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ABSTRACT

Two studies examined serial recall process . . first-grade Canadian children from inner-city and suburban backgrounds. In the first study significant differences were found in the serial position curve of recall. Suburban children recalled a greater number of early-presented, primacy items, while inner-city children who had equivalent span capacity, recalled more later-presented, recency items. In the second study, four subgroups of children were assigned to high and low SES, primacy or recency response groups. All groups showed significant shifts toward the alternative recency or primacy recall pattern following a training period. Recall is attributed to learned serial processing strategies rather than to differences in intellectual capability (Jensen, 1968). (Author)

Children's Memory: SES Differences in the Development of Serial Processing Ability

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Current developments in the study of memory have given rise to speculations that the strategies or rules used by subjects are important in understanding memory function (Norman, 1970). Only very recently has attention been given to the development of strategies for memory processing. While several developmental studies have concentrated upon defining an increase in memory capacity with age (Pasqual Leone, 1970; Case, 1970), and of visual registration and recall rates (Bosco, 1970), a recent review of research on children's memory has emphasized the need to examine further the development of planful, purposive strategies which are indicated by the organization of responses of children performing memory tasks (Flavell, 1971). Both quantitative and qualitative differences in retention processes are indicated in the recall patterns of adolescents and retarded adults (Belmont and Butterfield, 1971) and in the planned selection of items as "mnemonic mediators" exhibited by younger children (Flavell, 1971; Rossi, 1965).

Digit span and related tasks are presumed to reflect the subject's capacity for integrating data, and therefore may also account to some extent for individual differences at any point of development. Belmont and Butterfield (1971) have reviewed the evidence that forgetting rate is an attribute of individual differences between young adolescents in short-term memory performance. They conclude that virtually no evidence supports a decay rate variable, but that potential contributors to performance differences are the active acquisition strategies used by the subjects during storage, the retrieval strategies involved in searching through stored data, and the individual's capacity for storage.

Haith (1971) suggests that the striking deficit in visual short-term memory capacity of children of 5 years of age as compared to adults is not due to deficit in visual sensitivity or processing time, nor the inability to take in or verbally encode large arrays of items. Haith argues that the child's deficit is attributable to his inability, or lack of strategy, for encoding an array of simultaneously-presented items into a sequential form.

Several theories of cognitive development emphasize that developmental changes in children's intellect result from an increasing ability to formulate and apply information processing strategies to new learning situations (e.g., Bruner, 1964; Munsinger and Kessen, 1964; Hagen, 1971). Furth (1969) presents Piaget's position on the development of memory.

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"Memory performance depends most on operative schemes and can be expected to show corresponding changes as these schemes develop or change in importance". Therefore, it seems viable to consider that developmental differences in information processing capability could be observed in an elemental task such as digit span, which requires the storage and processing of items over short periods of time.

In Study I, conducted by the authors (Keeton and McLean, 1972), the major context was the question of whether there is evidence for such information handling strategies in the recall patterns of serial lists of digits in first grade elementary school children and whether some children differ from others in the type and efficiency of such digit-handling strategies. The study investigated whether differences may be identified in the recall patterns of serially presented digits in first grade children, and whether such differences might indicate the application of mnemonic rules or strategies for information handling.

A second purpose was to investigate whether such rules or strategies for handling newly encountered information might be important in the efficiency of the learning process. Since Jensen (1968) has suggested that performance on intelligence tests may also be viewed as an index of information handling efficiency in more complex learning tasks, the differences found in recall patterns were examined in the context of intelligence test performance.

Jensen (1968) also concluded that there is some indication that children from differing socio-economic status (SES) backgrounds encode digit series by different mental processes, even though they differ little, if at all, in their capacity to recall a series of spoken digits. Therefore the third purpose of the investigation was to determine whether first grade Canadian children from suburban and inner-city backgrounds apply different strategies to the handling of sequentially presented digits.

Fifty children from an economically-depressed urban area (low SES) and fifty from a suburban area (high SES) participated in the first study. Three standardized intelligence measures were obtained; Peabody Picture Vocabulary Test, Raven's Progressive Matrices, Coloured Form, and the Figure Copying Test; (Ilg and Ames, 1957). Five total recall digit memory tasks were presented both auditorily and visually. Results from recall of series of lengths 4 to 9 digits yielded five measures; span, position and adjacency (Jensen, 1968), primacy (the number of item

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pairs recalled from the first half of the presented series), and recency (the item pairs recalled from the second half of the series).

The results indicated significant differences between SES groups on the serial position effect of recall. Suburban children recalled significantly more primacy digits ($p < .001$). Conversely inner-city children recalled significantly more recency digits ($p < .002$). There were significant differences between groups on intelligence measures, but these differences were only weakly related to the alternative recall patterns. There were no differences between SES groups in digit span or capacity measures derived from the summed primacy and recency scores.

It was concluded that there is evidence for differnces in recall processes between Canadian children from low and high socio-economic backgrounds. These differences are in agreement with those found in the American study from which has emerged a major theory of cultural deprivation in learning (Jensen, 1969).

