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ABSTRACT

This 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. The subjects were 64 prekindergarten children attending six private preschools in the Los Angeles metropolitan area. The subjects were all Caucasian and spoke a standard English dialect. A learning set design encompassing 192 trials over eight days was employed. The following relevant factors were investigated: the presence of a redundant visual cue, the type of phoneme (stop vs. continuant), the phoneme position, and the phonemic contrast between the positive and negative exemplars. It was concluded from the results that the redundant visual cue improved performance considerably; when the cue was removed, however, performance fell to control group levels in the second week. Generally, continuants were superior to stops. The position and contrast factors interacted with phoneme type, Groups transferred within phoneme class were superior to those transferred between phoneme class. The results suggest that the vowel following the initial stop may be an important factor in recognition, but allophonic differences which occur in free variation in English with terminal stops are not important. (TS)

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CHILDREN'S RECOGNITION OF PHONEMES IN A WORD CONTEXT

George Marsh and Jim Mineo[1]

ABSTRACT

Sixty-four preschool children were trained on a task requiring them to recognize an isolated phoneme in a word context. A learning set design encompassing 192 trials over eight days was employed. Five relevant factors were investigated: a) The presence of a redundant visual cue; b) The type of phoneme (stop vs. continuant); c) The phoneme position; d) The phonemic contrast between the positive and negative exemplars.

The redundant visual cue improved performance considerably but performance fell to control group levels in the second week when the cue was removed. Generally, continuants were superior to stops. The position and contrast factors interacted with phoneme type. Groups transferred within phoneme class were superior to those transferred between phoneme class. In the second week a number of variables interacted in a complex fashion.

[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.

CHILDREN'S RECOGNITION OF PHONEMES IN A WORD CONTEXT

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 termed "phonetic segmentation" (cf, Calfee, Chapman, & Venezky, 1969).

It has been assessed by many different tasks including the following: a) Ability to identify or produce rhymes; b) Ability to discriminate whether words begin or end with the "same" sound; c) To say what word remains when a phoneme is removed; d) To sound out or spell by sound (i.e., given a whole word to produce its constituent phonemes in order); e) 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, along with knowledge of the alphabet, is one 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: a) Recognizing a printed word given a phoneticized pronunciation of the word; b) supplying phonemes corresponding to printed letters; c) recognizing unfamiliar words composed of familiar letters.

The latter skill is clearly the most important as 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) report kindergarten children's performance in detecting rhymes at chance but they indicate the poor performance in their study is 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).

A second question 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.

A third question concerns the use of external support for phonetic segmentation performance. Elkonin (1963) reports the use of two types of external support: a) A picture of the word is present; b) 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: a) Operation without external cues on the "plane of speech"; b) using highly discriminable cues such as colored chips to represent each sound; c) using English graphemes to represent each sound; d) referencing each sound to its articulatory movements.

In determining which one of the three latter conditions will produce optimal performance the considerations are as follows: a) There is probably little advantage of colored chips over capital graphemes in discriminabity for the K-level child. The use of the latter would have much greater transfer value to the reading task. b) The use of articulatory movements as a referent has the advantage of "naturalness" and is something the child could generate himself as a "response produced cue." On the other hand it would seem difficult to use these cues for all phoneme contrasts (e.g., voicing) and therefore their use would be of limited generality. There is some incidental evidence (Holland & Mathews, 1968) that having the child repeat the word out loud assists the child in recognizing phonemes in a word context. This result could be obtained because it forces the child to pay attention to his own articulatory movements, or it may facilitate performance merely on the basis of general attentional effects.

Another question is whether or not 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 will treat different allophones of the same phoneme 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 this hypothesis 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 releated (cf, Russell & Pfaff, 1969), and in words many 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 phonemic contrast (i.e., the number of shared phonemes in the positive and negative exemplars) has been judged to be a factor effecting performance on a phoneme recognition task (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 recognition of phonemes in a word context.

