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The present study is designed to assess the effects of phonemic type, position, contrast, and external cueing, as well as allophonic variation, on the recognition of phonemes in a word context.

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PRESCHOOL CHILDREN'S RECOGNITION OF PHONEMES IN A WORD CONTEXT

George Marsh and R. James Mineo[1]

ABSTRACT

Sixty-four preschool children were individually trained on a task requiring them to recognize an isolated phoneme in a word context. A learning set design encompassing 192 trials over 8 days was employed. The major factors investigated were: (1) the presence of a redundant visual cue; (2) phoneme type (stop vs. continuant); (3) phoneme position (initial vs. terminal); and (4) phonemic contrast between positive and negative exemplars (minimum vs. maximum). Allophonic variation of the terminal stop was evaluated on the last 4 days (transfer).

The redundant visual cue improved performance considerably over the first 4 days, but performance fell back to control group levels when the cue was removed on transfer. The other major findings were: (1) recognition of continuants was generally easier than stops, (2) phoneme type interacted with position and contrast factors, (3) terminal stop recognition was unaffected by allophonic variation, and (4) learning performance over days was very gradual.

Most of these findings were found to agree with those of other studies and a featural interpretation of phoneme discrimination.

[1]The authors acknowledge the assistance of Betty Berdiansky, Hattie Coatney, and Pat Valdivia in collecting the data; Carol Pfaff for recording the stimuli; and David Shoemaker for directing the computer analysis of data.

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The present study deals with the ability of the beginning reader to recognize the relationships between isolated letter sounds and the same sounds embedded in a word context. This ability, which is usually termed "auditory discrimination" in the reading literature, has also been called "phonetic segmentation" (cf, Calfee, Chapman, & Venezky, 1969).

It has been assessed by many different tasks including the following. 1) Ability to identify or produce rhymes; 2) Ability to discriminate whether words begin or end with the "same" sound; 3) To say what word remains when a phoneme is removed; 4) To sound out or spell by sound (i.e., given a whole word produce its constituent phonemes in order); 5) Given separate sounds of a word, to be able to recognize or produce the whole word (blending).

Performance on tasks of this type correlate highly with reading achievement (cf, Dykstra [1966] for a review of this literature). In fact, performance on this type of task, and knowledge of the alphabet are some of the best predictors of reading achievement (Chall, 1967). A major question is whether or not performance on a given task which correlates with reading ability indicates a causative relationship or merely an indirect correlation through some unknown factor. The only way to answer this question is through experimental procedures.

An early study by Murphy (1943) indicated that groups given training on tasks of this type were superior to control groups in global performance on reading achievement tests. A recent and more systematic experiment by McNeil and Coleman (1967) reported that groups given auditory training were significantly superior to control groups on the following three word identification skills: 1) Recognizing a printed word given a phoneticized pronunciation of the word; 2) Supplying phonemes corresponding to printed letters; 3) Recognizing unfamiliar words composed of familiar letters.

The latter skill is clearly the most important since it is the critical transfer performance in a phonics approach to reading. The superiority of the experimental groups in the McNeil and Coleman study is impressive because the control group received a reading program which taught some of the above skills (e.g., letter-sound association) directly.

Various outcomes have been reported concerning young children's abilities to perform some of the above tasks. The task of elision (reporting what word is left when a phoneme is removed) is a difficult one, and Bruce (1964) reported no success prior to a mental age of seven.

Calfee, Chapman, and Venezky (1969) found kindergarten children's performance in detecting rhymes to be at chance, but they indicated that the poor performance in their study was probably due to methodological problems (response bias and lack of task validity). In contrast to low performance on the rhyme detection task, 39% of the children's responses on a rhyme production task were correct in their study.

Calfee et al. (1969) also report their Ss failed on a same-different task in detecting initial sounds. Again task factors rather than subject deficiency are more likely responsible. Silberman (1964) gave several training sequences of this type and although no quantitative data is reported, it can be assumed his Ss successfully completed these sequences.

Children's performance on blending tasks has been reviewed by Desberg (1969). Children apparently are able to perform satisfactorily on these tasks after an unspecified amount of training.

The fact that children show positive transfer from training on letter sounds to reading whole words containing those sounds indirectly indicates that they recognize the relationships between the letter sounds and the same sounds embedded in a word context (Jeffrey & Samuels, 1967; Marsh & Sherman, 1969).

Another aspect of the phoneme recognition task concerns the transfer from one phonemic context to another. Zhurova (1964) reports that ability to recognize a given phoneme in a word context does not transfer to other contexts. Holland and Mathews (1963) report transfer between contexts but only for a specific phoneme. On the other hand, Elkonin (1963) and McNeil and Coleman (1967) have reported general transfer from one phoneme class to another. In the latter studies, however, the positive transfer may be related to nonspecific task factors rather than phoneme-specific factors.

One should also be concerned with the use of external support for phonetic segmentation since segmentation tasks are generally difficult to perform. Elkonin (1963) reports the use of two types of external support: 1) A picture of the word is present; 2) A "schema" (colored chips corresponding to each sound) is used. These two external supports are confounded in Elkonin's research and the picture is probably functionally irrelevant. According to Elkonin, some sort of external support seems to facilitate the task considerably over operating purely on the plane of speech."

The four possible conditions of external cueing are: 1) Operating on the "plane of speech" without external cues; 2) using highly discriminable cues such as colored chips to represent each sound; 3) using English graphemes to represent each sound; 4) referencing each sound to its articulatory movements.

