15

Direct Measurement of the Ways Children Know Language and Numbers

Joseph S. Edwards

We have said that experimental findings are heavily determined by the method of measurement. The Edwards article shows the implications of this in a particularly vivid way. Does Johnny know how to read? Does Jane know the alphabet? Does Jimmy know how to count? The answer to these seemingly simple questions depends on the method used for measuring reading, knowledge of the alphabet, and counting. In some instances, the child can name an object, for example, a ball, indicating that he has the response "ball" in his repertoire; he can also go get the ball when presented with the written word "ball"; yet, he cannot read the word *ball* in the sense of saying "ball" when presented with the printed word! One measure says that he can read and another measure says that he cannot. The measure that happens to be selected can have a profound influence on the educational fate of the child. That measurement procedures influence results is a fact of more than mere academic interest.

A full behavioral assessment of language must include an analysis of the ways in which symbols and objects are presented as well as the ways in which a person

This research was supported in part by PHS Training Grant HD 00183 from the National Institute of Child Health and Human Development to the Kansas Center for Research in Men-

effort of James Early, Maureen Mooney and particularly David Thomas made the research possible. Appreciation is also extended to Diane Edwards and Charles L. Sheridan for critically evaluating the manuscript. The author is now a faculty member of the psychology department of the University of Missouri at Kansas City.

This paper is dedicated to Ogden R. Lindsley, who taught me the value of direct measurements

responds to them. The result of such an assessment would be a functional analysis describing under what conditions symbols can be used. The function of language is its most essential aspect. Vygotsky (1962, p. 5) states the problem as, "A word without meaning is an empty sound, no longer a part of human speech." Bridgman (1927, p. 4) also points to a functional analysis when he states that, "For of course the true meaning of a term is to be found by observing what a man does with it, not by what he says about it." In the functional analysis described above, meaning is determined by the relationship between the method of presentation and the method of responding. Meaning becomes an experimental problem in an attempt to isolate the conditions under which symbolic events are functional.

An advantage of approaching meaning and language experimentally is that it may be possible to isolate deficits specific to the method of presentation, the method of responding, or both. Once a deficit has been specified, the procedures for remediation can be developed. Jaffe (1966) suggested that a common source of confounding language function is that visual and auditory presentations are typically not tested separately. It may well be that an individual has "auditory" language but not "visual" language; a fact not clarified if the two modalities are not tested separately.

Before a remedial procedure can be adequately tested, diagnostic procedures which pinpoint and record both skills and deficiencies with language must be developed. Schiefelbush (1969) strongly suggested that a functional analysis of the components of speech, language, and communication must be done if programs are to be adequately designed for the study and remediation of these processes.

The present studies were conducted as a part of a diagnostic research program to accomplish the goals of precisely pinpointing language functions. The methods of presenting materials and the methods of responding were varied to determine the ways in which a word, symbol, or number had meaning.

METHOD

Subjects

Thirty children (ages 2–12 years) participated. Nineteen of these children were enrolled in either special education classes or a tutorial program for disadvantaged youth.

Materials

Language and number skills were assessed with a variety of materials. Alphabet materials consisted of the capital letter sample from the *Wide Range Achievement Test* (Jastak, Bijou, and Jastak, 1965) and all 26 capital letters of the alphabet mounted on 3-by-5 cards. Word-object materials were obtained from the *Peabody Picture Vocabulary Test* (Dunn, 1965) and the Dolch word series (Dolch, 1953). Addition problems whose answers summed to 10 or less were the arithmetic materials. There were 20 problems. A fifth grade text was used to study reading comprehension.

General Procedure and Experimental Design

In each study pennies were used to reinforce correct responses unless otherwise specified. At the beginning of each task the child was instructed that each correct answer would earn him some money. At the end of the task the number of correct answers was calculated and the child was paid on a ratio of three or four correct answers per penny.

The rate of correct responses, the rate of wrong responses, the total rate, and accuracy were recorded to describe each child's performance. Rate and accuracy are perhaps the most fundamental dimensions of symbolic responding (Edwards, 1969). With both of these data it is possible to pinpoint the specific deficits and skills of individual children. In addition, these recordings are sensitive to: (1) behaviors whose rate must be accelerated (rate building task), (2) behaviors which occur at an acceptable rate but which must be brought under appropriate environmental control (accuracy task), and (3) behaviors which have to be built or shaped and whose rate must be accelerated. These data have proven to be satisfactory measures for determining what type of behavioral skills and deficits individual children exhibit.

The methods of presentation involved a separate assessment of auditory input from visual input. The method of response included saying, finding, and writing. The schematic diagram below outlines the procedures by input-output modalities and the text describes the details of the procedures.

