Movement into reading: Is the first stage of printed word learning visual or phonetic?

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KINDERGARTENERS WERE GROUPED according to their ability to read words: prereaders (no words read), novices (a few words read), and veterans (several words read). They were taught to read two kinds of word spellings: simplified phonetic spellings whose letters corresponded to sounds (e.g., JRF for *giraffe*), and visual spellings whose letters bore no sound correspondence but were more distinctive visually. Prereaders learned to read the visual spellings more easily than the phonetic spellings, while novices and veterans learned to read the phonetic spellings more easily. These results suggest that when children move into reading, they shift from visual cue processing of words to phonetic cue processing. Phonetic processing entails recognizing and remembering associations between letters in spellings and sounds in pronunciations. This learning mechanism, rather than visually based sight-word learning or sounding out and blending, is claimed to explain how children first become able to read single words reliably.

Le passage à la lecture: La première étape d'acquisition des mots imprimés est-elle visuelle ou phonétique?

LES ENFANTS de cours préparatoire étaient groupés selon leur compétence de lecture de mots: les pré-lecteurs (aucun mot lu), les novices (quelques mots lus) et les vétérans (plusieurs mots lus). On leur a appris à lire deux sortes d'épellations de mots: les épellations phonétiques simplifiées dont les lettres correspondaient aux sons (ex: JRF pour *girafe*), et les épellations visuelles dont les lettres ne correspondaient pas aux sons mais étaient plus distinctives visuellement. Les pré-lecteurs ont appris à lire les épellations visuelles plus facilement que les épellations phonétiques, tandis que les novices et les vétérans ont appris à lire les épellations phonétiques plus facilement. Ces résultats suggèrent que lorsque les enfants passent à la lecture, ils changent du procédé d'indication visuelle de mots au procédé d'indication phonétique. Le procédé phonétique entraîne des associations de reconnaissance et de souvenir entre les lettres en épellations et entre les sons en prononciations. Ce mécanisme d'acquisition, plutôt que d'être acquisition visuellement basée sur la vue des mots ou la distinction de sons ensuite unis, expliquerait comment les enfants sont d'abord capables de lire de manière sûre des mots usuels.

Progreso hacia la lectura: ¿Es la primera fase de aprendizaje de palabras impresas visual o fonética?

SE AGRUPARON NIÑOS de kindergarten según la destreza de leer palabras: prelectores (sin lecturabilidad), principiantes (leyendo algunas palabras), y experimentados (leyendo varias palabras). Se les enseñó dos tipos de deletreo de palabras: deletreo fonético simplificado, cuyas palabras correspondían a los sonidos (v.gr.: JRF por *jirafa*) y deletreo visual, cuyas letras no correspondían fonéticamente pero que se distinguían mejor visualmente. Prelectores aprendieron a leer el deletreo visual más fácilmente que el deletreo fonético, mientras que los principiantes y los experimentados aprendieron a leer el deletreo fonético más fácilmente. Estos resultados sugieren que cuando los niños progresan hacia la lectura, cambian del pro-

ceso de estímulo visual de palabras al proceso de estímulo fonético. El proceso fonético consiste en reconocer y recordar asociaciones entre las letras en deletreo y sonido de pronunciaciones. Este mecanismo de aprendizaje—en vez del de orientación visual, identificación y análisis de palabras o pronunciación pausada y combinación de sonidos—trata de explicar cómo los niños progresan a leer palabras individuales definitivamente.

Theories of reading acquisition differ about the involvement of letter-sound correspondences when children begin reading words. Gough (1982) and Gough and Hillinger (1980) have proposed that the first stage consists of paired-associate learning (called code learning) in which a distinctive *visual* feature of the stimulus (e.g., a zigzag line in one of the letters or the contour of the spelling) is selected and associated arbitrarily with the word response. This has been called sight-word learning by others. According to Gough, code learning may be used by beginners to read up to 40 or so words. However, the system begins to break down as the pool of visual features available for distinguishing among words is exhausted. At this point, learners shift into the second stage, called cipher learning, and they begin using letter-sound relations to read words.

An alternative view, one arising from our theory of printed word learning (Ehri, 1978, 1980, 1983, 1984), is that letter-sound processing characterizes what beginners do at the outset of learning. When children become able to identify consistently even a small number of words, they do this by accessing phonetic associations that have already been stored in memory. Phonetic associations between word spellings and pronunciations are stored using a *letter-sound recognition memory mechanism.* For this mechanism to operate, children must be familiar with letters and their names or sounds. In addition, when they see and hear spellings paired with pronunciations of specific words, they must pay attention to how at least some of the letters symbolize phonetic units detected in the pronunciation. For example, upon seeing *jail* and hearing "jail," they might associate the boundary letters *j* and *l* with the word's pronunciation by noticing that the names of the letters resemble the boundary sounds in the word. This form of phonetic processing differs from a more advanced stage of recoding in which spellings are sounded out and blended. According to our view, print-sound associations simply need to be *recognized,* not generated by learners, in order for the associations to be processed and retained in memory. At the outset of word reading, children's phonetic analyses of spellings are partial and incomplete because they know only some letter-sound correspondences, mostly those captured in the names of letters (if they have learned letter names). Words with similar letters are apt to be mistaken for each other, so word reading is not highly accurate. Children may begin this phase using mainly associations between consonant letters and sounds to remember spellings, not vowel letter-sound associations which are more complex and variable across words (Venezky, 1970). Although sounding out and blending skills are poor or nonexistent, they may develop as a result of practice at phonetic letter-sound recognition. As children's knowledge of letter-sound mapping relations expands, their analyses of spellings as symbols for pronunciations become more complete, and they are able to process and remember more letter-sound associations in spellings.

Our view is similar to Gough and Hillinger's (1980) in that a phonetic analytic system is seen as underlying effective printed word learning. However, the views differ in terms of when this system begins operating and how much information is required. Gough and Hillinger suggest that the child must possess fairly complete knowledge of letter-sound correspondences for cryptanalysis to succeed. In fact, in Gough's research (1982), a nonsense word decoding task is used to distinguish cipher learners from code learners. In contrast, we suggest that this process can begin with partial knowledge because memory for spelling-pronunciation associations of words enables beginners to compensate for incomplete deciphering skill in reading words.