Unlike Jensen's study, however, the question of race does not enter our study. With negligible exceptions our sample comprises students of white European backgrounds. Also, we found only weak evidence to support Jensen's contention that process differences are differentially related to intelligence in low and high SES children.

Purpose of second study

In order to examine further the nature of the processes involved in different recall patterns a training session was designed to change the child's chosen mode of response to the alternative mode, i.e., recency responding children were required to concentrate upon recalling primacy items, and primacy responders upon recency items.

The extent to which it is possible to change the children's response mode by encouraging the development of deliberate attention and rehearsal alternatives, (the trainability postulate), was the major question to which this second study is directed. A further purpose was to examine the effect of any shifts in response mode on recall capacity (the capacity postulate).

If, as Jensen suggests, the different processes for recalling digit series are permanent intelligence and SES related characteristics, and recency responding is not a

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sufficient condition for the emergence of primacy processing ability, then it would follow that the recency response patterns of low SES children would not be susceptible to modification.

If, however, the primacy response pattern is indicative of the emergence of rehearsal processes while the recency pattern is not, the opportunity to develop a specific rehearsal strategy might enhance the overall performance of recency responding children.

Finally, if both primacy and recency dominant children are exhibiting different cognitive styles in the form of equally active processing strategies, as we propose, then the opportunity to develop the alternative strategy should change the recall pattern of both groups, without increasing the total capacity of either.

Design of Study II

A subset of children used in a second-year follow-up replication of Study I were selected for inclusion in one of four cells of a 2 x 2 design, high and low SES by primacy and recency response dominance. (Table 1). Response patterns from the first study were used for the classification. From the suburban sample, 12 children were designated as primacy responders (group HiPri) and 14 as recency responders (HiRec). From the inner-city sample 12 children were designated primacy responders (LoPri), and 12 recency responders (LoRec).

Insert Table 1 about here

Digit recall was tested by the cued-recall probe technique (Atkinson et al., 1964). A pretest verified that the allocation of children to primacy or recency response dominant groups was appropriate under the conditions of a probe technique. In two 20 minute periods children were encouraged by a competitive game to pay attention to remembering the second or first half of the series of digit cards; the primacy children being tested on retention of second half digits, and recency children on first half digits. This was accomplished by colour-coding the stimulus materials; the digits in each half of the presented series were presented on differently coloured cards. The child was instructed to attend carefully either to the first or second colour of cards presented, reading but then forgetting the alternative coloured

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TABLE 1

Design of Study II

		Training Given			
		Primacy Responding		Recency Responding	
Digit series length		6	8	6	8
School Type (SES)	Inner City	N = 12		N = 14	
	Suburb	N = 12		N = 12	

Dependent Variables:

Pretest and Posttest } Primacy, Recency

Plus dependent measures from repeat of Study I: primacy and recency, PPVT, Raven's Progressive Matrices

cards. During training the cue card always matched a card in the to-be-remembered half of the series. Children were permitted to make a second choice if their first choice selection did not match the cue card.

The criterion posttest was a set of digit series in which the card colour did not change throughout the series, and the stimulus card occurred in any location in the series. The criterion series were interspersed among a set of colour change series, in which the child was tested from the to-be-remembered half. Thus the child was encouraged to maintain the response set induced by the training session, optimizing his overall chances of correctly identifying the stimulus card if he did so.

The pattern of each group's responses on the criterion posttest was examined for evidence of a shift in response, from primacy to recency or vice versa.

Results of Study II

Testing the trainability postulate

In Table 2 is displayed the mean pretest and posttest performance scores, summed over series length, for each group.

Insert Table 2 about here

In order to test the major hypotheses of the study, that training would influence response patterns, a 2 way multivariate analyses of covariance, high and low SES, and primacy and recency group designation, were performed on the posttest variables with pretest performance scores as covariates, (Table 3).

Insert Table 3 about here

The analysis of covariance of posttest measures revealed that there was a significant difference between SES groups on 1st choice only responses ($p < .01$) and between primacy and recency training groups on 1st plus 2nd choice responses ($p < .01$). Univariate analyses following the significant multivariate SES and training effects revealed that both posttest primacy and recency are significant contributors to these results.

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TABLE 2

Descriptive data for span variables, Study II.
Summed primacy and recency scores: measures of capacity.

