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Pictorial Mnemonics for Phonics

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Two experiments evaluated whether picture mnemonics help prereaders learn letter–sound associations. Pictures integrating the associations were compared with disassociated pictures and with a no-picture control condition. Children in the integrated-picture group learned five letter–sound associations (e.g., *f*, /f/), each represented by a picture whose shape included the letter (e.g., letter *f* drawn as the stem of a flower) and whose name (flower) began with the letter's sound. Children in the disassociated-picture group learned letter–sound associations with pictures having the same names as the integrated pictures, but drawn differently—without letter shapes. Children in the control group learned associations with picture names but no pictures. Prior to letter–sound training, all groups were taught how to segment the initial sounds of the picture names. Results revealed that children taught with integrated mnemonics learned more letter–sound associations and also more letter–picture associations than did the other two groups, which did not differ. Integrated pictures were effective because they linked two otherwise unconnected items in memory. The shapes of letters included in pictures reminded learners of previously seen pictures with those shapes whose names began with the relevant letter sounds.

Learning how graphemes map phonemes is generally acknowledged to be an important component of learning to read. Chall (1967) reviewed numerous studies examining the relationship between children's knowledge of letter–sound relations and early reading achievement and concluded that this knowledge is more central even than mental ability. Bond and Dykstra (1967), among others, have found that letter-name knowledge is the best single predictor of beginning reading achievement. Jeffrey and Samuels (1967) showed experimentally that training in letter–sound correspondences facilitates printed-word learning in beginning readers. Stanovich (1980) reviewed several studies indicating that decoding ability distinguishes skilled from less skilled readers more than do other components of the reading process. Not only researchers but also primary grade teachers regard knowledge of letter–sound relations as central. These relations are taught in most kindergarten classrooms, and most beginning reading texts include information about how letters correspond to sounds.

Unfortunately, the task of learning letter–sound associations is not an easy one for beginners. Difficulties arise from several sources. The number of associations to be mastered is considerable: more than 40 sounds for 52 visual figures, plus sounds for combinations of letters (i.e., digraphs). Many of the lowercase letters are visually similar and hard to discriminate. The phoneme sounds as well as the visual letter symbols are meaningless. Although the phonemes occur in normal speech, they are difficult to recognize when pronounced alone because their form in isolation is quite different from their form when blended with other sounds. Furthermore, the associations between letters and sounds are totally arbitrary, as there is nothing inherent in the visual symbol that suggests its name or sound. Ehri and Wilce (1979) found that first graders had much trouble learning pairs of arbitrarily associated, meaningless terms. In their study, the stimuli were four distinctive but unfamiliar figures, and the re-

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sponses were consonant-vowel-consonant nonsense sounds (e.g., mav, rel, kip, guz). The majority of the children (67%) could not learn the four sounds even after 15 practice trials, indicating that learning arbitrary associations between meaningless terms takes a long time. To the extent that children already know letter–sound relations when they enter first grade, they should have a head start in learning to read. Even knowing letter names should help because most of the names include a relevant sound (Durrell, 1980; Ehri, 1983). Ehri (1983) reported that she had no trouble teaching eight letter–sound associations to children who could already name the letters. However, she had much trouble with—and in fact gave up training—children who could not name the letters. She suggested that extracting sounds from letter names is a much easier task than learning letter–sound relations from scratch.

How to facilitate the task of learning visual–verbal associations that are meaningless and arbitrary has been studied extensively using the paired-associate learning paradigm. Rothkopf (1962) found that adults' memory for associations between resistor-code colors and numbers was superior when familiar links between the terms were identified, for example, when "red-2" was taught as "red heart broken into 2 parts," "brown-1" as "brown penny is 1 cent." Rohwer (1966) investigated various kinds of associative mnemonics in young children and found that the best connectives for remembering pairs of pictures or words were meaningful "actor-action-object" relations. Ineffective mediators were verbal connectives in the form of conjunctions or pictures displaying objects side by side. Many other studies confirm that paired-associate learning in children is much improved when learners create or are provided with concrete, meaningful, interactive, and imaginable connectives that link the stimulus and response terms in memory (Davidson & Adams, 1970; Ehri & Rohwer, 1969; Lippman & Shanahan, 1973; Rohwer & Levin, 1968; Rohwer, Lynch, Levin, & Suzuki, 1967).

Various kinds of mnemonics have been investigated for their effectiveness in facilitating prereaders' learning of letter–sound associations. Marsh and Desberg (1978) examined two types of response-elaborated pictures: pictures whose names began with the correct sounds (e.g., pumpkin for /pə/), called a *first-sound mnemonic*, and pictures that depicted an action producing the correct sound (e.g., a boy blowing out a candle and saying /pə/), called an *action mnemonic*. Control groups were shown no pictures or irrelevant pictures. Results indicated that both kinds of picture mnemonics facilitated performance during training when the pictures were present. However, when the letters were shown without pictures on the transfer task, experimental subjects were no longer able to recall the sounds better than were control subjects. The same pattern of results was observed by Samuels (1967) in a word-learning study with pre-first graders. Marsh and Desberg relate their results to other studies (Hagen, Jongeward, & Kail, 1975) indicating that younger children are not cognitively mature enough to benefit from mnemonics. However, another interpretation is that the mnemonics used by these researchers were inadequate (Levin, 1983). For mnemonics to be effective, not only must the response term involve something concrete and meaningful, but the mnemonic must effectively *link* the visual stimulus to the response so that when learners see the letter shapes, they are reminded of the mnemonic pictures or actions.

