The Journal of General Psychology, 1983, **109**, 201-210.

ALPHABETICAL SERIATION AS A READING READINESS INDICATOR*[1]

University of Notre Dame

KERI WEED AND ELLEN BOUCHARD RYAN

SUMMARY

Past research has shown seriation in prereaders to be predictive of later reading ability. A new alphabetical seriation task, involving a random set of letters as elements to seriate, was proposed as a better predictor of reading readiness than traditional seriation. Although both tasks require the ordering of discrete elements, alphabetical seriation also presupposes a limited knowledge of linguistic material which adds to its predictive value for reading. The effects of having a printed alphabet card present as a perceptual support were also examined. Results supported the viability of the new alphabetical seriation task as a seriation task and as a better predictor of reading readiness than traditional seriation. The perceptual support of the alphabet card increased the amount of time spent on the task, without a corresponding increase in accuracy. Time measures further suggested that most kindergarteners were not performing the seriation operationally. Elkind's theory of perceptual reorganization is suggested to account for the relationship between seriation and reading.

A. INTRODUCTION

Piaget theorized that the ability to seriate objects operationally is acquired only when children reach the concrete operations stage (3). He describes seriation as "an additive arrangement of asymmetrical transitive relations." Seriation is one of many factors which have been shown to correlate posi-

* Received in the Editorial Office, Provincetown, Massachusetts, on January 24, 1983.

[1] This article is based on a paper presented to the Sixth Biennial Conference for the Study of Behavioral Development in Toronto. Its preparation was partially supported by grant BNS76-09559 from the National Science Foundation and grant G-79-0134 from the National Institute of Education. The authors are indebted to the staff and students of the South Bend School corporation for their help and cooperation. Reprint requests should be sent to the first author at the address shown at the end of this article.

tively with beginning reading. The present study compares a new seriation task involving letters as a predictor of reading success to a traditional seriation task involving nonlinguistic material.

In Piaget's seriation research, three steps were found leading to operational seriation. First, children are unable even to draw an ordered configuration, given an array of various colored sticks differing in length and corresponding colored crayons. During the second step, which Piaget calls "semianticipation", children can draw the form but not actually put the sticks in order. Instead, they make many trial and error comparisions and have several small uncoordinated groups. In the third step, they are able both to draw the series and to perform the seriation operationally (e.g., by first selecting the shortest—or longest—stick, then the next, until all the sticks are in order).

Several researchers have found a significant correlation between reading and seriation, and have explained it by such differing concepts as operativity, serial ordering, and perception. Dolan, Lunzer, and Wilkinson (1) found that seriation and classification were the best measures of operativity in general and were the best predictors of reading in particular. They concluded that the cognitive and logical abilities involved in seriation were beneficial in reading. Watson (7) concluded that operativity, as measured by seriation, was a significant determinant of linguistic awareness (the understanding of the concepts of letters, words, and numbers) and that this was a major factor in learning to read.

Both Watson (7) and Waller (5) have delineated several ways in which reading involves serial ordering. Besides the obvious left to right ordering to reading, the specific order of the letters within words is important, as well as the order of the words within sentences.

Piaget sees perception, the third factor relating seriation to reading, as a part of seriation but not the basis for it. Studies by Piaget and Morf and by Lambercier, cited by Inhelder and Piaget (3), indicated that the perception of a serial configuration is not taken into account by the preoperational child when he compares two of the rods within the configuration. Instead, the child has to remove the rods from the configuration and compare them one by one to determine which is longest. Another study by Piaget, cited by Inhelder and Piaget (3), gives evidence that even when young children watch a serial arrangement of rods being placed in order they cannot draw it. Piaget claimed that the basis for both perception of a good form and operational seriation follows from the child's actions on seriable objects, with perception playing a reciprocal role in facilitating the child's actions. In

his research involving perception of ambiguous pictures and part-whole relationships, Elkind (2) concludes that these cognitive processes, involving logical manipulations, such as perceptual reorganization and schematization, are more important than the simple perception of a good form. He has proposed a perceptual reorganization factor to account for reading difficulties.

The present study proposes a new alphabetical seriation task as a better predictor of reading readiness than traditional seriation and investigates the effects of perception of a good form on this task. Instead of rods as elements to seriate, this task involves a random subset of letters from the alphabet which the children are asked to put in order, starting with the ones at the beginning of the alphabet. We expected to find three stages in the performance of this task paralleling the stages in Piaget's seriation research.