Description of variables	No. of trials	High SES				Low SES			
		Primacy		Recency		Primacy		Recency	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sum of pretest primacy 1st choice	14	4.58	1.84	3.22	1.63	2.58	2.21	2.75	1.77
(PREPRI) 1st + 2nd choice (series lengths 6 and 8 only)		7.58	1.80	6.08	1.22	5.08	1.82	5.34	1.82
Sum of pretest recency 1st choice	14	9.66	.98	8.64	1.47	8.25	1.48	6.83	1.72
(PREREC) 1st + 2nd choice (series lengths 6 and 8 only)		11.50	1.72	11.07	1.47	10.09	1.63	10.58	1.88
Recency minus primacy (REC-PRI)		-1.08	4.42	9.43	3.55	3.92	5.12	13.42	3.70
Criterion posttest primacy, 1st choice	14	3.17	2.01	4.14	1.79	1.92	1.44	2.50	1.73
(POSTPRI) 1st + 2nd choice		5.67	2.27	6.71	1.44	4.50	1.38	5.67	1.83
Criterion posttest recency, 1st choice	14	9.08	1.73	8.64	1.34	8.00	1.91	6.92	1.38
(POSTREC) 1st + 2nd choice		11.33	1.30	10.36	1.74	11.25	2.34	9.92	2.23
Pretest primacy + recency, 1st choice	28	14.24	2.27	11.86	2.26	10.83	2.23	9.58	2.26
(PRECAP) 1st + 2nd choice (series lengths 6 and 8 only)		19.08	2.18	17.15	1.81	15.17	1.98	14.92	2.42
Posttest primacy + recency 1st choice	28	12.25	2.22	12.79	1.76	9.92	2.54	9.42	2.06
(POSTCAP) 1st + 2nd choice (series lengths 6 and 8 only)		17.00	2.22	17.07	1.98	15.75	2.70	15.83	2.35

TABLE 3

a. Results of the multivariate analysis of covariance, Study II. Dependent measures: Posttest primacy and recency. Covariates: pretest primacy and recency.

Source	Multivariate F		d.f.
	1st choice only	1st + 2nd choice	
SES	5.60**	1.88	2, 43
Training	1.15	4.93*	2, 43
SES x Training	.33	.12	2, 43

* p <.05

** p <.01

b. Univariate tests for SES effect: 1st choice only

Source	M.S.	d.f.	F	p<
Posttest primacy	17.36	1, 44	5.10	.03
Posttest recency	10.46	1, 44	4.07	.05

c. Univariate tests for Training effect: 1st + 2nd choice

Source	M.S.	d.f.	F	p<
Posttest primacy	19.16	1, 44	7.45	.01
Posttest recency	12.46	1, 44	3.65	.06

The analysis of posttest residual gains scores provided confirmation and elaboration of the results of the multivariate analysis of covariance. The directional trend of the gain scores indicates that both high SES groups (HiPri, HiRec) show greater gains in 1st choice than in 1st plus 2nd, choice measures. In contrast, both low SES groups (LoPri, LoRec) show gains only in 1st plus 2nd choice measures. These results are illustrated in Figures 1 and 2.

Insert Figures 1 & 2 about here

In figures 3 and 4, these results are illustrated as bar diagrams to show the actual and predicted directional trends in the posttest gain or loss scores for each group of subjects.

Insert figures 3 & 4 about here

Testing the capacity postulate. An analysis of the capacity measures, derived from the summed primacy and recency scores, indicates, once again, SES differences in posttest 1st choice recall (Figure 5). In an analysis of covariance with pretest capacity as a covariate, the SES main effect for the 1st choice posttest capacity measure is significant at $p < .001$. This effect does not recur in the analysis of the 1st plus 2nd choice capacity measure. The training main effect is not significant in either analysis.

Insert Figure 5 about here

These results suggest that the training session may have differentially affected the 1st choice posttest performance of each SES group. However, when the second choice responses are added to the scores, the performance of both low SES groups on the primacy, recency and capacity measures fails to differ significantly from that of the corresponding high SES groups.

Discussion

From the results of Study I it was concluded that Canadian first-grade children exhibit different patterns in recall of serially-presented digit series. These patterns,