In determining which one of the three latter conditions to investigate in the present study, the following factors were considered: a) While articulatory movements may have the advantage of "naturalness" and can serve as mediators through the response-produced cue mechanism, their

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use would be limited to phoneme contrasts having distinctive articulatory features, i.e., those generally associated with place and manner but not voicing. There is some incidental evidence (Holland & Mathews, 1968) that having the child repeat the word out loud will help him in recognizing phonemes in a word context. But this result could have occurred because either it forces the child to pay attention to his own articulatory movements or it heightens his general attention level. b) There is probably little advantage of colored chips over capital graphemes in discriminability for the K-level child. Furthermore, the use of the latter would have much greater transfer value to the reading task.

There is also some question whether a child is responding phonetically or phonemically. Chomsky and Halle (1968) assert that children's speech perception may be more phonetic than phonemic. If true, this would negate one of the basic assumptions of a phonics reading program, i.e., that children treat different allophones of the same phone as the "same" sounds.

There is little direct evidence for the above assumption. Chomsky and Halle offer no documentation. However, there is some indirect evidence to support it in the reading literature. Some studies show children have more difficulty recognizing phonemes in terminal and medial position than in initial position (Cavoures, 1964). This may in part be due to a phone's position in a word. Stop phones in isolation are released (cf, Russell & Pfaff, 1969), and in words of these phonemes (e.g., p, k, t) are released in initial position, unreleased in some medial positions and in free variation in terminal position (Francis, 1958). If the child is attending to aspiration he would recognize the isolated phoneme in initial position but not in medial or perhaps terminal position. It would seem important to know if allophonic variation does indeed affect children's ability to recognize phonemes in a word context.

Several other variables have been shown to influence children's recognition of phonemes in a word context. Phoneme type (i.e., stops vs. continuants) has been a significant factor in blending tasks (cf, Desberg, 1969). As mentioned previously, the position of the phoneme in a word has been shown to be an important variable (Cavoures, 1964, Zhurova, 1964). In choice tasks, the number of shared phonemes in the positive and negative exemplars (i.e., phonemic contrast) has also been found to be a factor affecting phoneme recognition performance (Holland & Mathews, 1968).

The present study is designed to assess the effects of phonemic type, position, contrast, and external cueing, as well as allophonic variation, on the recognition of phonemes in a word context.

Method

Design

The study used a learning set design similar to one employed by Gibson, Farber, and Shepela (1967) in teaching kindergarten children to abstract visual spelling patterns. The study involved a training session extending over four days and a transfer session for a similar period. In the training session there were (1) two between-subject factors: a) the presence or absence of a visual cue (exemplars in print), and b) phoneme type (stops vs. continuants); and (2) two within-subject factors: a) the position of the phoneme in the word (initial--I or terminal--T), and b) phonemic contrast of the positive and negative exemplars (minimal--MIN or maximal--MAX). On each training and transfer day, each S received six blocks of four recognition trials, where a block contained one pair of words representing a combination of the within-subject factors, i.e., I-MAX, I-MIN, T-MAX, T-MIN.

In the transfer session, the training treatments changed as follows: 1) the visual cue was removed, 2) one-half of the Ss in each phoneme class condition were switched to the other phoneme type to assess interclass transfer, and 3) the other half of each group was switched to a new set of phonemes of the same type to assess intra-class transfer.

The effect of allophonic variation was studied in the terminal stop condition in the transfer session. In one-half of the words, the terminal stop was released and in the other half, it was unreleased. Since all stops in isolation are released, a comparison of performance when terminal stops are unreleased or released in the word will indicate how allophonic variation influences children's recognition of the phonemes.

Subjects

The Ss were 64 pre kindergarten children attending six private preschools in the Los Angeles Metropolitan area. The Ss ages ranged from 4 years, 4 months to 5 years, 7 months, with a mean age of 5 years. Thirty-four boys and 30 girls completed the study; 3 boys and 5 girls were dropped from the study due to illnesses and vacations. The Ss were all Caucasian and spoke a Standard English dialect. Children whose parents spoke to them in a foreign language (e.g., Spanish) were excluded from the study. The Ss ranged in IQ (Peabody Picture Vocabulary Test) from 65 to 131 with a mean of 104.

Apparatus and Materials

Major apparatus of the study consisted of a slide projector (Kodak Carousel Model 750), a stereo cassett recorder (Ampex Micro 88), two directional speakers and a rear-projection screen. The speakers were positioned at the left and right of the projection screen. The visual stimulus (visual cue condition) was synchronized with the audio stimulus by tripping the slide changer on the projector with an inaudible tone on the tape. The S sat approximately three feet from the speaker-screen display.

The materials consisted of 192 high-frequency word pairs chosen from available kindergarten lexicon lists (Rinsland, 1945; Kolson, 1960) the phonemes for the graphemes b, d, f, n, p, t, s, and m. The word pairs and target phonemes are given in Appendix 1. The word pairs were recorded by a linguist.[1] In the visual cue condition, the words were projected to the left and right margins of the screen and the graphemes for phoneme correspondence training were displayed on cards. Words and graphemes were shown in capital letters.

Procedure

Prior to testing, each S was given the Peabody Picture Vocabulary test. Each S was then randomly assigned to a treatment group and tested in a room provided by the school or a mobile laboratory if a room was not available.

Just prior to recognition training, the Ss in the visual cue groups learned to pair the phoneme used in the recognition task with its grapheme; the remaining Ss learned the same phonemes but with colored cards rather than the graphemes as stimuli. Training in the paired-associate task was carried to a criterion of 9 correct out of 10 responses.

