SENSITIVITY TO PHONOLOGICAL UNIVERSALS IN CHILDREN AND ADOLESCENTS

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This investigation shows that a non-English portion of the universal initial-cluster hierarchy is cognitively represented in monolingual English-speaking children and adolescents. Since the representation is stronger in adolescents, the universal structure of the hierarchy may be due to a universal acquisition process rather than to innate linguistic content.

+CCVC+ syllables were developed representing seven types of initial non-English consonant clusters, from a universal hierarchical ordering of the type IF +WX IS AN INITIAL CONSONANT CLUSTER IN A LANGUAGE, THEN +YZ IS ALSO AN INITIAL CONSONANT CLUSTER IN THAT LANGUAGE (Greenberg 1965), for which markedness matrices have been developed (Cairns 1969). Children (N = 40) and adolescents (N = 40) listened to a tape and read a corresponding written representation of twenty-four pairs of syllables which differed only in their initial cluster. Subjects were to decide which syllable in each pair probably occurs in more languages. Both adolescents and children were able to reconstruct that portion of the phonological hierarchy which was tested, although adolescents did so significantly better than children. The effect of psychological distance from English (Greenberg & Jenkins 1964) was demonstrated on the same subjects with separate materials, but did not account for the hierarchy effects, since the syllables were controlled for that variable.

Finally, responses of subjects confirmed a theoretical error in previous works, suggesting an alternate arrangement of part of the phonological hierarchy.*

The universal nature of cognitive linguistic representation is central to theories of language acquisition and language change. There are two major schools of thought on language acquisition, the empiricist and the rationalist. The empiricist position is that only the external stimulus can determine the conceptual organization of what the child learns. In current empiricist theories, the learning of a behavior pattern proceeds by reinforcement of successive approximations (Rheingold, Gewirtz & Ross 1959, Staats & Staats 1964). Some modification of this viewpoint, as in mediation theory, permits internal associations but does not change its basic empiricism (Fodor 1966, Jenkins & Palermo 1964). In direct opposition to empiricists, rationalist psychologists hold that much of language development is due to the emergence of innate structures (Chomsky 1965, Lenneberg 1966, McNeill 1966, 1970a). A modification of this position is that no linguistic structure is literally innate, but that there is an inborn universal PROCESS to language acquisition which underlies linguistic universals (Slobin 1966, Fodor).

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The philosophical contrast between empiricist and rationalist theories of language development is reflected in possible theories of diachronic phonological change. On the empiricist view, the source of linguistic change is random variability in the child's output. The adult community shapes future linguistic patterns by selectively accepting ('reinforcing') some variations. On the view that there are innate linguistic structures, 'a phonetic change occurs when the child fails to suppress some innate process which does not apply in the standard language' (Stampe 1969:448). The change exhibited will correspond to the 'addition' of a process to the phonology. On the view that the acquisition process is the source of some linguistic universals, language change is due to the interaction of the acquisition process with existing structures (cf. Bever & Langendoen 1971).

The existence of phonological universals receives a different explanation in each theory of language development. On the empiricist view, universals can be potentially explained only by reference to some universal properties of the world outside the child: e.g., the universal restriction against four adjacent stop consonants may be explained as a function of the acoustic-phonetic requirements involved in the differentiation of consonants. On the structural rationalist position, the phonetic universals can be due to innate constraints: e.g., the universal set of phonological distinctive features can be ascribed to innate physiological structures. Finally, on the innate acquisition process view, universals can be due to an interaction between properties of the non-psychological world and the regularities of the innate processes of acquisition. A possible example is the fact that certain phoneme orders are universally preferred over others, perhaps because they are easier to learn.

Once these theories are given specific examples, it becomes clear that all these kinds of universals may exist: thus certain universals may be due to physical acoustics, others to internal physiology, and still others to the learning process. The psychological reality of phonological universals bears crucially on such issues. Insofar as children are aware of a possible universal property that is not represented in their own language, we must assume that the basis for the awareness is internal, and potentially innate.

A universal phonological hierarchy of initial consonant clusters has been observed by Greenberg 1965. The data show an implicational ordering of the type IF +WX IS AN INITIAL CONSONANT CLUSTER IN A LANGUAGE, THEN +YZ IS ALSO AN INITIAL CONSONANT CLUSTER IN THAT LANGUAGE. The further down the hierarchy a cluster type occurs, the fewer the languages that contain it. If the complete hierarchy is internal, it should appear in the responses of monolingual English speakers to non-English clusters. If subjects are able correctly to predict the ordering of consonant clustering in the hierarchy which are NOT WITHIN THEIR EXPERIENCE, this would offer evidence of an internal basis for the universal hierarchy.

A diagram of the universal hierarchical ordering of consonant-cluster types, taken from Greenberg and from Cairns 1969, adapted by Pertz 1973, is shown in Figure 1. Seven points on the hierarchy (enclosed by a dotted line) represent clusters that do not occur in English. Each of these consonant-cluster types is paired with a type adjacent in the hierarchy for presentation to subjects, as exemplified in Table 1 below.

