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ABSTRACT

Speech discrimination by 12 children aged about 1 1/2 to 3 1/2 years was tested, using the discrimination learning procedure of Shvachkin's 1948 Russian study. Recent work on the acquisition of syntax and semantics shows an ordered acquisition for linguistic items; this pilot study was to test whether the ability to discriminate between consonants proceeds in a similar order and discrimination of any particular pair implies the ability to discriminate all others in order before it. Objects were given nonsense names differing only in initial consonants, and when the experimenter called one name, the children were requested to perform an action with the proper object to prove they could discriminate the consonants. Selection of subjects, experiment materials, scoring and testing procedures are detailed. Results show that Shvachkin's method is valid with American children, and an ordered sequence similar to the Russian order of classes of oppositions emerged. The acquisition orders are charted. Findings appear to justify a full replication study for English. (CHK)

THE DEVELOPMENT OF THE PERCEPTION OF PHONEMIC DIFFERENCES IN INITIAL CONSONANTS BY ENGLISH-SPEAKING CHILDREN: A PILOT STUDY[1]

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BACKGROUND AND PURPOSE

Over twenty years ago N. Kh. Shvachkin, a Russian psychologist, undertook to study experimentally the development of the phonemic perception of speech in children (Shvachkin 1948). He presented very young children (aged 0;10 - 1;6 at the beginning of testing) with pairs of objects to which he gave names consisting of CVC nonsense syllables differing only by a single initial consonant and tested their ability to discriminate between the names by requiring differential behavioral responses involving the objects. By this technique he arrived at an ontogenetic sequence of phonemic discriminations valid for all the children tested (N=19).

Recent work on the acquisition of syntax and semantics (Klima and Bellugi, 1966; Clark, 1969; Chomsky, 1969), has shown an ordered acquisition of linguistic items or rules, i.e., if x is present in a child's speech, then y is also, but y alone does not imply that x is present. Shvachkin's work suggested that the development of the child's ability to discriminate between all possible pairs of Russian consonants is ordered in the manner of a Guttman scale such that the ability to discriminate any particular pair implies the ability to discriminate all the others ahead of it in the order and inability to discriminate all the others after it.

Although the Shvachkin study was incomplete and needs replication, even for Russian, it suggests the hypothesis that a similar order of acquisition exists for the discrimination of English consonant opposition.

The present report describes a pilot study designed to provide data necessary for the proposed replication, with English-speaking children, of Shvachkin's classic experiment. The study was conducted primarily to (a) determine the validity and feasibility of Shvachkin's method, with appropriate modifications, for work with English-speaking children, and (b) obtain a preliminary order of the acquisition of phonemic contrasts of initial English consonants.

METHOD

The method used was a modification and extension of the one developed by Shvachkin (1948).[2] It is basically a discrimination learning task in which names -- nonsense CVCs differing in the initial sound only -- form the basis on which objects are discriminated. To indicate that he can discriminate between the names, the child must perform an action with the object named by the CVC when requested by the experimenter on a

given trial. The subject must learn that (a) there is a different name associated with each object presented, and (b) when the experimenter requests one of the objects, he must choose only the object associated with that name if he is to receive a reward. If the subject cannot discriminate between the two initial sounds that differentiate the names of the objects, it is assumed that he will choose randomly one or the other object, and that over a number of trials the number of correct and incorrect choices will be at chance.

Stimulus syllables. For every phonemic contrast in question nonsense CVCs must be devised so that they differ only in the initial consonantal sound. Each initial and final sound in the CVCs used in this study was one of the consonant phonemes of English. A suggested classification of the consonants used appears in Fig. 1. The phonemes /ŋ/ and /ž/,

	Manner \ Place	Labial		Dental		Palatal	Velar
		Bilabial	Labiodent.	Inter-dental	Alveolar		
Non-Sonorant	STOP (unvd)	p			t		k
	STOP (vd)	b			d		g
	AFFRICATE (unvd)					č	
	AFFRICATE (vd)					ǰ	
	FRICATIVE (unvd)		f	θ	s	š	
	FRICATIVE (vd)		v	ð	z		
Sonorant	NASAL (vd)	m			n		
	LIQUID (vd)				l, r		
	GLIDE (vd)	w				y	

Figure 1. Classification of Initial English Consonant Phonemes Being Investigated.

(adapted from Gleason, 1961)

which do not occur initially, and /h/ which does not occur finally were excluded. The vowels used in the CVCs were the lax vowels /I/ (high, front), /æ/ (low, front), and /U/ (high, back). These vowels were chosen because they occur in all dialects of American English and they represent a diverse range of articulator position. All the CVCs used were possible phoneme sequences in English (Whorf, 1940). In no case were the initial and the final sound in a given CVC the same phoneme. The CVCs used in the experiment appear in Fig. 2.

Classes of oppositions	Opposition tested	CVCs
CVC vs. VC	b-∅	/bæf/ - /æf/
sonorant vs. stop	n-g	/næf/ - /gæf/
	m-b	/mIk/ - /bIk/
	n-d	/næf/ - /dæf/
sonorant vs. affricate	n-ǰ	/næf/ - /ǰæf/
sonorant vs. fricative	m-v	/mæf/ - /væf/
nasal vs. liquid	m-r	/mæf/ - /ræf/
	n-r	/næd/ - /ræd/
nasal vs. glide	m-w	/mIf/ - /wIf/
nasal vs. nasal	m-n	/mIf/ - /nIf/
liquid vs. liquid	l-r	/lIf/ - /rIf/
glide vs. glide	w-y	/wIf/ - /yIf/
labial vs. nonlabial	b-d	/bæf/ - /dæf/
	b-g	/bæf/ -/gæf/
stop vs. fricative	b-v	/bæf/ - /væf/
	d-z	/dUf/ - /zUf/
stop vs. affricate	g-ǰ	/gæf/ - /ǰæf/
velar vs. dental, palatal	g-d	/gæf/ - /dæf/
vd vs. vl	v-f	/vIm/ - /fIm/
	b-p	/bIf/ - /pIf/
inter-dental vs. palatal	θ-š	/θUp/ - /šUp/
alveolar vs. palatal	s-š	/sUp/ - /šUp/
inter-dental vs. alveolar	ð-d	/ðæf/ - /dæf/
affricate vs. fricative	č-š	/čUf/ - /šUf/
liquid vs. glide	l-y	/lIf/ - /yIf/
	r-w	/rIf/ - /wIf/

Figure 2. List of CVCs Used as Stimulus Items.

