assumes that when a stimulus trace from stimulus 6 is initiated, there will be competition for associations from responses 6, 7, and 8. When stimulus 1 is presented, there will be competition for associations from all eight possible responses. Bugelski states that it is reasonable to infer that associations made in competition with a large number of others are likely to be less strong than associations made when there is little competition. As there is less competition possible towards the end of the list, he assigns a higher value to associations of the same degree of remoteness if they occur later in the list.

Another phenomenon observed in serial learning, the error gradient in serial recall, has also been cited as evidence of remote associations. McGeoch (1936) found that in the recall of serial lists, the items closest to the correct response which the subject is attempting to emit will be more likely to be the responses given incorrectly. That is, if the correct response is "C", the response of "B" or "D" is more likely to occur as an incorrect response than is a response of "A" or "E". A gradient of incorrect responses occurs with the largest number of incorrect responses being adjacent to the correct response, the next largest number being one position removed in both the forward and backward directions, and continuing in this manner with the number of incorrect responses decreasing as a function of distance in the list.

It has been pointed out by Jensen (1962) that certain serial-learning phenomena, such as the skewed serial-position curve, have been explained in terms of stimulus-response connections. These connections have been considered in terms of their relative strengths as affected by the interactions of excitatory and inhibitory processes assumed to accrue during learning or by response competition or interference between items resulting from stimulus generalization or from the formation of remote associations. These explanations must be restricted to serial anticipation learning, where there is a consistent temporal sequence of item presentation. Jensen (1962) conducted several experiments designed to determine whether the occurrence of the serial-position effect depends upon a temporal serial presentation of the items or whether the effect is a more general phenomenon which may also be present when items are ordered spatially rather than temporally. In the first experiment, nine different geometric forms were used as stimuli. These stimuli were presented simultaneously in a row, the series being predominantly spatial. Subjects were allowed to study the order for ten secs., after which _E_ scrambled the items and _S_ was required to replicate the order. The error curve resulting from this task was typical of serial position curves obtained by temporal serial presentation of items, although the greater proportion of errors occurred somewhat beyond the middle position. Further, the curve was less skewed than would be normally expected.

In the second experiment, Jensen presented nine geometric stimuli individually. These stimuli were always in one location and always appeared in random order. The spatial serial arrangement was in the _S_'s response-alternatives which consisted of a row of nine buttons on a response panel. The subject's task was to learn, by trial and error, which button was associated with a particular stimulus randomly presented on a screen in front of him. A correct response was reinforced by a "bong" before the next stimulus item appeared. The plotted results of the errors incurred for this task showed a serial-position effect. That is, the buttons on the ends of the panel were learned most readily and those in the middle were learned with the greatest difficulty. Jensen noted that this curve was produced by a non-serial presentation of the stimuli and a spatial serial arrangement of the response alternatives. He concluded that the essential features of the serial-position curve emerge under conditions other than the learning of a temporal sequence of item presentation by the method of serial anticipation. The theory of remote associations based on the stimulus trace notion cannot be used as an explanation of these results.

Recently, other theorists have begun to assess the validity of the notion of remote associations. Slamecka (1964) reviewed the previous studies relating to what he refers to as the "doctrine" of remote associations. On the basis of a series of derived-list studies, Slamecka contended that superior performance of a DL_1 over a scrambled control list, in which second-list items were randomly placed in sequence, was due to pattern recognition. When unfamiliar material was learned, no superiority of DL_1 over a scrambled control was found. In a later derived-list study, in order to prevent pattern recognition, Slamecka used a modified DL_1 in which 0, 1 or 2 items were skipped in an irregular manner, but which had an overall mean of one skipped item. He found no difference between performance under this condition and that on a scrambled control list. Slamecka suggested that the remote associations concept in its original form is of doubtful validity and offered an alternative conception of serial memorization which emphasizes the acquiring of the items per se, and then the learning of their positions in the list, rather than the formation of sequential associations.

Hakes, James and Young (1964) designed a derived-list study to test the generality of the Ebbinghaus results. They used the serial anticipation method to investigate first-, second- and third-order derived-list conditions. The learning of these groups was compared to that of a control group who learned two unrelated serial lists. The results indicated no positive transfer but suggested that the derived-list paradigms were paradigms of negative transfer. The results were interpreted as providing negative evidence for a theory based upon assumptions concerning the formation of remote associations during serial learning.

Bugelski (1964) has questioned Slamecka's criticism on the grounds that the particular control list used in Slamecka's studies may not have been sufficiently different in terms of degree of remoteness from the DL_1 since it was randomly derived. A better procedure might have been to compare Slamecka's modified DL_1 with appropriately modified derived-lists of higher degrees of remoteness. The results of a study conducted by Johnson[1] at the University of British Columbia involving a comparison of performance on Slamecka's modified DL_1 with that on modified DLs of higher degrees of remoteness confirmed Slamecka's findings. A DL_1 condition which varied on the order of 0, 1 or 2 degrees of remoteness, and a DL_3 condition which varied on the order of 2, 3, or 4 degrees of remoteness were compared in terms of trials to criterion and number of errors over ten trials. The results indicated no difference between performance on the DL_1 and the DL_3 conditions. Comparison of the two DLs combined with a control list constructed of items unrelated to those in the first list revealed a significant difference in favor of the control <u>S</u>s. The results of this study underscore the suggestion of Hakes and Young (1966) that the Ebbinghaus theory does not imply positive transfer in the derived-list

1. Johnson, G.J., "A re-appraisal of the concept of remote associations in serial learning (Manuscript)

studies, but that a DL of <u>any</u> degree of remoteness greater than zero may contain elements which contribute towards negative transfer. This reasoning is plausible if one assumes that the acquisition of a DL greater than zero requires "unlearning" of previously formed associations. Performance would then be expected to be influenced to some extent by the inherent interlist interference in the DL. Thus failure to obtain positive transfer for low-order DLs does not, in itself, disconfirm the remote associations theory.

Since the appearance of the above articles, the concept of remote associations has virtually disappeared from contemporary veral learning literature. Further, not only the remote associations doctrine itself has been challenged, but also the chaining concept of serial learning which implies that the preceding item is the functional stimulus in serial learning, has been brought into question.