Method

Design

The basic design of the study was learning set design similar to that employed by Gibson, Farber, and Shepela (1967) in teaching kindergarten children to abstract visual spelling patterns. The study involved a training session of 24 trials a day for four days and a transfer session for a similar period. In the training session there were two between Ss factors: a) The presence or absence of a visual cue (graphemes), and b) phoneme type (stops vs. continuants). There were in addition two within Ss 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). Each of the six daily blocks of four trials contained one pair of words representing a combination of these factors, i.e., I-MAX; I-MIN; T-MAX; and T-MIN.

In the transfer session (second week), 1) the visual cue was removed for both groups, 2) one-half of the Ss in each phoneme class condition (stops vs. continuants) 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 class to assess intraclass transfer. The position and contrast factors were maintained in the transfer session.

The effect of allophonic variation was studied in the terminal stop condition in the transfer session. In one-half of the words in this condition the terminal stop was released and in the other half it was unreleased. Since all stops in isolation were released, a comparison of performance when the terminal stops were unreleased and released in the words was designed to assess the effect of allophonic variation on 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' age ranged from 4 yrs. 4 mos. to 5 yrs. 7 mos. with a mean age of 5 yrs. 0 mos. There were 34 boys and 30 girls. The Ss were all Caucasian and spoke a Standard English dialect. Children whose parents spoke a foreign language to them at home (e.g., Spanish) were excluded from the study. The Ss mean IQ as measured by the Peabody Picture Vocabulary Test was 104 with a range of 65 to 131.

Apparatus and Materials

The apparatus was an audio-visual system consisting of a Kodak Carousel Model 750 slide projector which projected the graphemes on a rear projection screen in the visual cueing condition. The audio portion of the program was presented on an Ampex Micro 88 stereo cassette recorder. The slide projector was sequenced by an inaudible tone on the tape which presented the visual stimulus concurrently with the audio stimulus.

The materials consisted of 192 high frequency word pairs chosen from a kindergarten lexicon (Rinsland, 1945; Kolson, 1960). Each word pair was recorded by a linguist on one of six cassette tapes and the words were represented by capital graphemes on 35 mm slides. The entire set of stimulus words used in this study is shown in Appendix I.

Procedure

Prior to testing the children were given the Peabody Picture Vocabulary test. The children were then randomly assigned to one of the conditions of the experiment and were tested individually in a room provided by the school or a mobile laboratory trailer, if a room was not available.

The children in the visual condition were given Paired Associate (P-A) training on the grapheme-phoneme pairs which were used in the recognition task during training to a criterion of nine out of ten correct responses. The nonvisual group was given equivalent P-A training on the same phonemes but with colored cards rather than graphemes as the stimuli.

The Ss in the stop condition were presented with words which contained the phoneme /b/ or /d/ in the initial or terminal condition. The Ss in the continuant condition were presented with the phonemes /s/ and /m/. There were six blocks of four trials per day. Within each block of four trials there were two minimal contrast pairs either in the initial position (e.g., MAT--CAT) or terminal position e.g., CAT-CAB) and two pairs of maximal contrasts (e.g., SAT--HEN or HOT--JAM). The order of the pairs within a block was randomized with the restriction that one of each type occur in each block. The order of the positive and negative exemplars was also randomized. Each block of four trials contained a single phoneme exemplar and which phoneme occurred first was counterbalanced over days.

The actual task was a forced-choice matching-to-sample (A-B-X) paradigm. On each trial the Ss were instructed by a voice on the tape to indicate which word begins (or ends) with the sound X. The first word came over the left-hand loudspeaker and the second came over the right speaker. The child then indicated by pointing at the appropriate speaker. In the visual condition the audio was accompanied by the visual word which occurred on a screen next to the appropriate loudspeaker. The Ss were informed by the experimenter of the correctness of their response on each trial.

In the transfer session there was no P-A training with graphemes but all Ss were familiarized with the phoneme they were to listen for prior to testing.