Research on the emergence of spelling skill in children (Chomsky, 1979; Henderson &

Beers, 1980; Morris, 1981; Read, 1971, 1975) offers evidence that very young children are capable of letter-sound analysis. Findings indicate that novice readers and even prereaders can use their knowledge of letter names to create word spellings that are phonetically accurate, at least in terms of boundary letters, for example, BK to spell *back*, LT for *light*. Unconventional spellings have been observed for words such as *chicken* which is spelled HKN, the H chosen because it has the initial sound in its name "aich." If beginners can do this, then they ought also to be able to use their letter knowledge to recognize and remember relations between boundary letters in spellings and sounds in pronunciations and in this way commence learning to read words (Ehri, 1983). Any system that eases the memory load by eliminating the arbitrariness of the relationship between print and speech ought to be used if it is available, following the principle of least effort (Samuels, 1967).

Mason (1980) supplies some evidence indicating that letter-sound information can be processed by children when they first become able to read words in the absence of contextual cues. Mason conducted a longitudinal study to follow prereaders as they moved into reading. She examined how various subskills changed during this period. Her observations suggested three stages labeled to reflect the different processes being used to identify written words: *context dependency, visual recognition*, and *letter-sound analysis*. The least mature, context dependent learners used the same learning process to recognize words as to identify pictures, by treating the words as unique visual patterns. They could read words only in their typical contexts, on signs or labels, (e.g., stop sign, milk carton), not in isolation. They were still mastering alphabet letters. They could learn to identify 3 or 4 printed words on a 10-item list but they could not read these words when the case of the letters was altered, and they forgot most of the words after a 15-minute delay. At the next stage were visual recognition learners. In contrast to context learners, they could read a few words out of context and they had mastered letter names. Importantly, they appeared to use some letter-sound relations in processing words. They often preserved initial consonants when they misread words (e.g., *key* for *kit*). They would attempt to spell words. They were able to learn and remember words on the 10-item list better than context learners and could even recognize some of the words when letter cases were altered. Although the label for this stage suggests the use of visual information in processing words, Mason's description of what these learners could do suggests that rudimentary phonetic processes were being used. At the most advanced stage were the letter-sound analyzers who had mastered the orthographic system as a map for speech. They could use this knowledge to decode unfamiliar printed words accurately and could read multisyllabic words. In addition, they had no difficulty learning words on the 10-item list and could read them almost perfectly even when letter cases were changed and after a 15-minute delay.

The purpose of the present study was to obtain more direct evidence regarding children's use of visual and phonetic cues when they first begin learning to read words. To study these processes, three levels of beginning readers were distinguished according to their ability to read single preprimer words accurately on a pretest: (a) *prereaders* who could not read any words; (b) *novice* beginning readers who could read a few words; and (c) *veteran* beginning readers who could read several words. We examined these children's ability to learn to read two kinds of word spellings: (a) simplified *phonetic* spellings whose letters corresponded to sounds in pronunciations by virtue of the fact that the names of the letters included sounds found in the pronunciations (e.g., JRF for *giraffe*), and (b) *visual* spellings whose letters bore no correspondence to sounds but were more distinctive visually (e.g., XGST for *balloon*). Visual distinctiveness was enhanced by varying the height and ascending or descending position of letters within spellings to give each word a unique contour and by employing different letters in each spelling. The words and spellings are listed in Table 1. Of interest was whether the three reader groups would find the phonetic spellings or the visual spellings easier to learn. It was reasoned that if prereaders and novice readers are visual code learners, as

Table 1 Mean trials to criterion of veterans and novices in the word-learning tasks as a function of words and spellings

Nouns	Phonetic Spelling	Mean	Visual Spellings	Mean	Difference
GIRAFFE SET					
knee	NE	2.1	Fo	2.5	-0.4
giraffe	JRF	2.6	WBC	4.3	-1.7
balloon	BLUN	2.9	xgsT	5.9	-3.0
turtle	TRDL	3.1	YMP	6.4	-3.3
mask	MSK	3.3	uHE	7.3	-4.0
scissors	SZRS	3.8	qDjK	4.7	-0.9
Mean		3.0		5.2	
ELEPHANT SET					
arm	RM	2.3	Fo	2.4	-0.1
diaper	DIPR	2.3	xgsT	4.7	-2.4
elephant	LFT	3.5	WBC	3.1	+0.4
comb	KOM	4.7	uHE	4.9	-0.2
pencil	PNSL	4.7	qDjK	5.9	-1.2
chicken	HKN	5.5	YMLP	6.1	-0.6
Mean		3.8		4.5	

Gough claims, then both groups should do better with distinctive visual cues than with phonetic cues. However, if prereaders are visual learners but novices use a phonetic recognition memory mechanism, as we claim, then prereaders should learn better with visual cues while novice readers should learn better with phonetic cues. We agree with Gough in expecting veterans to be cipher learners and to learn better with phonetic cues than with visual cues.

Another purpose of this study was to examine subjects' memory for initial and final letters in words after they have learned to read them. Previous studies have reported that initial letters are more salient than final letters to beginning readers (Leslie, 1980; Marchbanks & Levin, 1965; Rayner, 1976; Rayner & Hagelberg, 1975; Timko, 1970; Williams, Blumberg, & Williams, 1970). However, these studies utilized letter discrimination or letter matching-to-sample tasks, not a word-learning task, and the letter sequences were not pronounced and did not symbolize words. Furthermore, no distinction was drawn between types of spellings. Of interest in the present study was whether initial letters would be better recalled than final letters in visual spellings as well as phonetic spellings by prereaders as well as beginning readers.

Method

Subjects

The subjects were selected from middle-class preschool and kindergarten classes. There were 30 boys and 26 girls who completed the tasks, mean age 67 months (range = 49 to 77 months). Only 6 were preschoolers, the rest

were kindergarteners. Only 5 were under 5 years of age. Nonnative speakers lacking proficiency in English were not included. There were 7 subjects who began but were unwilling to complete the experiment, 5 preschoolers and 2 kindergarteners. On the pretests, all but one of these subjects were prereaders. Preschoolers were tested during the summer, kindergarteners during the school year.

Materials and Procedures

Subjects were tested individually over a period of 3 days. Several pretests preceded the word-learning task and a letter-recall task.