Several studies which have provided a basis for attack on the chaining conception of serial learning are those which have investigated transfer from serial to paired-associate (PA) learning. It has been reasoned by Young (1962) that if serial learning consists of the formation of associations between adjacent items in a serial list, then positive transfer should be obtained in a serial/paired-associate transfer design in which pairs in the second list are formed from adjacent items in the serial list. That is, if adjacent items of a serial list (A-B-C-D...etc.) are used to construct individual pairs (A-B, B-C, C-D,...etc.) in a double function paired-associate task - where each item in the original list serves as both a stimulus and a response - performance on the transfer task should be better for experimental Ss than for control Ss who learn a serial list of items unrelated to the paired-associate task. This result, however, has not generally been the case. Young (1962) investigated transfer in a serial/paired-associate paradigm using single function lists in which items from the first list serve as either a stimulus or as a response item in the transfer task. In this experiment the subject learned a serial list of adjectives and then learned a paired-associate list composed of half experimental pairs constructed from contiguous items in the original list and half control pairs consisting of unfamiliar items. No positive transfer for the experimental pairs was observed.

The question of what is the functional or effective stimulus in serial learning has generated a great deal of interest and investigation. As early as 1920, Woodworth and Poffenberger suggested that _S_s may use position cues in serial learning. Others, (e.g. Melton, 1940), recognized the role of position identity as a mediator of interlist intrusions. However, it was not until the 1960's that the role of positional cues in serial learning was actively investigated. The results of a serial/serial transfer study (Young, 1962) suggested that the functional stimulus in serial learning is the position which the item holds in the serial list. In this study the experimental group learned two serial lists in which alternate items held the same ordinal position in both the original and second lists. The remaining items were randomly arranged in the second list. Thus half of the items held the same position in both lists and half the items were randomly redistributed into new positions. A control condition consisting of items unrelated to those of the first list was also included. On the basis of the ordinal position hypothesis it would be predicted that the learning of the items which did not change positions across lists would be facilitated. That is, Young's arrangement conforms to an A-B, A-B paradigm of positive transfer with A referring to the same serial positions in both lists and B referring to the same item in the two serial lists. Performance on those items which changed positions across lists would be expected to show interference and hence negative transfer, because different first-list responses are paired with the same position stimuli in the second list, thus creating an A-B, A-Br paradigm of negative transfer. If the chaining hypothesis is considered, all of the second-list items correspond to an A-B, A-Br paradigm which is one of negative transfer. In this paradigm no difference between performance on the sublists would be expected. If the ordinal position hypothesis is considered, positive transfer is expected for those items which did not change position across lists and negative transfer for those items which did assume new positions in the second list. Young's data show more correct responses for the unchanged items than for the items at re-arranged positions. The control list, in which all items were new items, was learned in fewer trials than the experimental list. Young suggested that these results support the ordinal-position hypothesis.

Ebenholtz (1963b) conducted a study which was similar in design to the one conducted by Young (1962). The transfer list for one group of <u>S</u>s contained items half of which were items from the original list and which maintained their original positions. New items were substituted for the remaining half of the transfer list. The following symbols represent the arrangement of the items in the two lists for one of the two experimental groups:

List 1: A, B, C, D, E, F..... etc.
List 2: K1, B, K2, D, K3, F..... etc.

A second experimental group was designated a mediation-control group. In the mediation condition, alternate items on the first list were repeated on the transfer list but were displaced at least four positions from their original list locations. This arrangement can be represented as follows:

List 1: A, B, C, D, E, F, G, H...etc.
List 2: F, K4, H, K5, J, K1, B, K2..etc.

Both arrangements represent conditions in which alternate items represent experimental items. There is a possibility that S might mediate transfer performance by implicitly reciting the original list and calling out every other item. In this way the subject could use his knowledge of the sequence of first list items to recall the experimental items in the second list. If this mediation were in fact responsible for facilitation of learning of repeated items, one would expect both groups to learn the repeated items at equivalent rates. Ebenholtz used a control group, for which all second-list items were completely new, to permit an estimate of the positive or negative directions of transfer. The results indicated that only those repeated items which maintained the same position in both lists were learned at a rate equivalent to non-repeated items. Ebenholtz concluded that the results provided no evidence for mediation but that they support the hypothesis that position cues are an important aspect of serial-learning. He suggested that the position an item holds in a serial list operates as the functional stimulus in serial learning.

Battig, Brown and Schild (1964) pointed out that the evidence for positional associations has been obtained predominantly with high-meaningful items (Young, 1959, 1961, 1962), or with shorter lists and slower presentation rates. (Ebenholtz, 1963). They attempted to evaluate the relative importance in serial learning of associations between adjacent items, associations with serial positions, and of more complex higher-order learning processes. Battig, Brown and Schild conducted a serial/serial transfer study in which the second serial list included three items from the first list placed in (a) same-adjacent, (b) changed-adjacent, or (c) same-non-adjacent serial positions. In order to assess any differential involvement of the three processes in different parts of the list, the positions of the critical second-list items in the original list were varied systematically in the second list. The authors suggested that there are complex multiple-item associative units which develop gradually, with practice, in the middle positions of a list, whereas initial items are learned by positional and sequential cues.

Postman and Stark (1967) used a serial/paired-associate task to re-examine the conclusions concerning the functional stimulus in serial learning. They analyzed transfer effects in order to determine the extent to which learning the transfer task is a function of practice. Postman and Stark assumed that if serial learning results in the establishment of associative links between successive items, there should be substantial positive transfer in the acquisition of paired-associates which are composed of adjacent items from the serial list. Positive transfer has not been found in several studies (e.g. Young, 1961; Jensen and Rohwer, 1965). Postman and Stark suggested that low degrees of transfer reflect failures of performance under conditions of massive interference inherent in the double-function paired-associate list due to backward associations in the PA list, rather than the absence of relevant associations. Their experimental design was formulated to evaluate transfer effects over a fixed number of trials and to determine the effect of information given to Ss as to the nature of the transfer task. All Ss learned an eight-item serial list to a criterion of one perfect recitation. Then they were given ten transfer trials on a double-function paired-associate list. There were three conditions of transfer. One group of Ss learned a paired-associate list composed of pairs of adjacent items from the serial list. For another group, there was no overlap between items in the serial and paired-associate lists. In the third condition, the paired-associate items were formed from non-adjacent items of the serial list. Under each condition of transfer there was an instructed and a non-instructed group. Subjects in all groups learned three sets of two lists. For a given subject, the paradigm of transfer remained constant from one cycle to another. Significant amounts of positive transfer were found for the Ss in the adjacent-pairing condition. Negative transfer resulted for the condition in which the paired-associate items were composed of non-adjacent items from the serial list. Instructions increased positive transfer but had no influence on negative transfer. The positive transfer increased and negative transfer decreased as a function of cycles. Postman and Stark interpreted the results as supportive of the hypothesis that serial learning involves the development of sequential associations.