Coleman and Morris (1978) examined letter–sound learning with picture mnemonics that more effectively integrated the graphemes and phonemes, for example, an owl drawn with two big eyes representing the digraph *OO* and saying /u/; a side view of a camel drawn with its two humps as the letter *M* and portrayed as eating from a dish of ice cream while saying /m/. In two experiments, performance with these mnemonics was superior to performance with stimulus-elaborated pictures (e.g., letter *h* drawn as a chair) and to performance with no pictures, but was no better than performance with response-elaborated pictures (e.g., phoneme /z/ depicted by a bee buzzing), although means were in the expected direction. One reason why the integrated mnemonics failed to facilitate learning may be that the links were complex and entailed too many components (e.g. an owl, its eyes, and the sound it makes). Coleman and Morton (1976) and Coleman (1981) described another study comparing the effects of single versus multiple integrated mnemonics. They reported that children who were exposed to several integrated pictures learned more letter–sound associations than did children exposed to only one mnemonic for each letter–sound association. However, they gave no details of the design and did not report any statistics.

The present study was conducted to examine whether a simpler type of integrated picture mnemonic might facilitate letter–sound learning, that is, one involving a first-sound mnemonic rather than an action mnemonic. Pictures were designed so that the shape of the relevant letter appeared as a salient visual feature in the drawing (e.g., the letter *w* forming part of the wings of an insect) and so that the name of the picture began with the target phoneme (e.g., the initial sound of *wing* is /w/). Various instructional programs use this type of mnemonic to teach letter–sound relations (Bloomberg, 1975; Durr & Hillerich, 1983; Laubach, Kirk, & Laubach, 1973; Wallach & Wallach, 1976). However, as far as we know, this mnemonic's effectiveness for letter–sound learning has not yet been tested experimentally.

In the present study, two experiments were conducted with prereaders. The purpose of the first experiment was to compare the effectiveness of integrated picture mnemonics with the effectiveness of a control condition in which letter–sound relations were taught with pictures having the same names as the integrated pictures, but drawn differently so that letter shapes did not form part of the drawings. The purpose of the second experiment was to replicate findings with a larger sample of letter–sound stimuli and to include a no-picture control condition.

Paired-associate learning involves three elements: learning stimuli, learning responses, and learning associations. To focus on associative learning and how it might be facilitated in the present study, we had to ensure that subjects were sufficiently familiar with the letter stimuli and the response sounds. Two procedures were used in this regard. First, subjects were given phonemic segmentation training prior to the experimental treatments to ensure that they could segment first sounds in picture names and therefore produce the response sounds during training. Second, to ensure that relevant visual features of the letter stimuli would be noticed, all subjects practiced drawing the shapes of letters. Drawing was considered preferable to simply exposing subjects to letter shapes because of the children's age: Young children are thought to engage in enactive rather than symbolic modes of representation (Bruner, 1964) and to be fairly passive and nonanalytic when simply looking at stimuli. For the same reasons, to ensure that subjects trained with integrated pictures would notice and process the connection between letter shapes and picture shapes, we had those subjects draw letters into simplified pictures of the objects rather than simply view the letter–picture combinations and listen to a verbal explanation. Because subjects practiced drawing letters, a posttest was included to determine whether this skill improved as a consequence of training.

Experiment 1

Method

Subjects. Twenty lower-middle-class first graders who did not pass the level-one mastery test of the Ginn (1976) basal reading program were used, 14 boys and 6 girls, with a mean age of 6 years, 9 months. The study was conducted in mid-October. Subjects were matched according to pretest scores, and members of pairs were randomly assigned to either the experimental group or the control group.

Materials and procedures. The study involved several phases: phoneme segmentation pretraining; pretesting to assess phonemic segmentation skill and letter–sound knowledge; letter–sound training; and posttesting. Pretesting and posttesting were conducted with individual subjects, whereas training was conducted with groups of subjects.

Segmentation pretraining. Training was patterned after Rosner (1974) and included several activities, such as clapping hands to syllables, identifying beginning consonant sounds, and manipulating counters to represent phonemes heard in words. Instruction was given to small groups of subjects for one month.

Pretests. Two pretests were given:

1. *Phoneme segmentation.* Children pronounced the initial consonant sounds in the names of 17 pictures of familiar objects (not those used in training).

2. *Letter–sound knowledge.* Children were shown 17 lowercase consonant letters and were asked to name each and to produce its typical sound in words.

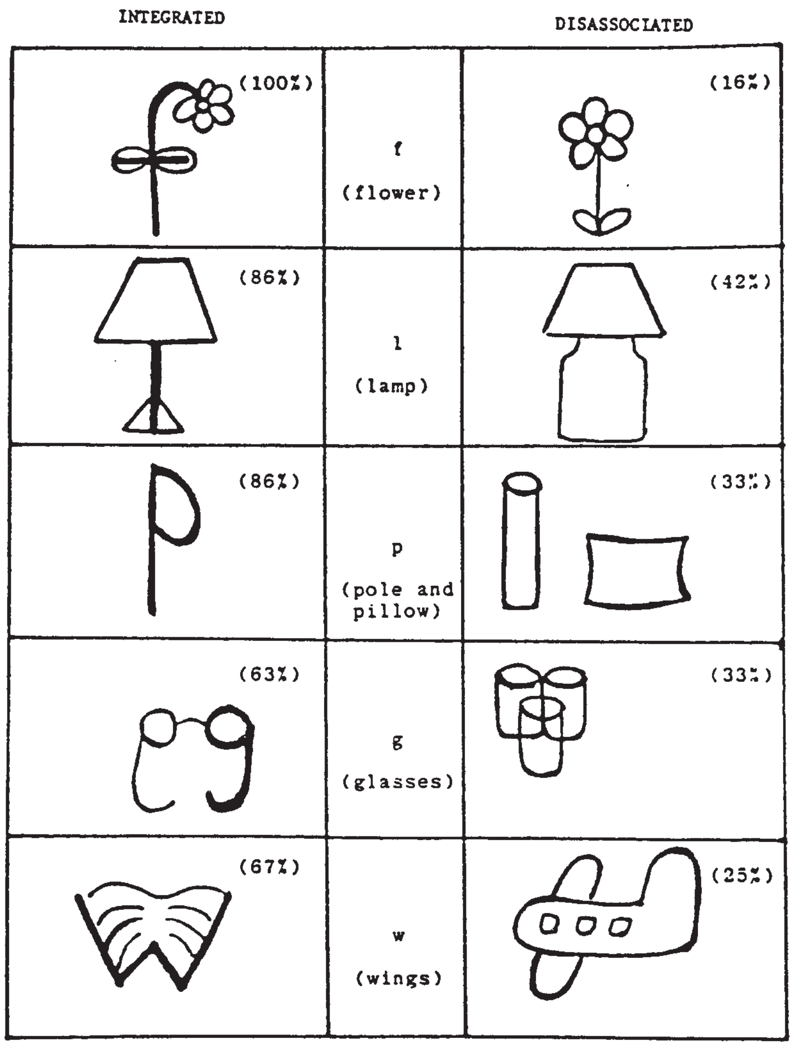

Figure 1. Integrated and disassociated mnemonic pictures used in Experiment 1. Percentages in parentheses indicate the proportions of subjects who learned the letter–sound associations during training in each condition.