Results

Training

The S's mean scores were analyzed in a 2 x 2 x 2 x 2 x 4 factorial mixed analysis of variance. The learning curves for the visual and nonvisual groups are shown in Figure 1. The visual group was significantly superior to the nonvisual group over all days ($F = 36.39$, $df = 1/60$, $p < .001$). The learning curves as a function of phoneme type are shown in Figure 2. The group trained on the continuants was superior to the group trained on the stops ($F = 5.50$, $df = 1/60$, $p < .05$). Of the three within subject main effects (position, phonemic contrast, and practice) only the practice effect was significant ($F = 7.15$, $df = 3/180$, $p < .01$).

There were significant first order interactions between phoneme class and the position factor ($F = 10.61$, $df = 1/60$, $p < .01$) and phoneme class and the contrast factor ($F = 7.40$, $df = 1/60$, $p < .01$). There was a marginally significant interaction between the position factor and the phoneme contrast factor ($F = 6.54$, $df = 1/60$, $p < .05$). The analysis of variance tables for the training and transfer sessions are shown in Appendix II.

Transfer

In the transfer session of the second week the data was analyzed in a 2 x 2 x 2 x 2 x 2 x 4 mixed model analysis of variance. The learning curves for the visual and nonvisual groups are shown in Figure 3. There was no significant difference between these groups in the second week ($F < 1$). The difference between phoneme classes in the second week was also not significant ($F < 1$).

Of the three within Ss factors again only the practice effect was significant ($F = 3.17$, $df = 3/168$, $p < .05$). Of the first order interactions only practice X the phoneme class switching variable was significant ($F = 4.35$, $df - 3/168$, $p < .01$). The learning curves as a function of intra- and interclass transfer are shown in Figure 4.

There was a significant fourth order interaction involving cueing, phoneme class, phoneme class switching, position and contrast ($F = 7.40$, $df = 1/56$, $p < .01$).

A t-test was run on the allophonic variation factor in the terminal stop condition and was not significant in the transfer session ($t = 1.02$, $df = 62$, $p > .05$).