Since it is impossible to test all the phonemic contrasts possible in the initial position because of the large number of combinations, certain classes of oppositions (generally based on those empirically derived by Shvachkin) were developed. Contrasts representative of the respective

classes were utilized in the experiment. A list of the classes of oppositions and representative phoneme contrasts appear in Fig. 3.

Class	Phoneme pairs
I. Opposition of absence vs. presence of consonant	b-∅, v-∅, m-∅, d-∅, ð-∅, z-∅, n-∅, g-∅
II. Opposition of manner of articulation	
Sonorant vs. stop	m-b*, w-b, n-d*, r-d, l-d, n-g*
Sonorant vs. affricate	n-ǰ*, l-ǰ, r-ǰ
Sonorant vs. fricative	m-v*, n-ð, w-v, l-z, r-z, n-z
Nasal vs. liquid	m-r, m-l, n-r*, n-l
Nasal vs. glide	m-w*, m-y, n-w, n-y
Liquid vs. glide	l-w, l-y*, r-w*, r-y
Nasal vs. nasal	m-n*
Liquid vs. liquid	l-r*
Glide vs. glide	w-y*
Stop vs. fricative	b-v*, d-z*, g-z, k-š
Stop vs. affricate	d-ǰ, g-ǰ, t-č
Affricate vs. fricative	č-š*, ǰ-z
III. Opposition of place of articulation	
Labial vs. dental, palatal, velar	b-d*, b-g*, v-z, v-ð, f-š, f-θ
Velar vs. dental and palatal	g-d*, g-ð, g-z, k-š, g-ǰ
Inter-dental vs. palatal	θ-š*
Alveolar vs. palatal	s-š*
Inter-dental vs. alveolar	ð-d*, θ-t, ð-z, θ-s
IV. Opposition of voiced vs. unvoiced consonants	b-p*, d-t, g-k, ǰ-č, v-f*, ð-θ, z-s

* Indicates oppositions tested in experiment.

Figure 3. Classes of consonant phoneme oppositions

Where possible, when manner of articulation was varied for a given phoneme pair, the place of articulation was held constant, and vice versa. Only voiced consonants were used throughout except for the opposition voiced C vs. voiceless C.

Subjects. Subjects were twelve children (5 males and 7 females) who were between the ages of 1;9 and 3;5 at the start of the experiment. A list of each subject's age and sex appears in Fig. 4. As indicated in Fig. 4,

Subject number	Sex	Age	Total number of test sessions
S1	F	2;10	11
S2	F	2;9	10
S3*	F	2;9	6
S4*	M	1;10	5
S5	M	3;5	11
S6	F	2;6	11
S7	F	2;1	13
S8	F	1;10	10
S9	M	2;10	11
S10	F	1;9	7
S11*	M	1;9	4
S12*	M	2;6	1

*Indicates subjects excluded from the final data analysis.

Figure 4. Subjects by sex and age.

four subjects were excluded or dropped out from the study. The reasons are given in Appendix B.

An initial interview with the parent(s) of each subject was conducted to determine suitability for inclusion in the experiment. All children chosen to be subjects satisfied the following criteria:

(1) Age - 1;5 to 3;5
(2) Not first born child in family
(3) Both parents native speakers of English
(4) No foreign language spoken at home
(5) No serious speech defects in parents and siblings

MATERIALS

Objects. The objects manipulated by the subjects were painted wooden blocks of various shapes and sizes. They differed on three dimensions: (1) shape - cylinder, column, cube, etc. (for complete inventory see Appendix C, (2) color - red, yellow, green, blue, white,

black, (3) size - large, small (not all the shapes were available in each size). Two objects presented together always differed on at least two of these dimensions and often on all three.

Eyes, mouth, nose and sometimes hair cut out of colored paper and/or felt were glued to each block to give it a face. Some of the objects also had buttons or bow ties attached. These additions to the blocks were designed to stimulate the child's desire to manipulate and play with the objects. The addition of faces to the blocks provided the opportunity to introduce the nonsense CVC associated with an object as the object's "name." Thus, the blocks became personalities and were referred to as "our little people who have the funny names." The objects were introduced to the Ss as "Mr. _____."

Props and activities. In order to ascertain if the subject could discriminate between the CVCs associated with the objects, on each trial the child was asked to perform some action with one of the objects only. The props used are enumerated in Fig. 5.

decorated carboard playhouse	doll dishes (saucer, spoon, cup)
cardboard slide	doll blanket and pillow
toy car	straw basket
child's beach pail	stick-on ribbon
woman's head scarf	rubber ball
	small doll-size hat

Figure 5. Props.

The following activities using these props were tried with each child during the course of the study.

(1) Giving the object. - The child is asked to give the object to E or to the mother. Sometimes on the last trial of a testing session Ss were asked to give the object to the observer.

Sample request: "Give Mr. _____ to Mommy.

(2) Placing the object. - The child is asked to put the object into the

basket/playhouse, onto the table, or in the car/pail.

Sample request: "Put Mr. _____ into the house to take a nap."

(3) Covering the object. - The child is asked to cover up or hide the object by placing the head scarf or basket over it.

Sampel request: "Hide Mr. _____ under the basket."

(4) Decorating the object. - The child is asked to stick a ribbon onto the object or to put a small hat on the object.

Sample request: "Put this hat on Mr. _____."

(5) Taking object for a ride. - The child is asked to take the object for a car ride or to give the object a ride on the slide.