Letter–sound training. Five lowercase letters whose names or sounds were known by the fewest subjects on the pretest were selected for training: *f*, *l*, *p*, *g*, *w*. Pictures to be associated with each letter were created: flower, lamp, pole and pillow (to be used by a giraffe), glasses, and wings. In each case, the first consonant sound in the name was the sound to be associated with the letter. Two drawings of each picture were created, one in which the shape of the lowercase letter was integrated into the picture and another in which the letter shape was not present. These pictures are displayed in Figure 1.

Training in letter–sound associations was conducted with groups of subjects in 20-min sessions over a period of 6 days by the classroom teacher (the second author).[1] Each training session included a review of the letter learned the previous day plus an introduction to a new letter. On the sixth day, all five letter–sound associations were reviewed. On each day, the experimenter worked first with the control group, then with the experimental group. Except as noted, training and testing procedures were identical for both groups.

A typical session can be illustrated by describing the training with the letter *f*. Subjects were given preprinted worksheets. The experimenter displayed and named a picture of a flower. Subjects repeated the

[1] One possible weakness of this design arises from the fact that there was a lack of independence in the treatment each subject received because training was administered to a group of subjects. From a formal point of view, this design involves a single experiment on a group and hence a single unit of analysis, yet students were considered as several independent units in the analysis of results. This weakness was corrected in the second experiment by administering treatments to individual subjects.

name, segmented and pronounced the initial sound, /f/, and traced the picture of the flower on their worksheets. (See drawings in Figure 1.) Then they drew the same flower freehand, first with the model present, then from memory. During this activity, children pronounced the name of the picture and segmented its initial sound once more.

Next subjects were introduced to the shape of the letter and its relationship to the picture by tracing the letter, drawing the picture on top of or beside the letter, producing the beginning consonant sound of the picture name, and then writing the letter symbolizing this sound. They drew the picture from memory again and then traced the target letter either on the picture or next to the picture. They were told that thinking of the flower and saying its beginning sound would help them remember what sound the letter *f* makes.

On the following day, before the next letter was introduced, the letter *f* was reviewed. Subjects drew the picture of the flower twice from memory, segmented the first sound of *flower*, traced the letter *f* twice either on top of or beneath their drawings, and finally wrote the letter two more times. These same procedures were used to introduce and review subsequent letters, *l*, *p*, *g*, and *w*, respectively. On the sixth day all the letters were reviewed.

Posttests. The five posttests described as follows were administered to individual subjects by a "blind" experimenter who was not aware of the subjects' group assignments. Posttests were given on the day following the final review session.

1. *Memory for letter sounds and pictures.* In these two tests, the five lowercase letters taught during training were shown, and children produced the sound associated with each and then recalled its picture.
2. *Phonemic segmentation and letter writing.* In these two tests, children were shown five pictures of objects different from those used during training but having the same initial consonant sounds (i.e., fish, leaf, pig, goat, witch). Subjects named each picture and then pronounced its initial sound. They then wrote the letter that stood for each sound.
3. *Picture drawing.* Children drew from memory the target pictures used in training. This test was used to verify that the pictures were equally memorable.

Results

To verify that experimental and control groups did not differ in any substantial way, matched-pair *t* tests were performed on pretest scores. Mean values are reported in Table 1. No differences were detected (all $ps > .05$).

To evaluate effects of letter–sound training, we conducted an analysis of variance (ANOVA). The independent variables were subject blocks (10 pairs), training condition (integrated vs. disassociated pictures), and time of test (pre vs. post). The dependent measure was the number of correct letter–sound associations produced. Table 1 presents the mean values for the letter–sound pretest (see "Target words") and posttest. Both main effects as well as the interaction were significant. Children who were taught with integrated pictures recalled more letter–sound associations than did subjects taught with disassociated pictures, $F(1, 9) = 13.05$, $p < .01$. Scores improved following training, $F(1, 9) = 24.44$, $p < .01$. Much greater gains were produced by integrated training than by disassociated training, $F(1, 9) = 13.05$, $p < .01$. To determine whether disassociated training improved performance at all, we conducted a matched-pair *t* test comparing pre- and posttest scores of the control group. The gain failed to reach significance, $t(9) = 2.09$, $.05 < p < .10$ (two-tailed). The same test applied to experimental subjects' scores revealed significant improvement ($M = 1.1$ for pre vs. 3.7 for post), $t(9) = 5.21$, $p < .001$ (two-tailed). These results indicate that integrated pictures are powerful mnemonics, whereas disassociated pictures are of doubtful value in teaching letter–sound relations to prereaders.