Letter name/sound knowledge. Subjects were shown a sheet displaying all 26 uppercase letters randomly mixed. They went through the set twice, naming each letter the first time and giving the sound made by each letter the second time.

Gray Oral Reading Test. Subjects read up to three of the easiest passages on the Gray test (1967). They were told to read each story quickly but accurately and to remember what they read. Subjects unsuccessful on the second story were not given the third. The measure used was the number of words correctly read in context in the first passage.

Word identification. Subjects were shown 17 cards, each displaying three or four printed words and one object drawing. Subjects named those they knew. Pictures were included to minimize nonreaders' sense of failure in the task. Two kinds of words were included: 40 preprimer and primer-level words (see Appendix) to measure subjects' word reading ability, and 12 target words to determine whether subjects could already read the words to be taught in the experiment.

Word-learning task. Two sets of six nouns naming objects were selected. Two types of uppercase spellings were designed for the words, phonetically relevant spellings containing letters mapping sounds in pronunciations, and phonetically irrelevant spellings exhibiting no sound-symbol correspondences but being highly distinctive visually. The words and their spellings are given in Table 1. The greater visual distinctiveness of irrelevant spellings was achieved by making the letters all different and by varying the size and ascending or descending position of some of the letters to give each spelling a unique shape. Phonetic spellings were much less distinctive visually in that some letters recurred across words and all were printed in uniform size to give words the same shape. Each of the letters used in phonetic spellings contained the relevant sound in its name. Repetition of letters between phonetic and visual sets was held to a minimum. Initial letters were unique across all spellings taught to each subject. In visual spellings, tall letters were 5/8 in. (1.59 cm), and short letters were 3/8 in. (.95 cm). In phonetic spellings, all letters were 3/8 in. (.95 cm).

Two paired-associate (PA) learning tasks were administered on different days to subjects. In one task, subjects learned to read a set of visual spellings, in the other task a set of phonetic spellings. The particular set of nouns assigned to each spelling condition and the teaching order of the conditions were counterbalanced across subjects. The anticipation method was used. On Trial 1, each spelling was shown, the experimenter pronounced the word and moved her finger underneath it, subjects imitated both responses, and then they were shown a card displaying the word and the picture it named. On subsequent trials, subjects were given 5 seconds to read each word. Then they were shown the word and picture. Words were arranged in a different random order on each trial. A maximum of 10 trials was given to learn the words to a criterion of 2 perfect trials.

Memory for spellings. Following each of the two PA tasks, subjects' memory for initial and final letters in the spellings of words was examined. An alphabetically ordered set of uppercase letters was displayed. Subjects were shown the picture seen previously of the referent of each target word, and they were asked to identify the first letter in its spelling by naming or pointing. Then the spelling of the word was shown with its final letter covered up, and subjects were asked to identify the final letter by naming or pointing.

Results

Composition of Reader Groups

Subjects were placed in one of three groups according to their reading ability as measured

by the word identification task. Mean scores and ranges on this task are given in Table 2. One prereader and one novice read as many words as the lowest scoring subjects in the next highest group. However, these 2 subjects read fewer words correctly on the Gray Oral Reading Test than any subject in the next highest group. Except for these, none of the word scores overlapped across groups. There were 8 subjects tested but not included in the analysis: 5 veterans who could read some of the target words on the pretest, 2 extra prereaders, and 1 extra novice.

One way analyses of variance (ANOVAs) were employed to determine whether these three groups differed significantly on other characteristics listed in Table 2. Main effects were significant in all analyses (all $ps < .01$). Post hoc pairwise comparisons using Tukey's method revealed that veterans and novices scored equivalently and significantly higher than prereaders on the measures of age, letter name, and letter-sound knowledge. All the groups differed significantly from each other in recognizing words in context on the Gray Oral Reading Test as well as on the primer-level word identification task.

Learning to Read Phonetic and Visual Spellings

The main purpose of this study was to determine whether the three groups would differ in their ease of learning phonetic and visual spellings. Based on Gough and Hillinger's (1980) theory, prereaders and novice readers were expected to learn the visually distinctive spellings faster than the phonetic spellings while veterans were expected to display the opposite pattern. Based on our theory, only prereaders were expected to do better with visual spellings while novices as well as veterans were expected to do better with phonetic spellings.

Performances on the printed word-learning tasks were subjected to an ANOVA. The independent variables were reading group, spelling stimuli (phonetic vs. visual), and trials (1 through 5). The dependent measure was the number of correct word responses. Mean values are portrayed in Figure 1. Main effects were significant for group, $F(2,45) = 25.48$, $p < .01$; spellings, $F(1,45) = 16.05$, $p < .01$; and trials, $F(4,180) = 80.51$, $p < .01$. Interactions were significant for Group x Spellings, $F(2,45) = 18.16$, $p < .01$; and Trials x Spellings, $F(4,180) = 6.17$, $p < .01$. Neither of the two

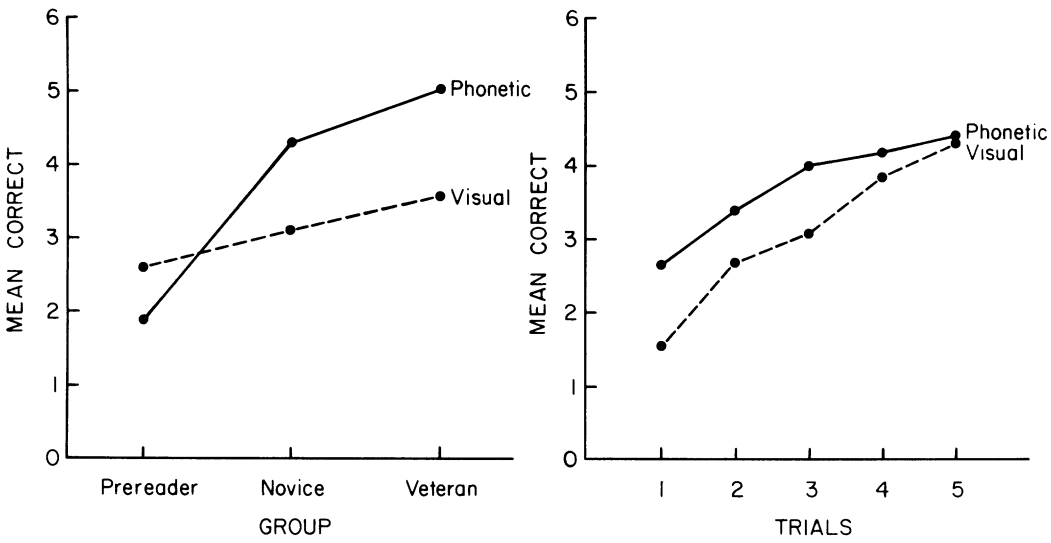
Table 2 Characteristics and mean performances of reader ability groups