Sample request: "Give Mr. _____ a ride in the car to the store."

(6) Surprise game. -E closes eyes, holds out hands, and asks the child to place the object she requests into her hands and surprise her when she opens her eyes.

Sample request: "Surprise me with Mr. _____."

(7) Showing object something. - The child is asked to show the object a prop, a picture on the wall, or something outside (through the window).

Sample request: "Show Mr. _____ the man mowing the lawn outside."

(8) Feeding the object. - A set of doll dishes is provided the child and he is asked to feed some imaginary food to the object.

Sample request: "Feed Mr. _____ some soup."

(9) Rolling ball to object. - The child is asked to roll a ball to the object when objects are place on the floor several feet apart in front of him.

Sample request: "Roll the ball to Mr. _____. It's his turn to play with it."

All the above activities seemed to be equally successful with both male and female subjects but certain children would perform for more trials or be more attentive when one activity was requested as opposed to another. A list of preferred activities was kept for each child, and these activities were initiated when the child was particularly difficult to work with.

SCORING PROCEDURE

The responses of each subjects are recorded from the first trial on which he is to choose between the objects on the basis of the names. For purposes of the analysis, only those trials including and following the first trial on which the child made a correct choice were considered.

The following responses are scored correct on a given trial: (a) the child chose the appropriate object and performed the activity; (b) the child chose the appropriate object but performed an activity other than that indicated by E.

The responses scored incorrect were: (a) the child chose an inappropriate object; (b) the child was attending to the experimental task, as judged by the observer, but still refused to make a choice between the objects. It was felt that in such cases the child may be refusing to choose because he could not discriminate and did not want to be incorrect.

Trials on which the child responded in the following manner were not included in the scoring: (a) the child did not make a choice between the objects and was judged by the observer as not attending to the experimental task; (b) the child made incorrect choices on several trials in succession when forced to choose by E, exhibiting extreme reluctance to continue playing with the objects and asking to leave the experimental room.

The observer made the decision as to whether the child was attending to the task. If the child was looking at the objects and/or the experimenter when E was saying the names of the objects, the observer judged that the child was attending to the task. If the child was interrupting E with irrelevant questions, walking around, turning away from the objects, or playing with the props, the observer considered the child as not attending to the task and scored the trial accordingly.

TESTING SESSIONS

Thirty-minute testing sessions were conducted twice a week for six weeks with the majority of the subjects. However, three subjects who were added later in the experiment (S10, S11*, and S9) were tested over only a three-week period. Two experimenters conducted testing sessions but each child was tested by the same E throughout the whole set of experimental sessions. An observer recorded the child's responses and made written comments during each session.

The first meeting with a subject was a training session designed to familiarize the child with the procedure and the experimenter. In this session only toys whose names were CVCs (ball, car, doll), were used as objects. On all subsequent visits the objects used were the decorated blocks described above which were given CVC names differing only in the initial consonant phoneme. A different phonemic contrast was investigated at each session.

TESTING PROCEDURE

S entered the experimental room and sat in a small chair opposite E. After an exchange of greetings E introduced the test objects.

(a) Introduction of object

E began the session with: "Today we have two little people who come play with us. Would you like to meet them?"
(S indicated affirmative response.)
"Good. Each of our people has his own name just like you and me. Your name is _____, and my name is _____. Let's meet our people and find out their names."
(E showed child first object.)
"This is one of our little people. His name is Mr. _____. Mr. _____. Say hello to Mr. _____.
If S responded with the object's name, E continued by discussing the distinguishing characteristics of the object repeating the name in every sentence. E might say:
"Mr. _____ is blue. Mr. _____ has yellow hair. Look at the pretty bow tie Mr. _____ is wearing."
E placed the first object on the floor facing S and said:
"Now let's see who else we have to play with today. Here is another one of our little people. He has a different name."
(E showed child second object.)
The entire procedure was repeated with the second object.

(b) Requests to perform action with objects (no choice required)

On the next six trials E requested the child to perform an action with one or the other object, pointing to the object or handing it to S.
"Put Mr. _____ in the basket."
The name of the object was repeated several times while the child was performing the action. If the child refused to perform the action, after several attempts to elicit the response, E did it for the child. The object was returned to its original position and E told the child

that now it was his turn to perform the action with the object. Each action was performed with both objects to assure that the child understood that a particular action may be performed with either object. On these and all subsequent trials, the names of the objects were presented in a random order; thus, sometimes the child was asked to perform an action with the same object on consecutive trials.

(c) Requests to perform action with objects (choice required)

On all subsequent trials E repeated the names of each object while pointing to the appropriate object and then asked the child to perform an action with only one of the objects.
"This is Mr. (CVC #1) and this is Mr. (CVC #2). (CVC #1). (CVC #2). Now listen. Put Mr. _____ in the basket. (E said only one of the names.)"
If the child was not attending to the task, E referred to an attribute of one of the objects to attract S's attention. E then repeated the names and asked the child to choose one of the objects. If the child performed the requested action with the appropriate object he was given a verbal reward ("That's very good," "Yes, that's Mr. _____," etc.) and was allowed to complete the activity. The object was then returned to its original position by E and another trial was begun.
If the child chose the correct object but performed an action other than the one requested by E he received a verbal reward for choosing the appropriate object and was urged to perform the requested action.
If the child chose the wrong object, the activity was interrupted and E informed S that he had made a mistake. E pointed to the appropriate object, repeated the requested and rewarded S for performing the action with the proper object when he did so. "No! That's not Mr. ____. I said Mr. _____. This is Mr. _____. (E pointed to appropriate object.) "Put Mr. _____ in the basket."
If the child refused to make a choice either by picking up both objects or not handling either object on the first request, E repeated the name of each object again and the same command. If the child still did not make a choice, and had not left the area, E indicated the proper object and if S performed the action he was verbally rewarded. Often this procedure was not possible since usually the child had engaged in some other activity and E's attempts to return the child to the situation were usually most unsuccessful.