To evaluate effects of letter–sound

Table 1
Mean Performance Scores of Integrated-Picture (IP) and Disassociated-Picture (DP) Groups on the Pretests and Posttests in Experiment 1

Test	IP ($n = 10$)	DP ($n = 10$)	t
	Pretest		
Phonemic segmentation			
Target words	3.7	3.3	0.81
Other words	8.1	8.2	0.06
Letter–sound			
Target words	1.1	1.1	0.00
Other words	6.0	5.9	0.29
	Posttest		
Letter–sound	3.7	1.8	3.77**
Picture recall	4.2	1.5	4.39**
Phonemic segmentation	4.4	4.3	0.23
Letter writing	3.4	2.2	2.88*
Picture drawing	4.9	4.9	0.00

Note. Five was the maximum score for all tests except the two "other words" tests, for which the maximum was 12.
* $p < .05$, two-tailed ($df = 9$). ** $p < .01$, two-tailed ($df = 9$).

training on the other posttest measures, we employed matched-pair t tests. Mean values and test statistics are given in Table 1. Subjects in the integrated-picture group were superior in being able to write letters for initial sounds of transfer words, indicating that letter–sound associations were better learned in both directions as a result of integrated-picture training. Not surprisingly, experimental subjects outperformed control subjects in being able to recall the pictures associated with each letter. To verify the function of pictures as mnemonics, we examined correct and incorrect responses. Results revealed that correct recall of sounds was accompanied by correct recall of pictures in the majority of cases in both groups (98% among experimental subjects, 74% among control subjects). Incorrect responses were characterized by a failure to respond with any sound or picture name (88% among experimental subjects, 90% among control subjects), rather than by incorrect associations. It was not the case that control subjects could not produce the target sounds or were unfamiliar with the pictures. As evident from scores on the phonemic segmentation and picture-drawing posttests given in Table 1, control subjects were able to segment sounds, even in words they had not practiced, and were able to draw most of the pictures. These findings reveal that the key to the integrated subjects' success in being able to produce correct letter–sound associations was their ability to recall and name the pictures associated with the letters.

To evaluate the adequacy of the particular mnemonics used in the experimental and control conditions, the proportion of subjects who acquired associations during training was calculated for each letter–picture pair. From the percentages reported in parentheses to the right of the drawings in Figure 1, it is apparent that all experimental pictures served as effective mnemonics for the majority of subjects not knowing the associations at the outset of training. In contrast, letter–picture pairs used with control subjects were uniformly ineffective.

Experiment 2

A second experiment was conducted in the laboratory rather than in the classroom to correct some inadequacies of the first experiment. A larger number of picture mnemonics were evaluated, and mnemonics were taught to individual subjects rather than to groups of subjects. Each subject was taught five letter–sound associations that he or she did not know on the pretest rather than a standard set. One weakness of Experiment 1 was that the referents in pictures were not always the same across experimental and control conditions. For example, eyeglasses were shown to experimental subjects, whereas water glasses were shown to control subjects. In Experiment 2, referent objects were the same, but were drawn so that the shape of the letter was a prominent feature in one but not in the other picture. Whereas only one control condition was included in Experiment 1, two control groups were used in Experiment 2, namely, a disassociated-picture group and a no-picture group. We thought it important to assess the contribution by using a no-picture group of pictures because there is evidence that pictures may interfere with learning under some circumstances (Samuels, 1967, 1970; Willows, Borwick, & Hayvren, 1981). Another problem in Experiment 1 was that subjects practiced drawing pictures of objects several times. Because the pictures drawn by experimental subjects contained the shapes of the letters, whereas those drawn by control subjects did not, experimental subjects were essentially getting extra practice drawing letters. The second experiment eliminated this difference.

Some other changes were introduced in Experiment 2. An experienced researcher (the third author), rather than the classroom teacher and her aide, trained and tested subjects, so a "blind" experimenter was not utilized in Experiment 2 to administer the posttests. The subjects in Experiment 1 were first graders, whereas the subjects in Experiment 2 were kindergartners. This was because it was easier to find subjects not knowing letter names or sounds among younger children. Two pretests were added to Experiment 2: a word-reading test to eliminate readers from the sample and the Peabody Picture Vocabulary Test (1959) to ensure ability equivalence across groups. Phonemic segmentation pretraining was limited to the five target sounds and was conducted not in groups, but with individuals who were taken to a criterion of two perfect trials in segmenting initial sounds in words. Letter–sound training was also conducted differently. All five letters were taught together rather than one letter per day. A paired-associate task was used in which teaching and testing trials were alternated to monitor subjects' progress during learning. During study trials, subjects drew letters, but did not try to reproduce letters from memory as they did in Experiment 1. Also, subjects in the two picture conditions were shown more elaborate, detailed pictures in addition to the simplified drawings they reproduced. This was done to clarify the meanings and typical functions or contexts of any objects that proved unfamiliar and to help subjects understand what the simplified drawings represented in case there was any doubt. Training lasted 6 days in Experiment 1 and 5 days in Experiment 2. Two posttests that did not prove essential in Experiment 1 were omitted from Experiment 2 (the phonemic segmentation test and the picture-drawing memory test). Memory for the names of objects associated with the letters was measured on test trials during training rather than on the posttest.

The purpose of the no-picture control condition was to assess the effect of pictures on learning. For this reason, subjects in this group did everything but view and draw pictures of the objects. They were taught names of the objects so that the response sounds would be linked to samples of real speech, just as they were for subjects in the other conditions. Clarifying the phonemic identity of the response sound with a familiar word was considered necessary to reduce the disparity between phonemes such as /b/ and their pronunciations ("buh").

Method

Subjects. From a pool of 53 subjects, 30 were selected. The subjects selected included 17 males and 13 females, with a mean age of 5 years, 9 months (range = 4 years, 9 months, to 7 years, 5 months). Five were preschoolers, 25 were kindergartners. Subjects whose Peabody Picture Vocabulary Test scores were most similar were grouped into threes, with each member of the triplet then assigned randomly to one of the three training groups. Subjects pretested in the pool of 53 were not included in the final sample for one of several reasons: they recognized too many letters (n = 7), they were unable to reach criterion in learning to segment (n = 7), they were uncooperative or unwilling to continue (n = 4), they moved before completing the experiment (n = 3), or mates could not be found to form a triplet (n = 2). Children lacking proficiency in English were not included in the original pool of 53.

Materials and procedures. There were four phases: pretesting, phonemic segmentation pretraining, letter–sound training, and posttesting, each conducted on a different day. Subjects were tested and trained individually.