FIGURE 1

Learning Curves for Visual and Nonvisual Cueing During Week 1

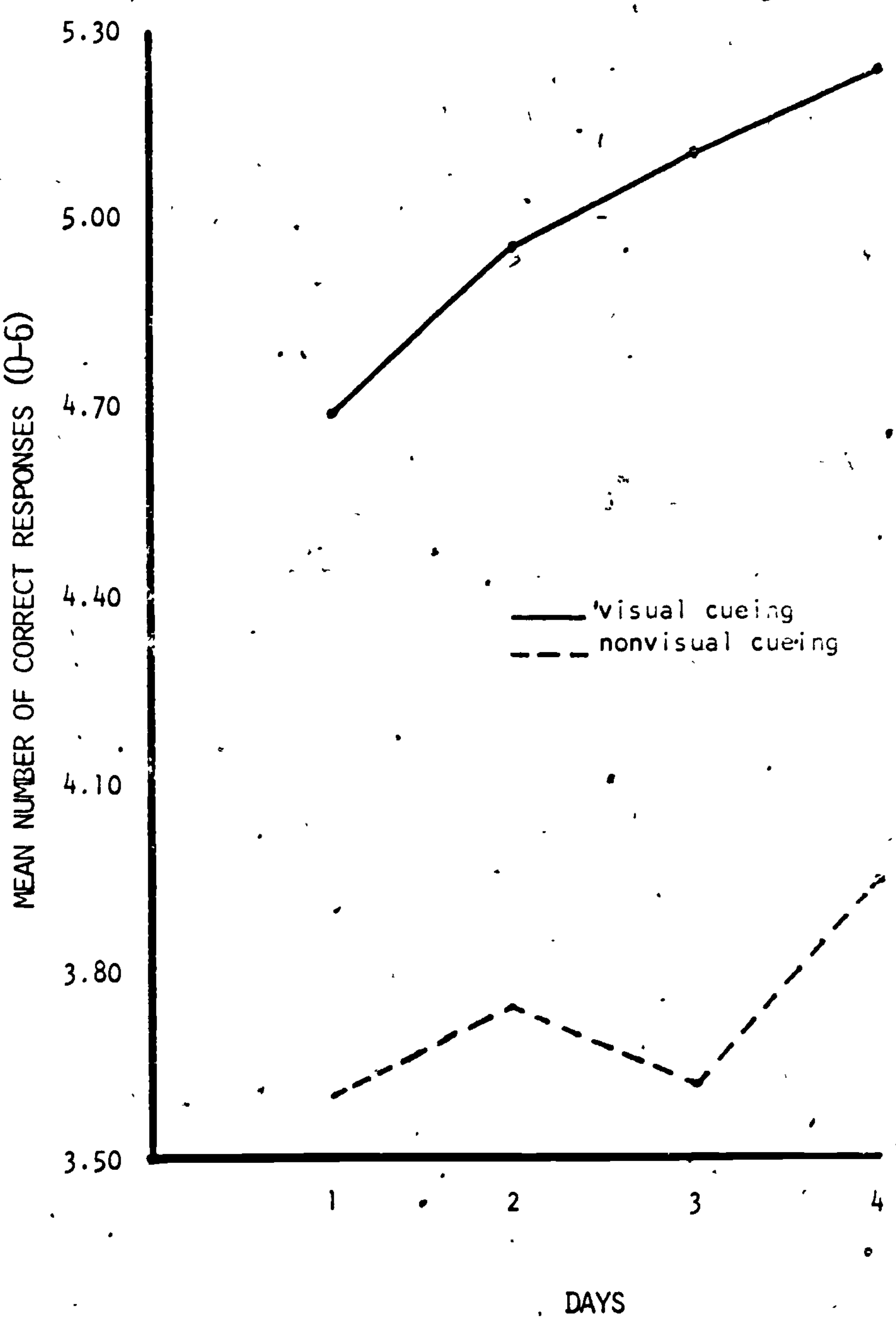


FIGURE 2