The recognition task was a forced-choice matching-to-sample (A-B-X) paradigm. On each trial the S was instructed by a taped voice to indicate which word begins (or ends) with the sound X. The words came over the left and right speakers in that order. The child then responded by pointing to one of the speakers. In the visual cue condition each word appeared on the screen next to the appropriate speaker prior to audio presentation of the words. The S was informed by the experimenter of the correct responses on each trial.

In the training session, Ss in the stop condition identified which word of a pair contained the phoneme /b/ or /d/ in the initial or terminal position. The Ss in the continuant condition identified words containing the phoneme /s/ or /m/. In the transfer session, Ss receiving the stop condition had words containing the phonemes /p/ or /t/; those in the continuant condition had words with the phonemes /f/ and /n/. Prior to the transfer trial series, all Ss were familiarized with the phonemes they were to identify in the word pairs. A weekend elapsed between the training session and the transfer session for all Ss.

A single phoneme was tested in each block and the phoneme which occurred first on each day was counterbalanced over days. The order of positive and negative exemplars of a pair and the order of pairs within the 4-trial block were randomized.

Results

The basic datum for the principal analyses of training and transfer performance was the number of correct recognitions over the six trials for each within-subject condition on a given day. The scores for training and transfer were analyzed separately with the mixed analysis of variance procedure. Between-subject dimensions were visual cueing and phoneme class for the training data analysis and visual cueing and phoneme class switching (inter- vs. intra-phoneme class) for the transfer data analysis. Number of session days (4), phoneme position and word pair contrast were the within-subject dimensions of both analyses. The results of the ANOVAs are summarized in Appendix II.

The essential between-subjects results for the training session are shown in Figures 1 and 2. Confirming the wide separation of the curves in Figure 1, the visual cue condition was significantly superior to the nonvisual condition, $F = 36.39$, $df = 1/60$, $p<.001$. Figure 2 shows that continuants were easier to recognize than stops in a word context, however this difference was only marginally significant, $F = 5.50$, $df = 1/60$, $p<.05$. As both figures show, performance over training days improved, and significantly so, $F = 7.15$, $df = 3/180$, $p<.01$.

Phoneme class significantly interacted with position ($F = 10.61$, $df = 1/60$, $p<.01$) and word pair contrast ($F = 7.40$, $df = 1/60$, $p<.01$) during training. It was found that performance was better in the initial position with the continuants but that the final position was superior for the stops. In the case of the interaction involving minimum-maximum contrasts, performance under the continuant condition was generally indistinguishable across contrast types whereas that under the stop condition was better with maximum contrasts.

The analysis of the training scores also revealed a number of marginally significant interactions at the .05 level. The size of the interaction effects, however, do not merit considering them here.

Figures 3 and 4 portray the between-subject main effects for the transfer session. In contrast to training, Figure 3 reveals that the visual and nonvisual cue conditions were quite indistinguishable during transfer ($F>1$). Figure 4 suggests that switching to phonemes within

