R E P O R T R E S U M E S

ED 011 954 24 AA 000 073

CONTINGENT VERSUS NON-CONTINGENT SPELLING PATTERNS. STUDIES OF ORAL READING, III. PRELIMINARY DRAFT.

BY- LEVIN, HARRY BIEMILLER, ANDREW J.

REPORT NUMBER BR-5-0617-7 PUB DATE JAN 66
CONTRACT OEC-4-10-113
EDRS PRICE MF-$0.09 HC-$0.88 22P.

DESCRIPTORS- *LANGUAGE SKILLS, *RESPONSE MODE, READING RESEARCH, *READING ABILITY, STIMULUS BEHAVIOR, *REACTIVE BEHAVIOR, GRADE 2, GRADE 3, GRADE 4, MEASUREMENT TECHNIQUES, WORD LISTS, *ORAL READING, CONSONANTS, ITHACA

THE EFFECTS WHICH CERTAIN CORRESPONDENCES BETWEEN SPELLING AND SOUND HAVE ON READING WERE ASSESSED. THE 54 SUBJECTS WERE DRAWN IN EQUAL NUMBERS FROM GRADES 2, 3, AND 4. TO COMPARE THE RESPONSE LATENCIES AND THE ERRORS MADE WHEN READING THREE INTERMIXED LISTS OF 12 WORDS EACH, THE CHILDREN WERE ASKED TO READ ALOUD EACH WORD AS IT WAS PRESENTED ON THE SCREEN. THE FIRST LIST CONTAINED WORDS BEGINNING WITH "C," "G," OR "K" IN SOME OF THEIR LESS COMMON PRONUNCIATIONS. THE SECOND LIST CONTAINED WORDS BEGINNING WITH THE SAME LETTERS, BUT IN THEIR MORE COMMON PRONUNCIATIONS. THE THIRD LIST CONTAINED WORDS DIFFERING FROM THE FIRST LIST ONLY IN HAVING INITIAL LETTERS WITH INVARIANT SPELLING-TO-SOUND CORRESPONDENCES. THE ORAL RESPONSES TO EACH PRESENTED WORD WERE TAPE RECORDED, AND THE INTERVAL BETWEEN PRESENTATION OF THE WORD ON THE SCREEN AND THE SUBJECTS RESPONSE CONSTITUTED THE VERBAL REACTION TIME. ERRORS WERE ANALYZED FROM A TRANSCRIPT OF THE TAPE. LONGER LATENCIES AND MORE ERRORS WERE FOUND IN USING THE FIRST LIST, BUT NO DIFFERENCES BETWEEN THE OTHER TWO LISTS WERE OBSERVED. RESULTS WERE MOST CLEAR-CUT FOR FOURTH GRADERS. ANALYSIS OF THE ERRORS SHOWED THAT MOST OF THE ERRORS MADE ON THE FIRST LIST CONSISTED OF GIVING THE MORE COMMON PRONUNCIATION OF THE FIRST LETTER. THE AUTHOR'S INTERPRETATION OF THE RESULTS WAS THAT THE CHILDREN RESPONDED TO THE SINGLE PRONUNCIATION PATTERN THEY HAD LEARNED, THE COMMON ONE, AND HAD DIFFICULTY WITH PATTERNS WITH WHICH THEY HAD LITTLE EXPERIENCE. HE CONCLUDED THAT THE CONTRASTIVE PRONUNCIATION FORMS SHOULD BE PRESENTED SIMULTANEOUSLY TO THE CHILD. (AL)

Preliminary Draft
January, 1966

Studies of Oral Reading[1]

III. Contingent versus Non-contingent Spelling Patterns

Harry Levin and Andrew J. Biemiller

Cornell University

In previous studies we have examined two factors which affect that part of the reading process in which graphic materials are decoded to their oral counterparts: real compared to pseudo-words (Levin and Biemiller, 1965) and pronounceability (Biemiller and Levin, 1965). In the present study we begin to examine the effects which certain correspondences between spelling and sound have on reading aloud. The correspondence system in English is complicated. The pronunciations of any vowel and most consonants depend on their environments in the word. The correspondences of clusters of letters compared to single letters are fairly predictable (Hockett, 1963; Venezky, 1965).