Pretests. Three pretests were given:

1. *Letter name and sound knowledge.* Subjects were shown 27 handprinted consonant letters. They named each and indicated what sound the letter makes in words. Uppercase and lowercase letters were mixed. The set included 16 target letter candidates plus their capital or lowercase mates if these mates differed in shape. All the letters and sounds (except one that was never taught [*s*, snake]) are given in Table 2. Subjects used in the experiment were those who did not know at least five letter–sound relations.

2. *Word reading.* This test was used to exclude readers from the sample. Subjects were asked to read 16 regularly spelled preprimer words, each printed in both uppercase and lowercase, and to identify five pictures mixed in with the words. Pictures were included to prevent total failure on the task. All but 4 subjects read 1 or 0 words. The 4 subjects reading 2, 2, 3, and 5 words, respectively, were unable to read any primer words on the Slosson Oral Reading Test (1963).

3. *Peabody Picture Vocabulary Test.* Standard procedures were used with this test.

Phonemic segmentation pretraining. Subjects were taught to segment and pronounce the five target sounds they would be taught. Five common names of people were pronounced (e.g., Florence), and subjects repeated each name and then pronounced the initial sound alone (e.g., /f/). If subjects were unsuccessful, the experimenter modeled the desired response and directed subjects' attention to her mouth and the articulatory gesture involved in producing that sound. Subjects were taken to a criterion of two flawless trials in a row on two sets of names. Then they were given the five object names that would serve as mnemonics during letter–sound training (see list in Table 2), and they were taught to segment their initial sounds to a criterion of one perfect trial. They were also asked what each word meant, and unfamiliar words were explained.

Letter–sound training. Sixteen consonant letters were selected for training. Objects having names beginning with the response sounds to be associated with letters were identified. Two simplified drawings of each picture were created. Examples are displayed in Figure 2. Because the capital form of the letter *t* resembled its object (table) more than did the lowercase form, the capital form was taught. All the other letters were lowercase. Integrated pictures contained the shapes of letters as prominent features in the drawings. Dissociated pictures were drawn so that the referent objects were the same as those in the experimental set, but were in a different position so that letter features were not evident. To make sure that subjects understood what these drawings portrayed, more detailed pictures or drawings of the same objects in color or

Table 2
Target Letters and Sounds: Frequency Taught and Percentage Correct in Each Training Condition in Experiment 2

Letter and sound	Object name	Frequency taught			% correct on posttest			Pattern	
		IP	DP	NP	IP	DP	NP	IP > DP	IP > NP
b, /b/	Baby buggy	0	0	1	—	—	0	—	—
v, /v/	Vase	3	8	3	100	50	67	Yes	Yes
T, /t/	Table	2	5	0	100	20	—	Yes	—
p, /p/	Pole and pillow	3	3	3	100	33	67	Yes	Yes
h[a], /h/	House	8	9	5	100	44	60	Yes	Yes
f, /f/	Flower	1	4	3	100	25	67	Yes	Yes
w[a], /w/	Wing	10	5	5	90	20	20	Yes	Yes
r, /r/	Roof	1	2	2	0	0	0	No	No
n, /n/	Nose	1	1	3	100	0	33	Yes	Yes
m, /m/	Mountain	2	1	3	100	0	33	Yes	Yes
l, /l/	Lamp	2	2	4	50	0	50	Yes	No
g[a], /g/	Glasses (eye)	3	2	8	100	0	50	Yes	Yes
c[a], /k/	Cave	5	2	5	100	0	60	Yes	Yes
d, /d/	Duck	1	0	1	100	—	0	—	Yes
y[a], /y/	Yak	8	6	4	88	17	75	Yes	Yes
Total		50	50	50					

Note. IP = integrated picture; DP = disassociated picture; NP = no picture.
[a] These letters do not contain the target sounds in their names.

embedded in contexts were created (e.g., two dogs and two people were shown, each wearing glasses, adjacent to an enlarged drawing of a pair of glasses). Most pictures were copied from children's books. Thus, integrated and disassociated pictures portrayed the same objects, but in different positions to reveal or conceal letter shapes. To create a comparable experience for no-picture subjects, verbal explanations of the meanings of object names were written (e.g., "Glasses are round pieces of glass set in frames worn on the nose to correct poor eyesight. People wear glasses so they can see better.").

Subjects were taught five letter–sound associations that they could not identify on the letter pretest. If subjects knew the name of a letter having the relevant sound in its name, it was not taught. If subjects were unfamiliar with more than five letters, they were taught the first five unknown letters from the list of letters in Table 2. The number of times each letter was taught is shown in Table 2.

Letter–sound training was conducted by using a study–test procedure. Training and testing activities were identical for all three groups except as noted below. Item order differed across all study and test trials. Five trials were administered, one per day for most subjects. Members of triplets completed training and testing in the same number of days.

The first study trial was introduced by telling subjects that they would be learning some letters and the sounds they make. They would see pictures or hear object names that would give them clues about the sounds of the letters. Integrated-picture subjects were also told that the shapes of the pictures would tell them what the letters looked like. Each letter was then studied in the following way. Integrated-picture and disassociated-picture subjects were shown the detailed picture of the object. No-picture subjects heard the name of the object and were asked whether they knew what it was. Subjects heard and repeated the object name plus its initial sound. In the two picture conditions, the experimenter directed subjects' attention to the important part of the picture by explaining what was going on (e.g., "The glasses look like this when they are on the heads of people and dogs. They look like this when they are not on their heads."). No-picture subjects listened to the verbal explanation of the object's meaning. Next, picture subjects were given a sheet with the letter printed next to a simplified drawing of the object (see Figure 2). No-picture subjects were shown a drawing of the letter. Integrated-picture subjects were told to notice how the picture was drawn to have the shape of the letter. Disassociated-picture and no-picture subjects were told to notice the shape of the letter. Subjects then named the object, pointed to the letter, and pronounced its sound. Subjects then practiced writing the letter, first by following preprinted broken lines, then by drawing it freehand. Next, integrated-picture subjects converted their freehand letter into the simplified drawing of the picture by adding the details. Disassociated-picture subjects were provided with a partly drawn object (a form equivalent to that part of the picture taken up by the letter in the integrated condition), and they added details to complete this picture. These drawing activities were explained and modeled by the experimenter during the first two study trials. Nothing comparable to the object-drawing experience occurred in the no-picture condition. During this step, initial sounds of picture names were not practiced as they were in Experiment 1. The final step involved having subjects look again at the letter and say the sound it makes. If unsuccessful, they were prompted to think of the object name. They were also told to remember the sound so they could say it when they saw the letter again. Any incorrect responses produced during the five study trials were corrected.