INPUT-OUTPUT SYSTEMS

Auditory	*Visual*	*None*
Listen—Find	Look—Find	. . . Find
Listen—Say	Look—Say	. . . Say
Listen—Write	Look—Write	. . . Write

Listen—Find: The experimenter says the symbol and the child selects the symbol he hears from an array of symbols spread out in front of him. This procedure assesses the child's ability to translate the auditory input into visual function. *Listen—Say:* The experimenter says the symbol and the child repeats orally the symbol he hears. This procedure crudely isolates any sensory problems in audition and precisely assesses whether the child can make the necessary speech sounds essential for a verbal language. *Listen—Write:* The experimenter says the symbol and the child writes what he hears on a sheet of paper. These three procedures enable an assessment of auditory skill relative to the responses of say, find, and write. This permits any response deficit to be isolated with respect to auditory stimuli. *Look—Find:* The child is shown a symbol from a deck of symbols and is asked to find the symbol that looks like the sample from an array of written symbols spread out in front of him. This procedure directly assesses visual function before more complicated procedures are introduced and insures that the child is able to match symbols visually. *Look—Say:* The symbol is presented to the child and he is asked to say what it is. This procedure assesses whether or not the child can say what he sees. This is the traditional oral reading assessment procedure. *Look—Write:* The symbol is presented and the child is to copy what he sees. This procedure assesses whether the child can reproduce what he sees and helps isolate listen-write and look-write skills and/or deficits. In all of these procedures, symbols were presented in a random order. . . . *Find:* Written symbols of the alphabet or number sequence are presented in a random array in front of the child. The child is instructed to point to the letters or numbers in the sequence that

they should occur. . . . *Say:* The child is asked to say the alphabet or count from 1–50 without either visual or auditory symbol inputs. Verbal recall is assessed with this procedure. . . . *Write:* The child is asked to write the alphabet or the number sequence from 1–50 without either visual or auditory inputs. Written recall is assessed with this procedure. These nine procedures directly assess both stimulus and response skills and deficits and can be made appropriate to assessments of performance with a variety of curricula (colors, numbers, letters, words, objects, etc.).

RESULTS

Study 1. Look—Say: Alphabet Sample of the Wide Range Achievement Test vs the Full Alphabet Curriculum

Figure 1 presents the performance of two out of eight children on the *Wide Range Achievement Test* (WRAT) sample and full alphabet. The first child performed at a higher level of accuracy (81%) on the full alphabet than he did on the WRAT sample (46%). The second child performed at a lower level of accuracy (40%) on the full alphabet than on the WRAT sample (100%). The WRAT sample is unrepresentative of the performance skills of both children. The test results grossly underestimate the performance of the first child and overestimate that of the second child.

Four other children who performed perfectly on the full alphabet also performed perfectly on the WRAT. The other two children had lower levels of accuracy on the WRAT.

The range of response accuracy for the eight children's performance on both tasks was 0–60%. This large difference supports the suggestion that the WRAT sample is only representative of a child's performance when he performs the full alphabet perfectly. In addition, it should be noted that the time taken to administer the full alphabet in comparison to that taken for the WRAT averaged about 25 seconds longer.

Study 2. . . . Say vs. . . . Write: Differential Skill in Reciting Numbers as a Function of the Method of Responding

Figure 2 shows the performance of three out of eleven children who said (. . . say) and wrote (. . . write) the numbers 1–50 from memory. The first child said the number sequence less accurately than he wrote them indicating that the method of assessing his skill in counting critically determines the accuracy of his performance. The second and third children recited the number sequence perfectly on both procedures. These two children can recite the number sequence, and the procedure used is not a critical determinant of their accuracy. The total response rates of these three children clearly indicates that . . . write is a much slower rate performance than . . . say.

The median total response rate for the eleven children on the . . . say procedure was 85 numbers per minute whereas the median rate for . . . write was 12 numbers per minute. . . . Say is approximately 7 times faster than . . . write. Every child said the numbers faster than he wrote them and this effect occurred in spite of wide differences in response accuracy. Examination of the third child's performance in Figure 2

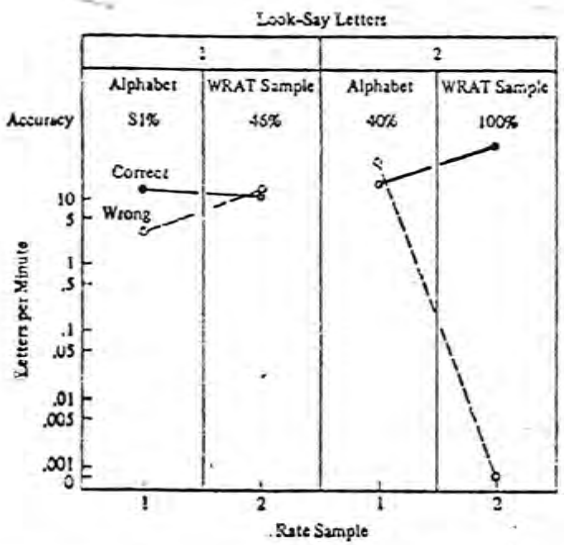


Figure 1 Differential skill in looking and saying capital letters of the alphabet as a function of a test sample.