Shuell and Keppel (1967) replicated a portion of the Postman and Stark study using different procedures and materials. All Ss learned a 12-item serial list to a criterion of one perfect recitation. Experimental Ss were then given ten trials on a double-function paired-associate task in which the successive elements of the serial list were preserved. Control Ss were given ten trials at the same task, but the serial and paired-associate lists were composed from unrelated sets of adjectives for this group. The method of item presentation for serial learning was varied. Within each condition, the starting point of the serial list remained the same for half of the Ss on all trials. The starting point was varied on each trial for the remaining Ss. After having learned the serial list, all Ss were informed of the nature of the construction of the double-function list and of the relationship between the serial and paired-associate lists. The use of the constant starting point for one condition represented a replication of part of the Postman and Stark experiment. By varying serial-position cues for the second group, the authors expected to maximize S's use of serial chains, as this procedure was supposed to eliminate the utilization of consistent serial-position cues during learning. The results showed that the experimental groups produced positive transfer. First-trial analysis indicated that positive transfer for the varied-starting-point group was significantly greater than that for the constant-starting-point group. The results support the assumption that the associative strength formed between contiguous items in the serial list is the critical factor producing the positive transfer observed on the paired-associate list. Thus Shuell and Keppel conclude that interitem associative chains are developed during serial learning.

Jensen and Rohwer (1965) used a serial/paired-associate paradigm to obtain evidence concerning the relative strength of sequential and positional associations in serial learning. The amount of transfer from a serial list to two different conditions of paired-associate learning was measured. In one design, subjects learned a serial list, A, B, C, D, etc., followed by a double-function paired-associate list constructed of adjacent items of the serial list (A-B, B-C, C-D, etc.). Control Ss learned a serial list which consisted of items unrelated to those of the paired-associate task. This condition was intended to be a test of of the sequential hypothesis. In the second experimental design, subjects learned a serial list, A, B, C, D, etc., followed by a paired-associate task which required them to associate items from the serial list with spatial positions in a horizontal rectangle (1-A, 2-B, 3-C, etc.) where each letter represents the serial-list items and each number represents a spatial position. When a red dot appeared in a horizontal rectangle, the subject was required to respond with the item which had occupied the corresponding ordinal position in the original list. A control group performed the same transfer task but learned a serial list of items unrelated to the paired-associate task. Jensen and Rohwer conceived this design as a test of the ordinal-position hypothesis. The results of the study indicated that although there was positive transfer in the first few trials for both designs, there was no significant overall transfer from serial to paired-associate learning for either the positional or the sequential task. Further analysis of the data showed that the percentage of transfer was significantly related to serial position; items at the beginning and end of the serial list showed positive transfer, while items in the middle of the original list showed zero or negative transfer.

Johnson (1972) suggested that any difference in the relative transfer effects yielded by the two types of design in the Jensen and Rohwer study may have been obscured by the low degree of absolute transfer that was imposed by the rapid presentation (2:2 sec. rate) of the transfer lists. Johnson replicated part of the Jensen and Rohwer study using a 4:4 sec. presentation rate. He extended the design by including negative transfer conditions for both the sequential task and the positional task. A third design, one of a sequential/positional type of transfer, was also included in the study. This transfer task combined the sequential and positional tasks in order to investigate the possibility that acquisition of a serial list involves a type of learning for which the effective stimulus consists of a combination of positional and sequential cues. If multiple cues are the effective stimulus, one would expect maximum transfer for the sequential/positional group relative to the other two experimental conditions.

The results of the study indicated that relative positive transfer was significantly greater in the positional group than in the sequential group. Performance of Ss in the sequential/positional group was not significantly greater than that of the Ss in the positional group except on paired-associate items from the middle of the serial list. Johnson interpreted the results as evidence that positional associations are a more essential factor in serial learning than are sequential associations, but that interitem associations may be included in the functional stimulus complex for some of the items in the middle of the serial list.

Although it is possible to obtain positive transfer with instructed subjects in a serial/double-function paired-associate task, the interpretation of this finding is not clear. Young (1968), among others, has suggested that such transfer reflects the subject's knowledge of <u>positional</u> aspects of the serial list, rather than, or as well as, any sequential associations that may have been established. Thus, while positive transfer in the serial/paired-associate paradigm is in agreement with the sequential-associations hypothesis, an unambiguous conclusion as to what constitutes the effective stimulus in serial learning cannot be made on the basis of these studies.

In a recent serial/serial transfer study, Dey (1969) had subjects practice two serial lists of identical length in random alternation in order to determine the effects of interlist serial-position generalization. Positional generalization was measured in terms of intralist and inter-list intrusion errors. A comparison was made of mean frequencies of interlist intrusions between disparate serial positions and of intralist intrusions. The results showed no significant difference between the two types of errors. Interlist errors were analyzed in terms of identical (or co-ordinate) serial positions and non-identical (or disparate) serial positions. It was found that the maximum number of intruding responses originated from the corresponding serial position in the other list. Further, the frequency of intrusions from a non-identical serial position in the other list declined systematically as positional disparity increased in either a forward or backward direction. Dey interpreted his findings as evidence in support of the hypothesis that associations develop not only between the items of a rote series and their serial positions, but also generalize between positions in inverse proportion to the intervening distance. The results of Dey's study are strongly in favor of the ordinal-position hypothesis.

It is evident that there has been a great deal of interest centred on the question of the functional stimulus in serial learning. It is also obvious that the particular mechanisms which underlie serial learning phenomena in general, and interlist transfer in particular, have not been determined. The usefulness of both the chaining concept and the ordinal-position hypothesis remains in doubt. The viability of the remote associations concept has been questioned as the bulk of evidence suggests that the concept is in need of revision if it is to be a usable entity.