	Beginning Reader Groups			
	Prereaders	Novices	Veterans	$T\sqrt{MS_e}$[a]
Reader Ability Grouping Criterion				
Primer Words (40 max)	0.1	4.4	17.8	3.7
Range	(0-1)	(1-11)	(11-36)	
Other Group Characteristics				
Sex	5F, 11M	10F, 6M	7F, 9M	
Age (months)	62.6	66.9	69.8	4.3
Letter names (26 max)	20.1	25.1	25.4	3.8
Letter sounds (26 max)	6.7	20.6	21.5	4.2
Gray Oral Words (21 max)	1.9	7.2	14.8	2.3
PA Task Assignments (Number of subjects per condition)				
Phonetic First/Giraffe Set	4	7	3	
Phonetic First/Elephant Set	4	3	3	
Phonetic Second/Giraffe Set	4	3	4	
Phonetic Second/Elephant Set	4	3	6	
Total	16	16	16	

Note. There were 16 subjects in each group.
[a]Tukey pairwise comparison test minimum significant difference, $p < .05$.

Figure 1

Mean number of phonetic and visual spellings identified correctly in the word-learning task as a function of beginning reader group (left panel) and learning trials (right panel)



remaining interactions was significant (both *ps* > .05).

From the left panel in Figure 1, it is apparent that differences in ease of learning favored phonetic spellings among veteran and novice readers but favored visual spellings among prereaders. To determine whether the difference in each group was significant, three matched-pair *t* tests were conducted. The dependent measure was the number of correct responses on the first five trials. Results were significant for all groups. Among prereaders, more visual than phonetic spellings were learned, $t(15) = 2.87$, $p < .025$. In the other two groups, more phonetic than visual spellings were learned: for novices, $t(15) = 4.18$, $p < .01$; for veterans, $t(15) = 4.92$, $p < .01$ (all two-tailed tests). Inspection of the performances of individual learners confirmed that the majority of subjects in each group exhibited the pattern characteristic of their group: 88% (veterans), 81% (novices), 75% (prereaders).

These findings are more supportive of our predictions than those of Gough and Hillinger (1980). Results indicate that prereaders are visual code learners while novice beginning readers are more like cipher learners than code learners in that they benefit from phonetic cues more than visual cues in learning words. Apparently, as soon as children become able to read more than a couple of words out of context, they are capable of deciphering spellings, at least partially.

Effect of Trials

The right panel in Figure 1 displays the significant interaction between spellings and trials. Inspection of values reveals that the advantage enjoyed by phonetic spellings was greatest early on during the learning trials and diminished as learning proceeded. The three-way interaction between trials, spelling types, and reader groups was not significant ($p > .05$).

Effect of Sex

The above ANOVA was repeated on a subgroup of subjects (5 males and 5 females from

each reader group) with sex included as an independent variable. No main effects or interactions involving this variable were detected (all $ps > .05$), indicating that males and females did not differ in their performance on the word-learning tasks.

Effect of Word Set and Task Order

Two different sets of nouns were taught as responses for phonetic and visual spellings (see Table 1). This variable as well as the order in which the two PA tasks were learned was counterbalanced across subjects yielding four task assignment (TA) groups (see Table 2). To determine whether these control variables produced any main effects or interactions involving the variables of primary interest, two ANOVAs were conducted, one analysis on a subgroup of 12 veteran and 12 novice readers (use of a subgroup here was necessary to achieve equal cell sizes), and another analysis on all the prereaders. The independent variables were task order, word set assigned to each condition, type of spelling (phonetic vs. visual), and trials. The dependent measure was the number of words correct. In the prereader analysis, neither task order nor word set resulted in any significant main effects or interactions (all $ps > .05$). However, in the reader analysis, two interactions were significant: Order x Word Set, $F(1,20) = 8.40, p < .01$; and Order x Words x Spelling Type x Trial $F(4,80) = 3.08, p < .05$. Inspection of means revealed that the two TA groups who learned phonetic spellings with the Giraffe word set and visual spellings with the Elephant set did better overall (means of both groups = 4.5 correct) than the two TA groups who learned phonetic spellings with the Elephant set and visual spellings with the Giraffe set (mean of one group = 3.8, other group = 3.2 correct).

To confirm and localize this effect, veteran and novice readers' performances on each word were calculated and compared. The measure was the mean number of trials taken to recall the word correctly twice in succession. Means reported in Table 2 verify the greater difficulty of learning phonetic spellings for the Elephant set. The hardest word, *chicken*, spelled HKN was especially difficult perhaps because readers were not used to the letter H (ai*ch*) symbolizing the affricate /č/. Although the Elephant set of phonetic spellings proved more difficult, this did not disrupt the major finding reported above. As is evident in Table 1, the pattern of superior performance with phonetic over visual spellings held for 11 of the 12 words, matched-pair t test, $t(11) = 3.53, p < .01$ (two-tailed test).

