DOCUMENT RESUME

ED 078 907 PS 006 519

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TITLE	Longitudinal Kindergarten-First Grade Perceptual Study: Temporal Ordering and First Grade Reading.
INSTITUTION	Institute of Medical Sciences, San Francisco, Calif.
SPONS AGENCY	Mount Diablo Unified School District, Concord, Calif.; National Center for Educational Research and Development (DHEW/OE), Washington, D.C. Regional Research Program.
BUREAU NO	BR-1-I-1043
PUB DATE	Feb 73
CONTRACT	OEC-9-71-0024(057)
NOTE	27p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, Louisiana, February 25 - March 1, 1973)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Auditory Tests; Cognitive Development; Early Childhood Education; Grade 1; Grade Equivalent Scores; Kindergarten; Learning Disabilities; Longitudinal Studies; *Perceptual Development; *Reading Readiness; Speeches; Test Results; *Time Factors (Learning); *Visual Measures
IDENTIFIERS	Metropolitan Readiness Test

ABSTRACT

This report investigates perceptual functioning in the kindergarten first-grade period for slow- and average-maturing children. Two sets of auditory and visual tasks were devised: (1) identifying the first of an ordered pair of lights or tones when speed of presentation was a factor, and (2) categorizing each stimulus signal either by a uni- or dual response. Consistent patterns of behavior were found for each group of children when reading readiness scores, grade level, and sensory modality were the crucial variables. Deficiencies in auditory, but not visual, perceptual encoding were found in slow learners' first-grade performance. (Author)

LONGITUDINAL KINDERGARTEN-FIRST GRADE PERCEPTUAL STUDY: TEMPORAL ORDERING AND FIRST GRADE READING

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<u>submitted for publication</u>

Paper presented at the annual meeting of the
American Educational Research Association
New Orleans, February, 1973

Support for this study was provided by the following sources:

Dept. of HEW, proj. no. 1-I-1043. Grant OEC-9-71-0024 (057)
"Perceived Order of Auditory and Visual Stimuli in Children"

General Research Support Fund, Institute of Medical Sciences,
San Francisco, California

Compensatory Office of Education, Mount Diablo Unified School
District, West Pittsburg, California

LONGITUDINAL KINDERGARTEN-FIRST GRADE PERCEPTUAL STUDY

TEMPORAL ORDERING AND FIRST GRADE READING

The present study attempts to explain certain aspects of perceptual-cognitive functioning within the context of a developmental model from the kindergarten period to the first grade. The purpose was to find out if certain kinds of basic perceptual skills in temporal ordering which may develop ontegenetically in the young child are likely to be delayed in those who are having trouble in learning to read. The theory postulated here is that a general lag in perceptual-cognitive maturation can be reflected in the rate that basic skills in temporal ordering develop in early childhood among children who are below average in reading readiness tests given at kindergarten. The lag is clearly seen in the crucial period between kindergarten and first grade, specifically in the temporal ordering of auditory and bi-modal events. Such a lag delays further development of intersensory encoding necessary to relate sound with symbol, as in the decoding of abstract stimuli, and in the reading process itself.

Although studies have shown differences between normal and retarded readers in temporal ordering skills. the developmental aspect has not been investigated between grades or among a number of different kinds of temporal ordering skills. By comparing several different auditory and visual presentations of ordering tasks, as well as one in which intersensory encoding is required, it was hoped that various levels of perceptual achievement for both the average and below-average reader would emerge.

Three separate sets of tasks in temporal ordering were constructed which would assess the child's ability to process uni-modal information, auditory or visual, between the kindergarten and first grade period. The variables, differences in initial reading readiness skills, in modes, grades, and rate of progress between grades were all assessed. A fourth task in intersensory encoding, more complex than the other three, was introduced at the end of the first grade, in order to assess the extent that poor performance on this task could be predicted by previously poor performance on the simpler uni-modal tasks. Another purpose of assessing intersensory encoding in this fourth task was to determine the extent that such a skill would show significant correlations with first grade reading ability.