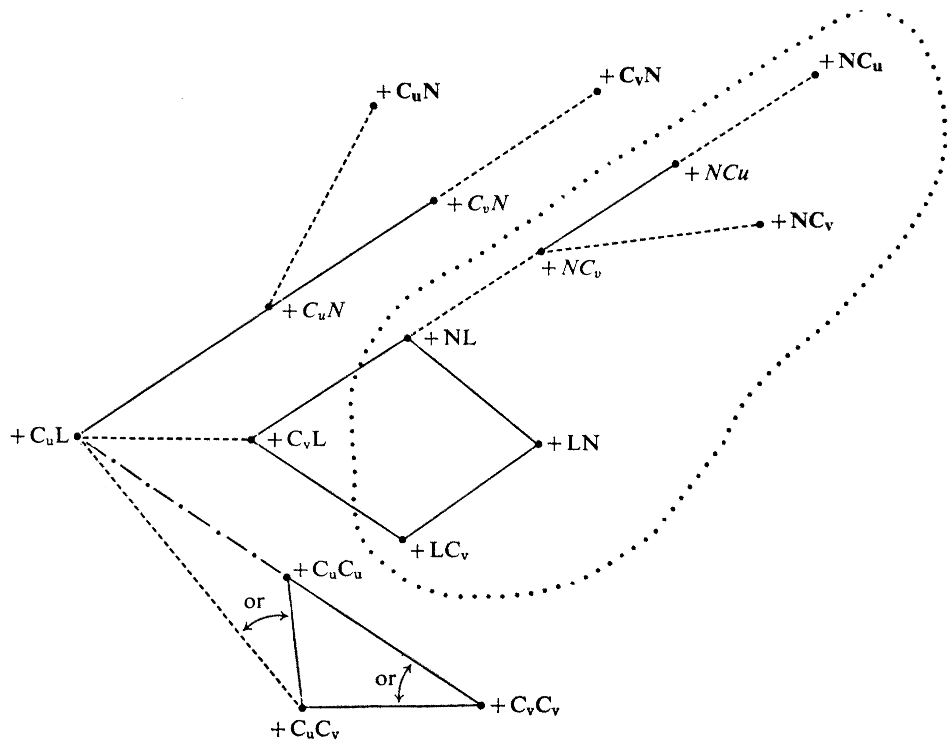

FIGURE 1

+	Onset of a word
V	Vowel
C_v	Voiced obstruent
C_u	Unvoiced obstruent
L	Liquid
N	Nasal
G	Glide
+*NC*	Homorganic nasal-obstruent sequence, e.g. /nd/, /mp/
+NC	Heterorganic nasal-obstruent sequence, e.g. /nb/, /mt/
>	Is implied by. + WX > + YZ should be read: 'If an initial consonant cluster of the type +YZ occurs in a language, then the type + WX also occurs.'
———	from Greenberg
—·—·	from Cairns
-----	Pertz interpretation

Of the six types of paired clusters, all except + LCv > + LN are well-motivated.[1] However, this prediction pair remained in the design where it was originally positioned.

[1] The ordering + LC_v > + LN is claimed in Greenberg and in Cairns, but underlying data show it to be unsound because of the confounding of languages with both voiced and unvoiced liquids in the language analysis. When languages with unvoiced liquids are separated from and not considered with those containing the more expected (and less marked) voiced liquids, it then appears that the placement of the LIQUID–VOICED OBSTRUENT cluster should follow at some point after the NASAL–LIQUID cluster, and should be more marked than that cluster. Clarification of this point has been made in correspondence with Greenberg (see Pertz 1973).

The basic empirical reflection of the hierarchy at issue in this paper is whether subjects can recognize which member of each pair is more likely to occur in some unknown language. If the nativist theories are correct, responses to the pairs should reflect knowledge of the order represented in the hierarchy. In addition, if the hierarchy is innate as linguistic CONTENT, younger subjects should be able to respond in accord with the ordering as well as OR BETTER THAN older subjects. But if the hierarchy is internal due to an innate acquisition PROCESS, then a greater sensitivity to the hierarchy could be shown by adolescents, since the innate acquisition process should show effects of increasing differentiation with increasing maturity. Finally, if either version of the nativist theory is false, subjects of both ages should show no knowledge of cluster orderings outside those in their language.