Since the attention span of such young children is very short, the same activity did not usually continue for more than four or five trials in succession. A particular activity was terminated if one of the following occurred: (1) the child left the experimental area, (2) the child repeatedly

refused to perform an action requested by E, or (3) the child suggested another activity.

The trials continued until time ended or the child completely refused to answer any of the requests. At the conclusion of each session each child was given a cookie from the "surprise drawer" and urged to come play again.

RESULTS

The first purpose of the experiment, to determine the feasibility of using Shvachkin's method with American children, was satisfied. After the first few testing sessions many of the children listened carefully to the names of the objects as E said them, made choices between the objects, and performed the action requested by E with some regularity. As expected, the younger children were more difficult to work with than the older children. Initially it took more sessions to teach the younger children the experimental procedure but most of them were soon performing the required task, although not as consistently or attentively as the older children.

At the end of each testing session the number of trials on which the S made a correct choice was tabulated. These data appear in Table 1, where, for each testing session, is listed (a) the opposition tested, (b) the number of correct choices/number of trials, and (c) the decision (marked as YES or NO) as to whether the S could discriminate between the two consonants tested. This decision was arrived at by utilizing the binomial probabilities distribution. If the S could not discriminate the initial consonant sounds of the CVCs presented during a testing session, one would make the hypothesis that responses should be random and by chance a correct choice would be made on half of the trials.

Under this hypothesis it is reasonable to anticipate that in a sample of X trials the observed number of correct choices will be .5X; and, furthermore, that if the observed number of correct choices is very far from this (Ex. all correct responses) one could conclude that the data contradict the hypothesis and render it implausible. How can one decide if the observed frequency of correct responses is "very far" from the expected frequency? One way is to decide that when, under the hypothesis, the probability of obtaining an observed frequency of correct responses is extreme -- say, 1/20 (.05) or 1/100 (.01) -- the observation data and the hypothesis are in conflict and this warrants a rejection of the hypothesis. Since the Ss in our sample made, on the average, one or two incorrect

Table 1. Summary Data Sheet: Number of Trials on which a Correct Choice Was Made. Total Number of Trials for That

Classes of Oppositions	S's	S 10 female 1;9	S 8 female 1;10	S 9 male 2;1	S 7 female 2;1	S 6 female 2;6	S 2 female 2;9	S 1 female
CVC vs. VC	b-ø	b-ø 5/11 NO						
sonorant vs. stop	n-g m-b n-d	n-g ✓ m-b 7/11 NO	n-g 3/8 NO m-b ✓ n-d 7/13 NO			n-d 10/12 YES		
sonorant vs. affricate	n-ǰ	n-ǰ 10/12 YES						
sonorant vs. fricative	m-v	m-v 9/12 YES						
nasal vs. liquid	n-r m-r	m-r 6/8 NO	n-r 4/5 *				n-r 10/12 YES	
nasal vs. glide	m-w	m-w 7/13 NO						
nasal vs. nasal	m-n		m-n 3/8 NO			m-n 9/11 YES		
liquid vs. liquid	l-r		l-r 3/6 *	l-r 6/14 NO	l-r 13/16 YES	l-r 8/14 NO	l-r 4/13 NO	
glide vs. glide	w-y					w-y 2/7 *	w-y 11/14 YES	
labial vs. non-labial	b-d b-g		b-g 11/14 YES	b-d 17/20 YES	b-d ✓ b-g 8/8 YES	b-d 8/12 NO b-g 6/11 NO	b-d 13/17 YES	b-d 12/
stop vs. fricative	b-v d-z		d-z 2/4 *	b-v 10/15 NO d-z 13/15 NO d-z ✓	d-z 9/12 YES	d-z 11/13 YES	d-z 13/16 YES	d-z 9/
stop vs. affricate	g-ǰ			g-ǰ 7/12 NO	g-ǰ 9/12 YES	g-ǰ 10/14 YES	g-ǰ 9/17 NO	
velar vs. dental & palatal	g-d		g-d 6/11 NO	g-d 18/25 YES	g-d 11/20 NO	g-d 2/7 *	g-d 9/16 NO	g-d 9/
vd vs. vl	v-f b-p			v-f 12/19 NO	v-f 7/12 NO		b-p 8/15 NO	b-p 6/
inter-dental vs. palatal	θ-š				θ-š 5/14 NO			θ-š 11/
alveolar vs. palatal	s-š			s-š 11/15 YES	s-š 10/14 NO		s-š 9/15 NO	s-š 10/
inter-dental vs. alveolar	ð-d			ð-d 6/14 NO	ð-d 10/12 YES			ð-d 8/
affricate vs. fricative	č-š				č-š 18/20 YES	č-š 9/14 NO		č-š 10/
liquid vs. glide	l-y r-w			l-y 10/12 YES	l-y 10/13 YES			l-y 7/1 r-w 6/1

Unscoreable testing session.

* No decision made due to too few total trials.

ry Data Sheet: Number of Trials on which a Correct Choice Was Made. Total Number of Trials for That Testing Session.