The advantage of this task as a reading predictor is that letters have a definite ordering, the knowledge of which the children can use during the task, whereas the ordering of stick lengths is entirely relational. Moreover, examining seriation with content (i.e., letters) more similar to that of the reading task ought to lead to stronger links between performances on the two tasks. Although all children were able to recite the alphabet and to recognize letters, it was hypothesized that those who were able to manipulate the letters and thus perform well on the task would also score higher on the reading-readiness test.

A mixed design was used to assess the extent to which the alphabetical seriation task can be viewed as a type of seriation and to examine the effects of perception of a good form on the alphabetical task. A card with the alphabet printed on it was available for one half of the children during the second half of the task. It was expected that this would be most beneficial to the children in the trial-and-error stage of actual seriation, rather than to the children who were operational or nonseriators. The good seriators would not need this cue, as they would be at an optimal level already, and the poor seriators should not be helped much since they still would lack the necessary cognitive structures.

In addition to the alphabetical seriation task the children were tested on a variety of other measures. Scores on traditional seriation, the Illinois Test of Psycholinguistic Abilities-Visual Sequential Memory subtest (ITPA), the Gates-MacGinitie Reading Readiness (GM) measure, and the Ravens Progressive Matrices (nonverbal *IQ*) were analyzed. Standardized prereading scores, from the Metropolitan Reading Readiness Test administered by the children's regular classroom teachers, were also analyzed. It was

hypothesized that all measures would correlate positively with reading readiness, with the alphabetical seriation task having the strongest correlation. Kindergarteners were chosen as *S*s so that the relationship between the variables could be evaluated prior to formal reading instruction.

B. Method

1. *Subjects*

Forty children enrolled in kindergarten classes in public schools served as *S*s. Testing occurred during the second half of the school year. All children were pretested to ensure knowledge of the alphabet, ease in reciting it, and knowledge of the names of the individual letters. As described in the procedure, three seriation groups were formed on the basis of scores on the traditional seriation task.

2. *Procedure*

a. First session. A group version of the Ravens Progressive Matrices Test was given to all children in their regular classrooms during the first session. Children were shown on a large screen with an opaque projector each of 12 colored matrices selected to tap the range of ability typical of kindergartners. Each child circled the correct answer on a black and white version of the pages while viewing the colored page on the screen.

b. Second session. During the second session the Piagetian seriation task was individually administered, followed by the standard version of the ITPA subtest. The materials used in the seriation task were modeled after the actual task used by Piaget (1). Ten sticks, .5 cm in diameter, ranging in length from 6 to 14 cm, plus two extra sticks to be inserted after the configuration was formed, were used. Each stick was painted a different color for discrimination as well as scoring facility. The task was performed on a 30 by 40 cm terrycloth-covered piece of cardboard having a lower edge on which the bottom of the sticks could be aligned.

The child was first shown the completed configuration and was then told that the sticks would be mixed up and that he or she was supposed to put them in order as they had been. The *E* then rearranged the sticks and gave them to the child in a random order. When the child finished, the two extra sticks were given with the instructions to insert them in their proper spots in the configuration. Two trials were given to all children and, on the basis of their performance they were assigned to a low, medium, or high seriation group. The mean percentage seriation scores for the three groups were 58%,

77%, and 96%, respectively. The high and low seriation groups each contained 13 children, the medium group, 14.

c. Third session. During the third session, all children were assessed on four trials of the alphabetical seriation task. To ensure that they understood the requirements of the task, numbers were used as examples. The *E* guided the child in putting five random digits in order. For example, the child would arrange the numbers 2 6 3 1 8 in order as 1 2 3 6 8. This was like the alphabetical seriation task, except that a shorter sequence of numbers was used instead of 10 letters. All children were able to understand the example and to put the numbers in order.

For the alphabetical seriation task the children were told that they would have to do the same thing with letters as they had just done with the numbers. A magnetic board with 2.5 cm letters was used. The child was presented with 10 letters in a predetermined random order on the magnetic board, was asked to name them, and was then instructed to put them into alphabetical order (trial 1). The task was then repeated, with the additional requirement that two new letters be inserted in their proper sequence after the arrangement was completed (trial 2).

For trials 3 and 4, half of the children in each of the three seriation groups were shown the alphabet card, a 20 by 42 cm piece of poster board with 2.5 cm block letters colored in blue, red, and green, and were told that the card might help them to put the letters in order. The card remained in front of the child during the task. Trial 4, like trial 2, required the insertion of two additional letters following completion of the arrangement. Although there was no time limit, the time taken to complete each trial was recorded.

d. Fourth session. The Gates-MacGinitie Word Recognition Test was administered individually during the fourth and last session.

Sessions were conducted in the same order for all children. Due to the qualitative differences between the tasks, carryover effects between sessions were not anticipated. Although practice with Piagetian seriation may have had slight effects on alphabetical seriation performance, these effects should be similar for all children and not bias the results presented.