Learning Curves for Continuants and Stops During Week 1

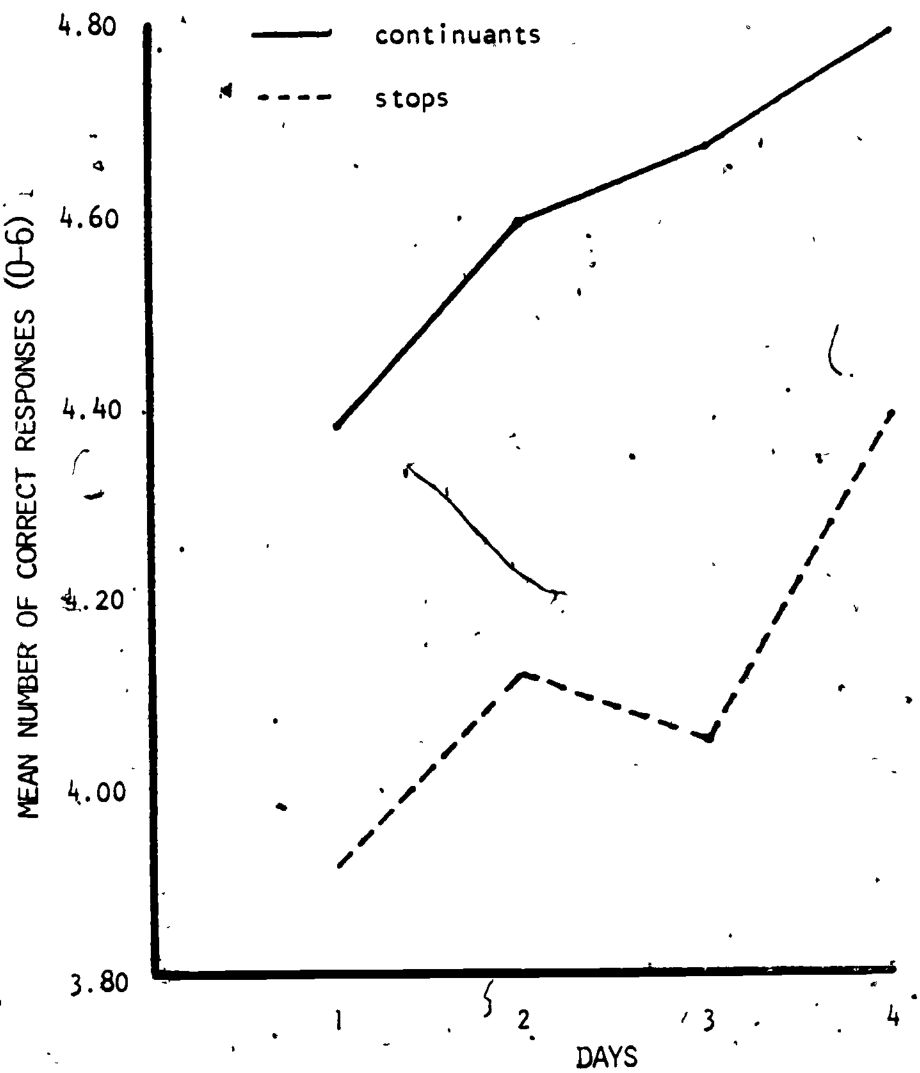


FIGURE 3