1;9	S 8 female 1;10	S 9 male 2;1	S 7 female 2;1	S 6 female 2;6	S 2 female 2;9	S 1 female 2;10	S 5 male 3;5
1 NO							
NO	n-g 3/8 NO m-b ✓ n-d 7/13 NO			n-d 10/12 YES			✓
YES							
YES							
NO	n-r 4/5 *				n-r 10/12 YES		
NO							
	m-n 3/8 NO			m-n 9/11 YES			
	l-r 3/6 *	l-r 6/14 NO	l-r 13/16 YES	l-r 8/14 NO	l-r 4/13 NO		l-r 9/11 YES
				w-y 2/7 *	w-y 11/14 YES		
	b-g 11/14 YES	b-d 17/20 YES	b-d ✓ b-g 8/8 YES	b-d 8/12 NO b-g 6/11 NO	b-d 13/17 YES	b-d 12/16 YES	b-d 12/16 YES
	d-z 2/4 *	b-v 10/15 NO d-z 13/15 NO d-z ✓	d-z 9/12 YES	d-z 11/13 YES	d-z 13/16 YES	d-z 9/12 YES	d-z 8/12 NO
		g-ǰ 7/12 NO	g-ǰ 9/12 YES	g-ǰ 10/14 YES	g-ǰ 9/17 NO		g-ǰ 10/16 NO
	g-d 6/11 NO	g-d 18/25 YES	g-d 11/20 NO	g-d 2/7 *	g-d 9/16 NO	g-d 9/12 YES	
		v-f 12/19 NO	v-f 7/12 NO		b-p 8/15 NO	b-p 6/13 NO	v-f 10/15 NO b-p 5/12 NO
			θ-š 5/14 NO			θ-š 11/14 YES	θ-š 6/12 NO
		s-š 11/15 YES	s-š 10/14 NO		s-š 9/15 NO	s-š 10/10 YES	
		ð-d 6/14 NO	ð-d 10/12 YES			ð-d 8/13 NO	ð-d 10/17 NO
			č-š 18/20 YES	č-š 9/14 NO		č-š 10/12 YES	č-š 4/12 NO
		l-y 10/12 YES	l-y 10/13 YES			l-y 7/15 NO r-w 6/12 NO	r-w 6/13 NO

session.

* No decision made due to too few total trials.

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choices per ten trials when the CVC names of the objects were "maximally different", i.e. the first consonant, vowel and second consonant were all different sounds for the two CVCs (E.g. /mIk/ - /dæf/), and the probability that by random choice a S will make two or less errors is .055, it was decided that if the probability of observing a given number of correct choices on X trials was .05 or less the hypothesis that the S was choosing randomly could be rejected.

Using this criterion each opposition in Table 1. was marked as YES (indicating that the random choice hypothesis was rejected and that the S was considered able to discriminate between the initial sounds of the CVCs) or NO (indicating that the random choice hypothesis could not be rejected and that the S was considered as not able to discriminate).

In the testing sessions where the total number of trials was seven or less no attempt was made to use this statistical procedure since the probability for making one error was greater than .05.

These sessions occurred mostly in test sessions with the younger children since they were easily distracted and often E would begin a trial several times. Also, the younger children more often reached for one of the objects before or while E was making a request, i.e., they were not listening for which name E was going to say. This behavior has been noted by Luria (1961) who reports that a child younger than two, when asked to give E one of a number of objects lying on a table, will not necessarily give the one requested, even if he knows its name. As soon as E starts to say "Give me . . ."the child reaches out and hands E the nearest or most attractive object. The word stimulates him to act. Because E had to begin a trial again often as a result of such behavior on the part of S, many fewer trials were completed than with the older children.

Test sessions that were totally unscoreable due to a complete lack of cooperation from S are indicated in Table 1. by a check mark. Typical behaviors during these sessions were: moving chairs around the room, refusing to look at the objects, and snatching objects away from E and refusing to return them. In all but one case these sessions were the initial test sessions with the youngest children.

While the experiment was in progress the question arose as to the validity of concluding that a child can discriminate between all the pairs in a class of oppositions from results obtained when testing with only one of the oppositions. Therefore, in some cases the same child was tested on two oppositions from the same class. No systematic attempt was made to study this question; but, for the six such instances that

were tested, in only one case were the results inconsistent for the two pairs of oppositions (S9 - stops vs. fricatives). In all the other cases the S's responses were consistent for the oppositions which were members of a class, i.e. if S could discriminate one phonemic contrast from a class he could discriminate the other opposition tested from the same class and similarly if he could not discriminate.

Tikofsky and McInish (1968), in a discrimination study with seven-year-olds, found that of all the voiced-voiceless oppositions, f-v, s-z, θ-ð were confused the most and produced the most errors. A possible implication of this finding is that some oppositions within a class are more discriminable than others. Therefore, in the full replication study this question will be systematically followed up.

DISCUSSION

Ordering of oppositions. From the data in Table 1, an ordered sequence of classes of oppositions emerged. This ordering, which is tentative pending further investigation, is presented in Fig. 6. When

Class of oppositions	Opposition(s) used in testing
1. presence of consonant vs. absence of consonant	b-∅
2. sonorant vs. non-sonorant	n-g, m-b, n-d, n-ǰ, m-v
3. nasal vs. non-nasal; nasal vs. nasal	m-r, n-r, m-w, m-n
4. labial vs. non-labial; stop vs. fricative	b-g, b-d; b-v; d-z
5. glide vs. glide	w-y
6. liquid vs. liquid	l-r
7. affricate vs. fricative; alveolar vs. palatal	č-š; s-š
8. stop vs. affricate	g-ǰ
9. velar vs. dental and palatal	g-d
10. liquid vs. glide	l-y
11. inter-dental vs. alveolar	ð-d
12. inter-dental vs. palatal	θ-š
13. voiced vs. voiceless	v-f, b-p

Figure 6. Ordering of oppositions from experimental data.

classes of oppositions are separated by a semi-colon this indicates that no evidence was available to permit ordering of these oppositions or that contradictory evidence from different pairs of Ss made it impossible to decide which of the two classes preceded the other. The sequence of the classes of oppositions ordered in #4 through #13 was obtained by the same method used by Shvachkin (1948). He proceeded as follows:

Step 1: Find an opposition which one S can discriminate and another S cannot discriminate. (Yes-No opposition)

Step 2: For the same two Ss, find an opposition which both Ss can discriminate. (Yes-Yes opposition)

Step 3: For the same two Ss, find an opposition which both cannot discriminate. (No-No opposition).