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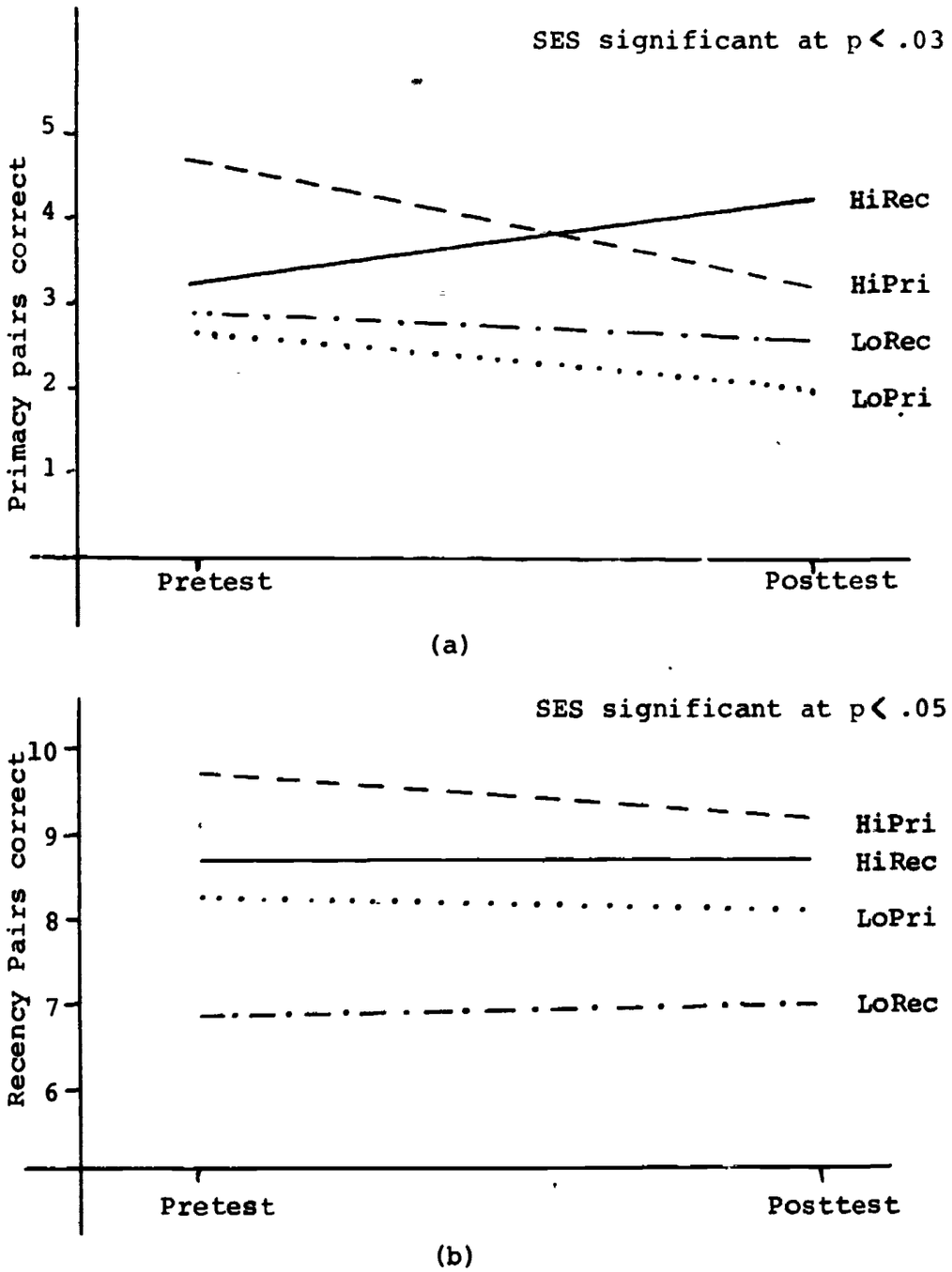
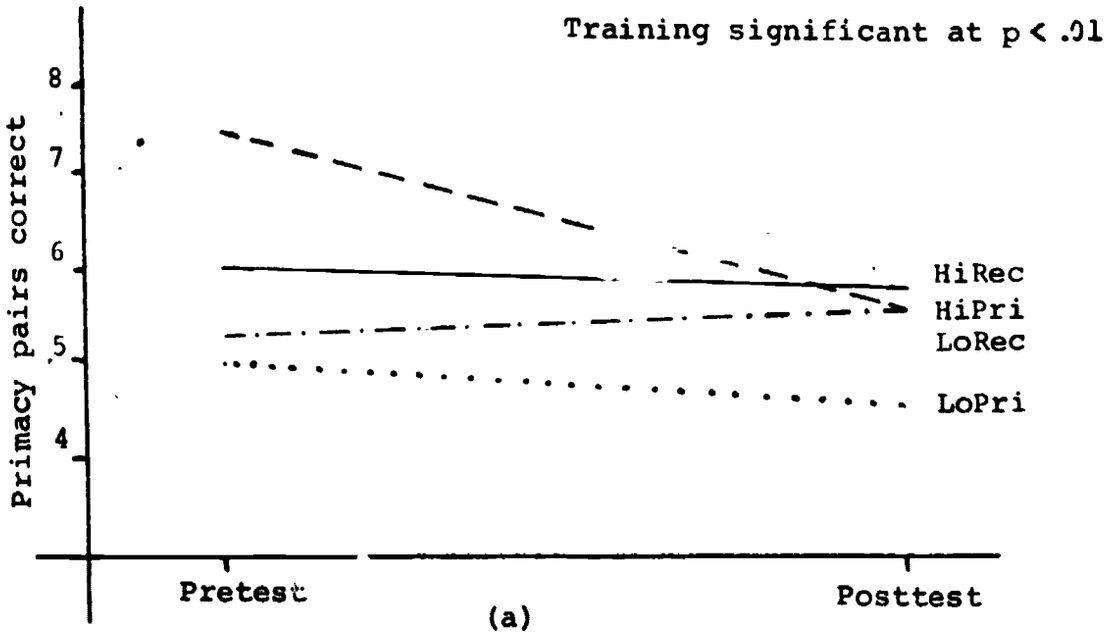