METHOD[2]

1.1. MATERIALS. Four experimental sets were developed, each of which included four examples of each of the six types of paired sequences; hence there were 24 CCVC syllable pairs in each set. Each pair of syllables in the CCVC framework consisted of differing CC clusters followed by identical VC's. All phonemes used were English, and each had a representative English grapheme. Each of the four sets of 24 nonce-syllable pairs was balanced for token examples within each type, and for front and back vowels, as nearly as possible (see Appendix I for a summary of the materials). In 27 cases (28.1%), only one of the nonce-words of the pair contained a possible English word (e.g. *ndin* 'contains' *din*). Of these, the syllable containing a non-English trigram was the predicted choice in 10 cases (10.4%), and the syllable containing the English trigram was the predicted choice in 17 (17.7%). In 8.3% neither member of the pair contained an English word, and in 47.9% each member of the pair contained an English word. In 15 pairs (15.6%) the identical trigram was contained in both pairs.

Greenberg & Jenkins 1964 showed that English-speaking subjects are sensitive to the relative number of English words that changing phonemes in a CCVC syllable will produce; e.g., /čwup/ is a greater 'distance from English' (DFE) than /swæč/. Since the present experiment involves judgments of relative frequency of occurrence in languages, it is important to control for the DFE in each pair of words. However, the nature of English phonology makes it impossible to equate all CCVC syllables for DFE. Ideally, each nonce-word within a pair should be equidistant from English, so that this factor will not influence the subjects' judgment about which cluster is more rational. In only three ordering-pairs was it possible to do this. The second phoneme position is the limiting factor: if a VOICED OBSTRUENT is in second position, the closest possible DFE is thirteen; if an UNVOICED OBSTRUENT, NASAL, or LIQUID is in second position, the closest possible DFE is nine. The six cluster-types, their DFE's, and what might be predicted based both on the hierarchy and on the DFE are shown in Table 1.

In order to assess the effect of DFE on judgments, four pairs of words were chosen from the original Greenberg & Jenkins stimulus words, differing from each

[2] A complete detailed description is available in Pertz 1973. The recorded speaker was Denis Croux.

PAIRED CLUSTERS		EXAMPLES	DFE	PREDICTED CHOICES	
				BASED ON HIERARCHY	BASED ON DFE
$+NC_u$	$+NC_u$	NTIFF, NKIFF	9, 9	$+NC_u$	Either
$+NC_v$	$+NC_u$	MBEEK, MPEEK	13, 9	$+NC_v$	$+NC_u$
+NL	$+NC_v$	MROCK, MBOCK	9, 13	+NL	+NL
+NL	+LN	MLIT, LMIT	9, 9	+NL	Either
$+LC_v$	+LN	RBEEK, RNEEK	13, 9	$+LC_v$*	+LN
$+NC_v$	$+NC_v$	NDIN, NGIN	13, 13	$+NC_v$	Either

TABLE 1. Predicted choices of subjects based on the phonological cluster hierarchy and on the distance-from-English phenomenon.

* Based on erroneous data in which languages having both voiced and unvoiced liquids were considered in a single category. Correct prediction should be +LN.

other by a DFE of 4. None of the Greenberg & Jenkins words used the initial cluster-types in the part of the hierarchy under investigation. Table 2 shows the nonce-words taken from Greenberg & Jenkins and their DFE's. The same four pairs were used with each of the four alternate sets of CCVC nonce-words developed, but order was randomized. The stimuli were recorded by a phonetically skilled linguist on Memorex cassette tape in a sound-controlled laboratory, using a cassette tape recorder (SONY model TC-110) with a directional microphone.

CCVC SYLLABLES		CLUSTER PATTERN	DFE
1	/klɛb/	$+C_uL$	4
	/θwæǰ/	$+C_uG$	8
2	/swæč/	$+C_uG$	4
	/trʊg/	$+C_uL$	8
3	/srʌm/	$+C_uL$	5
	/træx/	$+C_uL$	9
4	/čwʊp/	$+C_uG$	12
	/zgrɤ/	$+C_vC_v$	16

TABLE 2. CCVC syllables selected from Greenberg & Jenkins 1964.

1.2. SUBJECTS. Subjects were 80 monolingual English speakers, 40 between nine and eleven years of age, and 40 between sixteen and nineteen. Twenty in each group were males, and twenty females. All subjects were average or above in intelligence and in classroom achievement, and at or above the 31st percentile ($-1/2$ *SD*) in arithmetic, spelling, and reading on the *Iowa tests of basic skills* (Lindquist & Hieronymus 1964). There was no history of problems with articulation or hearing, or of left-handedness. None had traveled abroad or had been otherwise immersed in foreign languages except for Spanish or Portuguese. School instruction in French, Spanish, and German was permitted for the group over 16. (None of these languages has initial consonant-cluster types represented in the portion of the hierarchy under investigation.) Subjects were assigned to one of the four alternate sets, 5 males and 5 females at each age level to each set.

