DOCUMENT RESUME

ED 026 138

PS 001 531

By-Miron, Murray S.; And Others

Experiments in Grammatical Processing in Children. Research Project Number 1 of Project Head Start Research and Evaluation Center, Syracuse University Research Institute. Final Report, November 1, 1967.

Syracuse Univ., N.Y. Research Inst.

Spons Agency-Office of Economic Opportunity, Washington, D.C.

Report No-OEO-4010

Pub Date 1 Nov 67

Note-33p.

EDRS Price MF-$0.25 HC-$1.75

Descriptors-*Auditory Perception, Aural Stimuli, *Children, Grade 2, *Grammar, Kindergarten Children, Listening Comprehension, Listening Skills, Lower Middle Class, Perception, Phrase Structure, *Sentence Structure, Surface Structure, Transformation Generative Grammar

Identifiers-ITPA, Speech Perception, Wells' Immediate Constituent Analysis

In perceiving speech, a hearer may divide the utterance into predictable units. In the present investigation of these units, an alleged phenomenon (the resistance of the hearer to perceive extraneous auditory stimuli) was employed. It was argued that this resistance caused the hearer to perceive the irrelevant stimulus, if at all, primarily at the juncture of major units. Also investigated was the interaction between the verbal materials used and the perception of the extraneous stimulus (a click). The subjects were eight kindergarten and eight second grade children. The verbal materials, spoken to the children by an adult, were sentences and nonsentence strings of words. Also clicking sounds were made. The children were asked to tell where in the sentence or string of words the click occurred. The results indicated that a greater magnitude of displacement of the click from its actual position occurred for the sentences than for the nonsentence material. The younger children tended to preposition the click. In both age groups, there was a tendency for click location to be prepositioned in nonsentences and postpositioned in sentences. Also, as has been observed with adults, the preception of the click tended to migrate towards major unit boundaries in the sentence material. These boundaries were determined by Rulon Wells' immediate constituent analysis. (WD)

Project Head Start Research
and Evaluation Center
Contract # OEO 4010
Final Report
November 1, 1967

William J. Meyer
Center Director

Cooperating Agency
Syracuse University
Research Institute
201 Marshall Street
Syracuse, New York 13210

Experiments in Grammatical Processing in Children

Murray S. Miron
Vernon Hall
Michael Mery

1. Experiments in Grammatical Processing in Children
Murray S. Miron, Vernon Hall, Michael Mery

The experiments of this report are predicated on the assumption of a particular model of what it is that constitutes language and how it is that language is realized and understood as speech. Traditional models of the speaker/hearer have presumed that the user of language acts as a passive-filtering mechanism which serves to sort output or input units into molecular categories in canonical or Markovian fashion. The classic influences of the taxonomic grammars current up to the last decade, the deceptively obvious sequential ordering of speech in linear time increments, and the currency of psychological experiments on word frequency, stochastic influences in language and molecular reinforcement all conspired to encourage theories of language processing which did not distinguish between speech and language. Speech clearly is time ordered and uniformly is displayed as a series of concatenated units each occupying a linear increment of real time.[1] By analogy to the written forms of speech, these units were tentatively identified as word or sometimes even letter segments. The speaker of a language, and afterall nearly every hearer is a speaker, reflected upon the salience of word units and concluded therefrom that words had direct physical representation in speech.

[1]We may ignore, as the traditional approaches ignored, the simultaneous prosodic features (intonation, stress, etc.) which are imposed on top of these linear segments, if we recognize that such oversight is symptomatic of the taxonomic approaches which are under attack.

Most hearers and even some hearers who theorize about language have argued that words in speech are separated by energy dimunition points or pauses. Whatever the status of word units in language as a system may be, it is clear that no physical characterization of words is to be found in the acoustics of speech. It is a direct consequence of the traditional lack of separation in psychology of the systems of speech and language which engenders such erroneous observations.

By contrast there has recently emerged an explicit theory of language which sharply separates competence from performance, speech from language. This theory most closely identified with the pioneering monograph of Noam Chomsky (1957) attempts to explicitly characterize language as an hierarchically organized system of rules which permute syntactically molecular units into regularized structures of increasing abstraction and decreasing simularity to the terminal strings which are manifest in speech either as input or output of the system. The grammar of a language, in this view, is the deep lying set of regularities which account for, i.e., describe and explain, manifest structure. Understanding of any given utterance as a realization of the application of the linguistic system of rules, that is, as a well-formed utterance in a particular language; thus is viewed as the process of recreating the structural history of that utterance. Such a view presupposes an active model constructing, parsing approach to the decoding of language. Manifestly concatenated elements in speech must be tested against a permuted and abstract representation generated by the hearer seeking a derivational account of what is experienced in order to achieve understanding and thus assign meaning to that experience. Manifest content is thus distorted into a series of abstract concurrences of derived and perceived experiences. Further, the derived structure insofar as it predicts manifest content which may not as yet have been experienced, directs and controls perception in seeking confirmation of the hypothesized structural derivation. Speech, according to this model, is thus segmented into those units which correspond to predicted units by the assigned derivation. Whereas the concatenation model would predict a filtering of input experience into empty category slots, probabilisticly ordered in terms of their input access, this model superimposes structure upon input.