A test trial followed each study trial. It was conducted identically across conditions. To separate study from test trials, the child practiced counting for 1 min. Then subjects were told, "Now I want to see whether you have learned what each letter says. When I show you the letter, you tell me what sound it makes. Try to think of the picture (word) I told you that goes with the letter. This should help you remember the sound. But don't say the word out loud. Just tell me the first sound." Each letter was presented and subjects were asked what sound the letter makes. Then they were asked to name the picture or word associated with the letter. If unsuccessful, they were told the name and asked to give the first sound in the name that went with the letter.

Posttests. The posttests were administered the day after the final day of training for all subjects except three (one per condition) who completed the posttests two days after training.

1. *Recall of letter–sound associations.* Subjects were shown the five target letters, one at a time, and they pronounced the sound associated with each.

2. *Recall of letter shapes.* The experimenter pronounced each target sound and asked subjects to write the letter making the sound, the one they had practiced the day before. To clarify target sounds, children pronounced familiar nouns beginning with those sounds (not the training words).

Results

To verify that the three training groups

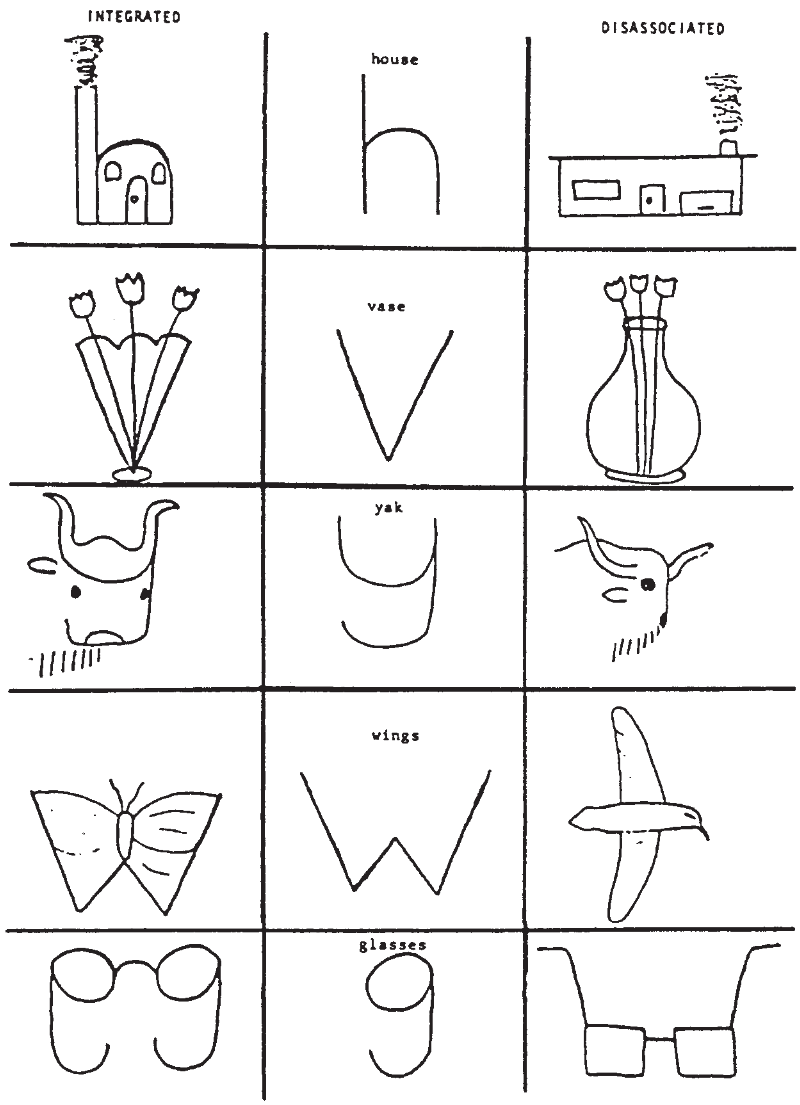

Figure 2. Examples of integrated and disassociated mnemonic pictures used in Experiment 2.

Table 3
Mean Performance Scores as a Function of Training Condition in Experiment 2

Phase	IP	DP	NP	*SD*	*F*
Pretest					
Age in months	73.8	69.6	69.5	6.62	1.37
Peabody IQ	101.9	101.2	100.9	3.49	<1
Letters named					
Uppercase (16 max.)	11.5	10.1	12.2	2.94	1.32
Lowercase (11 max.)	5.6	5.0	5.2	2.75	<1
Sounds known	1.9	2.1	2.8	2.86	<1
Words read (16 max.)	0.6	1.0	0.7	1.24	<1
Range	0–1	0–5	0–3		
Segmentation Pretraining					
Trials to criterion	5.1	4.4	4.4	3.81	<1
Words defined (5 max.)	3.7	3.8	4.1	0.41	2.49
Letter–Sound Training[a]					
Sounds recalled (5 max.)	4.4	1.4	2.1	1.55	40.56*
Pictures recalled (5 max.)	4.5	1.7	2.2	1.28	55.13*
Time per trial in min	11.3	10.7	8.8	3.33	6.27*
Posttest					
Sounds recalled (5 max.)	4.6	1.3	2.4	1.01	27.92*
Range	3–5	0–2	1–5		
Letters written (5 max.)	1.7	1.3	0.7	1.09	2.11

Note. There were 10 subjects in each training condition. IP = integrated picture; DP = disassociated picture; NP = no picture.
[a] Mean values per trial averaged over Trials 2 through 5.
* $p < .01$ ($df = 2, 18$).

did not differ in any important respect, their scores on several pretests were subjected to two-way ANOVAs. The independent variables were training group and subject blocks (10 triplets). As evident from the mean scores and test statistics reported in Table 3, there were no significant differences.