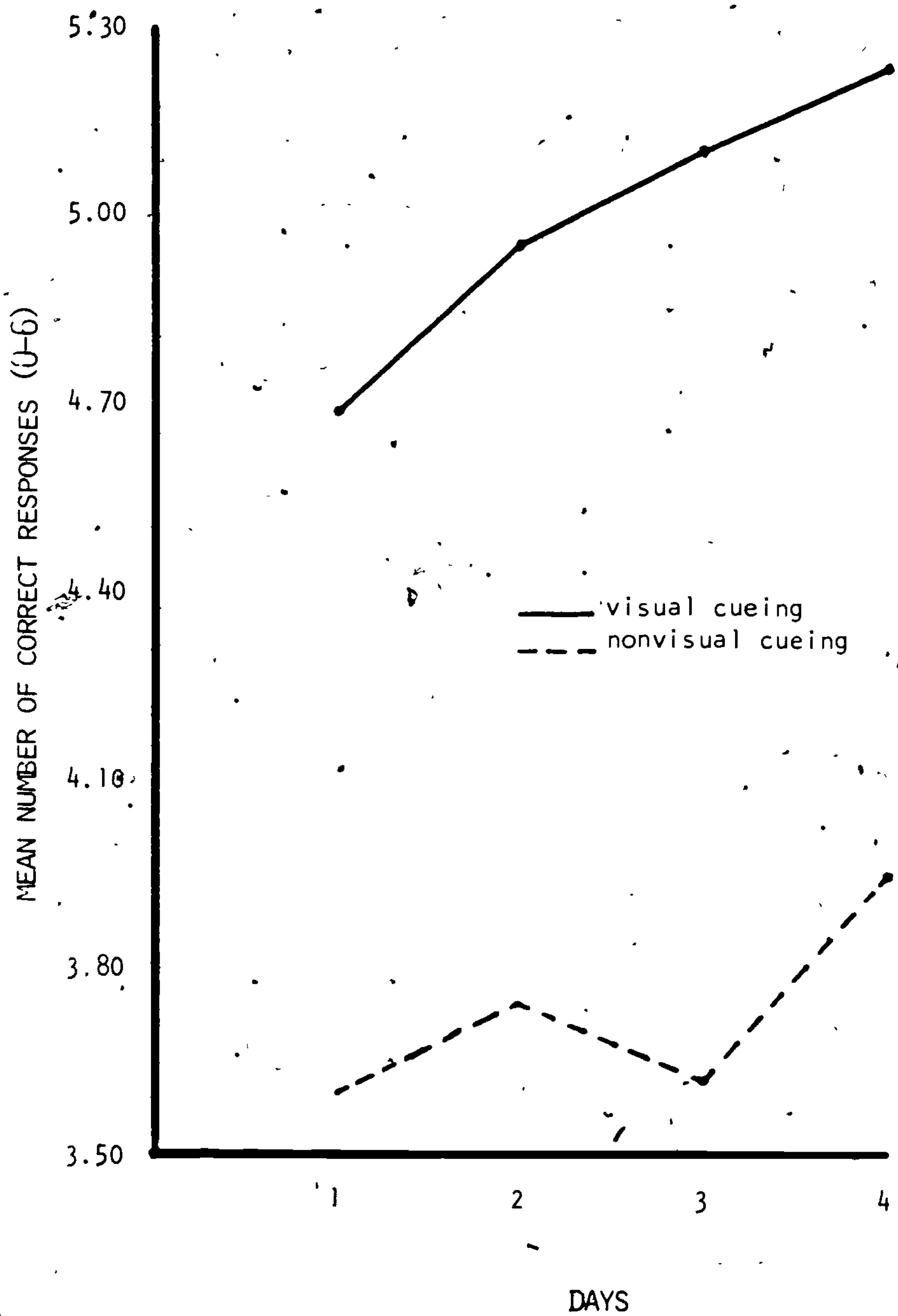

Figure 1. Phoneme recognition over training days for visual and nonvisual cue conditions.

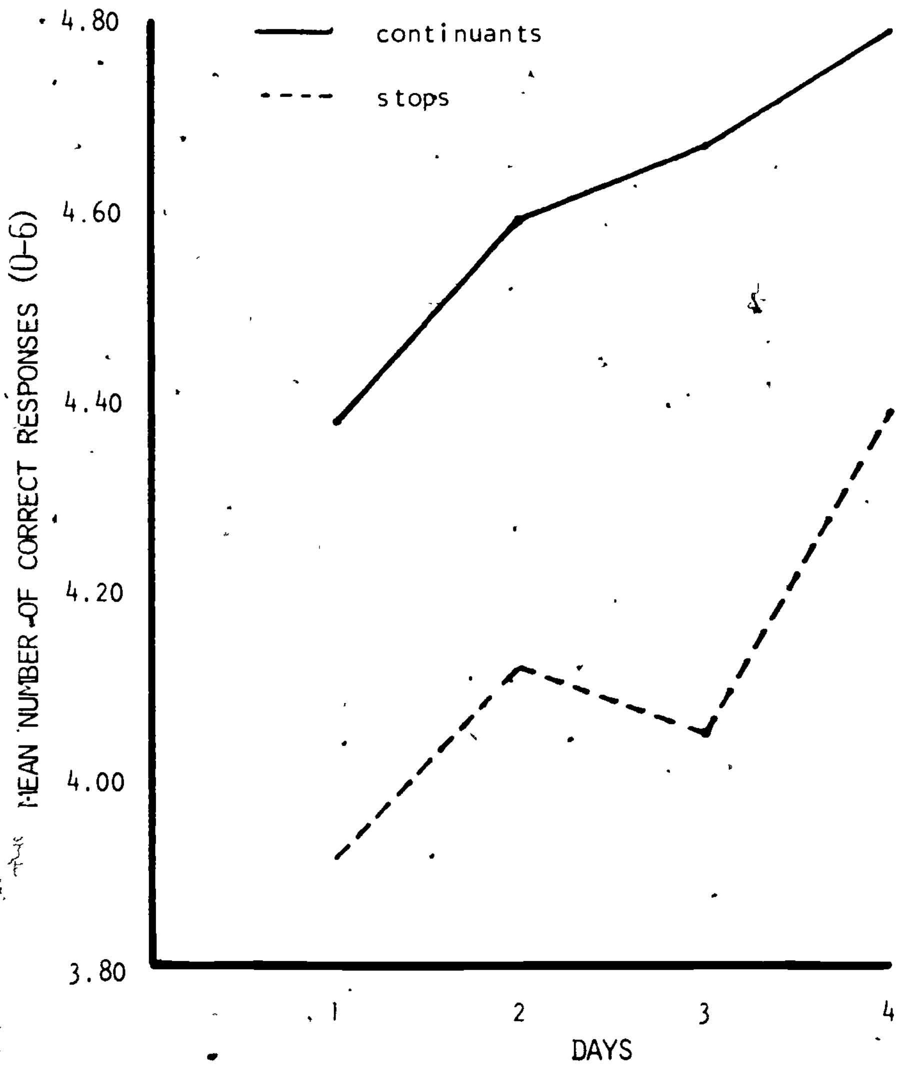

Figure 2. Phoneme recognition over training days and stop conditions.

TABLE 1

MEANS AND STANDARD DEVIATIONS OF TREATMENT CONDITIONS IN THE TRANSFER SESSION

Between Groups	Within Groups								
	I-MIN		I-MAX		T-MIN		T-MAX		
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Row Mean
V-No Switch	4.12	1.34	3.88	1.28	3.84	1.40	4.06	1.53	3.98
V-Switch	3.85	1.07	3.89	1.32	3.86	1.41	3.73	1.36	3.83
NV-No Switch	4.14	1.2	4.17	1.41	4.19	1.38	4.03	1.53	4.03
NV-Switch	3.94	1.29	3.55	1.30	3.62	1.29	3.83	1.26	3.83
Total Mean	4.01		3.87		3.88		3.91		3.91092

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the same phoneme class led to better recognition than switching to phonemes in another class. However, this difference failed to reach significance, $F = 1.59$, $df = 1/60$, $p > .05$.

A marginally significant improvement in recognition performance over transfer days was found, $F = 3.46$, $df = 3/180$, $p < .05$; but as Figures 3 and 4 indicate, this trend was somewhat smaller than the one found during training days.