Several recent lines of investigation lend considerable credence to this active model of speech perception. Ladefoged and Broadbent (1960) in presuming such a model, reasoned that perceptual units imposed upon input experience should show a tendency to resist extraneous interruptions. From the viewpoint of guided experience, distortions of the manifest experience which are not relevant, i.e., are not predicted by the derived modes which attempts to organize that experience, should either be ignored or at least resisted. Such observations have been well established for other forms of human experience, visual illusions providing the most dramatic of these. With regard to speech, the predicted resistance to irrelevant distortion could, as these investigators argued, serve to identify the superimposed segmental boundries being employed by the listener. To this end, Ladefoged and Broadbent added an extraneous, non-speech click to each of a series of sentences and digit strings. The Ss were instructed to identify the word which provided the locus for the extraneous sound. If this extraneous signal fell within a perceptual segment, its accurate location should be disturbed according to the size of the perceptual units which were being employed in the organization of the speech input. The investigation confirmed that errors in click location were indeed larger for sentential than non-sentential material. This finding at least grossly suggested that sentences were not being processed as discrete word units as is necessarily the case with random strings of digits. The presence of viable phrase units was at least plausible.

Any more refinement in these results requires a theoretical model which explicitly predicts the phrase segmentations of the speech stream on the basis of some inherent grammatical structure. One such model is that of Immediate Constituent Analysis elaborated some time ago by Rulon Wells (1947). In this model the surface structure of a given sentence is examined for constituent elements of decreasing complexity which by reference to substitutability and expansion in other utterances can be said to constitute a meaningful collocation of units. Thus, given the utterance: The king of England opened parliament, IC analysis would decompose the sentence first into the sub-units of (The king of England) and (opened parliament) on the grounds that the first constituent can be viewed as an expansion of a substitutable element such as (John) and the second constituent as an expansion of the substitutable element (worked) as in the complete utterance (John worked). The two constitutes thus isolated can be further analyzed into lower order constituents of (The king), (of England) and (opened) and (parliament). The remaining constitutes when analyzed into (The), (king) (of) and (England) finally reduce the sentential constitute into its elemental word constituents. It should be clear from the Polish notation that the final constituent structure:

(((The) (king))((of)(England)))((opened)(parliament)))

is hierarchally grouped into decreasingly complex constitutes which terminate in word elements of the total sentence. Further analysis is possible, e.g., the constituent (opened) might have been identified as the constitute composed of (open) and (-ed). For the present purposes such morphemic subdivision will not be employed. It should also be clear that each of the constitutes can be identified with one or another of the grammatical class markers which are the basis for their identification. Thus the first constitute (The king of England) is separable precisely because it is a substitutable expansion of the grammatical marker: subject. (Of England) in turn is a prepositional phrase which is functionally equivalent to all expansions of such phrases. Further, the IC analysis informs us that (of England) belongs to the constitute (The king of England) and consequently is a prepositional phrase used in adjectival function, precisely as (England's) (king) might have been used.

It is not, however, clear that the IC analysis can be a precise description of the underlying perceptual segmentations the hearer is presumed to use. IC analysis has the potential inadequacy of dealing with manifest structure as if such structure revealed underlying regularity. Its procedures are nonetheless reasonably explicit and easy of application.