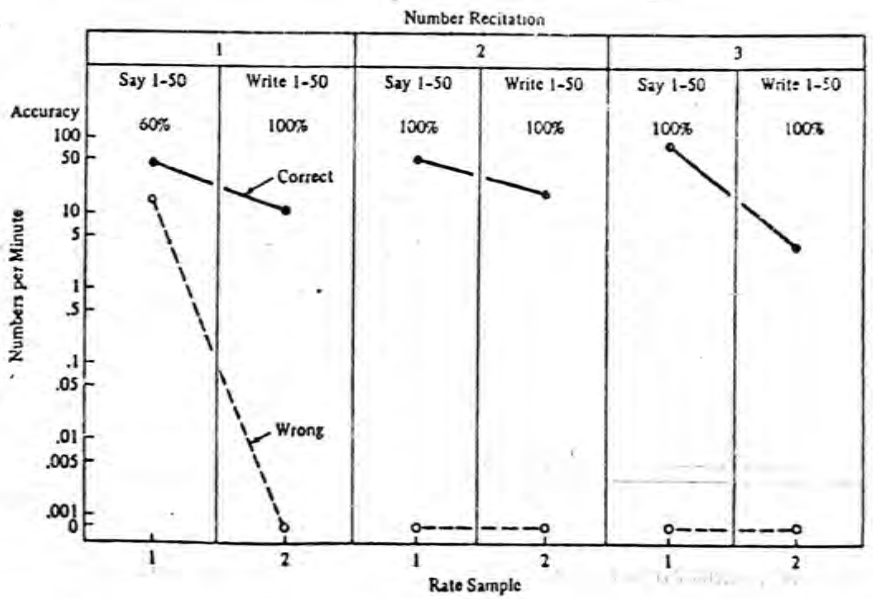


Figure 2 Number recitation skill as a function of the method of responding (saying vs. writing).

shows that he recites the numbers accurately in both procedures but the rate at which he writes the number (4 per min.) is 3 times lower than the median pupil's writing rate. A remedial program for this child would involve a detailed analysis of his writing performance. In contrast the performance of the first child clearly indicates a different remedial problem. His total response rate on both procedures approximates the median pupil's rate but the accuracy of his . . . say performance is much lower than his performance on the . . . write procedure. Remedial techniques for this child would attempt to determine methods for increasing his . . . say accuracy. If either the . . . say or the . . . write procedure had been used alone one would have come to opposite conclusions concerning this child's recitation skills.

Study 3. Look—Write: Differential Effects of the Method of Presenting Arithmetic Problems

This investigation sought to determine if the method of presenting arithmetic problems to children would affect their performance on addition problems. Five children, three of whom were enrolled in a special education class, participated.

Figure 3 presents three children's performance in adding number combinations which summed to 10 or less when number symbols ("2 + 2 = 4") and written number problems ("Two + Two = 4") were used. The overall accuracy of the first two children decreased when the problems were presented in written form. Both children performed perfectly when the problems were presented in symbol form. In contrast, the third child's performance indicates that he cannot add numbers in either symbolic or written form. The deficit exposed with the first two children has nothing to do with arithmetic skill but concerns the way that the skill is assessed. The third child's performance indicates that he has minimal arithmetic skills. The focus of a remedial program for him would concern the instruction of addition before learning how to read and work written addition problems.

Study 4. Alphabet Assessment: Different Ways to Know the Letters

In this investigation the performance of: (1) 12 children was analyzed using 4 assessment procedures and (2) a young child's (age 2 years and 10 months) acquisition of 7 different ways to know the alphabet is described.

Four procedures, . . . say, look-say capital letters, look—write capital letters, and listen—write capital letters were used to assess 12 children's skill in using letters of the alphabet.

The order of highest overall response rates was: . . . say, look—say, look—write, and listen—write. The median accuracy across all procedures was 90% or greater.

In Figure 4 Paul's performance with capital letters of the alphabet is presented. Look—write capitals yielded the highest accuracy and listen—write capitals the lowest accuracy. The letters were more effective stimuli when Paul looked and wrote them than when he listened and wrote them. This difference is further indicated by comparing his performance in the look—say and look—write procedures.

Variations in the input procedures with a writing response are shown in

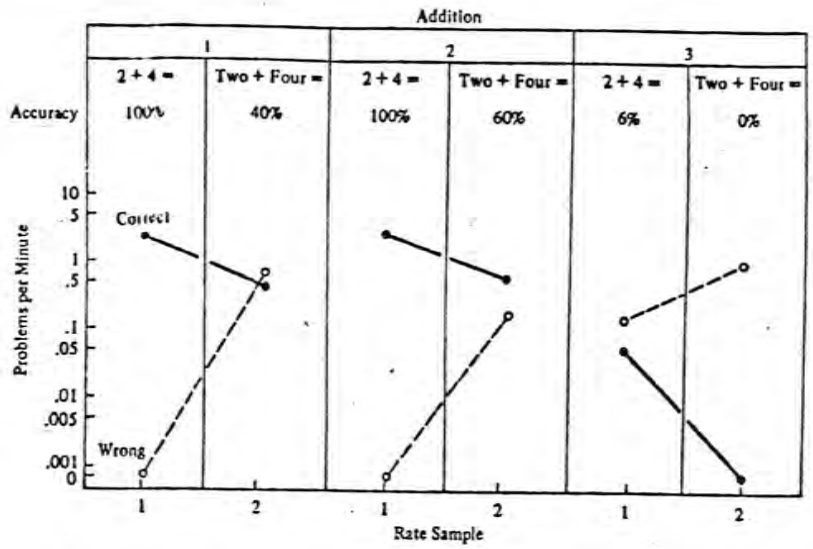


Figure 3 Performance on simple addition problems as a function of the method of presenting the problems (symbols vs. words).