1.3. PROCEDURE. The test was administered to all subjects individually during school hours. After informal discussion, formal instructions were presented in typewritten form and on tape. Subjects were told that they were to choose, on a simplicity criterion ('easier, more likely, or more usual'), which one of two words has the initial sound cluster used in more languages in the world. Subjects were first to look at a written presentation of each pair of stimulus words, then listen, then sound it out to themselves, and make their judgment. Subjects were directed to note that, in each pair of words, the two final sounds were identical; and they were to concentrate their comparative judgments on the initial sounds. Following four pairs of practice words, questions were answered; then the experiment continued. At the end of the 24 pairs of nonce-words based on the hierarchy, subjects were told: 'In the next set of words you will see that the words are different in *all* parts. Pay attention to the whole word rather than concentrating just on the beginning. Make your judgments the same way.' The control words from Greenberg & Jenkins were then presented. Subjects were given as much time as they required to make decisions.

In follow-up interviews, subjects were dropped from the sample if they stated that their decisions had been based on how similar a nonce-word was to English. (Three adolescents and one child were dropped for this reason and were replaced, so that there were still 40 in each group.)

1.4. RESULTS. Four tokens of each type of prediction-pair yielded a potential score of 0 to 4 for each subject, with a chance score of 2. The results for each cluster type are shown in Table 3. (Results for each separate stimulus pair are included in Appendix II.) The potential score for five pairs together (excluding the incorrect pair $+LC_v > +LN$) was 0 to 20, with a chance score of 10. In the analysis of the data, age levels were considered separately and in comparison with each other.

	ADOLESCENTS			CHILDREN		
PREDICTION TYPE	MEAN	*SD*	*t*	MEAN	*SD*	*t*
$+NC_u > +\mathrm{NC_u}$	2.8	0.85	5.93**	2.175	0.93	1.19
$+NC_v > +NC_u$	2.25	1.08	1.46	2.55	1.04	3.31*
$+\mathrm{NL} > +NC_v$	2.4	1.08	2.31	1.925	1.12	−0.42
$+\mathrm{NL} > +\mathrm{LN}$	2.75	0.81	5.79**	2.075	0.89	0.53
$+\mathrm{LC_v} > +\mathrm{LN}$	1.45	1.20	2.91**	1.75	1.08	1.46
$+NC_v > +\mathrm{NC_v}$	2.9	0.96	5.45**	2.45	0.85	3.50**

TABLE 3. Mean scores of adolescents and children for each of the six prediction types.
* $p < 0.01$ ** $p < 0.001$ (two-tailed tests) $\alpha = 0.01$

The four sets of stimulus words used as alternate forms were not significantly different from one another ($F = .37$). There was no significant difference due to the sex of subjects (9–11, $t = 1.16$; 16–19, $t = 0.28$; all subjects, $t = 1.44$).

Considering the five theoretically well-motivated types ($+NC_u > +\mathbf{NC_u}$; $+NC_v > +NC_u$; $+\mathrm{NL} > +NC_v$; $+\mathrm{NL} > +\mathrm{LN}$; $+NC_v > +\mathbf{NC_v}$), adolescents ($p < 0.001$) and children ($p < 0.01$) showed sensitivity to the hierarchy, as shown in Table 4. Adolescents showed significantly greater sensitivity than children ($t = 15.69$, $p < 0.0005$).

A 2×6 ANOVA for the two age-groups by the six prediction-types indicates significant effects of types of cluster pairs, age $\times$ types and age, as shown in Table 5.

Analysis of results for each of the six prediction-types separately clarifies the nature of the highly significant differences by type and by interaction (see Table 3.)

AGE GROUP	N	MEAN	SD	t
Adolescents	40	13.125	2.54	7.68**
Children	40	11.175	2.42	3.03*

TABLE 4. Mean scores of adolescents and children for the total theoretical phonological structure (without $+LC_v > +LN$).
* $p < 0.01$ ** $p < 0.001$ (two-tailed tests)

SOURCE OF VARIATION	df	MS	F
Age	1	8.80	8.46*
Types	5	11.31	10.86**
Interaction	5	4.06	3.90*
Within groups	468	1.04	

TABLE 5. 2 × 6 ANOVA for two age-groups by six types of prediction.
* $p < 0.01$ ** $p < 0.001$

A two-tailed t test for inferences drawn about a single mean was applied to each prediction-type.[3] In general, children's scores tended to be closer to chance than adolescents', except for $+NC_v > +NC_u$, where the reverse was true. This appears to be the main contributing factor for the significant interaction score noted in Table 5.

Results for the prediction $+LC_v > +LN$ reflect the fact that the hierarchy was based on an incorrect theoretical basis coming from Greenberg and from Cairns. The significant opposite results for adolescents ($p < 0.01$), with the similar trend for children, confirm the proposed placement of the questioned sequence ($+LC_v$) in the phonological hierarchy. (These negative results appear to be the factor contributing most strongly to the main effect of type; see §2.4 below.)

1.5. THE EFFECT OF DFE. The four pairs of words taken from Greenberg & Jenkins were analysed separately. Scores were compiled by crediting each choice which matched the DFE construct (yielding possible scores from 0 to 4, with a chance level of 2). Both adolescents ($p < 0.001$) and children ($p < 0.01$) showed a significant tendency to select the CCVC nonce-word closer to English when presented with pairs which were distance 4 apart from one another; this is shown in Table 6.