Several experiments have in fact employed the IC model as a test of the segmentations presumed to occur in perception. Garrett (1964) and Fodor and Bever (1965) demonstrated that subject displacement of the perceived locus of a transient non-speech event (a click produced by condensor discharge superimposed upon the speech material) could reliably be predicted from a knowledge of the IC constitutes of sentential material. In general, the deeper the level of constituent boundary, the greater was the tendency for perceived location of the position of the click. The depth of an IC boundary is equivalent to the syntactic complexity of the phrase segment involved. Thus, to return to our earlier example, the constitute boundary between England and opened is the deepest level of IC segmentation exactly because it represents the largest and hence most complex division of the utterance which is possible of subdivision. On either side of this deepest boundary, additional minor level segmentations can be identified. In general, the Polish notation reflects depth of boundary as a function of the number of parentheses which reverse the left-to-right flow of organization. The structure ((A)(B))(C) differs from ((A)((B)(C)) in that the former has as its major constituent boundary the division between B and C and the latter between A and B. Both constructions differ from the construction ((A)(B))((C)(D)) in that the boundary between B and C of this construction is deeper than those of the former two. It should be noted that no more than an ordinal scale of "depth of structure" is implied by this model, no motivation is being offered for an interval measure of the construct. In fact, only Yngve (1961) has serviously suggested comparing different sentences with regard to boundary depth in connection with speech processes.

In discovering that click distortions were drawn to major constituent boundaries, the previous investigations had subtly confirmed the importance of linguistic segmentation in perception. The objection that major constituent boundaries may also be marked by events which might have drawn the click perception, events such as pause or intonation, was subsequently eliminated in a further study by Garrett, Bever and Fodor (1966).

Thus it must be presumed that the hearer organizes the input speech stream into linguistic segments and that extraneous events which cut these segments are perceptually deferred until processing reaches a completed unit of segmentation.

By way of summary, the following conclusions appear to be well established. (1) Brief speech distortions in the form of readily perceived clicks migrate from their objective locii when imposed upon sentential material to the nearest major syntactic boundary as defined by immediate constituent analysis. (2) Accurate location of the objective locii of click distortions in sentential material is significantly enhanced when the locus of the distortion is adjusted to correspond with the major syntactic boundary. (3) Displacement of perceived locii of distortions is significantly reduced when non-sentential material is employed. (4) Neither pause events nor intonation cues, although in themselves capable of displacing perceived locii of distortions, when controlled, are found to significantly alter the attractive power of the linguistic segmentation. (5) These results are consonant with an interpretation which assumes that active syntactic segmentation is a necessary part of speech perception and that displacement of distorting events in speech is a result of an attempt on the part of the hearer to preserve the unitary integrity of those segments.

All of the foregoing experimental results are based upon an adult population of subjects. There is sound a priori reason to believe that children might differ from adults with regard to these effects. In reductio ad absurdum, the pre-linguistic child cannot be aware of segmentation in the speech stream and hence cannot be expected to attempt to preserve the integrity of such segments. Presumptively, the child proceeds by orderly stages from this pre-linguistic state through increasing linguistic competence involving progressively longer segmentation units of his input (cf Bellugi, 1967). Complex syntactic constructions beyond his competence stage should be either incorrectly segmented or not segmented at all. The click displacement procedure thus offers the investigator a subtle means of trying to trace the longitudinal development of linguistic competence in the child.

Several complications arise, however. First, for very young children the testing conditions themselves are complicated enough to make instructioning the child a potential obstacle. Second, the child appears to be much more sensitive to lexical difficulty than is the adult. In theory, given a particular syntactic construction with its appropriate IC segmentation, vocabulary (lexical) changes in no way modifies that structure. It is for this reason that the Carroll jabberwocky, "The slithy toths did gyre and gimble." is comprehensible. Consider the following three well formed English utterances.

1. (((The) (friends))((helped)((by)(Jane))))((tried)(hard))((for)((the)(prize)))
2. (((The)(reporters))((assigned)((to)(George))))((drove)(furiously))((to)((the)(station)))
3. (((The)(analysists))((allocated)((to)(Omar))))((schemed)(feverishly))((for)((the)(renumeration))))

As is apparent from the segmentations, all three utterances are instances of an identical construction. Unfortunately, no experimentation had manipulated this variable for adults or children.

<u>Ancillary Activity</u>

It seemed clear to the investigators that several pertinent problems had to be resolved before an actual experiment could be devised. First, despite the fact that the senior author had been involved in the click experimentation from the time of Garrett's original experiments (Garrett, 1965) no firm procedural rules had been worked out for such crucial matters as mode of presentation of the distorting signal, type of distortion, and amplitude of distortion. Although the earlier investigators tacitly assumed that such variables were not crucial to the displacement effect, no empirical evidence for such an assumption had been gathered.

Consequently, the present investigators began with a series of pilot studies which manipulated the mode of presentation of the transient distortion. In all, five procedural conditions were employed. In all instances, the superimposed distortion was a 60 msec., 1K Hz. tone burst adjusted to the RMS voltage level of the peak vowel of the utterance sample. Oscillographic tracings of the tone burst indicated that the rise and decay time was sufficiently fast to produce a square wave trace of reasonable sharpness. Listening judgments confirmed that the tone burst was readily apprehended, was free of switching distortion and was of sufficient duration to give rise to the perception of a distinctive periodic character differing markedly from the speech events upon which it was superimposed.