The remaining significant effect obtained on the transfer data was a third order interaction between cueing, phoneme class switching, position and contrast, $F = 5.44$, $df = 1/60$, $p < .01$. The means and standard deviations for the factor levels involved in this interaction can be found in Table 1. It is apparent from Table 1 that differences between the means are too slight to allow any description of the interaction that could be useful.

Allophonic variation in the terminal stop condition failed to achieve significance in a test comparing recognition under the released and unreleased conditions, $t = 1.02$, $df = 31$, $p > .05$.

Discussion

The major finding of the training session was the substantial improvement in phoneme recognition that resulted from presenting the previously P-A trained graphemes as a relevant redundant cue. The lack of difference between the visual and nonvisual groups during transfer when the visual cue was absent would imply however, that providing external supports during training will generate little, if any, non-specific transfer to the phonetic segmentation task performed entirely with the use of auditory cues, i.e., "the plane of speech." With regard to specific transfer effects, that is, whether training with a specific grapheme present facilitates recognition of the corresponding phoneme in the absence of the grapheme, no information is available from the study since the phonemes in the transfer task were different from those used in training.

The training data also revealed that children found it a little easier to recognize continuants than stops, a finding that agrees with previous work in "blending". As Desberg (1969) points out, most previous work in "blending" actually made use of a word recognition task. The word recognition task is somewhat the inverse of the task used here since the S is given isolated sounds and the word must be recognized, while in the present case the word is given and the isolated sounds must be identified.

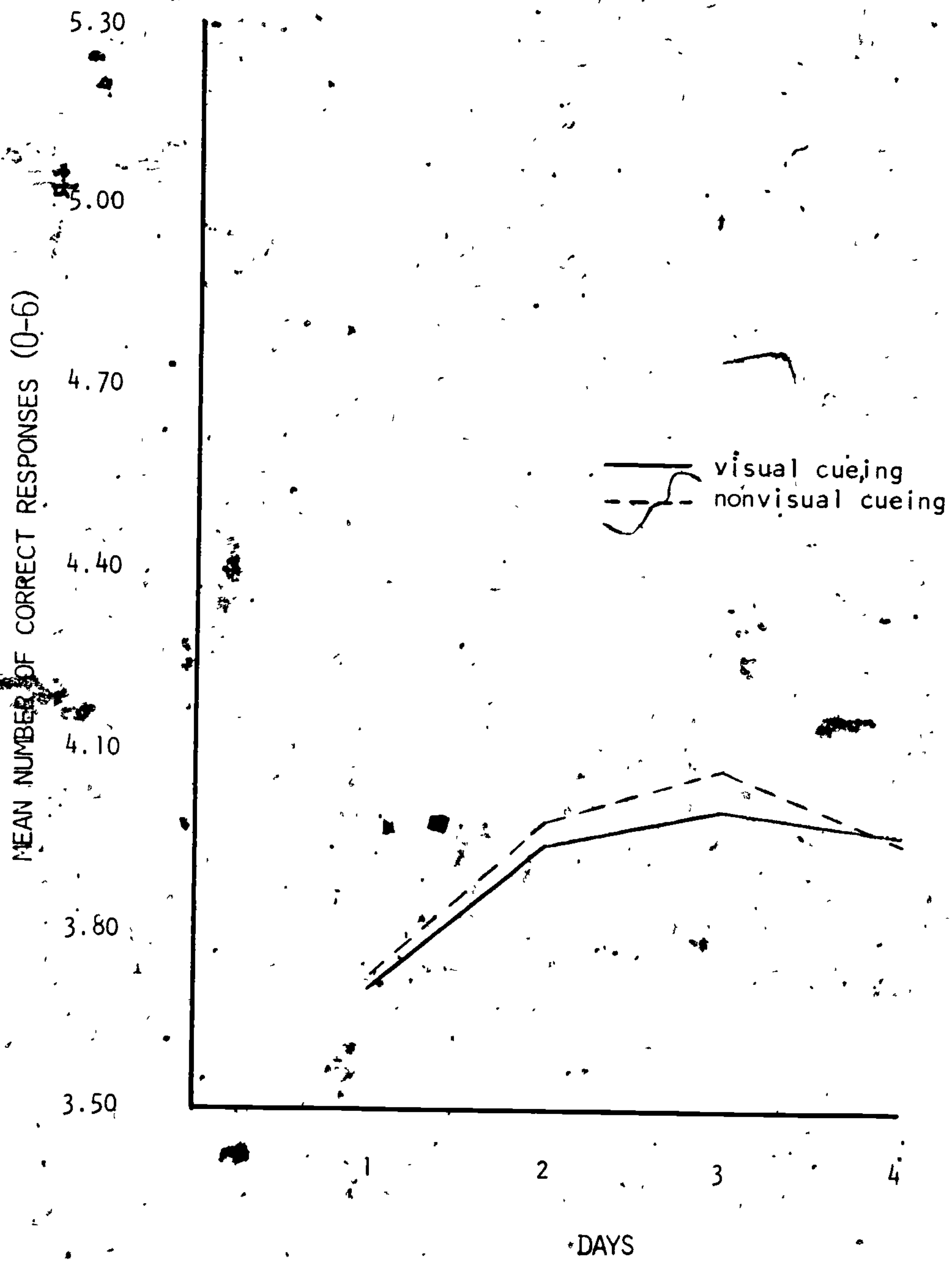

Figure 3. Phone recognition over transfer days for the cueing conditions of training.