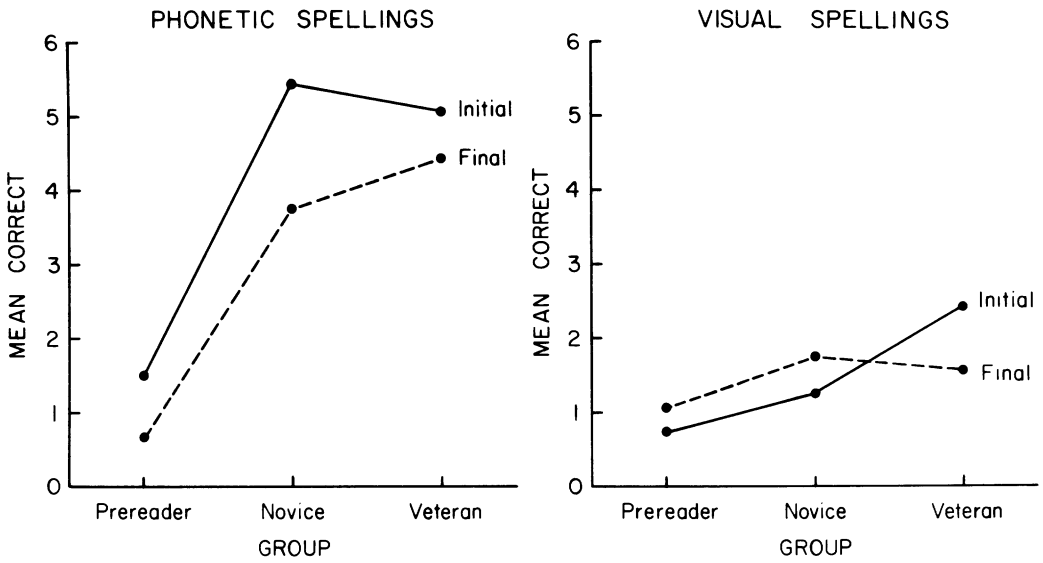
To account for the significant four-way interaction (Order x Word Set x Spelling Type x Trials) and to verify that the control variables did not disturb the patterns of central interest reported in Figure 1 for novices and veterans, mean values were inspected in each of the four task assignment groups. The pattern of recall favoring phonetic over visual spellings held up across all trials in all four TA groups. However, the differences were larger in some TA groups and on some trials than on others. The pattern of a diminished difference following Trial 3 (right panel of Figure 1) was evident in two of the TA groups, but the difference remained about the same across trials in the other two TA groups.

Memory for Spellings

After each word-learning task, subjects' memory for the initial and final letters of word spellings was tested. Recall was subjected to an ANOVA. The independent variables were reader group, type of spelling, and letter position. Mean values are portrayed in Figure 2. The main effect of group was significant, $F(2,45) = 40.56, p < .01$. Post hoc comparisons using Tukey's method revealed that veterans and novices performed equivalently and each outperformed prereaders. The main effect of letter position was significant, $F(1,45) = 11.93, p < .01$. Initial letters were known better than final letters. This occurred despite the fact that more information was provided for the recall of final letters (i.e., preceding letters were displayed). The main effect of spelling type was significant, $F(1,45) = 117.90, p < .01$, as well as the two- and three-way interactions between

Figure 2

Mean number of initial and final letters of phonetic and visual spellings recalled by subjects in the three reader groups at the end of the word-learning tasks



spellings and the other variables: Spelling Type x Reader Group, $F(2,45) = 24.52$, $p < .01$; Type x Letter Position, $F(1,45) = 12.70$, $p < .01$; Type x Readers x Position, $F(2,45) = 6.07$, $p < .01$. The Readers x Position interaction was not significant, $F < 1$. From Figure 2, it is apparent that among veterans and novices, letters in phonetic spellings were known much better than letters in visual spellings. In contrast, among prereaders, differences were minimal. The superiority of initial over final letters held mainly for phonetic spellings, not for visual spellings.

Scores of all subjects were included in the above analysis, regardless of whether they learned to read the words to criterion (i.e., perfect recall of the words twice in succession). A second analysis of letter recall patterns was conducted on just those subjects who reached criterion with phonetic spellings ($n = 29$) and with visual spellings ($n = 19$) in order to verify that recall patterns were the same. We thought that these subjects might know the letters better, particularly letters in visual spellings. However, results revealed otherwise. Phonetic spellings were still recalled much better than visual spellings. Of the subjects learning phonetic spellings, 90% (26 out of 29) recalled over half of the boundary letters correctly. Of the subjects learning visual spellings, only 5% (1 out of 19) recalled over half of the boundary letters. The fact that boundary letters in visual spellings were not remembered very well indicates that these were not the important cues used for learning associations between visual spellings and words. Comparison of the position of the letters recalled by these subjects revealed that first letters were identified significantly better than final letters in phonetic spellings, matched-pair t test $t(28) = 4.43$, $p < .01$ (two-tailed test), $M = 5.2$ (initial) vs. 3.9 (final). The difference however was not significant in the visual condition, $t(18) = 1.59$, $p > .05$, $M = 2.2$ (initial) vs. 1.8 (final). These results reveal that the superiority of initial over final letters in word memory is a relationship that holds in learning phonetic spellings but not visual spellings, indicating that the difference arises from the sound-

symbolizing function of spellings, not from their visual configuration.

Although there were only two prereaders who reached criterion in learning phonetic spellings, their letter recall is worth noting. These prereaders recalled initial letters much better than the other prereaders (M = 5.5 vs. 0.9), but they recalled final letters only slightly better (M = 2.0 vs. 0.5). This suggests that their success in learning the phonetic spellings may have been due to their use of initial letter-sound correspondences.

One explanation for prereaders' ability to learn visual spellings better than phonetic spellings is that prereaders may have been more familiar with the letters appearing in visual spellings than those in phonetic spellings. To evaluate this explanation, information on letter errors was used. The number of errors in identifying each of the 26 uppercase letters was determined on the larger sample of 63 subjects. Errors on 25 of the letters ranged from 3 to 9. The letter *I* proved exceptional with 34 errors (most mistaking *I* for lowercase *L*). These values were used to calculate the mean errors per letter for the three sets of spellings learned by subjects (i.e., two phonetic sets and one visual set, see Table 1). In these calculations, letter values ranged from 3 to 9. The letter *I* was assigned a value of 10. Results revealed almost identical means across the three sets of spellings: for total letters, M = 5.5 and 6.4 (phonetic sets) vs. 6.3 (visual set); for initial letters, M = 5.7 and 6.3 (phonetic sets) vs. 6.0 (visual set). These results rule out the possibility that greater familiarity with letters was the reason why prereaders learned visual spellings better than phonetic spellings.

Discussion

Processing Differences Between Readers and Prereaders

Results of the present study support the conclusion that novice as well as veteran beginning readers differ substantially from prereaders in the cues they attend to in learning to read words. Among prereaders, visually distinctive spellings are easier to learn whereas among beginning readers, spellings where letters function as symbols for sounds are easier.