AGE GROUP	N	MEAN	SD	t
Adolescents	40	3.025	0.95	6.76**
Children	40	2.550	1.09	3.21*

TABLE 6. Mean scores for Greenberg & Jenkins CCVC words based on DFE.
* $p < 0.01$ ** $p < 0.001$ (two-tailed tests)

Each subject's score for each of the six prediction-types was paired with his response for the Greenberg & Jenkins words. Had DFE been a factor in the selection of CCVC syllables designed to test the phonological hierarchy, there would have been no significant correlation with $+NC_u > +\mathbf{NC_u}$, $+NL > +LN$, and $+NC_v > +\mathbf{NC_v}$ (which are equidistant from English within the pair). A significant negative

[3] The level of significance chosen ($p < 0.01$) reflects repeated use of the same sample in a family of hypotheses based on a single theoretical framework. This is equal to a combined α of 0.06.

correlation would have been expected for $+NC_v > +NC_u$, and a positive correlation for $+\mathrm{NL} > +NC_v$. Because $+\mathrm{LC_v} > +\mathrm{LN}$ was theoretically questioned in terms of its position in the hierarchy, its correlation could not be anticipated. When product-moment correlations were computed for each type at each age-level, no significant correlation was found, nor were the relative correlation predictions confirmed. The data are shown in Table 7.

TYPE	ADOLESCENTS ($N = 40$) r	t	CHILDREN ($N = 40$) r	t
$+NC_u > +\mathrm{NC_u}$	0.17	1.07	0.12	0.74
$+NC_v > +NC_u$	0.19	1.45	0.23	1.46
$+\mathrm{NL} > +NC_v$	0.16	0.99	−0.12	−0.72
$+\mathrm{NL} > +\mathrm{LN}$	0.27	1.72	0.07	0.42
$+\mathrm{LC_v} > +\mathrm{LN}$	0.20	1.27	−0.26	−1.64
$+NC_v > +\mathrm{NC_v}$	0.21	1.24	0.30	1.93

TABLE 7. Product-moment correlations: individual scores for six prediction-types and scores for Greenberg & Jenkins words.

A contingency analysis, given in Table 8, shows that hierarchy predictions were followed better when both members of a pair either did or did not contain an English trigram than when one member of the pair did and one did not ($\chi^2 = 8.70$ for adolescents, children $\chi^2 = 21.65$).

NON-PREDICTED MEMBER OF PAIR:	PREDICTED MEMBER OF PAIR: ENGLISH AD*	CH*	NON-ENGLISH AD	CH	TOTALS AD	CH
ENGLISH	296	236	70	41	366	277
	(283)**	(218)	(83)	(59)		
NON-ENGLISH	99	88	45	47	144	135
	(112)	(106)	(32)	(29)		
TOTALS	395	324	115	88	510	412

TABLE 8. Number of predicted choices made by children and adolescents based on all possible combinations of English and non-English trigrams.

*AD = Adolescents, CH = Children ** (expected)

Table 9 expresses choices in percentages, and indicates that adolescents were more likely to choose the non-English trigram over an English trigram. At least for adolescents, the 'Englishness' of the syllable did not account for their confirmation of the hierarchy. To test the significance of their mean scores for each of the combinations, the two cells combining English and non-English trigram syllables

NON-PREDICTED MEMBER OF PAIR	PREDICTED MEMBER OF PAIR: ENGLISH AD*	CH*	NON-ENGLISH AD	CH
ENGLISH	64	51	70	41
NON-ENGLISH	55	52	56	59

TABLE 9. The effect of English vs. non-English trigrams: percentage of predicted choices made by children and adolescents in all possible combinations.

*AD = Adolescents, CH = Children

were compared for differences between means (cells 12 and 21). For children, the trend to do better when the predicted member contained an English trigram was not significant ($t = 1.39$, $p < 0.10$). On the other hand, adolescents chose the 'correct' cluster significantly more often when the predicted member did NOT contain an English trigram ($t = -2.09$, $p < 0.025$).

EVIDENCE FOR A SINGLE CONSTRUCT REPRESENTING AN INTEGRATED INNER REPRESENTATION OF PHONOLOGICAL UNIVERSALS

2.1. In order to determine whether an inner consistency enabled subjects to respond to each of the predictions according to a unitary structure (representing the phonological universals), scores for $+NC_u > +\mathbf{NC_u}$ and $+NC_v > +NC_u$ were summed for each subject and correlated with the same subject's sum for $+\mathrm{NL} > +\mathrm{LN}$ and $+NC_v > +\mathbf{NC_v}$. If the sums for two of the types correlated positively with the sums for two other types, there would be evidence of the same factor operating internally. Results shown in Table 10 indicate that adolescent subjects had a significant consistent inner representation of the phonological hierarchy ($p < 0.05$). Children had a positive correlation, but it did not reach significance.