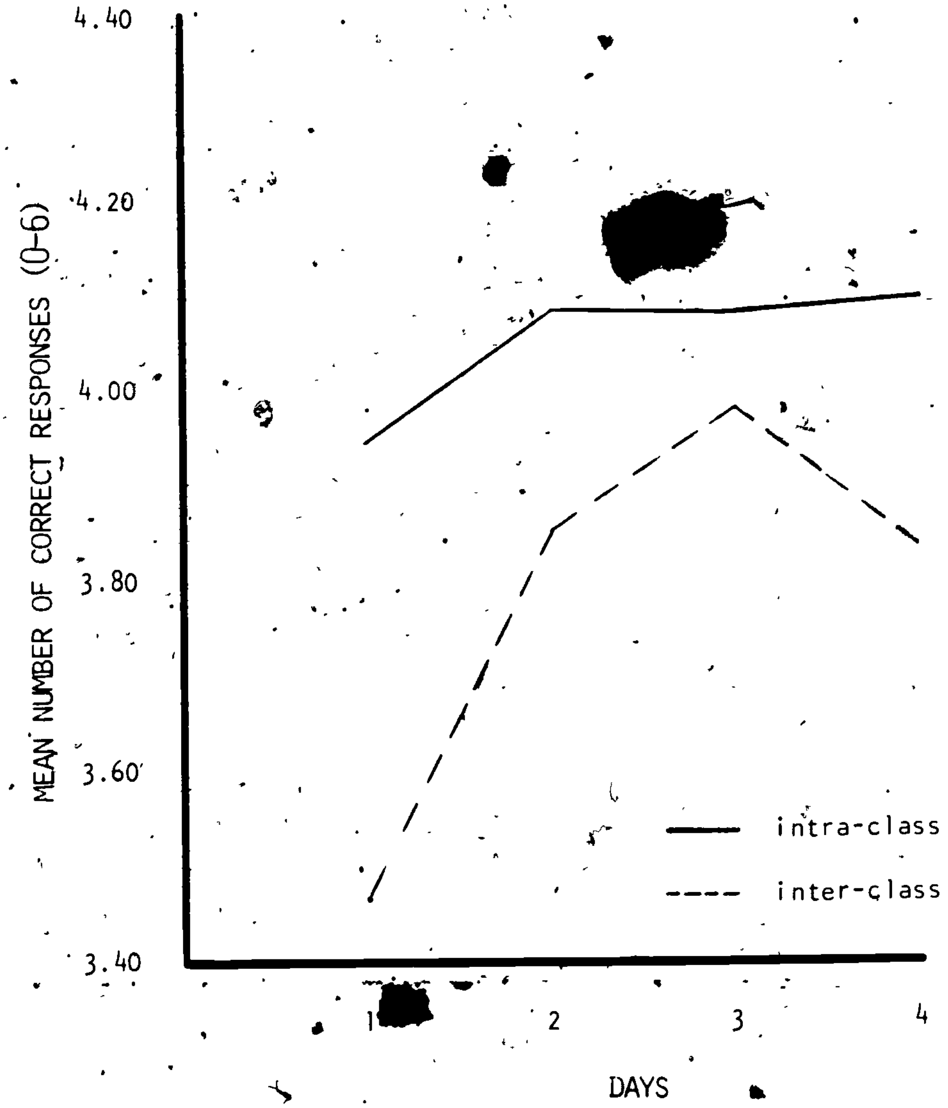

Figure 4. Phone recognition over transfer days for intra- and inter-phoneme class switching conditions.

One explanation that might account for the greater difficulty in recognitizing stops in "isolation" is that they cannot be produced strictly in isolation but must be followed by a vowel sound (in the present case a voiceless schwa /ə/). Since the following vowel sound in isolation is often not the same as the following vowel sound in the word there is a greater opportunity for a perceptual mismatch. However, a second and possibly more compelling explanation for the superiority of the continuants over the stops in the present study involves the phonemic contrast between the initial phoneme in the positive and negative exemplars of each word pair. A post hoc analysis[2] of the minimal word pairs used in the present study indicated that there were more phonemic contrasts differing by only one feature (place or voicing) in the stop condition than in the continuant condition.

The presence of such an imbalance in confusibility may well be responsible for the stop vs. continuant difference. A similar phonemic analysis should be carried out on the word recognition or blending studies using a choice procedure to determine the presence of a similar bias since phonemic contrast probably was not controlled in these studies either.

Although there was a significant days (practice) effect in both the training and transfer tasks, the learning demonstrated over 192 trials in eight days is not impressive. No group doing a purely auditory analysis had reached anywhere near perfect performance. In fact, on the last day of transfer there is a downturn in performance which is difficult to explain except on the basis of boredom or fatigue.

During training it was further found that performance was better in the initial position with the continuants but the opposite was true with the stops. The initial position has been found to produce superior performance in previous studies (e.g., Cavoures, 1964; Zhurova, 1964). The most logical reason for the reversal in the case of the stops is that while a stop in isolation is followed by a given vowel, in this case a voiceless schwa, the stop in the initial position is followed by any number of other vowels. Thus, the child may have difficulty in recognizing a stop phoneme as the same consonant sound when it is followed by various vowel sounds in the initial position. The problem would not occur to this extent with stops in the terminal position because a stop in terminal position in the present study (except for some cases in transfer session) was aspirated. An aspirated stop in terminal position is very similiar in sound to a stop in isolation followed by a voiceless schwa.

[2]The authors would like to thank Bob Rudegeair for this analysis.

Analysis of the training data also showed phonemic type to interact with phonemic contrast. Performance was similar under the maximum and minimum contrast conditions for the continuants which probably only reflects the relative ease in recognizing continuants. In the case of the stops, performance was superior, as expected, under the maximum contrast condition. As noted previously, the stops had more phoneme pairs in which the contrasts were phonemically minimal (i.e., a one-feature difference in place or voicing) as well as having a context of two overlapping phonemes other than the target phoneme.