To examine whether integrated pictures enabled subjects to learn letter–sound relations more effectively than disassociated pictures and no pictures did, performances on several training and posttest measures were subjected to ANOVAs. The independent variables were training group, subject blocks, and where relevant, trials (second through fifth trials). (Interactions involving the blocking factor were included in the error terms in these analyses.) Mean values and test statistics are reported in Table 3. The treatment groups differed significantly in their recall of letter–sound relations during training and also on the posttest. Post hoc procedures using Tukey's pairwise comparison method revealed that the integrated-picture group outperformed each of the other two groups ($p < .05$), which did not differ significantly ($p > .05$). From the ranges of scores given in Table 3 for the posttest measure, it is apparent that there was no overlap between scores of the integrated- and disassociated-picture groups. Only 30% of the scores were found to overlap between the integrated- and no-picture groups. These results verify the superior effectiveness of integrated mnemonics for learning letter–sound relations.

In the ANOVA of letter–sound recall during training, a significant effect of trials was detected, $F(3, 81) = 8.09$, $p < .01$, but no interaction ($p > .05$). All groups improved as learning proceeded.

Subjects' ability to recall the names of pictures associated with letters was recorded during the training trials. Analysis of picture-recall scores revealed the reason for the integrated-picture group's superior ability to learn letter–sound relations. During training these subjects were better able to retrieve picture names whose initial sound was the correct response. In the ANOVA, a main effect of treatment group was detected. Post hoc comparisons using Tukey's method revealed that the integrated-picture group recalled significantly more names than did the other two groups ($p < .05$), which did not differ significantly ($p > .05$). Mean values are given in Table 3. The Trials factor exerted a significant main effect, $F(3, 81) = 15.30$, $p < .01$, but no interaction ($p > .05$).

In Experiment 1, training with integrated mnemonics helped subjects learn to write the letters. However, this did not happen in Experiment 2. From Table 3, it is evident that memory for the letter shapes, as measured by the ability to write them, was very limited and not much different across the groups (overall mean was 1.2 letters correct out of 5 maximum). It may be that subjects did not get enough practice of the sort that puts letters into memory. In Experiment 2, each letter was traced and copied from a visible model. In contrast, subjects in Experiment 1 practiced drawing the pictures containing the letters from memory.

We expected that training with pictures would require more time than training without pictures because the former procedure included having subjects partially draw pictures. An ANOVA of the time per trial confirmed this hypothesis. Means and test statistics are reported in Table 3. Post hoc procedures using Tukey's method indicated that subjects in the integrated- and disassociated-picture groups did not differ in the amount of time taken ($p > .05$), and each group took significantly longer than the no-picture group ($p < .05$). The main effect of trials was significant in this analysis, $F(3, 81) = 27.39$, $p < .01$, as was the interaction between trials and treatment, $F(6, 81) = 3.03$, $p < .05$. Inspection of means revealed that time differences among the conditions were greatest on Trial 2 and diminished during subsequent trials.

Because the particular letters taught differed across groups, it is important to rule out the possibility that the integrated-picture group's superior performance resulted from this difference. Table 2 reveals how often each letter was taught in each group and the proportion of times its sound was given correctly on the posttest. From the final two columns, it is evident that the pattern of superior recall by the integrated-picture group held for 23 out of 26 comparisons. In no instance was recall in a control group superior to recall in the integrated-picture group. From these results, it is clear that the integrated-picture group did not outperform the other groups because its subjects were taught a few particularly effective mnemonics especially often. Most of the integrated mnemonics used in the present study were effective at facilitating recall.

During pretraining, it was evident that some of the words we had chosen as mnemonics were unfamiliar to some subjects. The words they were least able to define were yak, vase, cave, and baby buggy. However, differences in familiarity with words did not account for differences in letter–sound recall. The ANOVA comparing the three groups' ability to define words during pretraining revealed no significant differences (see Table 3). Furthermore, lack of familiarity with word meanings did not impair integrated-picture subjects' ability to make use of the words as mnemonics. As evident in Table 2, performance was no worse with the unfamiliar words than with the other words.

Analysis of the types of errors that occurred during letter–sound training revealed various sources of confusion, particularly at the outset. When asked for the sound made by a letter, subjects would sometimes give its name. Sometimes they would then pull the first sound out of the letter's name, saying for example, /d/ for "double-yu" (*w*), /w/ for "wie" (*y*), /s/ for "cee" (*c*), or /a/ for "aich" (*h*). Another type of error involved remembering a different label for the picture. For example, the letter *w* sometimes prompted the name of the object, butterfly or bird, rather than wings. A few times, the letter *p* elicited the name of the animal in the picture, that is, giraffe, rather than pole and pillow. Subjects who were taught voicing mates (i.e., /k/ and /g/ or /f/ and /v/) sometimes mixed up these associations. Also, similarly shaped letters were sometimes mistaken for each other (e.g., *h* and *n*, *y* and *g*). Some subjects may not have known the difference between terms used in the instructions (e.g., word vs. sound or name vs. sound). When asked for a sound, sometimes children gave the word. However, the experimenter always repeated the request, indicating that she wanted the other term of the association. This source of confusion was cleared up by the end of training, as almost no errors of this sort (1%) occurred on the posttest. If subjects gave a word or letter name, they almost always preceded or followed it with a sound.

General Discussion

Results of both experiments confirm the effectiveness of integrated picture mnemonics for teaching letter–sound relations to prereaders. The superiority of the integrated-picture group over the no-picture group in Experiment 2 indicates that pictures are the source of the advantage. The superiority of the integrated-picture group over the disassociated-picture group indicates that only one type of picture works, namely, one that links the shape of the letter to its sound. Results of Experiment 2 serve to replicate and extend the findings of Experiment 1, confirming effects for a larger number of integrated mnemonics.