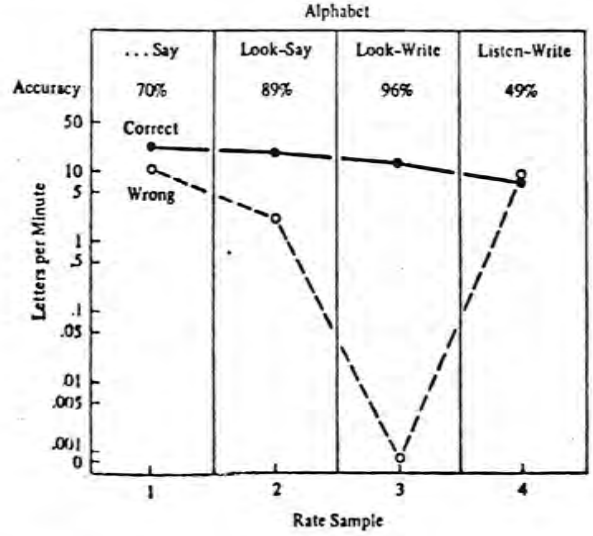


Figure 4 Differential performance of a boy under four different procedures for assessing alphabet skills.

rate samples 3 and 4. Auditory presentation of the letters produced the largest decrease in accuracy. The deficiency indicated involves a difficulty in reproducing letters that he hears. This deficiency, however, is not due to an inability to write the letters as demonstrated by the look-write procedure. In addition to showing Paul's relative skill with four ways of using the alphabet the overall rate at which he performed under the various conditions again corroborates the general finding that listen—write tasks take more time than any of the other procedures used here and that this area is the place where instruction is needed. This child's knowledge of the alphabet is a direct function of the procedures used to assess it.

Figure 5 presents performance rates and accuracy for a 2-year-and-10-month-old boy. Seven procedures were used to assess skill with capital letters of the alphabet in each of the 28 rate samples. Reinforcements for correct answers consisted of drinks of coke, praise, and mixed candy. Following the assessment sample in each session teaching periods were conducted in an attempt to improve this young boy's skill with the alphabet. The teaching involved drill with the procedures used in the assessments.

Inspection of the performance under the different procedures shows that this boy perfectly responded only in the listen—say procedure during the first rate sample. Acquisition to 100% accuracy was most rapid in the look—find, look—say, and . . . say procedures. In these procedures where 100% accuracy was obtained the order of highest overall response rates was: . . . say, listen—say, look—say, and look—find respectively. response (. . . write, listen—write, and look—write) rate correct and accuracy were the lowest. In the look—write and listen—write procedures accuracy improved from levels lower than 10% to 62% by the last session. Performance in the . . . write procedure shows the smallest improvement.

In procedures which required a find or say response the rate of acquisition was faster than in procedures which required a written response. The early perfect performance exhibited in the listen-say procedure demonstrated that this young boy had the capability of saying all the letters of the alphabet. Rapid acquisition in the look—find procedure indicated that he had no difficulties in handling visual stimuli. Using visually presented letters, simple variation in the response from say or find to write in the look—write procedure shows that the deficit is in writing. Improvement in writing during the look—write procedure is paralleled by simultaneous improvements in accuracy in the listen—write and in the . . . write procedures respectively. . . . Write skills appear to be dependent upon skills present in the look—write and listen—write procedures. This boy's performance in the listen—write procedure was largely a function of deficiencies in writing whereas Paul's performance under this procedure (Fig. 4) was a function of other variables since he demonstrated he could perform the look—write procedure perfectly.

In addition, the order in which this young boy's performance improved indicates the relative difficulty of acquiring language skills with these seven procedures. Listen—say, look—find, and . . . say are skills acquired more rapidly than look—write, listen—write, and