Fig.1 Study II: Primacy and recency recall, pre- and posttest, 1st choice only



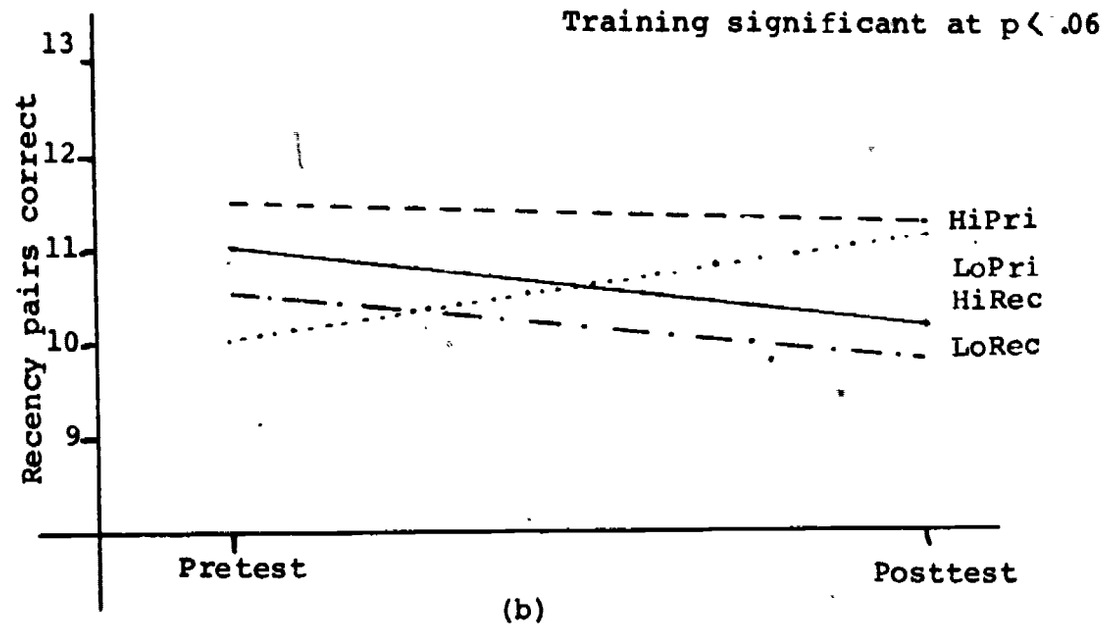
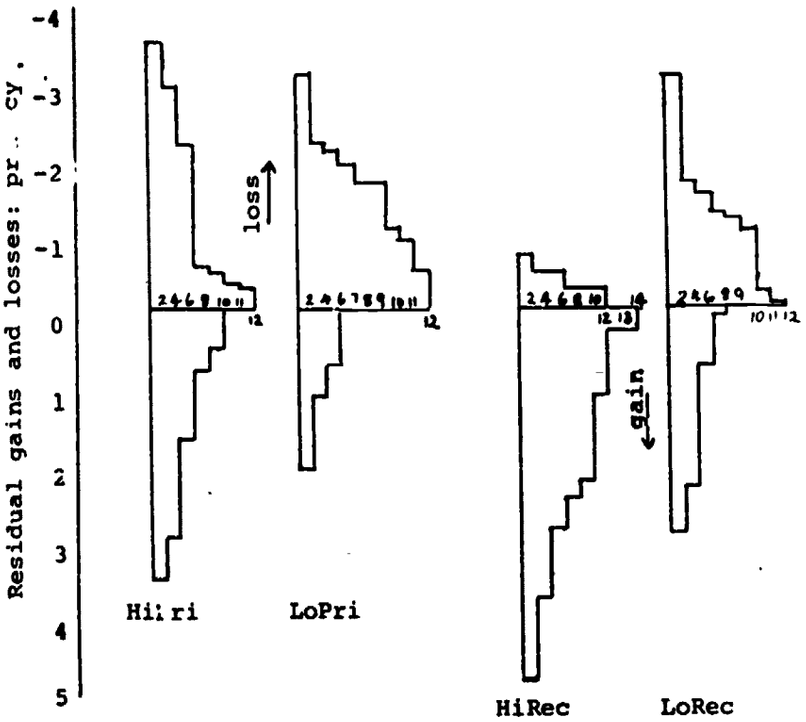


Fig. 2 Study II: Primacy and recency recall, pre- and posttest, 1st + 2nd choice



Abcissa: Number of subjects as plus-minus pairs.
(arrow indicates predicted direction
of trend of residuals)