The first set of tasks was originally used by the Soviet neuro-psychologist, Luria, (1959, 1960, 1961) to illustrate his hypothesis that the neurodynamics of the speech processes evolve in hierarchical levels in the young child, and help to modify the perceptual field and to guide his motor response at the same time. Luria described progressive stages in the child's development before he can coordinate two motor responses at once: verbal and tactile. For children under five or six, or for those with abnormal neurological development, such a dual response is too difficult, possibly because of a poverty of neural connections between the speech and motor areas of the brain (Luria, 1961). It should be noted that there is a basic difference between the Luria and the present experiment, namely in the mode of presentation. Luria used a pair of colored lights;

this study used lights, and also used as a separate task a pair of pitch tones.

The second set of tasks, adapted for the present report, pertained to the child's acuity in deciding which of two tones or two lights came first when the interstimulus interval became increasingly short. Previous research by the present author (1971) had shown that slow-maturing kindergartners had extreme difficulty in identifying a pair of tones in a temporal sequence, however slowly they occurred. The research had also shown that these same children had difficulty in identifying the temporal order in a bi-modal task consisting of a light and tone. In other words these kindergartners could not grasp the order of a pair of successive auditory stimuli, nor could they shift their attention from a light to a tone, or vice versa.

Other studies have clearly shown that the learning-disturbed child, whether dyslexic or aphasic, has a distinct disadvantage in practically all kinds of temporal ordering skills. Bakker (1972) found this to be true with dyslexic children. In a perceived order skill of two successive tones, Efron (1963a), Lowe and Campbell (1963), Holmes (1965), Rosenthal (1970), and Schevill (1971) have all independently found that aphasic and dysphasic subjects, both children and adults, are significantly slower than normal subjects. Now the intent was to investigate children's progress in such a perceived order task (PO) between the kindergarten-first grade period.

The term, <u>temporal ordering</u>, implies that the child is classifying more than one stimulus in time. Both of the first two tasks described above imply in their response measures the explication of a temporal order. Now two more skills in temporal ordering were used in the present experiment which required in their response measures the reconstruction or imitation of a given pattern (IP), and the identification of a cross-modal equivalence (CME) when the auditory (temporal) pattern was matched to a visual (spatial) one.

Previous research has already found correlations between poor reading ability and temporal ordering skills of imitation and cross-modal transfer. Leene and Bakker (1969) and Schevill (1971) each found that learning-disturbed and dyslexic subjects make significantly more errors in a temporal ordering imitation task than do normal subjects. Blank, Weider and Bridger (1968) found that poor readers could not recall a temporal-visual pattern as well as normal subjects. However, in a task of reproducing auditory rhythmic tapping patterns, Blank et al found that poor readers performed as well as normal readers. In the present author's opinion, the imitation rhythmic task in the Blank experiment did not require verbal analysis, and could be repeated by rote intuitively without conscious analysis. Not so for an earlier study by Stambak (1961), which did show that dyslexic children were inferior in reproducing auditory tapping patterns. In the case of the Stambak study, the rhythmic units were more in the nature of Morse-code groupings requiring verbal counting. Thus, deficiencies appear in auditory and visual recall.

In cross-modal transfer tasks, Birch and Belmont (1964) demonstrated that deficient readers had difficulty in making equivalences between two taps and two visual dots. Blank and

Bridger (1966) found that defective readers had difficulty in making an association between temporal and spatial patterns even within one modality, that is, in the transfer of a temporal pattern of lights to a spatial one of dots. Pursuing the problem further, Bryden (1972) used simple Morse-code types of tapping patterns in the auditory, visual, and combined auditory-visual modes. In analyzing both inter- and intra-sensory encoding with the consistent shift from temporal ordering to simultaneous presentation, he found that the most complex task for poor readers was the cross-modal shift from the auditory to visual modalities. Thus, both the inability to use multi-modal information, and to shift from a temporal sequence to a spatial distribution appeared to hinder poor readers.