A competent reader of English has been taught or has induced most of these complex relationships. He "knows", for example, that the pronunciation of the letter c in the initial position of a word depends upon the following letter: ca, ce, ci, co, cu, ch. This implies an added step in the processing of the contingent instances compared to words in which the first letter is invariably said the same way; e.g., d, m, l.

We asked ourselves how the necessity for additional information--the subsequent letter--would influence the verbal reaction time for reading words of these types. The prediction is not obvious. The initial letter itself is indeterminate, but the cluster, ca or ce, for example,

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[1]This research was supported by a contract with the U.S. Office of Education We thank Miss Susan Bostwick for her help with the analysis of errors.

is perfectly determined. Gibson (1962) suggests that readers learn spelling patterns as units based on their relationships to invariant corresponding sounds. This theory leads to the prediction that words with contingent relationships, as we have defined them, will be read as quickly as words whose initial letters are not dependent for decoding on their environments.

However, one may look at the formation of such higher order units developmentally. It is clear that mature readers do not process words letter by letter. Beginning readers process in the order, beginnings, ends, middles of words (Marchbanks and Levin, 1965). Therefore, we expect the two-stage processing of initial letters will result in longer reaction times than the non-contingent instances, <u>for younger readers</u>. Besides, it is reasonable that two letter units take longer to form than single letter units. (Units here mean the level of maximal predictability from spelling to sound.) In the course of learning to read, one level of correspondences may be well established while the other is still infirm.

In this study, we also examine the effects of the various spellings on the frequency and types of reading errors.

Method

This study was very similar in method to our first two studies. Subjects read aloud words presented on a screen. Their responses were tape-recorded. The interval between presentation of the word on the screen and the subject's oral response constituted the verbal reaction time. Errors were analyzed from a transcript of the tape. A more detailed description of this procedure, and of our measuring of verbal reaction

time will be found in Levin and Biemiller (1965).

Experimental Design and Stimulus Materials.

Three lists of words were drawn up. The first two lists, contingent-common and contingent-uncommon, used words beginning with an initial consonant whose pronunciation was dependent upon the following letter. Contingent-uncommon words used the less common pronunciation of the initial letter, (e.g., celt). Contingent-common words had the more frequent pronunciation, (e.g., colt). The third list, non-contingent, used words having all the same letters as contingent-uncommon words except the first. The first letter would be an initial consonant whose correspondence is invariant, (e.g., belt).

Three initial consonants were used in the contingent lists: c, g, and k. The letter c appeared in its /s/ form in the contingent-uncommon list and its /k/ form in the contingent-common list; g appeared in its /j/ and silent, (gn), forms in the contingent-uncommon list and its /g/ and /g/+ glide forms in the contingent-common list; k appeared in its silent (kn) form in the contingent-uncommon list and its /k/ form in the contingent-common list. Three words were used for each form. Where possible, contingent-common and non-contingent words were selected on the basis of being less frequent in the Thorndike-Lorge Juvenile List (1944) than the contingent-uncommon words. The entire list of words and Thorndike-Lorge frequencies appear in Table 1.

(Insert Table 1)

Subjects.

54 children from the West Hill Elementary School in Ithaca, New York were tested.[2] Eighteen fourth grade, eighteen third grade, and eighteen second grade children were randomly selected from one classroom in each grade. Due to extreme imbalances in the distribution of the sexes in the classrooms, no effort was made to balance the grades for sex.

Results

1. Verbal Reaction Time. The main hypothesis of this study concerns verbal reaction times to words beginning with "contingent" spelling patterns versus words not beginning with contingent spelling patterns. Results appear in Table 2.

(Insert Table 2)

An analysis of variance performed on these data indicated that the main effects (type of initial pattern, grade, and letter group) were all significant at the .01 level as was the interaction between initial pattern type and letter group. (A summary of the analysis appears in Appendix A)

Inspection of the means in Table 2 shows that our hypothesis is only partially confirmed. The mean reaction time for the contingent-common words does not differ significantly from the mean reaction time for non-contingent words. Contingent-uncommon differs from the other two groups. These points will be taken up later.

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2. We wish to thank the principal and teachers for their considerate help.