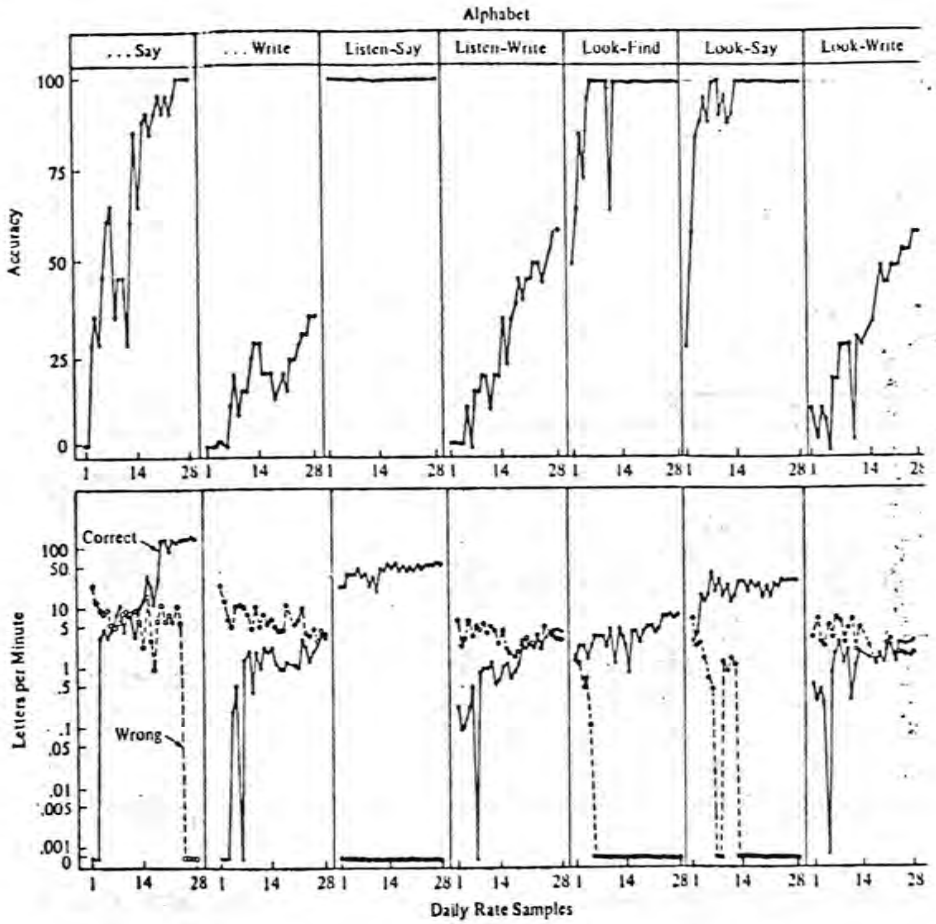


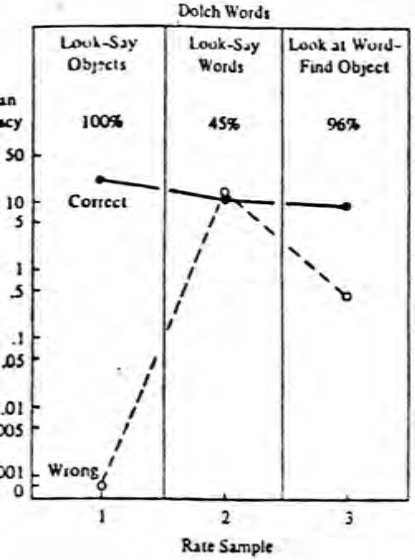
Figure 5 Acquisition of seven different alphabet skills by a young boy (2 years and 10 months).

difficulty with say and find responses. Difficulties with the writing response reflect his current level of motor coordination rather than specific difficulties with symbolic materials.

Study 5. How Do Children Know Words: Saying, Finding, Using

The results from three tasks are presented. The first task consisted of 25 words and their corresponding object pictures taken from the Dolch serie Three procedures: (1) look—say word (2) look—say objects, and (3) look a word—find object were utilized to de termine if eight pupils could use th words in these three ways.

Figure 6 summarizes the median ac curacy and the response rates of eigh pupils, four of whom were enrolled i a primary learning disability class an four who were enrolled in regular secon and third grade classes. The data fro both groups were combined since ther



e 6 The performance of eight pupils s that skill in oral reading (look-say s) does not accurately predict under- ing of those words.

no systematic relationship between grade placement and performance. median accuracy was highest for ifying the objects and lowest for ng and saying the words. The ill response rate was higher for ng the words and identifying the ts. The level of accuracy in look— he words does not accurately pre- whether any of the children could ie words to label a pictorial referent word. The deficiency exposed here erns how written words are used as li when two different methods of nding are provided.

e written words were not effective minative stimuli for producing ac- e "look at the word and say" re- es. However, a large number of same words were effective discrim- ve stimuli when the children did not have to look and say the word, but could respond to them with object pictures. Thus, the same event (written words) can have stimulus functions under one set of conditions and little or no function under other conditions. Remedial procedures based on this assessment would involve visually presented words to be orally read. The deficits of these children concern the method of responding to the written words, not their understanding of the meaning of the words.

The second task consisted of three procedures to assess performance on the *Peabody Picture Vocabulary Test* (PPVT). Since the PPVT provides norms to assess listen-to-the-word-and-find-the-picture levels of skill the cutoff points were utilized in this project so that an IQ score could be obtained in addition to an assessment of other language skills. The procedures were: (1) look—say words, (2) look at word—find object picture, and (3) listen to word—find object picture. Again, the procedures utilized here attempt to determine how children can use words. The procedures used in this task sought to isolate whether children would respond more effectively to words presented auditorally or visually as well as determine if they could say what the words were.