The Yes-No opposition is then ordered after the Yes-Yes opposition and before the No-No opposition. For example, S1 and S7 both could discriminate d-z and both could not discriminate f-v. S1 could discriminate g-d but S7 could not. These data yield the following ordering of these oppositions: d-z, g-d, f-v. In addition, both subjects could discriminate s-š. Adding this information, the order now becomes: d-z/s-š, g-d, f-v. Further, both S9 and S2 could discriminate d-z; they both could not discriminate f-v. S9 could discriminate s-š but S2 could not; therefore, the ordering of these oppositions is d-z, s-š, f-v. Combining the results of the comparisons for S1-S7 and S9-S2 the following order emerges:

d-z
s-š
g-d
f-v

This procedure was repeated for all pairs of Ss for all the combinations of Yes-No, Yes-Yes, No-No oppositions. In some cases contradictory sequences of ordering arose when data for ordering on opposition was considered from more than one source. In the majority of such cases, the source of the contradictory evidence was one pair of Ss. Since in Shvachkin's data one occasionally finds instances where the data from one child shows a divergence from the modal order (one opposition is discriminated before another), it is not unlikely that the same phenomena may have occurred in our data.

Also, in our study the children were tested for almost two months so it is possible that a number of the children may have acquired certain

contrasts during that period without our knowledge. An example will illustrate the point. If two oppositions (A and B) are ordered (A, B), and a S was at a stage of development prior to A, at the beginning of the experiment, a testing session early in the testing sequence with opposition A would reveal that this S could not discriminate that opposition. Now suppose that the child acquires both opposition A and B while the experiment is in progress and at some time after the child was tested on opposition B. The data would indicate that the S could discriminate opposition B but not opposition A. The data for this S would indicate that the order is (B, A) rather (A, B) as it would be for Ss who had not acquired these two oppositions while the experiment was in progress; this would therefore indicate an ordering different from that found in the data from other Ss.

The only instance where data from more than one pair of Ss presented contradictory evidence is in the oppositions b-d and d-z. Evidence from half of the pairs indicates that b-d precedes d-z and evidence from the other half indicates the reverse order. For the proposed full replication study, this implies that some of the Ss nearing this stage of development should be tested on b-d first and others on d-z first so that evidence may be obtained for the proper ordering of these discriminations. Furthermore, the inter-dental vs. palatal opposition appears late in the ordering as one would expect from Shvachkin's data. A possible explanation for these results is that the aforementioned oppositions occur in the fricatives only and there is some evidence, from production (Moskowitz 1970), that fricatives are acquired differently than other consonants.

The ordering for the classes of oppositions ordered #1-3 in Fig. 6. was obtained in a more global manner since not enough of the subjects tested were at a stage early enough to use the Shvachkin "Yes-No method". From S10 it was inferred that discrimination of n-$\check{j}$ and m-v preceded discrimination of m-r and m-w. From S6 and S7 it seemed that m-n, n-d and m-r occurred at some stage of development prior to the classes of oppositions ordered #4. Relying mostly on Shvachkin's findings it was decided to order the aforementioned classes of oppositions as they appear in Fig. 6. Since no information was available on the opposition presence of consonant vs. absence of consonant it was for the time being assumed that it precedes the discrimination of any consonants as Shvachkin states.

The data provide some helpful information on the ordering of several classes of oppositions not investigated by Shvachkin, mainly those containing affricates (sonorant vs. affricate, stop vs. affricate, affricate vs. fricative). Without such information it would be difficult to know at what stage of development to test for the presence of these distinctions.

A somewhat surprising finding was that the alveolar vs. palatal distinction is ordered before all other place distinctions except labial vs. non-labial. Jakobson (1968) would predict that the extreme positions of articulation (labial, velar) would be differentiated before the middle ones (dental, palatal).

A comparison of the ordering of oppositions obtained in this study and the ordering obtained by Shvachkin indicates that the general position in the sequence in which oppositions appear are highly similar for Russian and English. A comparison of orderings for both languages appears in Fig. 7. The ordering of oppositions, as was expected, is not the same

Order in Russian (from Shvachkin, 1948)	Preliminary order in English
1.	1. CVC vs. VC
2. sonorant vs. "articulated obstruent"*	2. sonorant vs. non-sonorant
3. palatalized vs. non-palatalized consonant	3. nasal vs. liquid, glide; nasal vs. nasal
4. nasal vs. liquid or glide	4. labial vs. non-labial; stop vs. fricative
5. nasal vs. nasal	5. glide vs. glide
6. liquid vs. liquid	6. liquid vs. liquid
7. sonorant vs. "non-articulated obstruent"	7. affricate vs. fricative; alveolar vs. palatal
8. labial vs. dental, palatal, and velar	8. stop vs. affricate
9. stop vs. fricative	9. velar vs. dental, palatal
10. velar vs. dental and palatal	10. liquid vs. glide
11. voiced vs. voiceless consonant	11. inter-dental vs. alveolar
12. "hissing" vs. "hushing" sibilant (alveolar vs. palatal)	12. inter-dental vs. palatal
13. liquid vs. glide	13. voiced vs. voiceless

* Shvachkin's "articulated obstruents" apparently consist of stops plus f and v; "non-articulated obstruents" are sibilants.

Figure 7. Comparison of the ordering of classes of oppositions for Russian and English.

for English as for Russian, but close enough to suggest that strong similarities exist. Differences which do appear can be attributed to

differences in the phonetic inventories and possibly the differing frequencies of occurrence distribution of various sounds in the languages.

The following comparison statements suggest, tentatively, that the order of acquisition of certain basic classes of oppositions may be stable across languages (or at least across certain related languages):

(1) The discrimination of voiced (vd) vs. voiceless (vl) consonants occurs late in the developmental sequence.

(2) The discrimination of liquids vs. glides occurs well after the discrimination of all other sonorant vs. sonorant oppositions (nasal vs. liquids, nasals vs. glides).

(3) Labials are discriminated from other positions of articulation before any other classes of oppositions dealing with place of articulation.

(4) Certain large classes of sounds, such as sonorant vs. non-sonorant, are distinguished before finer distinctions such as nasal vs. liquid (one type of sonorant vs. another type of sonorant) are made.

A feature analysis based on the ordering data is now in progress to be completed before longitudinal testing in the fall replication study begins Various hypotheses based on this analysis will be posited and subsequently tested.