Analysis of the course of learning revealed an advantage for integrated mnemonics from the outset. The most plausible explanation for the effectiveness of integrated pictures is that because the pictures incorporate the form of the letter and reveal the sound of the letter in their names, they enable subjects to connect letter shapes with their sounds in memory. Experimental subjects remembered the letter–picture associations much better than did control subjects, indicating that the pictures were available to prompt recall of sounds. Analysis of posttest scores in Experiment 1 revealed that in practically every case, whenever subjects were able to recall letter–sound relations, they were also able to recall the picture name, whereas failure to recall a sound was rarely accompanied by correct recall of the picture. Inspection of the effectiveness of the individual pictures (see Figure 1 and Table 2) revealed that almost all of the integrated pictures enabled a majority of the subjects to learn the associations during training. In contrast, none of the disassociated pictures achieved this level of success.

The two experiments yielded similar results except on one measure. In Experiment 1, integrated-picture subjects learned to write letters for sounds better than did control subjects. This did not happen in Experiment 2, where recall of letter shapes was poor across all groups. Effects in Experiment 1 may have been due to the fact that subjects practiced drawing the pictures containing letter shapes several times from memory. In Experiment 2, subjects only copied letters, and they wrote them fewer times. The extra amount of motor practice or the superior quality of practice involving memory retrieval may have made the difference. Another important factor may have been the subjects' ages. Experiment 1 learners were first graders, whereas Experiment 2 learners were preschoolers and kindergartners.

To assess the contribution made by pictures and to test the possibility that they might interfere with letter–sound learning, two control conditions were included in Experiment 2. Results of the ANOVA of children's scores during training and on the posttest failed to support the interference hypothesis. The slight differences in means favoring the no-picture group were not significant (see Table 3). However, comparison of the proportions of correct recall for each mnemonic in Table 2 revealed that for 10 out of 11 mnemonics, the no-picture proportions exceeded the disassociated-picture proportions. One reason for this may be that the shapes of the pictures competed with the shapes of the letters in memory and confused learners. Another reason may be that the pictures captured learners' attention at the expense of the letters. The procedure of having subjects draw the visually dissimilar pictures may also have been responsible. These possibilities await study.

The no-picture control condition was included to assess the effect of pictures on letter–sound learning. Because no-picture subjects did not draw pictures, their study trials were about 2.5 min shorter than those of integrated-picture subjects. In future studies, other kinds of no-picture control conditions might be compared with the integrated-picture condition. One possibility to be ruled out is that spending an equivalent amount of time in rote rehearsal of letter–sound relations is as beneficial as learning with integrated pictures.

Results of these experiments contrast with those reported by Marsh and Desberg (1978), who found that the improvement in letter-sound learning resulting from picture "mnemonics" disappeared when the mnemonics were taken away. Very likely the main reason why their mnemonics failed and why those used in the present study were successful is that here the visual forms of the letters were built into the pictures and thus provided a clear connection between the visual stimulus and the verbal picture name that cued the response sound. In Marsh and Desberg's study, the picture bore no relationship to the shape of the letter, only to the sound symbolized (i.e., like the disassociated pictures used in the present study). Thus, to be effective, the mnemonic must be evoked readily by visual features of the letter.

Present findings also contrast with those of Coleman and Morris (1978), who failed to observe facilitation from integrated mnemonics. Their approach to constructing mnemonics was to select a visual stimulus that included the shape of the letter as a salient feature and that could be said to produce the sound, for example, the camel's hump forming the letter *m* and the camel eating ice cream and saying "mmm." To link the letter shape to its sound, the learner had to recall the camel plus two of its properties that were not directly related to each other (i.e., the hump and the mouth saying "mmm"). In contrast, in our mnemonics the shape of the letter was an integral part of the object, and the critical sound always came from the first sound in the object's name. The greater simplicity of our integrative mnemonics may have been the source of their effectiveness.

Further investigation is needed to explore what properties of picture mnemonics make them most effective. In our attempts to create memorable mnemonics, we rejected those in which the letter shape was a less central or less dominant feature of the object pictured. For example, the letter *l* depicted by the base of a lamp was considered superior to the letter *l* depicted by the leg of a bear. As mentioned earlier, subjects sometimes committed errors in training by remembering the names of objects rather than their parts (e.g., bird or butterfly rather than wings). Whether such a factor limits the effectiveness of integrated mnemonics needs to be determined.

Another direction for future studies is to determine whether activities such as drawing letters and objects might be eliminated without reducing the effectiveness of integrated pictures in learning. Certainly it would be easier just to expose subjects to the integrated pictures and verbally direct their attention to the critical features of those pictures. Workbooks rely heavily on passive exposure rather than on active construction, so the development of materials would be easier if that approach proved equally effective. However, there are reasons for believing that simple exposure is not sufficient, particularly with younger children who may not pay attention to relevant features and connections. Furthermore, the task of learning letter-sound associations requires learning the stimulus and response terms as well as the associations, so activities such as writing letters and learning to segment initial sounds may be essential for stimulus and response learning. The reason for selecting these training procedures in the present study was to make sure that the integrated pictures were given a strong chance of revealing their effectiveness. Clearly an important next step in this research is to determine which components of the integrated training method are essential, since in the absence of evidence, curriculum developers may assume that one or another component is not.

The present study was aimed at examining how letter-sound learning might be facilitated in prereaders. It was not intended to assess the value of this learning for the acquisition of reading skill. There is already substantial evidence pointing to the importance of letter-sound knowledge as a prerequisite for moving into reading (Chall, 1967; Mason, 1980). Recently we have found that use of letter-sound knowledge to remember associations between word spellings and pronunciations in a word-learning task is a key factor distinguishing beginning readers from prereaders (Ehri & Wilce, in press). A next step in this line of research may be to verify that prereaders taught letter-sound relations with integrated picture mnemonics can then use this knowledge effectively to begin reading words.

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