Figure 7 summarizes five pupils' performance. The overall rate of response was highest for look—say words and lowest for look at the word and find the object picture. The median accuracy was highest on the listen to the word and find the object picture procedure and lowest on look and say the words. Although the level of accuracy of these pupils is extremely low in the look—say word procedure these same pupils are capable of using written words to label

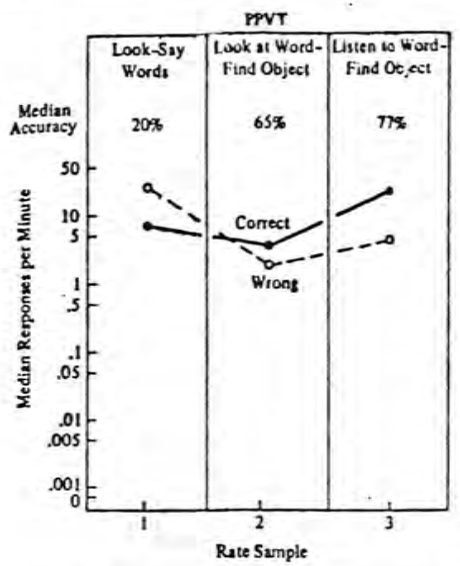


Figure 7 The performance of five pupils on three procedures to assess reading and understanding shows that every pupil understood words better auditorally than he did visually. This result was not accurately predicted by oral reading skills (look-say words).

pictures at a much higher level of accuracy.

The results from this task corroborate the findings using the Dolch words by showing that look at words and find the object pictures and listen to words and find object pictures are not always predicted by skill in look and say the words. In addition, every pupil did better on the listen to the word and find the object picture procedure than on the look at the word and find the object picture procedure. This result has consistently been found across all levels of accuracy and with three other tasks.

In two of the procedures used here responding was held constant (find the object picture) with variations made only in the method of presenting word stimuli. In this way determinations of the ways a child can use words is assessed directly. The third procedure used written stimuli and an oral response. Comparing the performance of a child under this procedure with that obtained in looking at the word and finding the object helps separate performance deficits which are a function of looking and saying words from understanding the words. These different procedures appear to have exposed language usage skills with words that are often independent of whether a child can say the word he sees.

Figure 8 presents a replication of the previous task with the addition of four other procedures to assess eleven children's performance. The children were enrolled in a special tutorial program for disadvantaged youth. Performance on the first 75 questions of the PPVT was analyzed. The seven procedures were: look—say words, look—find words, listen—find words, listen—say words, listen—say object name, look at the word—find the object picture, and listen to the word—find the object picture.

The highest rate performance of these eleven children was on the listen—say word procedure, the listen—say object name procedure, and the listen to the word—find the object procedure. Performance accuracy was lowest in look—say the words and highest on the other procedures that involved the use of words alone. Looking at the word and finding the object picture was less accurate for every child than listening to the word and finding the object picture but performance on these two procedures was considerably more accurate than on the look—say word procedure.

Again, these data show that visually

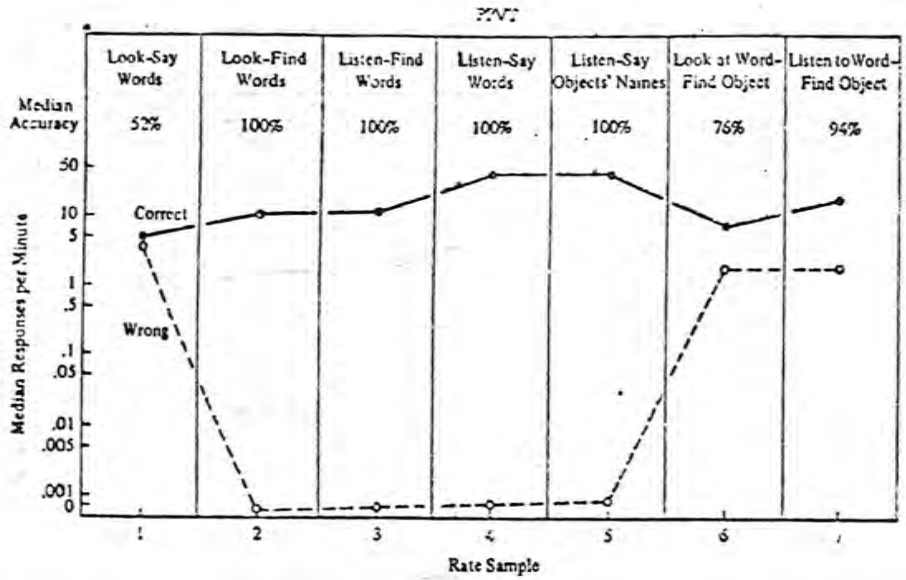


Figure 8 Performance rates and accuracy of eleven children under seven procedures for assessing word-object skills show that the major deficit involves oral reading skills (look-say words), not understanding the words (look-find words; listen-find words; listen-say words), the objects (listen-say object names), or the word-object relationships (look at word-find object picture; listen to word-find object picture).

esented words may have no function r one type of response but serve as an fective stimulus for another. Performce on the listen—find word, listen—y word, and listen—say object name ocedures rule out the possibility of stening, or perceptual impairments as ariables influencing the results. The edian accuracy of the children clearly dicates that they can use words in ritten and auditory modes when they n listen and say the words and object ames and find the visual duplicate of sample stimulus. Performance difficulties by all children are evident when e words are presented visually and a y or find response is required (look—y words; look at word—find object cture). Understanding the words used re appears to be less of a problem than training "look—say" the words skills. None of the pupils in this study could look and say the words better than he performed on the listen and find the word, listen and say the word, or listen and say the object name procedures. In addition, it was again found that all pupils performed at a higher level of accuracy when they listened to the words and found the object picture than when they looked at the word and found the object picture.