These results do not support Gough and Hillinger's (1980) claim that beginning readers start out learning to read their first 40 words by noticing and remembering visual cues. The least mature beginning readers in the present study were the novices. Performance on a pretest indicated that these subjects had learned to read only a few single words, certainly less than 40 words. In the word-learning task, these readers gave evidence that they were able to utilize phonetic letter-sound cues more effectively than visual cues, contrary to what Gough and Hillinger might expect. The subjects fitting Gough's (1982) description of visual word learners were the prereaders who had not learned to read any single words reliably. These findings suggest that visual code learning is not the way that prereaders move into word reading.

Our interpretation for the present findings is that movement into effective word reading requires a *shift* from visual to phonetic cue processing and that this shift is what enables children to begin reading their first words reliably. The form of phonetic processing thought to be employed at the outset of reading is one which involves the use of a letter-sound recognition mechanism to preserve associations between spellings and pronunciations in memory. This is a simpler form of phonetic processing than decoding which involves sounding out and blending letters. In the present study, novices were able to read only a few words on the word identification pretest, and they were not observed to accomplish this by decoding the spellings. Only 2 out of 16 subjects sounded out and blended any words (one child reading 2 out of 3 words this way, the other reading 1 out of 8 words this way). No novice was able to read the phonetically regular words *big*, *man*, and *run*. Nevertheless, they were able to learn phonetic spellings effectively. This supports the idea that a simpler phonetic learning mechanism was being used.

An alternative explanation for the superior word memory of novices over prereaders is that they possessed superior paired-associate learn-

ing skill (Samuels & Anderson, 1973). Present findings can be interpreted to argue against this possibility. If this were true, one would expect novices to outperform prereaders not only in learning phonetic spellings but also in learning visual spellings. However, from the left panel of Figure 1, it is apparent that the two groups differed very little in their ability to learn visual spellings while they differed substantially in their ability to learn phonetic spellings. Correlation coefficients confirmed this difference. The correlation between reader group (prereader vs. novice) and the number of phonetic spellings read correctly on the first five trials was high, positive, and significantly different from zero, $r = .77$, $df = 31$, $p < .001$. In contrast, the correlation between reader group and visual learning scores was low and nonsignificant, $r = .24$, $p > .05$, indicating that novices were not any more skilled than prereaders in learning spellings that lacked phonetic cues. This constitutes evidence against the paired-associate learning skill hypothesis.

An alternative way to view visual and phonetic word-learning patterns, one not incompatible with our view, focuses on the transfer value, both positive and negative, of the learners' knowledge of letter names and sounds. Learners with substantial knowledge (novices) should exhibit positive transfer in learning spellings containing those letter sounds, while they should exhibit negative transfer in learning spellings containing conflicting letter sounds. In contrast, learners with less knowledge of letter names and sounds and little experience using this knowledge (prereaders) should exhibit little transfer, either positive or negative. Results of the word-learning task were partially supportive. Greater positive transfer was evident among novices than among prereaders, but greater negative transfer was not apparent. That is, visual spellings did not impair the learning of novices more than prereaders.

Additional evidence for negative transfer was sought in an analysis of subjects' word intrusion errors during word learning with visual spellings. It was reasoned that if letter knowledge interfered, then novices should produce a greater proportion of phonetic-based intrusions than prereaders. Phonetic intrusions were defined as incorrect words having sounds corresponding to at least one letter in the visual spelling (e.g., YMLP evoking the response "pencil" or "comb"). Pronunciations of all the intrusions produced by each subject during learning were examined for their correspondence to any letters in the visual spellings, and the proportion of phonetic intrusions was calculated for each subject. All subjects produced at least one intrusion. Most of the intrusions (over 95%) were other words in the six-word set. The resulting proportions and also the total number of intrusions were subjected to Mann-Whitney tests. (A nonparametric test was used because the distributions of scores were skewed.) Although there were no differences in the number of intrusions, $M = 7.9$ (novices) vs. 10.6 (prereaders), $U = 99.5$, $p > .05$ (two-tailed test), novices produced a greater proportion of phonetic intrusions than prereaders, $M = 75.8\%$ vs. 57.7%, $U = 73.5$, $p < .05$ (two-tailed test). (By chance, one would expect the intralist intrusions regarded as phonetic to be produced about 52% of the time, because they constituted 52% of the possible misassociations.) This constitutes some evidence for greater negative transfer among novices. However, interference from letter knowledge did not depress their learning of visual spellings below that of prereaders.

Interestingly, novices also produced more phonetic intrusions than veterans, $M = 75.8\%$ vs. 53.7%, $U = 63.5$, $p < .05$ (two-tailed test) although the number of intrusions did not differ between these groups, $M = 7.9$ vs. 7.8, $U = 119$, $p > .05$. Perhaps phonetic interference from single letter-sound relations declines as readers become used to looking for multiple letter-sound correspondences in spellings.

Present findings contribute evidence bearing on Mason's (1980) stages of printed word learning. Results support Mason's description of Stage 1 children as context dependent learners who process words mainly by attending to visually distinctive cues. These were the prereaders in our study. Also, results support Mason's description of children at Stage 2 who learn words by attending to letters. These were the novices in our study. However, present find-

ings indicate that the label for children at this stage (i.e., visual recognition learners) is inaccurate. According to our results, movement into Stage 2 involves a shift in the way that learners process visual letters in words. Whereas Stage 1 learners process letters like pictures as strictly visual stimuli, Stage 2 children process letters as symbols for sounds in pronunciations. In other words, visual processing shifts from being iconic to being symbolic (at a phonetic level). Calling this a visual recognition stage fails to capture the full process and to distinguish it from Stage 1 processing. A better label for word learning at this stage might be visual-phonetic recognition learning rather than visual recognition learning.

Is Movement Into Reading "Natural"?