Although there are certain strong similarities in the order in which various classes of oppositions are discriminated in Russian and English, a discrepancy is noted in the age at which Russian-speaking versus English-speaking children are able to make most of the discriminations. Shvachkin does not provide information on the age at which each opposition was discriminated by each subject; however, he does list the subjects' ages at the conclusion of the experiment at which time some of them could discriminate all the oppositions tested in Russian. The ages of the children varied from 1;9 to 2;0.

In the study conducted with English-speaking children, subjects who were 2;7-2;11 at the end of the experiment could not discriminate oppositions in certain classes by our criteria. This discrepancy of results may be due to several factors:

(1) Procedure - Shvachkin does not present an exact description either of the method he uses or of what controls, if any, he implemented. One might surmise that cues, of which he may

not have been aware, could have been available to Ss which assisted them to choose the correct object.

(2) Number of trials/statistical tests - Shvachkin makes no mention of how many sessions he spent with the children or how often the children were tested. No statistical manipulation of the data is presented. His criteria for when a child was considered able to discriminate an opposition was if the child "always" chose the correct object. He reports that the testing sessions only lasted from 10-15 minutes. If he tested each of his subjects on one opposition per session, it is unlikely that any given child was asked to make a choice between the object more than 4 or 5 times a testing session. It is possible that a subject could choose the appropriate object each time on so few a number of trials, but that if one considered the performance of this subject over manytrials, a random distribution of correct responses vs. incorrect responses might result. Some of the children we tested had 3 or 4 correct responses in succession but their performance over all the trials was not statistically different from chance, indicating that they were choosing randomly.

(3) Subjects - It is quite possible that children in the U.S.S.R. are much better trained at an early age to obey commands and perform according to the wishes of adults. Also, since children in the U.S.S.R. are sent to state nurseries as infants, it may be that they are exposed to experiences which make it easier for them to attend to the names of the objects and to follow the requests of E.

Finally, our data indicate that an individual difference factor, perhaps as much as 6-8 months, may be in operation. Two of our subjects were 2;3 at the end of the study and they could discriminate oppositions other children aged 2;9 or more could not. However, such variation does not pose a serious problem since if experimental results show that the order in which oppositions are acquired is invariant, it need not necessarily follow that this ordering is tied to a particular age.

FOOTNOTES

[1] This study was supported by NSF Grant No. GS-2329 to C.A. Ferguson for research on Aspects of the Acquisition of English Phonology.

The investigator gratefully acknowledges the help of Dr. Eve V. Clark who always found time to discuss any problems which arose during the course of the experiment and the numerous suggestions offered by Dr. Williamsen on what activities would appeal to yound children. Dr. Robert Calfee made valuable comments on the experimental design and suggested modifications in the statistical analyses.

To Marcy Macken, who acted as the other experimenter and as an observer, I extend my sincerest gratitude not only for the many hours spent working with the children but also for the many ideas and criticisms she offered.

My thanks also to Carol Farwell and Charles Jennings, who served as observers on numerous occasions and often raised important questions about various aspects of the experiment.

[2] Appendix D gives an account of how the method was modified for work with American children and other information thought useful for investigators who may want to use this procedure in the future.

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APPENDIX A

Abstract of Shvachkin's Article

Shvachkin, N. Kh. "Razvitiye fonematicheskogo vospriyatiya rechi v rannem vozraste" (The development of phonemic speech perception in early childhood), Izvestiya Akad. Pedag. Nauk RSFSR, 1948, 13:101-132.

Shvachkin investigated the development of phonemic discrimination of words in Russian children ten to twenty-four months old. His exploratory study indicated that phonemic perception develops concomitantly with semantic development, initial sounds in words are distinguished before final sounds, and phonemic differentiation evolves in a predictable sequence.

On the basis of these results, Shvachkin selected children not yet able to perceive words phonemically and initiated the transition to phonemic speech by creating a situation in which the children developed the need to name objects and differentiate them by their names. Each child was given the task of manipulating various objects which had been assigned contrived Russian-sounding monosyllabic names. In each situation, the child was required to perform a specified action with one of three objects, two of which had names identical except for the initial phoneme. Each contrasting pair of initial phonemes was an opposition indicated by the pilot study. The child was considered to have mastered a particular phonemic distinction if he correctly completed every task within a given set.

The experimental data revealed an ontogenetic sequence in the development of phonemic discrimination in Russian children, which Shvachkin divided into twelve stages. A schematic summary of these stages is included below.

Stage	Phonemic Distinction
1.	Vowels
	a. a vs. other vowels
	b. Front vs. back: i-u, e-o, i-o, e-u
	c. High vs. low: i-e, u-o
2.	Presence vs. absence of consonant: C-ØC
3.	Sonorant vs. articulated obstruent: m-b, r-d, n-g, y-v
4.	Palatalized vs. nonpalatalized: n-n', m-m', b-b', v-v', z-z', l-l', r-r'
5.	Sonorants
	a. Nasal vs. liquid or glide: m-l, m-r, n-l, n-r, n-y, m-y
	b. Nasal vs. nasal: m-n
	c. Liquid vs. liquid: l-r
6.	Sonorant vs. nonarticulated obstruent: m-z, l-x, n-ž
7.	Labial vs. nonlabial: b-d, b-g, v-z, f-x
8.	Stop vs. fricative: b-v, d-z, k-x, d-ž
9.	Velar vs. dental and palatal: d-g, s-x, š-x
10.	Voiced vs. voiceless: p-b, t-d, k-g, f-v, s-z, š-ž
11.	"Hushing" vs. "hissing" sibilants: ž-z, š-s
12.	Liquid vs. glide: r-y, l-y

Abstract written by Carolyn Johnson.

APPENDIX B

Subjects Excluded or Dropped from the Study

S3: Attended for a total of six sessions over a period of five weeks. She sometimes paid attention to the names and then chose an object, but more often she reached for an object before E began to make a request. It was E's opinion that she did not understand that she was to choose an object on the basis of the name spoken by E.