Study 6. Longitudional Study in Reading Comprehension

Figure 9 presents Jerry's (9 years old) performance using four procedures for assessing his reading comprehension.

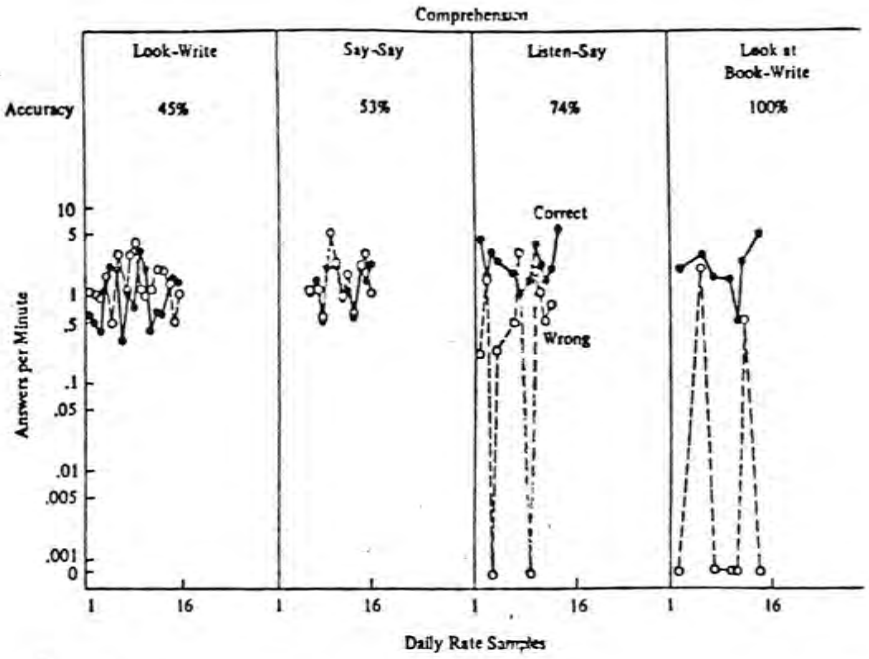


Figure 9 Performance of a boy on four comprehension assessment procedures shows th his skill is a function of the assessment procedures.

Look at the question and write the answer, say the question and say the answer, listen to the question and say the answer, and look at the book and write the answer were the procedures. The highest level of accuracy occurs when Jerry looks at the book and writes his answers. Looking at the questions and writing the answer and listening to the question and writing the answer produced the lowest levels of accuracy.

This chart shows that the method utilized to assess Jerry's understanding of the reading material critically determines the accuracy of his performance. Look at the question and write your answer and listen to the question and write your answer procedures if used independently of the other two procedures would have revealed the conclusion that Jerry did not "understand" material. His accuracy is too low. Je deficiency, however, is largely a func of the method of asking him the q tions. Comparisons of results from listen to the question and write answer procedure with say the ques and say your answer procedure sh a difference of 21% in overall accur The effective use of the reading m rials was also determined by compa his performance on the look at question and write your answer pr dure with look at the book and y your answer procedure. Accuracy in latter procedure improved 55%. result clearly shows the power of method of presenting questions and method of responding that are used this child. Jerry's diagnosis was "

eader," "had difficulties in comprehen-
on," and "stutters." This classification
ppears to be too imprecise to pinpoint
ne exact deficiencies of Jerry's per-
rmance.

DISCUSSION AND SUMMARY

he procedures presented in this paper
volved an assessment of language
nction by varying either the method
presenting the materials or the
ethod of responding to those materials.
ata were presented which showed that
ne method of presenting materials may
rve as an effective stimulus with one
pe of response but have no function
hen a different response is required.
ata also indicated that variations of
e stimulus using the same response
itically affected performance rates and
curacy hese results question the
atemen... nade by McCarthy and Kirk
discussing the experimental edition of
e *Illinois Test of Psycholinguistic Abilities*
rmat as:

> To test pure decoding ability, only the
> ode of reception, auditory or visual, need
> specified (i.e., it is irrelevant how the
> bject responds). To test encoding ability
> ly the mode of response, vocal or motor,
> ed be specified. To test association ability,
> a combination of abilities simultaneously,
> entire channel must be specified (1961,
> 3).

n contrast to the quote above, the
a presented here show that input-
put systems must be precisely speci-
l to pinpoint and analyze language
icits. The procedures used here show
t when language is defined in behav-
l terms, experimental investigations
the ways language is used can be made directly. Skinner (1957) outlined a framework which provided new terms and definitions of potential behavioral functions of language. However, the major research emphasis has concerned the manipulation of vocal response rates in small animals and humans (e.g., Greenspoon, 1955; Lane, 1961; Salzinger and Waller, 1962). Very little emphasis has been placed on an analysis of how language is functional both as a stimulus and as a response (cf. Holz and Azrin, 1966).