AGE GROUPS	N	r	t
Adolescents	40	0.39	2.61*
Children	40	0.21	1.34

TABLE 10. Product-moment correlations: the sum of $+NC_u > +\mathbf{NC_u}$ and $+NC_v > +NC_u$ correlated for each S with $+\mathrm{NL} > +\mathrm{LN}$ and $+NC_v > +\mathbf{NC_v}$.
* $p < 0.05$

2.2. DISCUSSION. Both children and adolescents showed significant awareness of the implicational hierarchy of phonological clusters. Since none of the clusters were drawn from English, such a result indicates that the basis for their knowledge is some internal deductive capacity, rather than pure induction over their experience. Furthermore, the lack of significant correlation between the distance from English and the pairs drawn from the hierarchy suggests that subjects responded to the hierarchy pairs without reference to English words. The fact that adolescents matched the theoretical model more closely than children suggests that the innate structure is inherent to the learning process, and not inborn content. Cairns (p. 882) proposes that the general psychological basis for the implicational cluster hierarchy is an internalized simplicity criterion: the production and perception of sequences with greater markedness requires 'more and more skills of vocal-tract control and of perception'. Lower scores of children in making judgments based on this simplicity criterion would indicate that they are less sensitive to subjective feelings of relative difficulty.

Thus the view of language learning as based on innate processes (Slobin, Fodor) fits the outcome of this investigation somewhat better than a view based on inborn content (McNeill 1966, 1970a). Fodor (p. 106) points out that 'any organism that extrapolates from its experience does so on the basis of principles that are not themselves supplied by experience'. He proposes that the child does not learn that simplicity should be a criterion applied during language learning, but comes equipped with that criterion to the language-learning situation. Results of the present empirical study confirm that a simplicity criterion is available to subjects, and that use of it enables them to match a theoretical construct based on universals outside their experience.

Biofeedback may shape the categorization system for the universal phonological hierarchy. On this view, as children improve their ability to make fine discriminations, their application of the simplicity criterion refines the internal hierarchical representation. Hence the capacity to categorize and simplify is inborn, but its development requires maturation and experience. Adolescents are more conscious of the structure of the universal phonological hierarchy; however, what is in the conscious may well exist in the unconscious. If so, children may be applying the same criterion to language learning, though less consciously sensitive to it.

2.3. DIACHRONIC PHONOLOGICAL CHANGE. Diachronic changes do not appear irregularly: they are constrained by the mental structures which create universals such as the cluster hierarchy. If a language develops a new consonant cluster, it already has the other types; no type appears which precedes it in the hierarchy; no cluster is lost unless those beyond it in the hierarchy are absent. If Stampe's view of progressive diachronic change emanating from children's innovations were true, we would expect children to respond to the universal phonological hierarchy as strongly as or more strongly than adolescents. But children's conscious grasp of the hierarchy is less secure than that of adolescents. What may be true, then, is that children attempt relatively unconstrained phonological innovations, but that adolescents filter these, allowing permanent changes in the clusters only along the hierarchy.

2.4. A PROPOSED CHANGE IN THE HIERARCHY. Results of the investigation confirmed the discovery that the prediction $+LC_v > +LN$ was not properly motivated in the literature. Our subjects' responses showed the original placement of the LIQUID–VOICED OBSTRUENT cluster to be incorrect. Re-analysis of Greenberg's data shows that the placement of $+LC_v$ should be that in either Figure 2 or Figure 3.

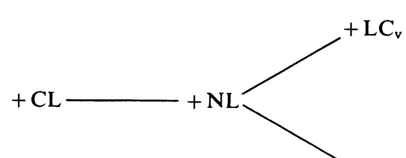

FIGURE 2. First suggested alternative placement of the $+LC_v$ cluster in the phonological hierarchy.

$+CL$ ———— $+NL$ ———— $+LN$ ———— $+LC_v$

FIGURE 3. Second suggested alternative placement of the $+LC_v$ cluster in the phonological hierarchy.

(See fn. 1 above.) However, the strongly significant favoring of LIQUID–NASAL over LIQUID–VOICED OBSTRUENT in our study suggests that the placement of the latter cluster in the hierarchy is following both LIQUID–NASAL and NASAL–LIQUID, as in Fig. 3. We expect that investigation into additional languages will support this placement. Such confirmation would strengthen the hypothesis that phonological universals are represented by an internal psychological structure.

CONCLUSIONS

3. This investigation into the possible internal representation of a universal phonological hierarchy has shown that it is known to monolingual speakers even when it is outside their language, and that it is more consciously available to adolescents than to children. Such internalization appears to be one of learning process rather than linguistic content. In addition, responses of subjects confirmed a theoretical 'error' in previous works, suggesting an alternate arrangement of part of the phonological hierarchy. Seen in the light of age-comparisons, diachronic phonological change appears to be 'controlled' or 'directed' by adolescents who filter the productions of children, permitting progressive changes only along the lines of the phonological hierarchy.