3. *Analysis and Design*

Data from the alphabetical seriation task were scored both for accuracy, by the longest correct sequence of letters, and for amount of time spent on the task. The scores for the first two trials were summed and considered Block I, and the scores for the third and fourth trials were considered Block II. All children received identical treatment for Block I, while during Block

II half of the children were in a perceptual support condition and had the alphabet card present. The dependent measures were analyzed by a 3 (seriation group) × 2 (perceptual support condition) × 2 (trial block) analysis of variance.

C. Results

For accuracy scores the main effect for seriation group was found to be significant, $F(2,34) = 6.06$, $p < .01$. Very little difference on the alphabetical seriation task was found between the middle and high seriation groups. The high seriators scored 80% correct, the middle seriators scored 79%, and the low group scored only 60%. Duncan's Multiple Range test indicated that the high and medium seriator groups were not statistically different from each other, but both were different from the low group. The lack of a trial-block effect indicated that no improvement attributable to practice or to the perceptual support occurred over the four trials.

The main effect for perceptual support group approached significance, $F(1,34) = 4.08$, $p < .051$, but the perceptual support and trial-block interaction did not, indicating that the two groups, equated on seriation, selected for the two perceptual support conditions performed differently on the alphabetical seriation task even before the experimental manipulation. This was most pronounced in the low seriation group. Although this sampling bias made further analysis misleading, the perceptual support of the alphabet card definitely did not increase accuracy on the alphabetical seriation task.

For amount of time, a significant main effect for the perceptual support condition was found, $F(1,34) = 9.7$, $p < .01$; and the main effect for seriation group approached significance, $F(2,34) = 2.74$, $p < .079$, with the high and medium seriator groups taking longer ($M = 101.65$ sec for the high group, $M = 97.39$ sec for the medium group, and $M = 70.48$ for the low group). A significant interaction effect was also found for perceptual support and trial block, $F(1,34) = 12.5$, $p < .001$. The mean time scores confirm that the availability of the alphabet card as a perceptual cue increased the amount of time to complete the task, $t = 2.68$, $p < .05$ ($M = 80$ sec without and $M = 120$ sec with the cue). The increase in the time spent was equivalent across all groups, as indicated by the absence of a significant interaction between seriation group and trial block. No other main effects or interactions for accuracy or time scores were significant.

On the Piagetian seriation task, the *E* recorded whether or not the child used a strategy. The children were grouped according to whether they

TABLE 1
PEARSON CORRELATIONS BETWEEN READING READINESS MEASURES

Measures	Ravens	ITPA	PR	GM	S	ST	AS
ITPA[a]	.033						
Prereading (PR)	.42**	.10					
GM[b]	.43**	.10	.60***				
Seriation (S)	.54***	.16	.21	.38**			
Seriation time (ST)	.17	−.11	−.07	.15	.54***		
Alphabetical seriation (AS)	.38**	.18	.26	.45**	.51***	.04	
Time	.18	.08	−.10	.21	.33*	.27*	.55***

[a] Illinois Test of Psycholinguistic Abilities-Visual Sequential Memory Subtest.
[b] Gates-MacGinitie Word Recognition Test.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

employed a one-to-one comparison strategy or no strategy. No children were found who rearranged the sticks by using an entirely operational strategy. The performance difference between these two groups ($M = 80\%$ *vs* $M = 69\%$) approached significance, $F(1,34) = 4.00$, $p < .053$.

Correlations between the four alphabetical seriation trials were high, ranging from .80 to .92, indicating that this task was reliable. The correlations between the amount of time taken on the four trials was lower due to the insertions on two trials ($r = .65$, but still significant $p < .01$). Significant correlations were also found between the other measures as predicted (see Table 1). The Gates-MacGinitie Word Recognition test (a traditional measure of reading readiness) was significantly correlated with standardized prereading scores, the Ravens Nonverbal Intelligence test, seriation, and alphabetical seriation. However, after effects attributable to nonverbal intelligence were partialled out, only the standardized prereading scores and alphabetical seriation remained significantly correlated with the Gates-MacGinitie, $r = .52$, $p < .001$ and $r = .35$, $p < .05$, respectively. Contrary to expectations, the ITPA Visual Sequential Memory Test was not significantly correlated with any of the other measures.

D. DISCUSSION

The relationship between Piagetian seriation and the new alphabetical seriation task was confirmed by the significant correlation between the two.