The inference common to all the temporal ordering research used in this report is that underlying speech processes (Luria, 1961), or speech areas of the brain (Efron, 1963b), or verbal analysis (Blank et al, 1968) are actual facilitators of good performance. Unfortunately this hypothesis cannot be tested in the present experiment. What could be tested was the extent that the child during the kindergarten-first grade period could discriminate successive tones, encode them, pay sustained attention to a series, and associate symbols to them which would have meaning in a visual-spatial context. More specific questions pertaining to when the child first spoke, the extent of his vocabulary, and early sentence development were not considered. If the readiness test given at kindergarten (Metropolitan) is an indication of verbal competence (and many educators believe this to be true), then we have at least one measure of the child's verbal development. However, since that test may be culturally biased, and does not really measure early development of the speech processes, we really do not have a precise measure of neurological development of the so-called "language areas" of the brain. The language-based criteria, such as the Metropolitan and actual reading ability at first grade, are ends as well as means in the present study, just as are the temporal ordering skills themselves. Unfortunately the inferences by previous researchers were not tested here that the development and intactness of the language processes are at the root of temporal ordering facility. Instead the basic inference of this study could be stated as follows: if children with learning disturbances and minor neurological dysfunctions have significant deficits in temporal ordering skills, then the slow learner, presumably within the normal limits in cognitive and neurological functioning, may also be lower in the continuum than the successful learner from a developmental point of view in these skills.

The hypotheses of the present study were that

1) In the kindergarten-first grade period children who are slow in developing reading skills would show a lag of approximately a year when compared to successful readers in the Luria dual categorization (DC), the perceived order (PO), and the reproduction or imitation (IP) of patterns when the stimuli were a pair of lights, a pair of tones, or a light-tone combination.

2) Differences would also be apparent when the auditory and visual sub-tasks of the DC, PO, and IP skills are compared:

namely that all children would perform the visual significantly better than the auditory sub-tasks during the kindergarten-first grade period.

3) Deficits in specific temporal ordering skills at kindergarten would leave the slow reader with inadequate basic prerequisites for morecomplex integrative skills at first grade such as a cross-modal equivalence task (CME) and actual reading ability.

METHOD

FIGURE I

SUMMARY OF TASKS ADMINISTERED AT KINDERGARTEN AND FIRST GRADE

Pre-test (Kindergarten)	Tasks Kindergarten & 1st grade	Post-tests (end of first grade)
Metropolitan Readiness Test	1. Dual Categorization a) tone b) light 2. Perceived Order a) tone b) light c) bi-modal 3. Imitation of Patterns a) tone b) light	1. Cross-modal Equivalences between temporal and spatial auditory & visual presentation. 2. Level of reading in standard texts.

Initially 240 kindergartners from three separate schools in West Pittsburg, California were administered the Metropolitan Readiness Test. Form the original kindergarten sample 25 were randomly selected above the 65th percentile, and 25, below the 35th percentile. The population was from a low socio-economic segment, mixed in ethnic and racial backgrounds. The pre-test, Metropolitan scores, was used as the basis for dividing the subjects into two groups throughout this experiment.

All children were tested again at first grade in a post test well in the spring after they had received almost a year of reading instruction. The post test had two parts: a) a cross-modal equivalence task (CME) with the lights and tones, and b) a measure of the child's exact reading level. The criterion, successful or slow readers, was derived from the combined judgment of the classroom teacher and the slow reader's individual tutor or reading specialist. Since all the slow learners were reciving daily individualized instruction outside of the classroom, it was comparatively easy to pinpoint the reading level of each child. Successful readers were those who were in the first grade reader or at least half-way through the first primer. Slow readers were considered those who were just about to begin the first primer, or who were in the 4th, 3rd, or 2nd pre-primers, or indeed who were not reading at all. These six levels of reading ability were correlated to the Metropolitan Readiness Test given at kindergarten. The correlation was .92, giving some indication of the validity of the base-line of measurement, successful and slow readers, for the present study.

The three sets of temporal ordering tasks, DC, PO, and IP, were given at kindergarten and again at first grade to the same children, as well as the pre- and post-tests described above.

TASKS

Dual Categorization. This task, adapted from Luria (1959, 1960, 1961) required the immediate verbal response for each successive signal, that the child say "yes" for the "positive" stimulus, and "no" for the negative one. In addition, the response required the coordination of two motor actions at once, the verbal categorization and a tactile pressure on a telegraph key to concur with the positive, but not negative, verbal response. Luria found that immature children under five or six years of age could categorize either by a verbal or by a tactile response, but that they had difficulty in synchronizing the two.