In the past, the remote association investigations have been formulated within the framework of a sequential associations conceptualization. Research has failed to confirm a number of predictions concerning the operation of remote associations. Johnson[2] has suggested that this failure may possibly reflect inadequacies of the chaining hypothesis as to the nature of the functional stimulus in serial learning. It may be possible to revise the remote associations concept in terms of the evidence which emphasizes the importance of positional cues in serial learning. If the degree of remoteness of a particular item in a derived list is defined in terms of its ordinal position in the list relative to first-list learning, rather than in terms of the number of items separating it from the item which immediately preceded it in the original list, then the previous derived-list studies may be considered to be irrelevant to the remote associations issue. By re-defining

2. Johnson, ibid.

remote associations in this manner it can be hypothesized that the level of difficulty of a particular derived-list item is a direct function of the degree of remoteness of its position in the derived list relative to the position it held in the original list. Performance on the derived list might, then, be determined by the average degree of positional remoteness of individual items in the list. Conventional arrangements for derived lists of first, second and third orders of remoteness and the degree of remoteness for each item in terms of <u>interlist positional relations</u> are shown in Table 3. The average degree of remoteness with regard to positional relationships is similar for the three lists. Therefore, large differences in amount of transfer for these lists would not be expected. Further, these values do not increase as a linear function of degree of remoteness as it has been traditionally defined. It can be shown that for a list of any given length, the degree of remoteness in terms of sequential relations does not correspond to the average degree of remoteness in terms of positional relations. Previous studies investigating the effects of remote associations on serial/serial transfer have been carried out from the point of view which assumes sequential chaining in serial learning. The traditional

Table 3

Conventional Arrangements Representing Derived Lists of First, Second and Third Orders of Remoteness and Degree of Remoteness for each Item in terms of Interlist Positional Relations

DL_1	TL	R^o	DL_2	TL	R^o	DL_3	TL	R^o
1-A	1-A	0	1-A	1-A	0	1-A	1-A	0
2-G	2-B	1	2-E	2-B	2	2-D	2-B	3
3-B	3-C	2	3-I	3-C	4	3-G	3-C	6
4-H	4-D	3	4-B	4-D	6	4-J	4-D	2
5-C	5-E	4	5-F	5-E	3	5-B	5-E	1
6-I	6-F	5	6-J	6-F	1	6-E	6-F	4
7-D	7-G	5	7-C	7-G	1	7-H	7-G	4
8-J	8-H	4	8-G	8-H	3	8-K	8-H	1
9-E	9-I	3	9-K	9-I	6	9-C	9-I	2
10-K	10-J	2	10-D	10-J	4	10-F	10-J	6
11-F	11-K	1	11-H	11-K	2	11-I	11-K	3
12-L	12-L	0	12-L	12-L	0	12-L	12-L	0
Mean degree of remoteness		2.50			2.67			2.67

method for deriving lists of varying degrees of remoteness with respect to interlist sequential relations does not yield systematic differences in degree of remoteness as defined in terms of interlist positional relations. Thus it may be argued that the appropriate tests of the effects of remote associations on serial/serial transfer have not yet been conducted.

If one is to reconceptualize serial/serial transfer from an interlist positional point of view, a novel method of deriving lists is necessary. Arrangements conforming to DL_1, DL_2 and DL_4, where degree of remoteness is defined as the amount of change in ordinal position across lists, are presented in Table 4. It can be seen that the differences among derived lists in terms of average degree of remoteness are more pronounced than in lists derived using the traditional method.

Johnson[3] reports a study designed to investigate the possibility of re-opening the remote associations issue by comparing performance on transfer tasks where transfer lists are derived to represent various degrees of remoteness with respect to interlist positional relations. In order to

3. Johnson, ibid.

Table 4

Arrangements Conforming to DL_1, DL_2, and Dl_4. Degree of Remoteness is Defined as the Amount of Change in Ordinal Position Across Lists

DL_1	DL_2	DL_4	TL
1-B	1-C	1-E	1-A
2-A	2-D	2-F	2-B
3-D	3-A	3-G	3-C
4-C	4-B	4-H	4-D
5-F	5-G	5-A	5-E
6-E	6-H	6-B	6-F
7-H	7-F	7-C	7-G
8-G	8-E	8-D	8-H
9-J	9-K	9-M	9-I
10-I	10-L	10-N	10-J
11-L	11-I	11-O	11-K
12-K	12-J	12-P	12-L
13-N	13-O	13-I	13-M
14-M	14-P	14-J	14-N
15-P	15-M	15-K	15-O
16-O	16-N	16-L	16-P

reduce any possible effects of pattern recognition on second list performance, a serial/spatial discrimination design rather than a serial/serial transfer design was used. For different groups of fifth-grade Ss, the order of arrangements of the items in the transfer task corresponded to a DL_0, DL_1, DL_3 or control paradigm with respect to their arrangement on the serial task. Lists were derived by the method shown in Table 4. For the serial task, all Ss were required to reconstruct the order in which a horizontal array of 12 plastic animals was presented. The entire stimulus array was exposed for 20 seconds on each trial and then items were scrambled and re-presented to S with instructions to duplicate the original order. This procedure was repeated until the subject was able to achieve two successive errorless reproductions of the sequence. Upon reaching criterion, Ss were administered one of three spatial tasks. For this task, 12 cardboard cups, each of which covered one of the items used in the serial task, were presented in a row before each S in each of the DL conditions. Subjects were asked to learn which cup contained each of the 12 animals. They were given five seconds in which to give a response for each cup before it was raised to expose the appropriate item for one second.

Each S was given five trials at the task. For control Ss, the method of presentation was the same, but the items in the spatial task were different from those used in the serial task. For the DL_0 condition, the objects were placed in the same position as they held in the serial task. The DL_1 and DL_3 items were displaced from the positions held in the serial task by one and three positions respectively.

Data were scored in terms of the total number of errors on the transfer task. Significant positive transfer was found for the DL_0 condition and significant negative transfer was indicated for the DL_3 condition. The performances of the control group and the DL_1 group were approximately equal. All comparisons among the three derived-list conditions were significant. Johnson interpreted the results as support for the hypothesis that DL performance is a decreasing function of degree of remoteness as defined by intertask ordinal position relations.