Finally, the transfer data revealed that the children in this study were little affected by allophonic variation of stops in the terminal position of single-syllable words. The results discussed previously suggested that the vowel following the initial stop may be an important factor in recognizing the initial stop. But, by contrast, it appears that allophonic difference in terminal stops, which occur in free variation in English, has little affect on recognizing stops in this position.

Pedagogical Recommendations

The failure to find any substantial general transfer from training with redundant visual does not serve to validate this as a pedagogical strategy for phoneme segmentation. When children are given P-A phoneme-grapheme training prior to segmentation training, they apparently rely on the previously learned visual cues to do these tasks during recognition testing if auditory discrimination is not required in the task. Whether visual cueing thus has an inhibitory or synergistic effect on auditory cueing needs to be investigated further by testing for specific (the same phonemes used in training and transfer) as well as nonspecific transfer.

The unimpressive recognition performance in the present study is not convincing evidence that auditory training alone is sufficient for phone segmentation and suggests the investigation of other word attack skills. If, however, aural segmentation training is subsequently found to facilitate word attack, then the results of the present effort would suggest: 1) Introducing words which begin with continuants, 2) Introducing words which end with stops, and 3) Employing words in early instruction that have as few phonemes in common as possible, especially when the phonemes to be learned are stops.

APPENDIX I

WORD PAIRS PRESENTED ON EACH TRAINING DAY FOR STOPS /b/ AND /d/

DAY 1	DAY 2	DAY 3	DAY 4
tack - back	gone - bat	bell - hot	cuff - bill
like - bag	ban - can	bet - get	rib - Rick
pub - pup	cat - cab	heat - robe	kit - bit
tub - hat	rib - vain	jog - job	hat - rib
pan - dan	hut - ride	dot - gas	lass - kid
pad - pack	dot - gain	done - run	dear - pen
gate - door	got - dot	fat - fad	lad - lack
can - raid	code - coat	tide - lake	peel - deal
robe - rope	sat - rob	lack - lab	rob - rot
bag - roll	cut - cub	pill - bean	tube - miss
bag - tag	cat - bat	for - lab	car - bit
mob - fix	bed - mop	beam - team	bush - push
cat - done	dog - mat	fade - fate	deep - keep
red - fat	sat - sad	ten - den	rope - den
mat - mad	red - fun	need - gin	leg - led
dime - time	care - dare	dig - wall	lip - mad
coke - ban	game - bet	big - case	but - time
tab - tag	bell - tell	not - knob	Mike - tub
care - bear	same - jab	robe - sun	bar - car
cab - heel	fib - fit	bill - kill	rut - rub
cave - duck	date - gate	debt - pet	mice - led
kid - kick	mate - doll	hat - dip	dan - cut
can - Dan	side - gap	nod - knock	lid - lick
rid - let	rig - rid	red - hum	gun - done

WORD PAIRS PRESENTED ON EACH TRANSFER DAY FOR STOPS /p/ AND /t/

DAY 1	DAY 2	DAY 3	DAY 4
like - cap	cup - raid	pair - dare	mop - mod
beep - bead	gas - pass	dig - dip	big - pig
pack - back	peace - for	pipe - dog	mine - path
pile - gear	cop - cog	fan - lip	side - cop
cab - tab	take - bake	man - right	beam - team
bag - bat	fell - tame	coat - code	fate - fake
hail - tack	beet - beak	hole - ten	shot - hum
rat - give	bell - rot	tear - bear	tick - near
paid - beam	coke - cope	car - map	game - ripe
keep - make	code - pig	lap - lack	pill - kill
cab - cap	dime - gap	bin - pin	pave - hall
pad - dad	pick - kick	pun - goal	lip - lick
rot - rob	take - sign	cheat - some	toss - more
tag - bag	bike - sat	cub - cut	den - shut
like - rate	but - bug	nod - type	cuff - tough
her - tan	tone - done	bell - tell	leg - let
can - pan	page - cage	pen - den	keep - hill
cope - seem	peel - cone	leap - lead	read - reap
cape - cake	deed - deep	sail - hop	pore - door
peg - kill	lap - nine	push - keen	pen - big
bet - bed	kit - kid	did - heat	time - rhyme
sad - right	tame - game	ten - den	knob - not
fine - tail	tell - sock	dot - dog	debt - fill
tan - Dan	site - read	tire - sole	life - talk

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WORD PAIRS PRESENTED ON EACH TRANSFER DAY FOR CONTINUANTS /f/ AND /n/

DAY 1		DAY 2		DAY 3		DAY 4	
vat	fat	fate	hate	life	sit	fall	hope
beam	beef	puss	puff	fought	hot	fox	sox
got	calf	heap	deaf	roof	room	buff	bum
fire	sat	fail	cup	some	fit	roof	hike
ban	bass	pass	knit	sign	heat	mine	case
sin	cat	cove	cone	night	height	cap	nose
sap	nap	dog	cane	live	line	hat	gnat
not	sight	net	set	pail	not	move	moon
beef	come	goof	pick	lamb	laugh	mill	fill
mad	fad	rush	rough	fix	tear	wife	set
home	fat	veal	feel	bad	puff	for	tame
life	live	fake	bomb	fight	site	cuff	come
rope	nail	read	nine	gun	pal	poor	none
Ben	hot	Dan	goal	hill	neat	hook	nook
nail	hail	dine	dice	dean	dear	men	mess
cave	cane	hear	near	kneel	veal	pan	his
life	lice	hit	feel	game	five	fat	ball
cuff	mile	safe	save	hog	fog	loaf	car
sail	fail	hear	fear	jem	Jeff	goof	goose
far	sip	ripe	laugh	safe	mix	for	more
pat	bean	sip	nap	note	vote	mine	mice
net	lock	night	gas	line	cove	news	lose
name	same	duck	done	nice	hear	rain	like
kin	kiss	den	pile	gave	gain	tape	knock