A second dependent variable, errors, was expected to show the same pattern of effects as verbal reaction time. Error percentages are shown in Table 3.

(Insert Table 3)

An analysis of variance revealed that the effects for percentage of errors are identical with those obtained for verbal reaction times. Again, responses to contingent-common words did not conform to our expectations. (A summary of the analysis appears in Appendix A.)

The significant interactions obtained between initial pattern types and letter groups are caused by changes in the relative effects of contingent-common and non-contingent patterns on the different letter groups. These changes are probably a function of the particular words used to represent these types of initial spelling patterns.

Latencies for Correctly Read Words. In our first study (Levin and Biemiller, 1965) we found that words read incorrectly required longer verbal reaction times. This suggests that the significant latency findings presented in Table 2 are artifacts of the greater number or errors made to words with less frequent contingent initial spelling patterns. In Table 4 are presented the frequency of correctly read words and the latencies to these words.

(Insert Table 4)

Although the overall means for each grade conform to the pattern of high latencies for contingent-uncommon words and low reaction times for contingent-common and non-contingent words, inspection of letter group and letter group by grade values indicate that several letter group by grade sets do not conform to the patterns observed in Tables 2 and 3.

On the other hand, the fourth grade Ss conform most clearly to the pattern observed in Table 2. Fourth graders make fewest errors. Hence we may hypothesize that the contingency effect comes out most clearly with competent readers.

The data in Table 4 suggested a further analysis. Different numbers of subjects are providing our estimates of mean latency per word for the correctly read words. These varying frequencies could seriously bias the results. For example, we find that fourth graders made about 40 fewer correct responses to contingent-uncommon words than to the other two types of words. The same subjects who failed to make correct responses to the contingent-uncommon words may have been generally poorer readers and hence taken longer in processing those words they could read. This would result in increased mean latencies to the contingent-common and non-contingent lists. We decided, therefore, to examine differences in the reaction times of subjects who gave correct responses to both contingent words and associated non-contingent words. Three comparisons were made; contingent-uncommon to contingent-common, contingent-uncommon to non-contingent, and contingent-common to non-contingent.

In comparisons involving contingent-common words, groups of words must be compared because single pairs of words are not matched. Thus, comparisons are made between mean latencies for words beginning with c and a vowel, g and a vowel, etc. Unfortunately, there are not enough second and third graders with groups of correct responses to make comparisons worth while. Results for the fourth graders are shown in Table 5.

(Insert Table 5)

Again we find the same pattern of high latencies to contingent-uncommon words and relatively low latencies to contingent-common and non-contingent words. Analysis of this small sample by t-tests indicates that the difference between mean latencies to contingent-uncommon words and the other two types are just short of significance. (t = 1.85 and 1.64 with 23 degrees of freedom)

These various analyses may be summarized as follows: latencies are highest to words that have contingent-uncommon initial spellings; common contingent spellings do not differ from control words whose initial spellings have a one-to-one correspondence to sounds.

The Nature of Errors. The finding is well established that reading errors occur least frequently at the beginnings of words, somewhat more often at the ends of words and most frequently in the middle of words (Jensen, 1962; Marchbanks and Levin, 1965). In Table 6 it can be seen that the errors made to the contingent-common words and to the control words follow this pattern. For our purposes we have analyzed only the initial errors compared to all other types. However, the errors made to the contingent-uncommon words diverge markedly from the expected pattern. Of the total of 368 errors, including omissions, 282, or 76%, involved the initial parts of the words. These 282 errors are broken down further in Table 7 to show that 107 mistakes involved only the initial part of the words. Also, it is important to note that 243 of the 282 errors involved the children saying the contingent-common form to the contingent-uncommon spelling; that is, "kell" was said to the written word, cell. In summary, then, the nature of the errors was atypical to one set of words and below we shall discuss the implications of

these findings for our original hypotheses.