Present findings suggest that movement into reading requires children to process print in a qualitatively different manner from that done as prereaders. As such, movement into reading cannot be regarded as evolving "naturally" out of encounters with print in the environment, contrary to the claims of Goodman and Goodman (1979) and Harste, Burke, and Woodward (1982). Masonheimer, Drum, and Ehri (in press) present additional evidence for this. They screened a large sample of preschoolers 3 to 5 years old ($N = 217$) to select those who could identify at least 8 out of 10 samples of environmental print (e.g., *Jack in the Box, Star Wars, Pepsi, Stop*) ($n = 102$). Then they administered a word-reading task comprising 10 preprimer words such as *go, run, big, in,* and *stop.* If it is the case that mastery of print in the environment leads children into reading, then one would expect to observe a normal distribution of scores ranging from low to high on the word-reading task. However, this did not happen. Rather, scores were discontinuous and bimodal. The large majority of the subjects, 94%, recognized no more than 3 words, and 56% read no words at all. The remaining 6 subjects read at least 8 of the 10 preprimer words plus several words on the Slosson test. The fact that the sample included very few readers and no subjects in the middle between prereading and reading suggests that learning to identify print in the environment may not be sufficient to enable children to move into effective word reading. However, because results are correlational, they fall short of supporting a causal inference.

Masonheimer et al. (in press) also examined to what extent the readers and prereaders in their study were utilizing alphabetic cues to read words in the environmental print samples. Results revealed large qualitative differences between the two groups. In one experiment, they systematically eliminated various cues in the print samples (i.e., logos, colors, distinctive print styles) to determine which cues were critical for identification. Prereaders' accuracy in identifying the print declined when logos were removed, and scores dropped to near zero when the words were shown in manuscript type. In contrast, readers' accuracy remained high and unaffected by these changes. In another experiment, first and final letters in the print samples were altered (e.g., XEPSI for PEPSI). Prereaders failed to notice any of these changes, even when they were asked whether there was anything wrong or strange in the pictures. Rather, they looked at the altered print and said the names associated with the logos. Showing the original print samples side by side with the altered samples increased prereaders' attention to letters, but the best performing group (the 5-year olds) still noticed only 36% of the letter changes. In contrast, readers detected these alterations even without being asked. These results indicate that in identifying environmental print, readers focus on letters while prereaders ignore the letters and "read" the environment. Age was not a factor since 5-year-old prereaders were as dependent on environmental cues as 3-year olds. The 5-year-old prereaders revealed somewhat better knowledge of alphabet letters in a letter-naming task than younger subjects ($M = 36$ vs. 30 correct out of 52), but they still focused on nonalphabetic cues to identify words in the print samples. These findings add support to the claim that movement into effective printed word learning requires a qualitatively different way of processing printed words, one that prereaders do not naturally hit upon as they encounter print in their environment. The problem is that they habitually pro-

cess context and configurational cues, and this precludes their attending to phonetic cues which must be done to begin reading words reliably.

Importance of Letter Knowledge

What is it that enables children to shift from visual to phonetic processing of printed words in the way we have described? One likely prerequisite is that they need to be familiar with the names or sounds of alphabet letters appearing in the spellings. From Table 2, it is apparent that novices differed significantly from prereaders in this respect. Whereas novices had mastered letter names (M = 96% correct), prereaders had not (M = 77% correct). This mastery/nonmastery distinction was also apparent in Masonheimer et al.'s (in press) study: Readers identified a mean of 98% of the letters correctly whereas the oldest prereaders (5-year olds) identified a mean of only 69% correctly. In the present study, novices made greater use of letters in learning phonetic spellings than prereaders as evidenced by their superior memory for boundary letters in these spellings (see Figure 2). Note that subjects could succeed in this recall task by pointing to the correct letter in an alphabetic array. They did not have to name it to be correct. Also note that because prereaders took longer to learn the phonetic spellings than novices, they actually saw the letters more times. Because these findings are correlational, they are insufficient to show cause. However, they are consistent with the hypothesis that children need to possess letter name/sound information before they can become effective word readers.

Evidence for the importance of letter knowledge can be found in other studies. Letter name knowledge at the start of Grade 1 is known to be the best single predictor of reading achievement at the end of Grade 1 (Chall, 1967). Interestingly, studies of children who have learned to read before they enter school often mention mastery of letters as an event preceding movement into reading (Bissex, 1980; Healy, 1982; Lass, 1982; Mason, 1980). Although about 10 years ago several experiments failed to provide evidence that letter name knowledge facilitated learning to read, these studies are flawed in several ways (Ehri, 1983). Also, the distinction drawn in these studies between letter name and letter-sound knowledge is fallacious because most letter names contain the relevant sounds (Durrell, 1980). If children know letter names, it is a simple matter to learn or figure out the relevant sounds contained in the name. If they do not know names, then they face the difficult task of learning these arbitrary meaningless associations (Ehri, 1983).

To what extent letter knowledge by itself is sufficient to move a child into effective word learning is unclear. It may be that if learners possess letter knowledge, then very little prompting is needed to get them to use it to process and remember associations between spellings and pronunciations. Alternatively, if the habit of processing words visually like pictures is a strong one which must be unlearned, or if phonemic segmentation skill is needed as well to analyze multiple letter-sound relations in spellings (Lewkowicz, 1980), then movement into effective word learning may not be so straightforward and may require some form of instruction. In the present study, it was not possible to determine how novice readers had learned to process letter-sound cues in words since this presumably happened outside the laboratory. The role of instruction in teaching children to make use of their letter knowledge awaits further study.

Salience of Initial Letters in Spellings

Results of the letter-recall test in the present study yielded evidence bearing on the question of whether initial letters are more salient than final letters in the printed words learned by beginning readers. Initial letters were found to be more salient, but only in phonetic spellings, not in nonphonetic spellings that were more distinctive visually. This was true even among subjects who had learned the visual spellings to criterion. Initial letter salience was evident among beginning readers who could use phonetic cues effectively to learn words, but it was not evident among prereaders using visual cues to learn words. These results combine to indicate that

the salience of initial letters in word learning is a result of the sound-symbolizing function of spellings. This conclusion contrasts with that in other studies attributing initial letter salience to their visual configuration (Marchbanks & Levin, 1965; Rayner, 1976; Rayner & Hagelberg, 1975; Timko, 1970; Williams et al., 1970).