Learning Curves for Cueing Groups During Week 2

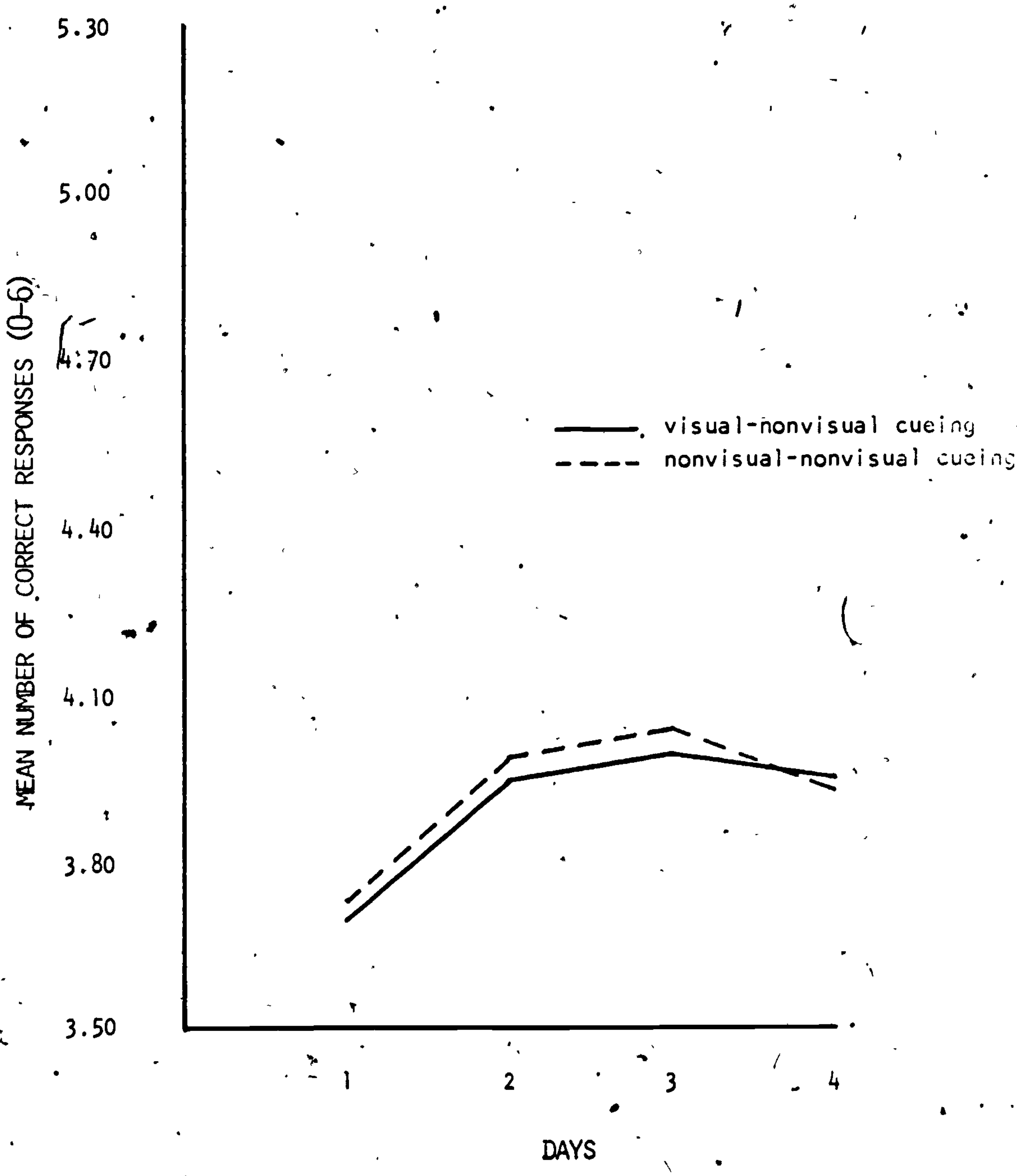
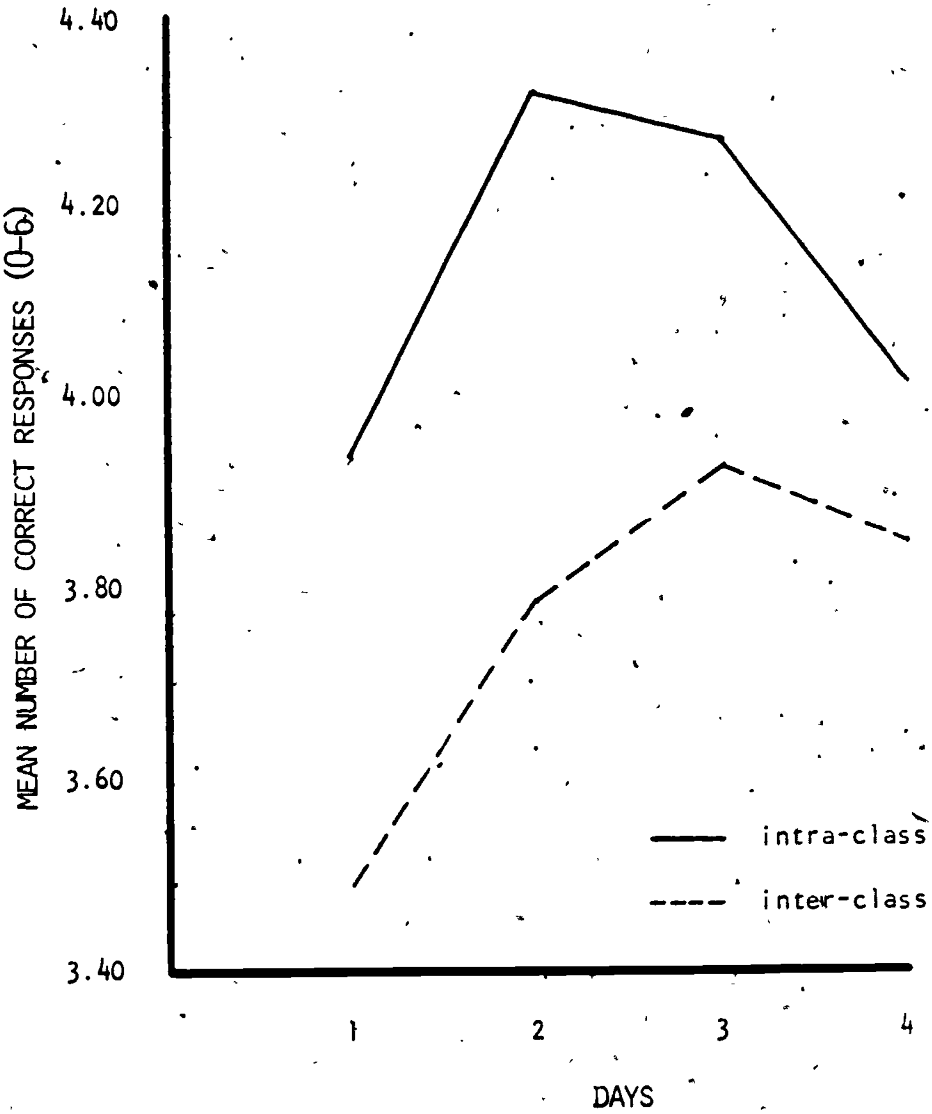