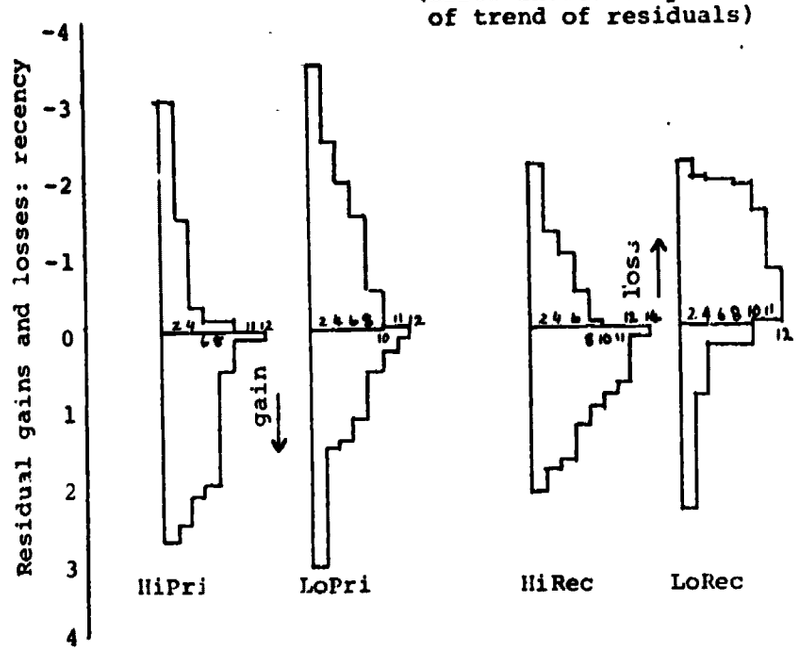


Fig. 3 Bar diagram of distribution of students' residual gains or losses in 1st choice posttest recall as predicted by pretest recall.