In the present experiment a series of 30 stimulus signals were used, as a means of assessing the child's sustained attention span as well as his perceptual-motor coordination at the beginning of the temporal sequence. The pattern of stimulus signals was as follows: + - + - - + + - + - - + + - - + + - - + + + - + - + + - + -. For the light task, the "+" signified the red light, and the "-" the green light; For the tone task, "+" signified the low tone, and the "-", the high tone. One half of the sample was presented with the light task first; the other half, the tone task. The electronically-timed stimulus generator, controlled by E, regulated the ISI between stimuli to one second, with each stimulus lasting for approximately 50 msec. Responses were measured according to one- and two-dimensional categorization: one point for each correct verbal response or a total of 30; and one point for each tactile response, or another total of 30. In other words, the highest score the child could receive would be 60 points for the 30 stimulus events.

Task 2: Perceived order of a pair of stimuli. The second task dealt with the child's acuity in identifying the first of an ordered pair of stimuli occurring in extremely rapid succession. Three sets of stimuli were used in this task: a pair of tones, a pair of lights, and a bi-modal combination of a tone and light. In each of the three perceived ordering tasks the stimuli were presented with longer interstimulus intervals (ISI) at first: 1000 msec., and then decreasing , 600, 400, 250, 175, 125, 100, 80, and 60 msec. In cases where a one-second interval between two signals was not sufficient, the time interval between the first and second stimulus was extended accordingly, even though it was apparent that such a child was essentially perceiving and categorizing only one signal at a time instead of the first of an ordered pair. At each interval the pairs of stimuli were given six times. The child's score was his own fastest inter-stimulus interval, based on 100% accuracy for six trials.

Task 3: Imitation of patterns. In this task the child imitated what he heard or saw by striking two tonebells in a certain order or by pressing two buttons to elicit the light sequence. For the light task the child was given an electronic box, and he pushed the red and green buttons in the appropriate order as he watched the lights flash on. For the tone task, he struck his own tone bells in response to the pattern which was electronically generated. Both the lights and tones were produced in temporal order of approximately one-half second intervals for each stimulus signal. Every one of the 30 items counted for one point in the scoring.

FIGURE 2

Sequences Used in Imitation of Pattern Task

(Tone task: + = low tone; - = high tone.
(Light task: + = red light; - = green light.)

This sequence was given twice: once for tones, once for lights.

1) -	11) - + -	21) - - + +
2) +	12) + - +	22) - - + -
3) +	13) - + +	23) + - + +
4) -	14) + - -	24) + + - - +
5) ++	15) + + +	25) + + - - +
6) +-	16) + - - +	26) - - - + +
7) --	17) - + + -	27) - + - - +
8) -+	18) + + + -	28) - - + - +
9) ++-	19) - - - +	29) - + + - -
10) --+	20) + + - +	30) + + + - +

Post-task: Cross-modal equivalence. This task, given only at the completion of the experiment, consisted of two parts: in part 1 the stimuli were the two tones, and in part 2 the stimuli were bi-modal, consisting of a light and the two tones. In each case the stimulus patterns had to be matched to visuo-spatial symbols. Figure 2 shows the visuo patterns for part 1, in which the high and low tones are symbolized by "up" and "down" windows in space. Figure 2 itemizes the visuo patterns used to represent the low, high tones and the light (+, 0, -). For practice the child drew