(Insert Tables 6 and 7)

Discussion

Two alternative hypotheses were germane to this experiment. The first stated that for children contingent spelling patterns would require more processing time than those which can be translated to sound without concern for the environments of the letters. The second hypothesis was that the contingent forms become higher order units as a results of the invariant relationship of the letter group to sound. Two types of contingent spelling patterns were contrasted with control words. The contingent-uncommon forms were words whose initial letters could be decoded only by taking into account the second letter of the sequence. The contingent-common form also followed this pattern but were more frequent in English than the former list. Our results indicate that the time taken to decode and say the words on the various lists differed. The contingent-common and non-contingent words were decoded with about equal speed and both of these types of words were read considerably more rapidly than contingent-uncommon words. These results hold even when the instances were limited to those words read correctly.

To this point neither of the hypotheses are clearly confirmed. As a matter of fact, the most conservative interpretation is that these children are responding to a single pattern which they had learned (the common one) and were having difficulty with the pattern with which they had little experience. In other words, the results fit the ubiquitous finding that reaction time is related to the frequency of the word.

The nature of the errors that children made raises some interesting speculations. Reading errors are rarely made at the beginnings of words. Yet the most usual form of errors made to the contingent-uncommon word occurred in this position of the word. In fact, children transposed the contingent-common pronunciation to these other forms. This means that the children had not formed a higher order unit of the initial two letters in the word but were responding only to the initial letter.

It seems to us that the children were over-trained on one form and without the contrastive introduction of the complementary form were not able to derive the higher order unit. Our pedagogical recommendation, therefore, would be that the two contrastive forms be introduced simultaneously to the child.

Summary

Spelling-to-sound correspondences may be direct or contingent. In the latter case, pronunciation of one letter depends upon its environment (cent vs. cant). The present study compared response latencies and errors to three intermixed lists of twelve words each. The first list contained words beginning with c, g, or k in some of their less common pronunciation, (e.g., cell, gem, gnaw, and knelt). The second list contained words also beginning with c, g, and k, but in their more common pronunciations, (e.g., colt, gum, grab, ketch). The third list contained words differing from the first list only in having initial letters with invariant spelling-to-sound correspondences, (e.g., dell, hem, flaw, dwelt). Longer latencies and more errors to the first list but no differences between the other two lists were observed in a sample

of fifty-four children drawn in equal numbers from the second, third, and fourth grades. Results were most clear-cut for fourth graders. Analysis of the errors showed that most of the errors made on the first list consisted of giving the more common pronunciation of the first letter.

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Table 1

Words and Thorndike-Lorge Frequencies

Contingent-uncommon	Frequency	Contingent-common	Frequency	Non-contingent	Frequency
CELL	212	CARL	21	DELL	12
CELT	2	COLT	120	BELT	260
CENT	700	CAN'T	?	BENT	250
GEM	109	GUM	31	HEM	30
GERM	28	GALL	15	TERM	340
GENT	7	GOLF	1	DENT	5
GNAT	15	GRAB	57	BRAT	10
GNAW	110	GLEN	22	FLAW	7
GNASH	28	GLAND	17	TRASH	5
KNELT	83	KETCH	6	DWELT	121
KNIT	137	KICK	214	FLIT	62
KNOT	115	KILN	20	BLOT	19

Table 2

Mean Verbal Reaction Times in Seconds

by Contingency, Grade, and Letter Group.

	Initial Pattern Type			
	Contingent		Non-contingent	All Words
	Uncommon (CENT)	Common (COLT)	(DENT)	
All Words and grades	4.27	3.13	3.01	3.44
Grade				
4th	2.66	1.88	1.70	2.08
3rd	4.16	3.14	3.16	3.49
2nd	5.68	4.38	4.19	4.75
Letter Group				
c-vowel	3.46	2.64	2.20	2.77
g-vowel	3.85	2.49	3.00	3.11
g-consonant	5.15	3.49	3.24	3.96
k-consonant	4.21	3.91	3.61	3.91

Table 3

Mean Percent Errors by Initial Pattern Type, Grade and Letter Group

		Initial Pattern Type			
		Contingent		Non-contingent	All
	N	Uncommon	Common		
All words and grades	54	52.0	28.9	29.5	36.8
Grade					
4th	18	35.1	13.9	15.3	21.4
3rd	18	55.6	34.7	33.8	41.4
2nd	18	65.3	38.0	39.3	47.5
Letter Group					
c-vowels	54	46.9	24.1	19.1	30.0
ge-vowel	54	54.9	21.6	25.9	34.2
g-vowel	54	64.8	35.2	24.1	41.4
k-vowel	54	4.14	34.6	48.6	41.6