The major question left open by this research is how the conscious judgments of our subjects are reflected in the actual behavior which shapes the ontogenesis and phylogenesis of language. It is possible that children are less conscious of the cluster hierarchy simply because they are less conscious of ALL their internal structures. Thus, while our results suggest that the universal phonological structure arises from innate processes, it is possible that the universals are due to innate content that itself emerges developmentally. It is difficult to devise studies (or arguments) that would distinguish these alternatives. In either case the fundamental point remains the same. The hierarchy is available to both children and adolescents, even in the absence of the specific data on which it is modeled.

APPENDIX I

PRACTICE WORDS

(1) hmeer – hneer	(3) tyap – dyap
(2) wfill – wvill	(4) ydzole – ytsole

SET A

(1) ntiff – nkiff	(13) rneek – rbeek
(2) mbick – mlick	(14) mpite – mbite
(3) nrack – ndack	(15) rnot – nrot
(4) rmawl – mrawl	(16) mboot – mdoot
(5) nduff – ntuff	(17) ntock – mtock
(6) nlub – lnub	(18) mcud – mpud
(7) mbit – mrit	(19) nloop – ndoop
(8) npite – mpite	(20) ngag – ndag
(9) mbale – nbale	(21) rmoak – rdoak
(10) lgore – lnore	(22) ldag – lnag
(11) mdall – ndall	(23) mlack – lmack
(12) ntote – ndote	(24) mbeek – mpeek

SET B

(1) ntout – npout	(8) rdap – rnap
(2) nluff – nduff	(9) mbout – mgout
(3) mlash – mbash	(10) lniff – nliff
(4) nboak – mboak	(11) npore – mpore
(5) ndout – nrout	(12) mtub – ntub
(6) mlit – lmit	(13) lmack – ldack
(7) ndock – ntock	(14) nbash – ndash

(15) lnot – lbot
(16) ntiff – ndiff
(17) rbite – rmite
(18) rnail – nrail
(19) mtair – mpair
(20) mpit – mbit
(21) ndoom – mdoom
(22) mbeek – mreek
(23) rmite – mrite
(24) mbout – mpout

Set C

(1) rnale – rgale
(2) ndore – nbore
(3) mtick – ntick
(4) rmash – mrash
(5) mpore – mbore
(6) mlote – lmote
(7) nlair – ndair
(8) lnoot – nloot
(9) mpoor – npoor
(10) lmit – lbit
(11) ndin – ngin
(12) nrag – rnag
(13) ntale – ndale
(14) ndote – nrote
(15) mboot – mdoot
(16) mbore – mlore
(17) nbate – mbate
(18) mrock – mbock
(19) mpit – mkit
(20) ndep – ntep
(21) ldit – lmit
(22) nkale – ntale
(23) mbill – mpill
(24) mrock – rmock

Set D

(1) ndar – ntar
(2) mluff – mbuff
(3) rgoot – rnoot
(4) lniff – nliff
(5) lmall – ldall
(6) nbote – mbote
(7) mpeak – npeak
(8) lnout – lbout
(9) ntub – ndub
(10) mtall – ntall
(11) ndore – mdore
(12) nrag – ndag
(13) rnoop – nroop
(14) mball – mrall
(15) ngiff – ndiff
(16) ndame – nlame
(17) mkot – mpot
(18) rdash – rmash
(19) nkuff – ntuff
(20) mbare – mgare
(21) mlite – lmite
(22) mpate – mbate
(23) mrack – rmack
(24) mbot – mpot

APPENDIX II

Stimulus pairs are listed according to vowel position. The numbers beside each pair indicate the number of times (of a possible ten) that children (C) and adolescents (A) made a choice corresponding with the universal hierarchy. The pairs which are tokens of the comparison of LIQUID–VOICED OBSTRUENT with LIQUID–NASAL show 'correct' choice for the revised hierarchical ordering (LIQUID–NASAL occurs if LIQUID–VOICED OBSTRUENT occurs).

(1) High vowels (* = pairs repeated in two different sets).

TYPE	FRONT		C	A	BACK		C	A
$+NC_u > +\mathrm{NC_u}$	/mpɪt/	/mkɪt/	4	8	/mpul/	/npul/	6	7
	/mtɪk/	/ntɪk/	6	7				
	/mpik/	/npik/	6	6				
	/ntɪf/	/nkɪf/	4	4				
$+NC_v > +NC_u$	/mbik/	/mpik/	7	7				
	/mpɪt/	/mbɪt/	6	7				
	/mbɪl/	/mpɪl/	7	3				
	/ntɪf/	/ndɪf/	7	7				
$+\mathrm{NL} > +NC_v$	/mbik/	/mrik/	5	8	/nlup/	/ndup/	3	7
	/mbɪk/	/mlɪk/	3	3				
	/mbɪt/	/mrɪt/	5	7				
+NL > +LN	/mlɪt/	/lmɪt/	3	9	/lnut/	/nlut/	4	5
	/nlɪf/	/lnɪf/*	6	6	/rnup/	/nrup/	5	3
	/nlɪf/	/lnɪf/*	6	7				