FIGURE 3
PICTORIAL REPRESENTATIONS USED IN CROSS-MODAL EQUIVALENCE TASK

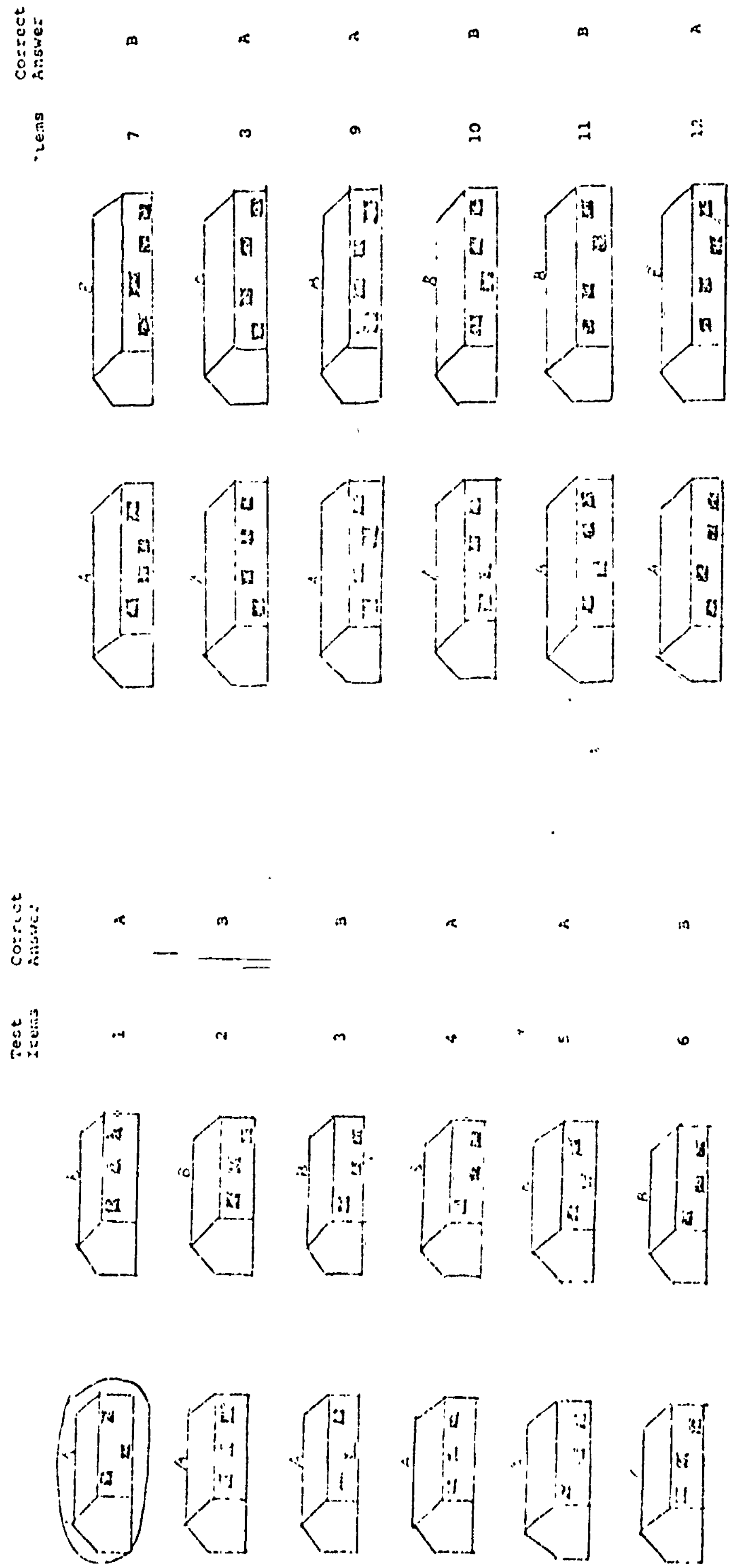

FIGURE 4

Lights and Tones Used in the Cross-Modal Equivalence Task
(+ = low tone; 0 = high tone; − = light)

13) + 0 0
0 0 +

14) + 0 +
+ + 0

15) + − − +
− − + +

16) + − + +
+ + − +

17) + − 0 0
+ + − −

18) + − − 0
− − + 0

19) + + − − 0
− − + + 0

20) + − − − 0
+ 0 0 − −

21) 0 0 0 + −
0 0 0 − −

22) + 0 0 0 0
+ − − 0 0

23) + + − − 0
0 0 − + +

24) 0 0 0 + − −
0 0 0 + + −

25) + 0 0 0 − −
− + 0 0 0 0

26) + + + + − 0
− − − − 0 0

27) 0 0 + + + −
0 0 − + + +

28) − 0 − + 0 0
+ 0 + + − +

29) + 0 + − − 0
+ − − + 0 +

30) + 0 + + − +
− 0 − + + 0

cards one at a time as he learned to associate each stimulus with its symbol. When a whole temporal pattern was given, the signals were spaced approximately one-half second apart. Each of the 30 patterns counted for one point in the scoring.

Apparatus. The same apparatus was used for all of the tasks in this experiment. It consisted of a stimulus generator which activated a pair of lights, vertically mounted on a panel in front of the child, and a pair of tone bells which the child could hear but not see. The two tone bells were middle C and high F# an octave and a half above middle C. Mallets automatically struck the tones in a concealed suitcase. In addition the child had in front of him a duplicate set of tone bells and his own mallet, as a means of practice before the actual testing began, and as a means of associating the auditory stimuli to specific objects. Since his tone bells differed in size and in color, the child could associate one tone with the "big" one (the "white" one), and the other tone with the "little" one (or the black" one). All presentation was electronically monitored.