S4: Very immature and dependent on his mother. He never left his mother's lap. It was very difficult to get him even to attend to the objects and when he did make a choice and was wrong, he became very frustrated and refused to respond to the objects again. The sessions got progressively worse until he cried and went to the door repeatedly to leave.

S11: Attended for four sessions before his parents moved out of the country. He would not respond to E's requests and often threw the objects around the room.

S12: Attended only one session. He would not obey either E or his mother and roamed about the room at will. He threw a temper tantrum when E would not let him continue an activity. Also, at the first session it was discovered that the mother was not a native speaker of English.

APPENDIX C

Objects Used in Ordering Experiment

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2) 
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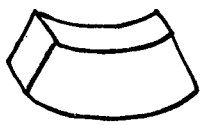
3) 
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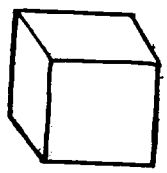
6) 
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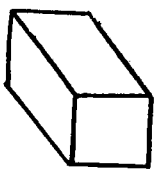
7) 
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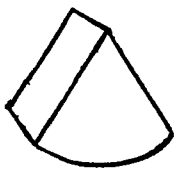
8) 
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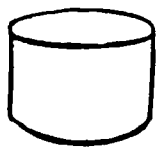
9) 
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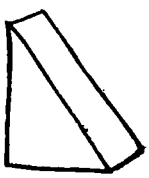
10) 
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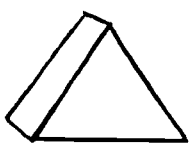
13) 
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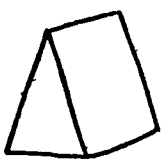
14) 
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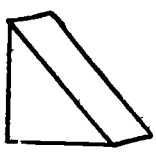
16) 
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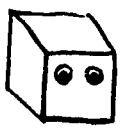
17) 
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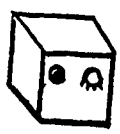
18) 
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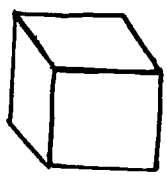
19) 
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APPENDIX D

Development of the Experimental Technique

Testing Procedure. The original plan was to use three objects in testing an opposition. The names of the first and third objects differed on the initial consonant only. The name for the second object was composed of different consonant sounds (both initial and final) and a different vowel. In this procedure the first and second object were presented together for six trials, then the second and third object together for six more trials. The first and third object were presented for the remainder of the trials with six additional trials, interspersed between them, on which either the first and second objects or the third and second were presented.

The first few sessions with this procedure showed that teaching a child the name of the second object, which yielded no information on whether the child could or could not discriminate an opposition, was undesirable. By the time the experiment progressed to the stage where the two objects with the critical names were presented, the subject was tired and more easily distracted than in the beginning. In the test sessions with the younger children, the experiment never progressed any further than the child learning the names for the first and second object.

Another problem arose due to the fact that E had to put away one object and bring out another one many times during the course of the session. This caused great difficulty with several children who still wanted to play with the object that was being removed.

A decision was made to designate the first two testing sessions with a child as training sessions. On these two sessions two objects whose CVC "names" would be completely different were presented to teach the child that the names of the objects were different. During these training sessions the subject had an opportunity to learn the procedure and to get acquainted with E. On all subsequent testing sessions trials with the second object were eliminated altogether.

At first the names of the objects were not repeated at the beginning of each trial; but often so much time elapsed between trials (while the subject was playing with props, or exploring the room) that this procedure was initiated.

A detailed account of the procedure that was finally developed appears in the method section of this paper under testing procedure.

Props and activities. During the course of the experiment extensive notes were compiled on the effectiveness of each prop. Comments as to the desirability of utilizing these particular props in an experiment of this type appear below:

1) Hats: Use of a hat was found to be attractive but proved to be undesirable if it fit one object better than the other.

2) Doll-size dishes: The use of dishes was especially effective with the youngest children and appealed to subjects of both sexes.

3) Pail: The pail used in the study was too decorative and therefore proved to be undesirable since Ss spent too much time looking at and talking about the pictures drawn on it.

4) Ball: The ball did not capture the other children's attention. Younger children insisted on rolling it off the table and too much time was spent chasing the ball to retrieve it.

5) Playhouse: The playhouse was especially effective with the youngest children. It sustained their attention longer than many of the other props.

6) Slide: The slide was the most attractive prop. However, a disadvantage in using the slide was that some Ss seemed to feel that the "little people" (objects) had to take turns on the slide and sometimes chose the objects in an alternating pattern.

7) Toy car: The car was a very popular prop. However, sometimes Ss played with the car itself rather than choosing an object to place in the car.

8) Basket: Most Ss enjoyed hiding the objects by placing the basket over them. It was discovered that care must be taken to see that the objects are farther apart than the diameter of the basket or the child will cover both objects simultaneously.

9) Blanket and pillow: These items were not very successful. None of the children played with these objects for more than two or three trials.

10) Woman's scarf: Use of this prop was discontinued after the first few times because Ss put it on their heads and otherwise played with it paying little attention to the objects.

Initially it was thought that the following requests would be sufficient to sustain the child's interest in the "game".

(a) "Point to Mr. _____."

(b) "Give me (E) Mr. _____."

(c) "Put Mr. _____ in the basket/on the table."

Several sessions with the children proved this to be a highly monotonous and uninteresting procedure. Children so tested quickly tired of following the commands, became distracted, and simply refused to perform any actions with the objects at all. The request to point to the object was particularly unsuccessful and was dropped completely. For the two other requests it was decided that a greater variety of possibilities for manipulation of the objects was necessary. Therefore, a number of activities were devised. The activities performed with the objects were mostly quite satisfactory with the following exceptions: Covering the object (3) was less than satisfactory because some of the subjects refused to let the object "come out of hiding." When the subject was asked to roll the ball to the object (9) it was sometimes difficult to judge at which object the child had aimed since the ball would often roll right between objects. These two were discontinued when their disadvantages were discovered.