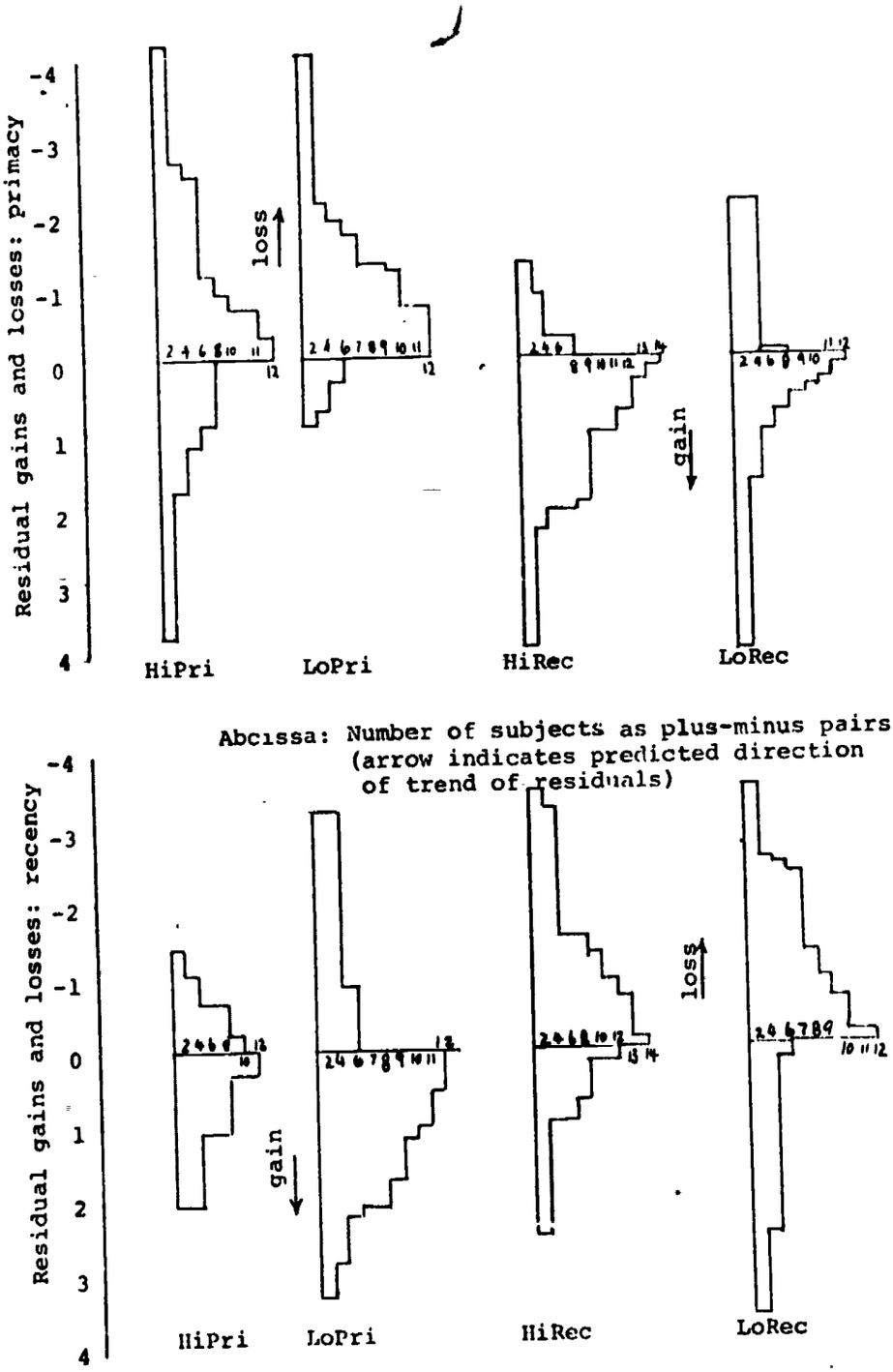
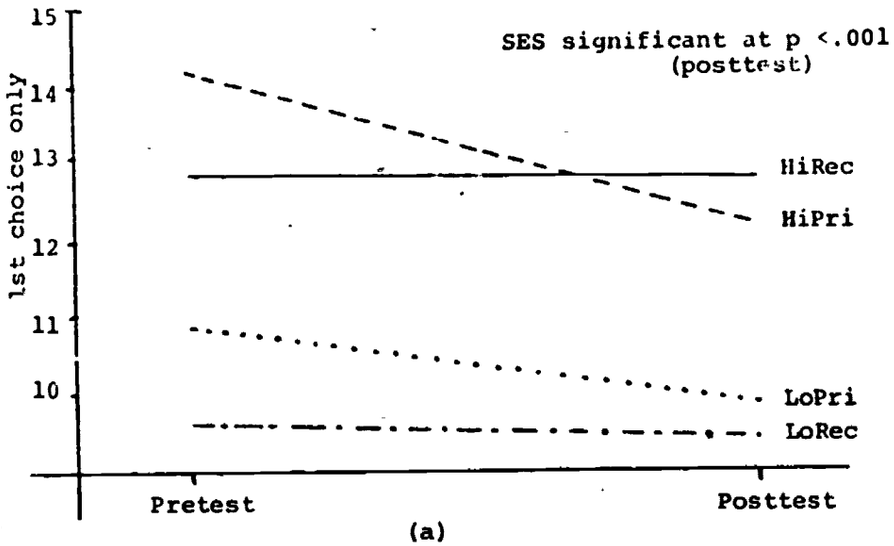
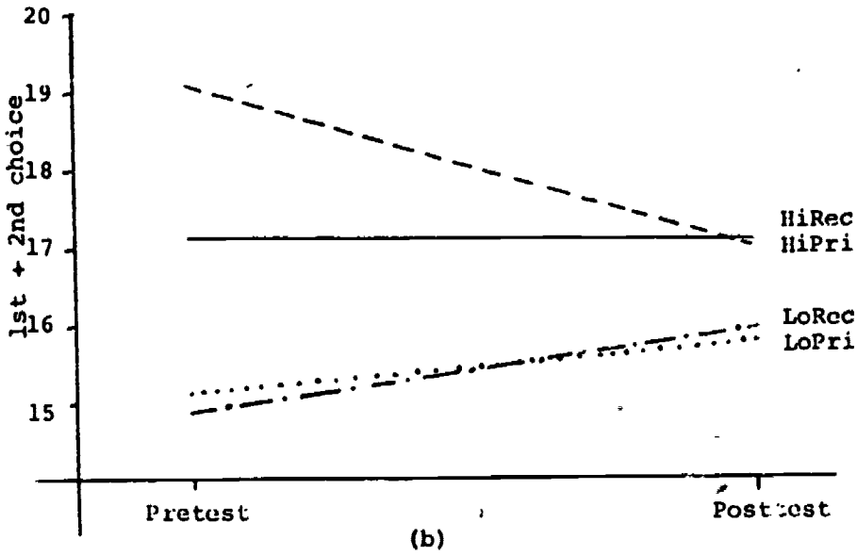


Fig. 4 Bar diagram of distribution of students' residual gains or losses in 1st plus 2nd choice posttest recall as predicted by pretest recall.



(a)



(b)

Fig. 5 Total primacy + recency pairs, correctly recalled for series lengths 6 and 8; pretest and posttest: Study II.

primacy or recency dominant, do not appear to be related to performance on the Peabody, Raven's or Figure Copying Tests, but are significantly related to socio-economic status.

Three possible explanations were proposed to account for the results.

As Jensen (1968,1969) suggests, the difference in response patterns might be a function of intelligence-related learning capability. Since this would imply that the recency response patterns were not susceptible to modification, this explanation is rejected on the basis of the results of Study II.

Response patterns might also result from selective acquisition and rehearsal processes. Primacy responding may indicate the developmental emergence of early rehearsal, while the recency pattern shows evidence of passive monitoring rather than active rehearsal processes.

Also, primacy and recency responding may indicate alternative but equally effective cognitive styles in active memory processing.

SES differences in trainability and capacity.

From the results of Study II, it is proposed that different strategies for information selection and organization are indicated in the performance of each group, requiring different explanatory models to account for development and competence.

For the high SES group the retention techniques which produce the primacy pattern may be developmentally more advanced than the recency techniques. Recency recall may imply less effective retention since children who initially exhibit the primacy pattern show a marked decrease in retention capacity when they assume a recency response mode. The capacity of the recency children is not decreased by the initial switch to a primacy response mode, and may perhaps increase with further practice to reach the level of capacity of primacy children.