For the DC task, the child used a telegraph key for his response for the "positive" stimuli.

RESULTS

Differences between groups at kindergarten and first grade.

Initial differences at kindergarten, and final differences at first grade were found to be statistically significant in practically all of the sub-tasks shown in Table 1.

Insert Table 1 here

Developmental differences between groups, grades, and modes.

In addition, successful scores on the various tasks given at kindergarten and repeated at first grade for the DC, PO, and IP tasks were entered into three sets of multi-variate analyses of variance, with two groups of reading readiness ability, two grade levels, and two modes of presentation as the variables. (The PO bi-modal task was omitted from this particular analysis, since the intent was to compare in a symmetrical study the difference between the auditory and visual components of each task.). Considering all variables, the successful readers were superior to the poor readers at the .0001 level: DC, $F\ (1,44) = 21.41$; PO, $F\ (1,44) = 23.33$; and IP, $F\ (1, 44) = 48.49$. Grade differences for the light task were significant at the .0001 level: DC, $F\ (1, 44) = 29.87$; PO, $F\ (1, 44)\ 21.13$; IP, $F\ (1, 44) = 53.21$. For the tone task the grade differences were also significant at the .0001 level: DC, $F\ (1, 44) = 41.52$; PO $(1, 44) = 22.74$; IP, $F\ (1, 44) = 46.48$. The difference between the auditory and visual modes of presentation was also significant at the .0001 level when the average of both groups was taken into account: DC, $F\ (1, 44) = 35.53$; PO, $F\ (1, 44) = 61.60$; and IP, $F\ (1, 44) = 48.31$. As Table 1 indicated, of the auditory and visual sub-tasks (omitting for the moment the consideration of the bi-modal PO task), all tasks showed significant differences between groups at kindergarten, and all but two, at first grade. Similarly, the multi-variate analyses showed that the difference between groups from the kindergarten to the first grade remained parallel, except in the two tasks, DC, lights, and PO, tones. (For the DC light difference: $F\ (1,44) = 9.02$, $p < .004$. For the PO tone difference: $F\ (1, 44) = 9.64$, $p < .003$.

<u>Task correlations</u>. Intercorrelations of kindergarten scores were made to assess similarities among the sub-tasks. Since the group as a whole represented a discontinuous sampling along the dimensions of reading readiness ability, it was decided to measure the two groups (high and low scores) in separate matrices, shown in Table2 . Because no sex variables were found, the sex variable was not included in the intercorrelations. Two striking intercorrelation features are found: a) the relationship among all the auditory sub-tasks (for all subjects) and b) particularly for the slow group: the significant correlation of the PO tone task with practically all the other tasks.

Insert Table 2 here

Another purpose of this report was to find how underlying deficiencies of the slow reader(or capabilities for the successful reader), revealed at kindergarten in the DC, PO, and IP tasks, would reflect in the more complex intersensory post-test, CME, and also in first grade reading ability. For individual correlations between the groups, and also between the CME task and first grade reading ability in reference to the kindergarten tasks (DC, PO, IP), the matrices in Table 3 show different kinds of relationships. No one task given at kindergarten correlates significantly with both the CME and first grade reading for everybody. What proves to be a significant correlation for one group may not be so for the other group (see, for example, the bi-modal task, PO, which slow kindergartners could not do at all, and therefore had difficulty with the bi-modal aspects of the CME task; whereas this was not even a factor for the successful reader, who had no trouble in bi-modal transfer). On the whole, each kindergarten score in temporal ordering (with the exception of DC lights) correlated for the slow reader to a significant degree with the post-task, CME; whereas the relationship between individual kindergarten scores and first grade reading was stronger for the successful reader. As Table 3 indicates, the most significant relationship common to both groups was the combined kindergarten scores, DC, PO, and IP, which correlated beyond the .001 level of confidence with the two post-tests, CME and first grade level of reading ability. In addition the matrices show that the CME task alone would be a significant factor in assessing how the child from either group would be reading at the end of first grade.

DISCUSSION AND CONCLUSIONS

The present study was directed toward finding differences in temporal ordering skills between successful and slow beginning readers during the crucial kindergarten-first grade period. From a developmental viewpoint, differences emerged between groups, modes, and grades. While the child who is reading in the first primer or first reader by the end of the first grade can perform temporal ordering skills with both visual and auditory information, the slow reader is able to deal only with the visual aspects with comparative success. This relative delay in auditory processing may be one factor which is standing in the way for developing more complex skills in intersensory integration.