FIGURE 4

Learning Curves for Intra-Phoneme Class and Inter-Phoneme Class Groups During Week 2



Discussion

Obviously the most powerful factor in the training session was the presence of the graphemes as a relevant redundant cue. Since the child had, in memory (from the P-A training), which grapheme represented which phoneme he could do the "auditory" analysis by using the visual cues alone. The lack of difference between the visual and the nonvisual groups in the transfer session when the visual cue was removed indicates that the visual group had probably been relying on the graphemes to do the task during training (week 1). A program which starts out having children abstract graphemes from a visual word apparently has no general positive transfer to the task of abstracting phonemes from an auditory word. The question of whether or not there would be specific transfer, that is, whether being trained with the grapheme S present would facilitate auditory analysis of words beginning with /s/ was not answerable by the design of this study since the phonemes in the transfer task were different than those in training.

The second significant main effect in the training session was the superiority of the continuants over the stops. This finding is in line with previous work in "blending." As Desberg (1969) points out, most previous work in "blending" actually uses a word recognition task. The word recognition task is somewhat the inverse of the present task 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.

A logical reason for the greater difficulty in recognizing 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 reason 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. This was not controlled in the design of the materials in this study.

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

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

analysis should be carried out on the studies in word recognition (blending) using a choice procedure to see if a similar bias exists since this factor is 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 has reached anywhere near perfect performance or for that matter asymptotic performance. In fact, on the last (eighth) day of training there is a downturn in performance which is difficult to explain except on the basis of boredom or fatigue.

Although the two [illegible] Ss main effects (position and phonemic contrast) were not significant, this is probably due to the interaction of these variables with other factors, particularly phoneme type. With regard to the interaction between phoneme position and phoneme type it was 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 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 similar in sound to a stop in isolation followed by a voiceless schwa.

In the case of the interaction between minimum and maximum contrast and phonemic type, performance was similar under these two conditions for the continuants which were relatively easy anyway. Only in the case of the stops was the minimum-maximum variable effective with the maximum being superior as expected. 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.

There was also a reversal interaction between the position factor and the phonemic contrast factor in that performance in the initial position was superior in the minimum condition while the opposite was true in the terminal condition. These differences however, were quite small and the interaction is only marginally significant. Further research involving only these variables would be advisable to find out if the effect is replicable.

In the second week those Ss switched within phoneme classes were superior for the first three days of transfer training to the groups switched between phoneme classes. On the fourth day the within class group inexplicably declines almost to the level of the interclass group thus producing the interaction of this variable with practice.

Also, five of the six variables studied in the second week interact with each other in a complex fashion. This interaction probably accounts for the absence of some significant main effects in the second week. The interaction of so many variables in such a complex fashion makes interpretation of the second week results very difficult. These variables and their simple interactions should be untangled in a series of smaller transfer studies, taking them a few at a time.

Finally, the comparison of the performance on trials where the isolated stop phoneme and the terminal stop in the target word were the same allophones with the condition where the allophones were different was not significant. This suggests that the children in this study were not affected to any large extent by the allophonic variation normally found in English.

The results discussed previously suggest that the vowel following the initial stop may be an important factor but allophonic differences which occur in free variation in English with terminal stops is not important.