Another study reported by Johnson[4] used a serial/serial transfer paradigm. Adult Ss learned a 16-item serial list (composed of common adjectives) under a standard serial anticipation procedure. From a 16-item transfer list, first-list arrangements were derived in terms

4. Johnson, ibid.

in terms of interlist positional relations. These arrangements represented DLs of 1, 4, or 8 degrees of remoteness. Half of the words on the transfer task - those designated as experimental items - were carried over from the first list and were placed in positions appropriate to each derived-list condition. The remaining adjectives - the control items - were new to the subject; that is, they had not appeared in the first list. For each derived-list condition there were two groups of subjects. For one group, experimental items occupied even positions in the list, and control items occupied odd positions. for the second group, this relationship was reversed. A control group learned a first list in which all items were unrelated to those used in the transfer task. Data were scored in terms of the number of errors over ten trials. Intralist comparisons of experimental and control items showed positive transfer for items representing a DL_1 paradigm and negative transfer for items representing DL_4 and DL_8 paradigms. Performance on control items did not differ across derived-list conditions. Performance in the DL_1 was significantly better than performance in DL_4 or DL_8 for the experimental items. Performance on experimental items in the DL_4 was not significantly different from that on experimental items in DL_8. Compared to the performance of the control Ss, all three DL groups showed significant negative transfer on both experimental and control items. With the exception of the lack of differences between performance on the experimental items in DL_4 vs DL_8, the results are in agreement with a modified remote associations analysis of serial/serial transfer effects.

The heretofore rather puzzling finding of Young, Hakes and Hicks (1965) may be explained by using the suggested modification of the remote associations concept. Positive transfer was found for an eight-item DL_1 list derived in the conventional manner. However, performance on either a 12-item or 16-item DL_1 list reflected negative transfer. Calculation of the average degree of remoteness in terms of interlist positional relations for a traditionally derived 8-item DL_1 is 1.50. For a 12-item list, the average degree of remoteness is 2.50. For a DL_1 of 16-items, traditionally derived, the average degree of positional remoteness is 5.00. It can therefore be seen that as the list length increases, the average degree of positional remoteness increases and thus an increase in the amount of negative transfer would be expected.

Slamecka's failure to find differential transfer effects in the traditionally derived DL_1 and his modified

DL_1 are to be expected in view of the present considerations. The average degree of positional change in his DL_1 and modified DL_1 conditions is identical, therefore no difference in transfer would be predicted.

If lists are derived so that for a DL_1 condition, the degree of positional remoteness of each item is one, that for each item in a DL_2 is two, and that for each item in a DL_4 is four, and if transfer is a function of positional change, a difference in amount of transfer across conditions should be observed.

The present experiment was designed to test the above predictions using a serial/serial transfer design. Lists were derived so as to equalize the degree of interlist positional remoteness for each item in a given list. That is, all items in the DL_1 condition were of one degree of remoteness; items in the DL_2 group were of two degrees of remoteness; while items in the DL_4 condition maintained four degrees of remoteness. The method of construction of these lists is shown in Table 4. An instruction variable was included in the study. That is, some Ss were informed as to the manner in which the items were arranged in the second list relative to first-list positions. Subjects informed as to the interlist positional relationships were expected to show greater amounts of positive transfer than those Ss who were not instructed as to the positional relationship of the items across lists.

Method

Subjects. Sixteen volunteer Ss served in each of eight groups. Ss were male and female graduate students and senior undergraduate students at the University of British Columbia. All Ss were naive to the task. The assignment of Ss was carried out in blocks of eight with one subject per block being randomly assigned to a given group. Within each of the blocks, assignment followed a different predetermined random ordering of the eight conditions. All Ss served individually.

Materials and Design. A different set of materials was used for each of two replications. From each set of material four serial lists were constructed - a transfer list and three different first lists. These lists were composed of 16 two-syllable adjectives. For a given replication, the transfer list was the same for all Ss, with first-list items being arranged so as to provide for four experimental conditions. There were four conditions of transfer defined by the relationship between the first serial list and the transfer list. In condition DL_1, the transfer list consisted of the 16 items from the first list placed either one position before or one position after the one held by the item in the first list. That is, if items of the serial list were represented by B, A, D, C,...etc., then the transfer list would be constructed of items in the order of A, B, C, D,...etc. In condition DL_2, the transfer list consisted of the appropriate 16 items from the first list arranged so that each item was displaced two positions. Thus, if the first serial list is represented C, D, A, B, G, H, E, F,...etc., the transfer order becomes A, B, C, D, E, F, G, H,...etc. Similarly, DL_4 items were arranged so that the transfer items appeared either four positions earlier or four positions later than they did in the first list. That is, if the first list is represented E, F, G, H, A, B, C, D,... etc., the transfer list for the DL_4 is A, B, C, D, E, F, G, H,...etc.

Half of the experimental subjects were instructed as to the nature of the relationship between the serial list and the transfer task. The remaining Ss were not given information pertinent to the construction of the transfer list. Subjects in the control condition learned both transfer lists - one as first-list learning and the other as the transfer task. Half of the control Ss learned Transfer List A followed by Transfer List B, while the other half reversed the procedure. The design of the serial lists is shown in Table 5.

The adjectives used in constructing the lists were taken from Hagen (1949) and from Melton (1940). All items were selected and arranged so as to minimize meaningful and formal similarity both within and across the two lists. Items were presented on a Lafayette memory drum.

Procedure. The serial lists were presented at a 3-sec. rate with a 6-sec. intertrial interval. Learning of all lists was by the anticipation method. In all conditions, Ss were required to attain a criterion of two consecutive perfect recitations on the first serial list.

Following first-list learning, all Ss were immediately administered the transfer task. Those Ss in the "instructed" experimental groups were informed that the words would be the same as those in the list they had just learned. The instructed Ss were also given information as to the number of positions each word would be changed in the second list relative to its position in the first list. Control Ss and non-instructed Ss were told only that they would now learn a second list of words. Eleven trials at