Primacy and recency patterns correlate weakly with intelligence indices of high SES children. Possibly the intelligence measures may not mark individual differences in developmental level within this age group. Differences might be revealed in the follow-up study, in an older group in which more children have acquired primacy recall.

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For high SES children one might speculate that the environmental press (Hagen, 1971) encourages the development of primacy retention techniques for preserving early-presented information within the limits of average span capacity while later items are being monitored.

For low SES children, the techniques which produce both primacy and recency recall patterns of supra-span length series appear to benefit retention. Capacity is increased following training in both primacy and recency recall techniques, although this emerges only on first plus second choice responses.

While the objectives of the suburban child seem to include accurate, 1st choice recall of a limited set of early presented items, the goals of the inner-city child seem to be the recall of a larger number of recently-presented items, possibly at the expense of accuracy.

The low SES primacy group demonstrates the largest Study I capacity score. In the Study II posttest, group LoPri shows a large posttest gain on recency recall and group LoRec shows a moderated gain on primacy recall. Both low SES groups demonstrate a parallel gain in 1st plus 2nd choice capacity which approaches that of the high SES group. These results suggest that both primacy and recency designated low SES groups are demonstrating alternative but equally efficient processing techniques. Either form of training session results in equal increases in retention. This may be due to practice or to the development of specific selection and rehearsal techniques. It seems likely that for the low SES groups the experimental training situation contributes to an environmental press for increased retention capacity, regardless of the form of memory mediating technique employed. Strategies for primacy recall do not normally characterize the performance of inner-city children, and, as suggested in the study by Spaans (1971), may not emerge spontaneously during normal developmental changes.

SES differences in intelligence.

The results of Study II are interpreted as indicating different cognitive organization in inner-city and suburban children. It is suggested that these differences are learned, and include a system of selection and retention priorities which are developed to meet the specific demands made upon the child in accommodating of this environment and specifically to the experimental task. Cole and Bruner (1971) contend

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that groups from different subcultures are predisposed to interpret experimental situations differently, and are motivated by different concerns relevant to the experimental task. The experimenter is not justified in assuming equivalence of experimental treatments or in making inferences about lack of competence in any subgroup.

In reporting SES group differences in patterns of digit memory, Jensen (1968) also concludes that different underlying mental processes are indicated by the recall characteristics of each SES group. Jensen's conclusion is supported by the interpretation of the results of Study II and evidence from other cross-cultural studies. However, Jensen further contends that the underlying mental processes are indicators of intellectual deficit (Level I) and competence (Level II). The term "intelligence" is defined by Jensen to mean "those abilities primarily associated with scholastic aptitude" (1968, p.1330). Although the performance of children in Studies I and II failed to substantiate the relationship of recall patterns to intelligence, one may also question whether Jensen is making a unwarranted extrapolation from observed group differences to inferred deficits. The crux of the argument presented by Cole and Bruner is that "those groups ordinarily diagnosed as culturally deprived have the same underlying competence as those in the mainstream of the dominant culture, the differences in performance being accounted for by the situations and contexts in which the competence is expressed" (1971, p.870).

For several decades digit memory tasks have formed one component of standardized intelligence tests (e.g., Binet, Wechsler, W.I.S.C.). The results of Study II suggest that primacy patterns in digit span performance may be indicative of some developmental or ability factor in young children, but only in those children from the dominant, (high SES) cultural environment. Inner-city children may apply different decision criteria and processing strategies to digit memory tasks, perhaps producing responses which are interpreted as deficient in accuracy and complexity when compared to the response of suburban children. (One typical criterion of span is correct positional recall.) While response patterns may be different and often fail to reach the specific criteria of suburban children's performance one cannot infer lack of competence or inability to develop strategies appropriate to meeting such criteria. The number and organization of the routines which children apply to a recall task may differ as a function of development, age,

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genetic makeup or environmental factors, but for any child the routines may imply organized structures and strategies, appropriate to his conception of the task in hand.

When the task is a serial one, presented in the classroom situation in the context of schooling, the performance of inner-city children fails to reach the set of criteria which the average suburban child accomplishes. There is widespread agreement in the importance of the tasks as educational objectives, (e.g., reading, writing, computation), and on the performance criteria. Therefore inner-city children appear to lack the competencies which are necessary for success in school learning. For the social and psychological reasons presented, we may choose not to consider that inner-city children lack competence, especially if this should be interpreted to mean a lack of intellectual deficits which cannot be remedied. Competence includes the child's recognition of specific contexts which are appropriate for the application of learned skills. Alternatively the notion of broad - based competence must be abandoned, and a search begun for the identification of the underlying skills and processes which apply to specific tasks in school learning. The role of the teacher will be to lead the child to develop new skills or to transfer the skills he already possesses from other contexts to meet the criteria of these tasks.

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