WORD PAIRS PRESENTED ON EACH TRAINING DAY FOR CONTINUANTS /s/ AND /m/

DAY 1	DAY 2	DAY 3	DAY 4
base - cave	beef - loss	pace - pave	gin - toss
dice - dive	hole - soul	set - life	sun - top
vat - sat	soak - like	ban - guess	piece - peeve
sap - jail	lice - live	veal - seal	such - hutch
bum - bull	hate - mate	gave - game	vine - mine
bam - hit	dumb - dove	dime - veal	bat - them
like - mad	mat - pill	meat - heat	have - ham
mat - hat	hike - name	bear - mit	roll - met
got - sad	vine - sign	sub - hub	head - said
case - cave	fine - pass	rail - race	puff - sit
base - five	lease - lean	deaf - sock	bus - bun
had - sad	sat - hen	bun - gas	rice - calf
comb - cove	mob - can	hill - mill	tot - tom
van - man	beam - beef	live - limb	hot - jam
hiss - beam	hill - bum	make - bull	meet - pill
man - vine	hush - mush	lime - rat	mop - hop
dole - dose	sell - fun	sip - cave	heat - seat
can - sick	hope - soap	hang - sang	loss - lawn
soak - poke	noon - noose	pass - pat	six - vat
fan - boss	den - face	hear - lass	pass - life
vain - main	heal - meal	mop - cat	dog - mill
hat - game	mill - pen	roof - room	hope - mope
fill - map	cuff - come	hit - mit	laugh - lamb
dime - dive	let - rum	ram - hog	dim - hub

APPENDIX 2

SUMMARY OF ANOVA FOR TRAINING SCORES

Source	df	Mean square	F
Between Subjects	63		
Cueing (C)	1	410.06250	36.39**
Class (CL)	1	62.01562	5.50*
C X CL	1	14.06250	1.25
Error	60	11.26953	
Within	960		
Practice Days (P)	3	8.17448	7.15**
C X P	3	1.75781	1.54
CL X P	3	.69010	.60
C X CL X P	3	4.00781	3.51*
Error	180	1.14297	
Position (PO)	1	.01563	.02
C X PO	1	.39063	.42
CL X PO	1	9.76563	10.61**
C X CL X PO	1	2.25000	2.45
Error	60	.92005	
Contrast (CO)	1	.39063	.46
C X CO	1	.01563	.02
CL X CO	1	6.25000	7.40**
C X CL X CO	1	3.51563	4.16*
Error	60	.84505	
P X PO	3	1.47135	1.42
C X P X PO	3	.74219	.72
CL X P X PO	3	1.55469	1.50
C X CL X P X PO	3	2.95573	2.86*
Error	180	1.03446	
P X CO	3	1.46094	1.48
C X P X CO	3	.77344	.79
CL X P X CO	3	.79948	.81
C X CL X P X CO	3	2.33594	2.38
Error	180	.98342	
PO X CO	1	8.26563	6.54*
C X CO X PO	1	.14063	.11
CL X CO X PO	1	.14063	.11

*$p < .05$
**$p < .01$

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C X CL X CO X PO	1	.25000	.20
Error	60	1.26380	
P X PO X CO	3	1.61719	1.60
C X P X PO X CO	3	1.72135	1.76
CL X P X PO X CO	3	1.78385	1.77
C X CL X P X PO X CO	3	2.20573	2.19
Error	180	1.00773	

APPENDIX 3

SUMMARY OF ANOVA FOR TRANSFER SCORES

Source	df	Mean Square	F
Between Subjects	63		
Cueing (C)	1	.19141	.02
Switching (S)	1	18.59766	1.59
C X S	1	4.25391	.36
Error	60	11.68567	
Within	960		
Practice Days (P)	3	5.41016	3.46*
C X P	3	.10807	.07
S X P	3	1.55599	1.00
C X S X P	3	.27474	.17
Error	180	1.56122	
Position (PO)	1	.56250	.24
C X PO	1	.06250	.03
S X PO	1	.00000	.00
C X S X PO	1	.06250	.03
Error	60	2.33229	
Contrast (CO)	1	.76563	.82
C X CO	1	.14063	.15
S X CO	1	.06250	.07
C X S X CO	1	.00000	.00
Error	60	.93724	
P X PO	3	2.71354	1.79
C X P X PO	3	.77604	.51
S X P X PO	3	.51563	.34
C X S X P X PO	3	.17188	.11
Error	180	1.51866	
P X CO	3	1.94792	1.84
C X P X CO	3	.71875	.68
S X P X CO	3	.72396	.68
C X S X P X CO	3	1.33854	1.28
Error	180	1.05642	
PO X CO	1	2.06641	1.42
C X PO X CO	1	.03516	.02
S X PO X CO	1	.09766	.07
C X S X PO X CO	1	7.91016	5.44**
Error	60	1.45306	
P X PO X CO	3	2.22266	2.11
C X P X PO X CO	3	1.63932	1.56
S X P X PO X CO	3	.10807	.10
C X S X P X PO X CO	3	1.44043	1.37
Error	180	1.05287	

* $p < .05$
** $p < .01$

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