Table 5

Serial Lists for DL_1, DL_2, DL_4, and Control Conditions

DL_1		DL_2		DL_4		TRANSFER LIST	
A	B	A	B	A	B	A	B
Handy	Upper	Joyous	Legal	Sudden	Woven	Exact	Secret
Exact	Secret	Timid	Giant	Yellow	Overt	Handy	Upper
Timid	Giant	Exact	Secret	Quiet	Pious	Joyous	Legal
Joyous	Legal	Handy	Upper	Little	Basic	Timid	Giant
Yellow	Overt	Quiet	Pious	Exact	Secret	Sudden	Woven
Sudden	Woven	Little	Basic	Handy	Upper	Yellow	Overt
Little	Basic	Sudden	Woven	Joyous	Legal	Quiet	Pious
Quiet	Pious	Yellow	Overt	Timid	Giant	Little	Basic
Vocal	Daring	Ready	Inner	Adept	Major	Yearly	Funny
Yearly	Funny	Outer	Tired	Frozen	Erect	Vocal	Daring
Outer	Tired	Yearly	Funny	Kindly	Naive	Ready	Inner
Ready	Inner	Vocal	Daring	Bored	Aware	Outer	Tired
Frozen	Erect	Kindly	Naive	Yearly	Funny	Adept	Major
Adept	Major	Bored	Aware	Vocal	Daring	Frozen	Erect
Bored	Aware	Adept	Major	Ready	Inner	Kindly	Naive
Kindly	Naive	Frozen	Erect	Outer	Tired	Bored	Aware

the transfer task were given to each S with no response being required for the first presentation of the list. Data were compiled over ten transfer trials. Upon completion of the transfer task, all experimental Ss were given a mimeographed sheet which showed the first list appropriate to the condition represented by a column of letters, A, B, C, D,... M, N, O, P. Subjects were asked to reproduce the new order of the items as they appeared in the transfer task. Subjects were given two minutes to complete this task. The total number of errors was calculated for each subject.

Results

Comparison of the four groups (collapsed across replications) in terms of trials to criterion on the first list was used as a means of assessing possible differences in initial ability. The overall mean number of trials to criterion was 10.82. The range was 10.17 to 11.47. Analysis of variance indicated no significant differences among conditions, $F(3, 124)<1$.

Early transfer effects. Performance on the transfer task was examined in terms of the number of errors on the first transfer trial. The mean numbers of errors during the first transfer trial for the instructed subjects in the first-, second- and fourth-order derived lists were, respectively, 7.51, 9.75 and 5.43. The mean numbers of errors for the non-instructed Ss for the first transfer trial in the DL_1, DL_2 and DL_4 groups were, respectively, 10.48, 11.03 and 8.43. The mean number of first-trial errors for the control Ss was 12.26.

The mean numbers of first-trial errors for the instructed Ss and the non-instructed Ss, collapsed over all DLs, were, respectively, 7.56 and 9.98. Analysis of variance indicated that the effect was significant ($F=20.07$, $df=1, 121$; $p<.01$). The mean numbers of first trial errors for Ss in the DL_1, DL_2 and DL_4 and control groups were, respectively, 8.99, 10.39, 6.93 and 12.25. Analysis of variance indicated a significant difference among groups ($F=21.29$, $df=3, 121$; $p<.01$). The interactive effects of the Instructions and Conditions factors were not significant. ($F=1.16$, $df=2, 121$). Pairwise comparisons among the four conditions based on Newman-Keuls' procedure indicated significant differences ($p<.01$) between the DL_1 and DL_2 tasks and between the DL_4 and DL_2 tasks. Both the DL_1 and DL_4 conditions were found to be significantly different from the control condition ($p<.01$). The DL_1 vs DL_4 comparison did not approach significance.

Overall transfer effects. Performance on the transfer task was examined in terms of number of errors over ten transfer trials. The mean numbers of errors over ten trials for the instructed Ss in the first-, second- and fourth-order derived lists were, respectively, 23.69, 33.50 and 18.20. The mean numbers of errors over ten trials for the non-instructed Ss were, respectively, 38.44, 48.00 and 41.56. The mean number of errors for the control group was 50.41.

The mean numbers of errors for the ten transfer trials (collapsed over DL conditions) were 25.13 for the instructed Ss and 42.66 for the non-instructed Ss. Analysis of variance indicated that this difference was significant ($F=18.46$, $df=1, 121$; $p<.01$). The mean numbers of errors for Ss in the DL_1, DL_2 and DL_4 and control groups were, respectively, 31.07, 40.75, 29.88 and 50.39. Analysis of variance indicated significant differences among conditions ($F=15.27$, $df=3, 121$, $p<.01$). The interactive effects of the Instructions and Conditions factors were not significant ($F=.02$, $df=3, 121$). Multiple comparisons among the four conditions according to Newman-Keuls' procedure indicated significant differences ($p.<01$) between the DL_1 and DL_2 conditions and between the DL_4 and DL_2 conditions. Both the DL_1 and DL_4 conditions differed significantly from the control group. ($p < .01$). The DL_1 vs DL_4 comparison did not approach significance. Performance curves for the three DL conditions (collapsed over levels of the instructions variable) and the control group are presented in Figure 1 in terms of number of errors at each position over ten transfer trials.

The pattern recognition task responses were scored in terms of the number of errors at each position for each subject. The mean numbers of errors for the instructed Ss in the first-, second- and fourth-order derived lists were, respectively, 1.63, 4.25 and 2.89. The mean numbers of errors for the non-instructed Ss in the DL_1, DL_2 and DL_4 groups were, respectively, 8.75, 14.81 and 9.94. The mean numbers of errors for the instructed and non-instructed Ss, collapsed over the three experimental conditions, were 2.92 and 11.16 respectively. Analysis of variance indicated that this difference was significant ($F=71.61$, $df=1, 90$; $p < .01$). The mean numbers of errors for Ss in the DL_1, DL_2 and DL_4 groups were, respectively, 5.19, 9.54 and 6.44. Analysis of variance indicated a significant difference among conditions ($F=7.04$, $df=2, 90$; $p < .01$). The Conditions by Instructions interaction was not significant ($F=1.41$, $df=2, 90$). Pairwise