$+LN > +LC_v$	/lmɪt/	/lbɪt/	4	5	/rgut/	/rnut/	7	7
	/rnik/	/rbik/	2	6				
	/ldɪt/	/lmɪt/	6	9				
$+NC_v > +NC_v$	/ndɪf/	/ngɪf/	6	8	/ndum/	/mdum/	7	6
	/ndɪn/	/ngɪn/	2	8	/mbut/	/mdut/*	3	7
					/mbut/	/mdut/*	7	6

(2) Mid vowels:

TYPE	FRONT		C	A	CENTRAL		C	A	BACK		C	A
$+NC_u > +NC_u$	/mter/	/mper/	6	7	/nkʌf/	/ntʌf/	8	5				
	/nkel/	/ntel/	5	8	/mtʌb/	/ntʌb/	4	4				
					/mkʌd/	/mpʌd/	3	6				
$+NC_v > +NC_u$	/ntel/	/ndel/	8	6	/ndʌf/	/ntʌf/	2	7	/ntot/	/ndot/	3	4
	/mpet/	/mbet/	8	5	/ntʌb/	/ndʌb/	4	9				
	/ndɛp/	/ntɛp/	5	5								
$+NL > +NC_v$	/nler/	/nder/	3	7	/nlʌf/	/ndʌf/	4	7	/ndot/	/nrot/	5	6
	/ndem/	/nlem/	7	3	/mlʌf/	/mbʌf/	7	7				
$+NL > +LN$	/rnel/	/nrel/	4	6	/nlʌb/	/lnʌb/	3	8	/mlot/	/lmot/	6	8
$+LN > +LC_v$	/rnel/	/rgel/	4	8					/rmok/	/rdok/	8	4
$+NC_v > +NC_v$	/nbel/	/mbel/	1	10					/nbok/	/mbok/	6	8
	/nbet/	/mbet/	6	8					/nbot/	/mbot/	5	6
	/mber/	/mger/	7	6								

(3) Low vowels:

TYPE	FRONT		C	A	CENTRAL		C	A	BACK		C	A
$+NC_u > +NC_u$					/mkɑt/	/mpɑt/	6	7	/mtɔl/	/ntɔl/	2	10
					/ntɑk/	/mtɑk/	2	4	/npɔr/	/mpɔr/	2	9
$+NC_v > +NC_u$					/ndɑk/	/ntɑk/	7	3	/mpɔr/	/mbɔr/	6	8
					/ndɑr/	/ntɑr/	4	8				
					/mbɑt/	/mpɑt/	6	5				
$+NL > +NC_v$	/mlæš/	/mbæš/	4	7	/mrɑk/	/mbɑk/	2	6	/mbɔr/	/mlɔr/	6	3
	/nræk/	/ndæk/	2	6					/mrɔl/	/mbɔl/	6	7
	/nræg/	/ndæg/	6	5								
$+NL > +LN$	/mlæk/	/lmæk/	4	9	/rnɑt/	/nrɑt/	1	4	/rmɔl/	/mrɔl/	1	9
	/rmæš/	/mræš/	4	7								
	/mræk/	/rmæk/	7	6								
	/nræg/	/rnæg/	5	7								
$+LN > +LC_v$	/rdæš/	/rmæš/	7	6	/rdɑk/	/rmɑk/	5	7	/lgɔr/	/lnɔr/	7	5
	/ldæg/	/lnæg/	10	5	/lnɑt/	/lbɑt/	4	7	/lmɔl/	/idɔl/	6	5
	/rdæp/	/rnæp/	6	8								
	/lmæk/	/ldæk/	5	5								
$+NC_v > +NC_v$	/ngæg/	/ndæg/	2	7					/ndɔr/	/nbɔr/	8	6
	/nbæš/	/ndæš/	6	7					/mdɔl/	/ndɔl/	2	7
									/ndɔr/	/mdɔr/	4	8

(4) Diphthongs:

TYPE	/ai/		C	A	/au/		C	A
$+NC_u > +NC_u$	/npɑit/	/mpɑit/	2	7	/ntɑut/	/npɑut/	4	7
$+NC_v > +NC_u$	/mpɑit/	/mbɑit/	4	6	/mbɑut/	/mpɑut/	8	5
$+NL > +NC_v$					/ndɑut/	/nrɑut/	2	7
$+NL > +LN$	/rmɑit/	/mrɑit/	4	7				
	/mlɑit/	/lmɑit/	5	8				

$+LN > +LC_v$	/rbait/	/rmait/	7	6	/lnaut/	/lbaut/	3	8
$+NC_v > +NC_v$					/mbaut/	/mgaut/	6	7

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