However, although the low seriation group performed at a low level on the alphabetical task, the middle and high seriator groups performed equally well on this task. This could possibly be explained by strategy differences in the performance of the two tasks. On the Piagetian seriation task, the children apparently used either a trial-and-error strategy or no strategy. Unfortunately, on the alphabetical seriation task, specific strategy data were not collected. Anecdotal evidence suggests that children generally used no strategy or else recited the alphabet, picking out each letter as they came to it and put it in order. The greater ease with which a higher-order strategy appears for the alphabetical seriation task may account for the lack of discrimination between the high and medium seriation groups.

Time scores support the position that none of the children were actually performing operationally. For both seriation tasks, the more accurate children also took longer. Once children start performing operationally, this trend should reverse, and less time should be needed to complete the task. It should be noted that time measures, not typically used in assessing seriation, do seem to provide valuable additional information regarding children's level of performance.

Alphabetical seriation, rather than traditional seriation, was supported as a reading readiness predictor. Alphabetical seriation was significantly correlated with the Gates-MacGinitie, even when the variance attributable to nonverbal intelligence was partialled out. However, this study did not confirm the high correlation between seriation and reading readiness that has been found by past research (4, 5). Although the basic correlation was significant, it was reduced substantially when nonverbal intelligence was partialled out. Scott found a high correlation between seriation and reading, but he did not control for the effects of intelligence. Watson (6) found a significant correlation when controlling for verbal, rather than nonverbal, intelligence. The present study underscores the critical role nonverbal intelligence plays in early perceptual processes and beginning reading. However, this finding should be interpreted with caution because of the relatively small sample size ($N = 40$), as compared to Scott ($N = 120$) and Watson ($N = 100$).

Both Watson (7) and Waller (5) suggested that an ordering concept was important in both seriation and reading. It was expected that the ITPA Visual Sequential Subtest would provide a degree of control for this ordering factor, since it requires the child to remember the order of different figures. It was thought that as the importance of the ordering concept to reading increased, the correlation of the ITPA with the reading readiness measures

would increase. The lack of any relationship indicates either that the ordering concept is not important in reading readiness or that the ITPA subtest is not a valid assessment tool.

The theory that seriation involves more than just perception of a good form was supported. No difference in accuracy was found for any of the groups with the alphabet card present. The significant increase in time scores indicates that the children did notice the card; but no corresponding improvements in accuracy resulted.

This study and past research suggest that both alphabetical seriation and reading require more than perception of a good form. It also appears that there is more than just a sequential ordering factor involved, since ordering of designs was not correlated with reading readiness. Elkind's theory of perceptual reorganization seems most promising in light of these findings. Although Piaget believes operativity cannot be taught, Elkind did find significant improvements in reading after perceptual reorganization training. Although Watson (7) believes a minimum cognitive level is important if reading instruction is to be beneficial, he does suggest seriation training or perceptual reorganization training as a possible means of facilitating this development. Further studies are necessary to substantiate the effects of such training.

Now that the alphabetical seriation task has been established as potentially valuable, further research needs to examine its similarities and differences with regular seriation, its susceptibility to modification and training, and its links with reading. In order to investigate the transition between the different stages in seriation, a wider age range is necessary. It would be beneficial to test children from the ages of four through eight so that the full range of strategies leading to operational seriation could be examined. Further, the predictive validity of the alphabetical seriation task needs to be established by analyzing its relationship to reading in the first and second grade.

References

1. Dolan, T., Lunzer, E. A., & Wilkinson, J. E. The effectiveness of measures of operativity, language and short-term memory in the prediction of reading and mathematical understanding. *Brit. J. Educ. Psychol.*, 1976, **46,** 295-305.
2. Elkind, D. Reading, logic, and perception: An approach to reading instruction. In D. Elkind (Ed.), *Children and Adolescents: Interpretive Essays on Jean Piaget.* New York: Van Nostrand, 1963.
3. Inhelder, B., & Piaget, J. The Early Growth of Logic in the Child. London: Routledge & Kegan Paul. 1964.

4. SCOTT, R. Social class, race, seriating, and reading readiness: A study of their relationship at the kindergarten level. *J. Genet. Psychol.*, 1969, **115,** 87-96.
5. WALLER, T. G. Think First, Read Later: Piagetian Prerequisities for Reading. Newark, DE: Internat. Read. Assoc., 1977.
6. WATSON, A. J. Multiple seriation and learning to read. *Austral. J. Educ.*, 1979, **232,** 171-180.
7. ———. Cognition and units of print in early readers. In J. Downing & R. Valtin (Eds.), *Linguistic Awareness and Learning to Read.* New York: Springer-Verlag, in press.

Department of Psychology
University of Notre Dame
Notre Dame, Indiana 46556