Nevertheless, the slow beginning reader in this experiment should not be considered as being abnormal in neurological functioning, even though his scores on the DC. PO, and IP tasks may be as slow as the older educationally-handicapped child with auditory processing deficiencies (Schevill, 1971, also unpublished data by the author). The slow reader in the present study is making progress from kindergarten to first grade at a comparable rate with his above-average peers, and by first grade is performing some of the visual tasks almost as well as they. What seems to be happening to the slow learner is a relatively late start in developing basic facility in perceiving and classifying a succession of events. Unfortunately, this slower start in processing perceptual information correlates with a slower start in learning to read.

Another purpose of this experiment was to investigate the extent that intercorrelations existed among the three variables, kindergarten performance of the temporal ordering skills, and the two post-tests, CME and first grade reading ability. Undeniably, relationships exist within and among all of these variables that may have significant implications in learning. From the data it is possible to hypothesize how deficits in kindergarten can be reflected in later performance of both post-tests: CME and actual first grade reading. For example, the perceived order task of a bi-modal succession of a light and tone correlated significantly at kindergarten with the more complex post-task, CME. Whereas at kindergarten the slow learner required over a minute for the interstimulus interval in order to register whether a light or tone occurred first, he did not have a deficit in this respect by first grade. Nevertheless, evidence suggests that the comparative late development in the basic PO bi-modal task delayed facility in the more complex bi-modal CME post-test. Another PO task deficiency at kindergarten may also have impeded the slow learner's progress. The PO tone task correlated significantly with the other temporal ordering skills. Such a correlation implies that if the slow learner needs a long time interval between two tones in order to indicate their order, then memory span (IP), facility to classify a tone by a dual tactile pressure and verbal label (DC), and his ability to translate a whole series from an auditory to visual context (CME) also becomes influenced in task performance. <u>Even though each one of these skills involves a different kind of response, basically each one depends on the child's acuity for identifying a pair of auditory events in quick succession.</u>

How cross-modal integration relates to the reading process is another question. Although the stimuli in the present study were only a pair of lights and a pair of tones, the CME task may have reflected some of the perceptual processes that are involved in matching the spoken word to the written symbol. For example, the reading process is essentially a left-to-right movement on the printed page. For the child who has not mastered such a directional skill, the incompetency will show up in verbal decoding as well as in the CME task involving abstract lights and tones. When the reading involves the matching of the spoken word to printed symbols, some of the aspects of learning to associate a sound with a visual symbol are the same as in the CME task.

Furthermore, the verbal reading process requires the combination of skills found in the DC. PO, and IP tasks, as well as the CME post-test. Whether the child is attending to a verbal meaningful symbol or an abstract light or tone signal, he still must be able to demonstrate flexibility of sensory processes to integrate the auditory with the visual. He should be able to recall a temporal series of symbols consisting of at least three components, whether they be letters or signals; and he should be able to register in his mind what followed what when they occur in quick succession. In categorizing a series of symbolic letters, he must be able to classify them by their sound and visual representation in a temporal and spatial context. In other words, proceding from the more complex to the simple, the underlying functions used in the CME, IP, PO, and DC tasks can be generalized to relate to those used in the reading process. To have a comparatively non-verbal battery of temporal ordering skills may indeed give us a basic measure of the child's perceptual-cognitive functioning underlying the reading process itself. If some of these processes are not sufficiently developed by first grade, then the reading facility is also delayed.

Or even if certain skills such as the PO tone and PO bi-modal tasks are comparatively easy for the slow learner by first grade, such facility has developed all too recently for him, and does not provide enough of a time lapse for the child to reap of the benefits, so to speak. At least evidence suggests that the precursor of unsuccessful reading for the slow reader may be the PO tone task; and of unsuccessful cross-modal integration, the PO bi-modal task (both PO tasks being practically impossible for him at kindergarten).