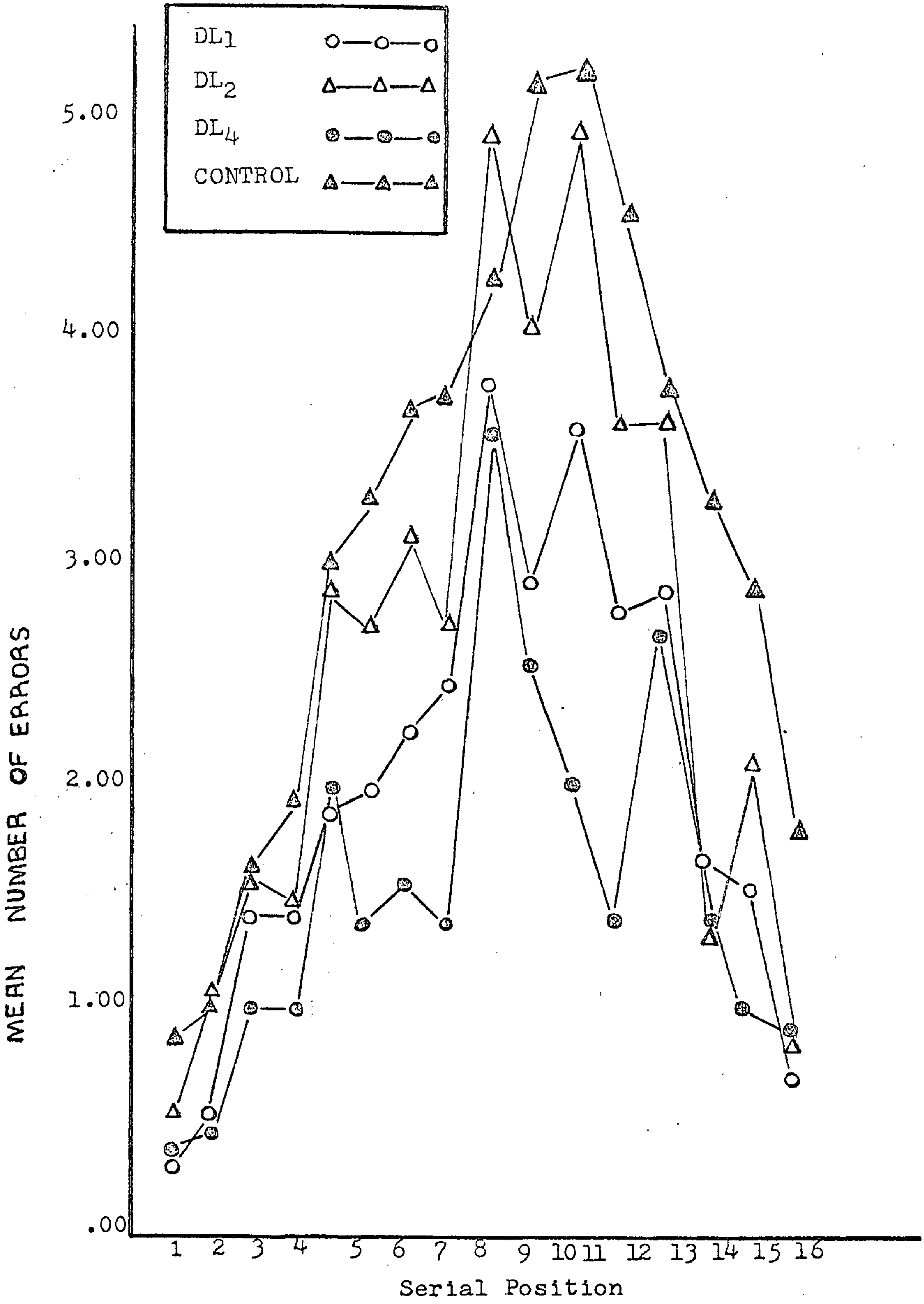

Fig. 1. Mean number of errors at each position over ten transfer trials

comparisons with the Newman-Keuls test indicated significant differences ($p < .01$) between the DL_1 and DL_2 conditions and between the DL_4 and DL_2 conditions. The difference between the DL_1 and DL_4 tasks did not approach significance.

Discussion

The results of the present study indicate that positive transfer in the DL_1 and DL_4 groups, when compared to the control group, is obtained in the serial/serial paradigm. The DL_2 performance was slightly superior to performance by control Ss, but this difference does not approach significance. There is no indication in the data of negative transfer in either the instructed or the non-instructed condition.

The results of the present study cannot be adequately interpreted from either a sequential association or ordinal position point of view. The chaining hypothesis cannot be used to account for the difference between the DL_1 and the DL_2 conditions. The finding that performance on the DL_4 list was significantly better than that on the DL_2 list is in accordance with a sequential association interpretation since, in the DL_4 condition, there are twice as many sequential associations carried over from first-list learning to the transfer task, as there are in the DL_2

condition. However, if the preceding item is the effective stimulus in serial learning, then DL_4 performance should be greatly superior to DL_1 performance, as there are four times as many sequential associations maintained across tasks for DL_4 than for DL_1. The data, however, indicate no significant difference between the DL_1 and DL_4 conditions.

Neither can the results be considered as strong support for the ordinal position hypothesis. The superior performance of the DL_1 subjects, compared with the performance of the DL_2 subjects, is in agreement with this view. That is, the DL_1 items were displaced one position in the transfer task relative to first-list learning, while items in the DL_2 condition were removed two positions relative to the first-list learning. However, the superior performance of Ss in the DL_4 condition (for which items were displaced four positions in the transfer task relative to first-list learning) over the performance of Ss in the DL_2 condition (for which items were displaced two positions in the transfer task relative to first-list learning), cannot be adequately interpreted from an ordinal position standpoint.

In an unpublished dissertation, Shiryon (1965) reported a study in which second-grade Ss learned three serial lists of common pictures. One group, E_1, learned a list symbolized A-B-C-D-1-2-3-4, and then a list symbolized 5-6-7-8-E-F-G-H. A second group, E_2, learned a list symbolized 1-2-3-4-A-B-C-D followed by a list E-F-G-H-5-6-7-8. Both groups then learned a third list, A-B-C-D-E-F-G-H. A control group learned two unrelated serial lists and then learned the A-B-C-D-E-F-G-H list common to the other two groups. The positions of items in the first two lists were consistent with their positions in the subsequent test list for group E1, but were not consistent for group E_2. The ordinal-position hypothesis would lead to the prediction that, since E_1 items retain the same serial positions, positive transfer should occur for this group. As the E_2 items change serial positions, negative transfer should result. The chaining hypothesis implies no difference between groups, since the same number of appropriate associations may be assumed to be formed between items in each condition. On the basis of the chaining hypothesis, superior performance of both E_1 and E_2, as compared to the control group, would be predicted. Shiryon's results were in agreement with the chaining hypothesis. However, Young (1968) points out that there may be another, equally plausible, interpretation of these results. Jensen (1962) suggested that serial learning involves a process of response integration. That is, the items in a list are given some particular sequence by the subject without each item's being exclusively dependent upon a specific eliciting stimulus or cue. Slamecka (1964) suggested that serial items are fixed in their relative positions in the list by means of being associated with a subject-generated sequential or spatial symbol (such as first, second, etc.) rather than through being associated with each other. Young states that both the Jensen and Slamecka hypotheses may be distinguished from the ordinal-position hypothesis by noting that it is the relative ordinal position which is stressed in their analyses. Young suggests that the position hypothesis could be used to interpret Shiryon's data if it is assumed that the relative, rather than the absolute, position of the item in the serial list is the functional stimulus.