APPENDIX I

Name ______________________________

Condition ________________________ N V Age ________

Date ________	Date ________	Date ________	Date ________
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	lobe - 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	rid - rid	red - hum	

/f/
/n/

Name ____________________

Condition ____________________ N V Age ________

Date ________	Date ________	Date ________	Date ________
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 -
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	give - gain	

/p/
/t/

Name ____________________

Condition ____________________ N V Age ________

Date ________	Date ________	Date ________	Date ________
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 - jet
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

/s/
/m/

Name ____________________

Condition ____________________ N V Age ________

Date ________	Date ________	Date ________	Date ________
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
ban - 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 - ton
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	

APPENDIX 2

Training (Week 1)

Source	df	Mean square	F
Between	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 (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

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	

Transfer (Week 2)

Source	df	Mean square	F
Between	63		
Cueing (C)	1	.07910	.006
Class (CL)	1	9.18848	.73
Switching (S)	1	2.34473	.19
C X CL	1	.21973	.02
C X S	1	.93848	.08
CL X S	1	18.86816	1.52
C X CL X S	1	4.92285	.40
Error	56	12.42899	
Within	960		
Practice (P)	3	4.70931	3.17*
P X C	3	.01921	.02
P X CL	3	.19629	.44
P X S	3	6.46191	4.35**
P X C X CL	3	.95671	.64
P X C X S	3	.44108	.30
P X CL X S	3	1.01139	.68
P X C X CL X S	3	.15983	.11
Error	168	1.48554	
Position (PO)	1	.61035	.26
PO X C	1	.00879	.004
PO X CL	1	3.63379	1.58
PO X S	1	12.91504	5.62*
PO X C X CL	1	.11816	.05
PO X C X S	1	1.33691	.58
PO X CL X S	1	.07910	.03
PO X C X CL X S	1	.11816	.05
Error	56	2.29897	
Contrast (CO)	1	.71191	.66
CO X C	1	.04785	.04
CO X CL	1	.02441	.02
CO X S	1	1.06388	.99
CO X C X CL	1	.00879	.01
CO X C X S	1	.51660	.48
CO X CL X S	1	.04785	.04
CO X C X CL X S	1	.02441	.02
Error	56	1.07352	
P X PO	3	2.35254	1.62

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

P X PO X C	3	.53223	.37
P X PO X CL	3	1.80827	1.25
P X PO X S	3	3.94889	2.72*
P X PO X C X CL	3	.82389	.57
P X PO X C X S	3	.37077	.26
P X PO X CL X S	3	.29525	.20
P X PO X C X CL X S	3	.06348	.04
Error	168	1.45001	
P X CO	3	2.54264	2.84*
P X CO X C	3	.68066	.76
P X CO X CL	3	3.25618	3.63*
P X CO X S	3	1.25879	1.40
P X CO X C X CL	3	1.73014	1.93
P X CO X C X S	3	.19108	.21
P X CO X CL X S	3	.72754	.81
P X CO X C X CL X S	3	1.47493	1.64
Error	168	.89644	
PO X CO	1	2.95410	2.48
PO X CO X C	1	.00879	.01
PO X CO X CL	1	.04785	.04
PO X CO X S	1	5.49316	4.61
PO X CO X C X CL	1	3.87598	3.26
PO X CO X C X S	1	.35254	.30
PO X CO X CL X S	1	.11816	.10
PO X CO X C X CL X S	1	8.81348	7.40
Error	56	1.19014	
P X PO X CO	3	1.55566	1.50
P X PO X CO X C	3	2.13118	2.05
P X PO X CO X CL	3	.76921	.74
X PO X CO X S	3	3.57389	3.43
P X PO X CO X C X CL	3	.99316	.95
P X PO X CO X C X S	3	.71452	.69
P X PO X CO X CL X S	3	.11035	.11
P X PO X CO X C X CL X S	3	1.02282	.98
Error	168	1.04061	

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