In sum, then, the present study gives limited evidence that the root of the problem of poor beginning reading skills for the child scoring low in standardized reading readiness tests may be due to several factors. Between groups, these factors are a) the lag of approximately a year in the development of basic perceptual skills, and b) the proportionately later start in acquiring skills to perform the auditory sub-tasks. Within the slow-learning group one specific factor is the comparatively late start in facility to perceive two auditory events in quick succession. Early deficits in this task are related to poor performance in the other kindergarten tasks in temporal ordering, as well as more complex integrative skills at first grade. The second factor possibly attributable to poor reading within the slow-learning group is the the lack of flexibility in intersensory processing at kindergarten (PO bi-modal). Such a deficit at that point in time provides an inadequate basis for more complex intersensory decoding to develop by first grade. It seems that <u>early</u> perceptual development is a crucial factor in later intersensory intergration and reading.

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TABLE 1
COMPARISON OF GOOD AND POOR READERS ON INDIVIDUAL TASKS

Good (high) readers: N = 21. Poor (low) readers: N = 25

	Mean at Kindergarten			Mean at First Grade		
	High	Low	t	High	Low	t
<u>Dual Categorization.</u>						
perfect score = 60						
a) tone	45.52	33.44	3.20**	56.47	44.12	3.49**
b) light	55.66	40.80	4.74**	59.28	54.40	2.35*
<u>Perceived Order</u>						
perfect score = 60 msec.[1]						
a) tone	406	1340	-4.74**	280	647	-2.59*
b) light	140	295	-3.63**	77	152	-3.47**
c) bi-modal	401	1272	-4.23**	205	466	-2.24*
<u>Imitation of Pattern</u>						
perfect score = 30						
a) tone	15.33	8.24	5.62**	20.90	11.96	5.95**
b) light	17.61	11.44	6.23**	23.04	15.24	5.34**
<u>Cross-modal Equivalence</u>						
(post-task)						
perfect score = 30				26.47	16.12	5.71**

* = beyond .05 level of confidence; ** = beyond .01 level

[1] Lower numbers denote in the PO task a shorter interstimulus interval between signals, therefore a better score.

TABLE 2

INTERCORRELATIONS OF THE DC, PO, AND IP SUB-TASKS GIVEN AT KINDERGARTEN

(High Reading Readiness Group, N = 21)

	DC light	PO tone	PO light	PO bi-modal	IP tone	IP light
DC tone	.55**	-.64***	-.31	-.46*	.76***	.52*
DC light		-.50*	-.14	-.30	.45*	.50*
PO tone			.27	.36	-.77***	-.45*
PO light				.25	-.28	-.34
PO bi-modal					-.30	-.18
IP tone						.59**

(Low Reading Readiness Group, N = 25)

	DC light	PO tone	PO light	PO bi-modal	IP tone	IP light
DC tone	.69***	-.50**	-.16	-.48*	.66***	.40*
DC light		-.27	-.29	-.23	.31	.19
PO tone			.55**	.65***	-.76***	-.61***
PO light				.57**	-.41*	-.36
PO bi-modal					-.58**	-.58**
IP tone						.59**

* = beyond .05 limit of confidence, ** = beyond .01 limit of confidence; *** = beyond .001 level of confidence

Note: The three perceived order tasks had an inverted score relationship, which gave a "-" sign when correlated with criteria having a high numerical value for a high score.

TABLE 3

CORRELATION MEASURES

KINDERGARTEN TASK PERFORMANCE WITH TWO POST-TESTS: CME AND FIRST GRADE READING ABILITY

Successful (high) group, N = 21; Slow (low) group, N = 25.

	Cross-modal equivalence		1st grade reading	
	high	low	high	low
DC tone	.50*	.60***	-.50*	-.66***
DC light	.76***	.35	-.49*	-.52*
PO tone	-.60**	-.57**	.58**	.52*
PO light	-.45*	-.47*	.50*	.36
PO bi-modal	-.37	-.76***	.45*	.50*
IP tone	.53*	.59**	-.59**	-.36
IP light	.59**	.54**	-.73***	-.33
Total kind-ergarten	.66***	.73***	.73***	.63***
CME			-.60***	-.62***
Total scores (average for both groups)			.73***	

* = beyond .05 limit of confidence, ** = beyond .01 limit of confidence; *** = beyond .001 level of confidence.

Note: The score values for first grade reading ranged from 1 to 6, and were inverted in the sense that "1" denoted a high score, and "6" a low score. In addition to the PO values, which were also inverted, these values produced a "-" sign when correlated with tasks having a high numerical value for a high score.