Positional associations may be assumed to be the basis of the transfer effects observed in the present study if one assumes that S's knowledge of absolute positions of the items during first-list learning may be used during the transfer task when relative position is the appropriate cue. The fact that subjects may have learned the appropriate ordinal position of the items in the first list and transferred this knowledge to the second task is most evident in the data for the DL_4 condition. The data for this condition (see Fig. 1) show more errors at positions 5, 9 and 13, and fewer errors at the remaining positions than would be expected if the items were not in contiguous clusters. Although DL_4 items were displaced four positions relative to the first list in terms of absolute position, items were transferred in blocks of four with only four of the 16 items occupying a different relative position on the transfer task. It may be that the items at positions 5, 9 and 13 are the only items which the subject has to "re-learn" in the DL_4 transfer condition. Once he has learned the new positions of these four items, the remaining items in each sublist follow in the same relative positions as they held in the first list. Thus the subject might somehow view the transfer task as consisting of four, more or less distinct, blocks, or four small serial lists, where the relative ordinal positions for items within each block are maintained across lists.

One interpretation of the results of the pattern recognition task is that the transfer-list pattern is more easily recognized when successive pairs of items change positions (DL_1) or when blocks of four items change positions (DL_4). The superiority of DL_4 performance over the DL_2 performance might also reflect S's knowledge of the relative position as well as the absolute position of items. It seems to be easier for the subject to replicate the pattern if every pair of items is reversed (DL_1) or if the items are rearranged in fairly large clusters (DL_4).

The effects of the instructions variable were not found to be differential among conditions. However, on the basis of the present study, it can be concluded that instructions is an important variable which can increase the amount of positive transfer in serial learning regardless of list difficulty. This finding may also be in agreement with the relative position hypothesis if one assumes that the instructions might have helped S to articulate the absolute position cues in first-list learning and thus facilitate the use of his knowledge of the relative positions of the items in the transfer task.

It may therefore be concluded that the results of the present study are not compatible with either the sequential or the ordinal-position hypothesis of serial learning, but may be interpreted as providing evidence supporting a relative ordinal-position hypothesis. However, it would appear that the serial/serial transfer paradigm is not an adequate one to test implications of the ordinal-position hypothesis. One possible suggestion might be to re-design the study using a serial/spatial transfer task so that the temporal order of second-list items is varied from trial to trial, thus reducing the possibility that the subject recognizes entire blocks of items carried over from first-list learning to the transfer task.

References

Battig, W.F., Brown, S.C. and Schild, M.E., "Serial position and sequential associations in serial learning", Journal of Experimental Psychology, 1964, 67, No. 5, 449-457.

Bugelski, B.R., "A remote association explanation of the relative difficulty of learning nonsense syllables in a serial list", Journal of Experimental Psychology, 1950, 40, 336-348.

Bugelski, B.R., "In defense of remote associations", Psychological Review, 1965, 72, 169-174.

Dey, M.K., "Generalization of position association in rote serial learning", American Journal of Psychology, 1970, 83, 248-255.

Ebbinghaus, H., "Memory: A Contribution to Experimental Psychology". Trans. by H.A. Ruger and C.E. Bussenius, New York, Teachers College, Columbia University Press, 1913.

Ebenholtz, S.M., "Positional cues as mediators in discrimination learning", Journal of Experimental Psychology, 1965, 70, 176-181.

Haagan, C.H. "Synonymity, vividness, familiarity and association value rating of 400 pairs of common adjectives", Journal of Psychology, 1949, 27, 453-463.

Hakes, D.T., James, C.T. and Young, R.K., "A re-examination of the Ebbinghaus derived-list paradigm", Journal of Experimental Psychology, 1964, 68, 508-514.

Hakes, D.T., and Young, R.K., "Theoretical note: on remote associations and the interpretation of derived-list experiments", Psychological Review, 1966, 73, 248-251.

Hull, C.L. et al "Mathematico-Deductive Theory of Rote Learning - A Study in Scientific Methodology", New Haven, Conn: Yale University Press, 1940.

Jensen, A.R., "Temporal and spatial effects of serial position", American Journal of Psychology, 1962, 75, 390-400.

Jensen, A.R., and Rohwer, W.D., "What is learned in serial learning", Journal of Verbal Learning and Verbal Behavior, 1965, 4, 62-72.

Johnson, G.J., "Sequential and positional cues in serial to paired associate transfer", American Journal of Psychology, 1972, 85, 325-337.

Lepley, W.M., "Serial reactions considered as conditioned reactions", Psychological Monographs, 1934, 46, 1.

McGeoch, J.A., "The duration and extent of intra-serial associations and recall", American Journal of Psychology, 1936, 48, 221-245.

Melton, A.W., "Materials for use in experimental studies of learning and retention of verbal habits". Mimeographed manuscript, University of Missouri, 1940.

Postman, L., and Stark, K., "Studies of learning to learn, I.V. Transfer from serial to paired-associate learning", Journal of Verbal Learning and Verbal Behavior, 1967, 6, 339-353.

Shiryon, M., "A test of the serial-position interpretation of verbal serial rote learning", Unpublished doctoral dissertation, Berkeley: University of California, 1965.

Shuell, T.J., and Keppel, G., "A further test of the chaining hypothesis of serial learning", Journal of Verbal Learning and Verbal Behavior, 1967, 6, 439-445.

Slamecka, N.J., "In inquiry into the doctrine of remote associations", Psychological Review, 1964, 71, 61-76.

Woodworth, R.S., and Poffenberger, A.T. Textbook of Experimental Psychology, Columbia University Library, 1920, as cited in Ebenholtz, 1965.

Young, R.K., "Tests of three hypotheses about the effective stimulus in serial learning", Journal of Experimental Psychology, 1962, 63, 307-313.

Young, R.K., "The stimulus in serial verbal learning", American Journal of Psychology, 1961, 74, 517-528.

Young, R.K., "Serial learning", in T.R. Dixon and D.L. Horton (eds) "Verbal Behavior and General Behavior Theory", Englewood Cliffs, N.J., Prentice Hall, 1968, 122-148.

Young, R.K., Hakes, D.T., and Hicks, R.Y., "effects of list length in the Ebbinghaus derived-list paradigm", Journal of Experimental Psychology, 1965, 70, 338-341.