Table 4

Mean Latencies for Correct Responses and Number of Correct Responses

X Initial Spelling Pattern, Grade and Word Group

	Initial Spelling Pattern							
	Contingent				Non-contingent		All	
	Uncommon		Common					
	no. correct	mean latency	no. correct	mean latency	no. correct	mean latency	no. correct	mean latency
All words	285	2.64	446	2.35	436	2.28	1167	2.42
Grade								
4th	144	2 22	166	1.56	183	1.65	513	1.51
3rd	97	2.41	142	2.28	143	2.32	382	2.34
2nd[1/]	44	3.52	118	3.21	110	2.88	272	3.17
Group								
c-vowel	83	3.00	121	1.72	125	2.34	329	2.35
g-vowel	66	1.95	125	1.99	124	1.97	315	1.97
g-consonant[1/]	49	3.58	102	2.46	119	2.20	270	2.75
k-consonant	85	2.34	98	3.11	75	2.89	258	2.78

1/ No correct second grade responses for g-consonant contingent-uncommon.

Table 5

Approximate 1/ Mean Latencies by Initial Pattern Type and Letter Group Among Fourth Grade Subjects Reading Words Correctly.

	Contingent-uncommon	Contingent-common	Non-contingent
c plus vowel	3.18	2.25	2.44
g plus vowel	3.36	2.79	3.27
g plus consonant	5.85	2.92	2.93
k plus consonant	4.44	2.52	3.14
All words	3.73	2.44	2.90

1/ Values vary slightly from those presented here depending on which comparison is being made. Not all subjects read every subgroup correctly. Values presented here represent estimates of latencies based on the maximum number of observations used in any comparison. Overall differences in estimates of mean latencies by initial pattern type never differed by more than 0.2 seconds.

Table 6

Number of Errors of Different Types X Initial Patterns

	Initial Pattern			
	Contingent		Non-contingent	All
	Uncommon	Common		
All errors	368	200	210	778
Initial errors	282	29	9	320
Opposite Conting. Form	243	10	--	--
Other	29	19	--	--
Non-initial Errors	27	138	168	333
Ommissions	59	33	33	125

Table 7

Location of Error X Initial Pattern Type

	Initial Pattern			
	Contingent		Non-contingent	
	Uncommon	Common		
Error on initial spelling pattern only.	107	11	2	120
Error on initial and non-initial spelling patterns.	175	18	7	200
Error on non-initial spelling patterns only.	27	138	168	333
	309	167	177	653

Appendix A

Summary of Analysis of Variance-Latencies

Source	SS	df	MS	F	p
Grades	101.2330	2	50.6163	6.735	.005
Error 1	383.2878	51	7.5150		
Types	28.3182	3	9.4394	21.453	.001
Types X Grades	5.7142	6	.9524	2.164	.10
Error 2	67.3090	153	.4400		
Contingencies	24.4929	2	12.2465	23.416	.001
Contingencies X Grades	2. 6397	4	.6599	1.262	ns
Error 3	53.3756	102	.5230		
Contingencies X Types	8.8905	6	1.4817	3.394	.005
Contingencies X Types X Grades	2.7880	12	.2323	.532	ns
Error 4	133.6006	306	.4360		
Words within	64.5702	24	2.6904	7.032	.001
Residual Error	486.6673	1272	.3826		

Summary of Analysis of Variance-errors.

Source	SS	df	MS	F	p
Grades	24.0751	2	12.0376	5.019	.01
Error 1	122.3104	51	2.3982		
Types	4.6723	3	1.5574	10.623	.001
Grades X Types	1.4311	6	.2385	1.627	.20
Error 2	22.4244	153	.1466		
Contingencies	22.5473	2	11.2737	42.350	.001
Contingencies X Grades	.3508	4	.0877	.329	ns
Error 3	27.1574	102	.2662		
Types X Contingencies	11.2181	6	1.8697	13.932	.001
Types X Contingencies X Grades	.7850	12	.0654	.487	ns
Error 4	41.0525	306	.1324		
Words Within	25.3456	24	1.0561	9.034	.001
Residual Error	148.6543	1272	.1169		