Other Studies of Visual and Phonetic Processes

Some but not all lines of research on reading acquisition support the conclusion of the present study that phonetic processes are more central to printed word learning than visual processes. Research on poorer readers indicates that strictly visual skills do not explain their difficulties. In an extensive review of many studies, Vellutino (1979) concluded that there is little convincing evidence to support visual-perceptual and visual-memory deficit theories of reading disability. Rather, the difficulties of poorer readers appear to involve verbal processes. Liberman and her colleagues have analyzed the kinds of word-decoding errors produced by poorer beginning readers and have found that only a small proportion arises from visual sources (Fowler, Liberman, & Shankweiler, 1977; Fowler, Shankweiler, & Liberman, 1979; Shankweiler & Liberman, 1972). The large majority are linguistic, not optical (Liberman, 1982). Williams (1977) reviewed evidence for the modality matching hypothesis, the idea that some children learn to read better by using visual cues while other children learn better by using auditory cues. Her conclusion was that there is no firm evidence that even a subgroup of readers can be found who learn best in the visual modality. These findings all point to the unimportance of visual skills for learning to read.

In contrast, there are word-processing studies which conclude that the visual forms of words are processed, even by beginning readers. These studies, reviewed by Barron (1981), tested the hypothesis that beginning readers recognize words by translating spellings into pronunciations while older readers recognize words by going directly from print to meaning without any phonological mediation (Barron & Baron, 1977; Condry, McMahon-Rideout, & Levy, 1979; Rader, 1975). In the study by Barron and Baron (1977), children were given two tasks, a sound task in which they decided whether picture-word pairs rhymed (e.g., picture of broom and the word *room*), and a meaning task in which they decided whether picture-word pairs went together semantically (e.g., *pencil - paper*). As subjects performed the tasks, they repeated aloud the word *double*. It was reasoned that if subjects use phonological recoding in recognizing words, then tying up their vocal apparatus should interfere with performance in both tasks. Results revealed interference in the rhyming task but not in the meaning task, indicating that even first-grade children can process words visually without phonological mediation.

How do we account for the discrepancy between this evidence that beginning readers use visual cues to recognize words and present findings that phonological cues are central while visual cues are unimportant? Our explanation draws a distinction between processes used to *learn* printed words and processes used to recognize them once they have become familiar visual forms (Ehri, 1980, 1983, 1984). Whereas learning is essentially phonetic, recognition is essentially visual. The process of learning unfamiliar spellings entails using phonological analyses to store associations between spellings and pronunciations in memory. The process of reading familiar spellings (i.e., those that have been stored in this way already) involves accessing the stored associations. This is a visual process in that the cues triggering recognition are visual (i.e., letter symbols), not phonetic. In studies supplying evidence for visual processing of words, (Barron, 1981; Posnansky & Rayner, 1977), the words studied were ones children had already learned to read. In contrast, the words used in the present study were ones that subjects had not learned to read. Very likely this explains why visual cues proved important in the former studies while phonetic cues proved important in the present study. This view of visual processing explains why visual

skills have not been found to account for the difficulties of poorer readers. This is because the visual skills which are important for reading are specific to the print system and involve learning to interpret letters as symbols for sounds. They are not general, visual, picture-processing skills.

Implications for Instruction

Present evidence regarding how children move into reading is essentially correlational and hence insufficient for drawing inferences about cause. Furthermore, because instructional processes were not studied directly, inferences about how children should be taught to read cannot be drawn. What can be identified, however, are directions for future research on instruction. One question to be explored is whether or not it is wise to push prereaders into reading words until they have mastered letter name/sound relations. Present findings suggest that it may not be. Another question is whether, once children learn all the letter names, they are ready to begin using this knowledge to read words or whether they must learn additional letter-sound relations not found in the names (e.g., short vowels, dipthongs, digraphs) before proceeding. Certainly they will not be able to make complete sense of many spellings until all of this is known. However, the ability to perform a partial analysis may be sufficient at the outset of word learning. Another question is whether beginners need to be given systematic instruction and practice in how to use their letter knowledge to find correspondences between spellings and pronunciations or whether correspondences can be discovered spontaneously during systematic exposure to words. A further question is whether, when children first begin reading words, their exposure should be limited to words whose spellings "make sense" in terms of their letter knowledge. Very likely, sensible spellings are important to insure that children can detect a sufficient number of phonetic relationships to strengthen the habit of attending to phonetic cues. Seeing spellings with sensible boundary letters may be especially important at the outset. These are some of the more important instructional questions arising from present findings and awaiting investigation.

We must point out that use of a paired-associate learning task in the present study does not mean that we are advocating a PA task to teach children to read words. This task was used in order to isolate word-learning processes so that they could be studied. Very likely, effective word learning requires that the words be processed in meaningful, functional contexts. Such processes were not investigated in the present study.

As evident from the instructional implications suggested above, present theory and findings lead us to take a position in the controversy over whether children should be taught to recognize words by sight or by phonetic analysis (Chall, 1967; Groff, 1974, 1975; Haber & Haber, 1981). Our position is that instruction in phonetic analysis is essential, particularly since it may require a *shift* in the cue system used naturally by prereaders. The type of phonetic analysis recommended at the outset of learning is one involving letter-sound recognition memory. Whereas phonetic instruction is viewed as central, instruction in visual processing of words is viewed as a waste of time. This is because effective visual processing is thought to result from an effective phonetic letter-storage mechanism rather than from direct instruction on the visual properties of words.

Although we have focused exclusively on the importance of phonetic processing in learning to read, we do not mean to suggest that this is the whole of learning or that this solves the problem of learning to read. Phonetic processing is merely one capability that makes an important contribution at the outset of learning. Clearly there are many other competencies to be mastered as well before, during, and after the child moves into reading.

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APPENDIX

Words included in the 40-item word identification test and number of novices reading each word correctly (Max = 16)

up - 7	see - 3	eat - 1	run - 0
no - 6	stop - 3	it - 1	good - 0
yes - 6	yellow - 2	boy - 0	man - 0
you -6	red - 2	school - 0	house - 0
the - 5	play - 2	little - 0	ball - 0
go - 5	dog - 2	like - 0	children - 0
we - 4	in - 1	said - 0	daddy - 0
jump - 4	come - 1	big - 0	blue - 0
is - 4	green - 1	girl - 0	mother - 0
book - 3	look - 1	car - 0	happy - 0