Hively (1966) presented an experimental design similar to the one described in this paper. However, no data were presented to support the design. The present study has established a design and showed in what ways that design has sensitivity over other currently available methods (e.g. ITPA, PPVT). By varying the methods of presenting symbols and their referents, it is possible to directly record and separate skills and deficits. The procedures were shown to be maximally sensitive to pinpointing a particular deficit thus permitting precise remediation steps to be undertaken. In fact the same procedures can be used to analyze as well as teach, thus making it an economical package. Meaning and understanding become relevant insofar as a procedure identifies under what conditions language is functional for any particular person and subject matter. The development of specialized instructional methods to teach specific performance skills can be evaluated daily with the assessment procedures appropriate to that instruction.

Rates of responding (correct, wrong, total) and the overall accuracy of that responding provide maximally sensitive records for specifying performance skills and deficits. This combination of records permits a wide range of flexibility in analyzing the performance of single children as well as making comparisons across children and across procedures. Deficits which involve rate, accuracy, or both rate and accuracy can be precisely identified. Remedial programs based on these data could focus precisely on increasing specific dimensions of a behavior. Learning involves both rate and accuracy. Pinpointing the exact parameters of performance increases the precision of diagnostic methods and remedial procedures.

The following conclusions can be made from the studies conducted here: (1) a standardized test sample may or may not be representative of a person's performance, and it is not always possible to predict under what conditions representativeness is obtained, (2) typical reading assessments (look—say words) may not accurately predict a child's use of the word under other conditions, (3) the procedures used to assess reading comprehension can drastically alter performance rates and accuracy, (4) look at the word and find the object picture and listen to the word and find the object picture assessments showed that every child did better when he listened to the word and found the picture, (5) comparisons of performance on look and say words with look at the word and find the object picture revealed that every child could use more words than he could say, (6) alphabet assessments indicated that looking and saying letters and listening and writing the letters appear to be independent of a child's ability to orally recite the same letters, (7) the assessment of counting skills and addition showed that performance was critically affected by the method of responding and the method of presenting the arithmetic problems, (8) assessments and instruction with seven alphabet procedures revealed that the procedures are sensitive to specifying performance skills and deficits in a young child and that the same procedures can be used as the instructional format, (9) the method of responding is clearly an important variable in curriculum analysis, and must be specified as precisely as the stimulation methods if we are to precisely analyze skills and deficits and suggest curriculum revisions functionally.

REFERENCES

Bridgman, P. W. *The logic of modern physics.* New York: MacMillan, 1927.

Dolch, E. W. *Match.* Champaign, Illinois: The General Press Publishers, 1953.

Dunn, L. M. *Peabody Picture Vocabulary Test.* Minneapolis: American Guidance Services, Inc. 1965.

Edwards, J. S. Precisely teaching children labeled learning disabled. Unpublished dissertation, University of Kansas, 1969.

Jaffe, J. The study of language in psychiatry: psycholinguistics and computational linguistics. In Arieti, S. (Ed.), *American Handbook of Psychiatry,* Vol. III. New York: Basic Books, 1966.

Jastak, J. F., Bijou, S. W., and Jastak, S. R. *Wide Range Achievement Test.* Wilmington, Delaware: Guidance Associates, 1965.

Greenspoon, J. The reinforcing effect of two spoken sounds on the frequency of two responses. *American Journal of Psychology,* 1955, 68, 409–416.

Hively, W. A framework for the analysis of elementary reading behavior. *American Educational Research Journal,* 1966, 3, 89–103.

Holz, W. C., and Azrin, N. H. Conditioning

human verbal behavior. In Honig, W. (Ed.), *Operant behavior: Areas of research and application.* New York: Appleton-Century-Crofts, 1966.

Lane, H. L. Operant control of vocalizing in chickens. *Journal of the Experimental Analysis of Behavior,* 1961, **4,** 171–177.

McCarthy, J. J., and Kirk, S. A. Experimental Edition, *Illinois Test of Psycholinguistic Abilities.* Urbana, Illinois: University of Illinois Press, 1961.

Salzinger, K., and Waller, M. B. The operant control of vocalization in the dog. *Journal of the Experimental Analysis of Behavior,* 1962, **5,** 383–389.

Schiefelbusch, R. L. Language functions of retarded children. *Folia Psychiatrica,* 1969, **21,** 129–144.

Skinner, B. F. *Verbal behavior.* New York: Appleton-Century-Crofts, 1957.

Vygotsky, L. S. *Thought and language.* Cambridge: The M.I.T. Press, 1962.