The five procedural conditions, in their order of presentation to Ss, were as follows.

1. Speech in one ear, click only to the other ear.
2. Speech in one ear, click plus white noise in the other ear.
3. Speech in both ears, click multiplexed with speech in the other ear.
4. Speech in both ears, click multiplexed with speech in both ears.
5. Speech in both ears, no click.

Ten adult Ss, tested two at a time, were exposed to all five conditions. They were given printed versions of each of ten recorded sentences and instructed to expose the printed version immediately after listening to its spoken rendition, indicating thereon with a slash mark the precise locus of the extraneous signal. Ss were told that the tone-click could occur anywhere in the sentence, either on a particular word or between words. In addition, they were falsely informed that the repetitions of the sentences for the various listening conditions might differ and that they were to indicate whether or not the sentence had been modified by a same/different judgment. The latter procedure was adopted in order to assure that the multiple repetitions of the same sentence would receive equally careful attention.

The stimulus materials were devised such as to recreate the structural form of those employed by Garrett, Bever and Fodor (1966) while manipulating lexical difficulty at two levels. Table 1 displays these sentences with their numbering

TABLE 1 - Adult Pilot Stimulus Materials Paralleling Those Employed by Garrett, *et al.*, (1966) with Manipulated Lixical Difficulty

1a(1). IN ORDER TO CATCH HIS TRAIN, *JOHN DROVE QUICKLY TO THE STATION.

1a(2). IN ORDER TO ELUCIDATE HIS POSTULATE, *LOBESCHEVSKY TOILED DILIGENTLY IN HIS ARBORETUM.

1b(1). THE FRIENDS HELPED BY JANE TRIED *HARD FOR THE PRIZE.

1b(2). THE ANALYSTS ALLOCATED TO OMAR *SCHEMED FEVERISHLY FOR THE RENUMERATION.

2a (1). IN HER WISH FOR *CANDY MARY WAS VERY SAD.

2a(2). IN HER EXPECTATION OF *NUPTIALS, TRIBLENKA WAS SURELY SOPHISTICAL.

5a(1). AS A GOOD PART OF HIS NEW FRIEND'S *PRESENT, THE BOY WAS GIVEN A QUARTER.

5a(2). AS A CONCOMITANT CONSEQUENCE OF THEIR RECENT INNOVATION'S *IMPACT, THE CARTEL WAS ALLOTTED A DISPENSATION.

5b(1). THE OLD SHERIFF WHOSE IDEAS STILL GREATLY AFFECT THE WEST WAS *GIVEN A PRIZE.

5b(2). THE OCTOGENERIAN ADJUDICATOR WHOSE BRIEFS STILL GREATLY SWAY THE *BAR WAS AFFORDED AN ACCOLADE.

*Indicates objective locus of tone-burst.

keyed to the comparable sentence form used by Garrett, et al.

The distribution of click displacements confirmed that found by Garrett, et al. Lexical difficulty, as predicted, did not exert an influence on the degree or occurrence of displacements. The first of the procedural conditions matching that employed in the earlier investigations (speech in one ear, tone-burst in the other) produced the greatest magnitude of perceived click displacement. The second condition which added white noise to the click ear-channel produced the second greatest total amount of displacement. Despite the fact that this second condition did not produce as much displacement as the first, it was this noist plus click condition which was adopted for all subsequent testings. The quiet dichotic listening channel of the first condition introduced the possibility of an extraneous attention factor in the task. Listening under such a condition subjectively conditions a hearer to expect sound only in one ear. The short tone-burst which punctuates an otherwise quiet channel may very well catch the subject unready for sound in the unused ear. Displacement of the click locus under such a condition could be argued to be contaminated by readiness factors which are extraneous to the segmentation effects. The continuous white noise condition with its brief overlaid tone burst holds the distortion channel open. In addition, the quiet channel of condition one is necessarily a relative determination. Noise is, of course, present, it is merely undefined in character and at a low level. Flaws in the recording tape, random cathode emissions from the tube components of the amplifier and stray external electromagnetic radiation all produce noise peaks which conceivably could be mistaken for the experimentally manipulated click. Sound experimental practice thus appeared to dictate the use of the determinant noise condition over that employed by the other investigators. Parenthetically, it should be noted that it was for similar reasons that the 1K Hz. tone rather than the condensor produced discharge was adopted in these experiments. The periodic character of the 1K tone makes it a distinct event which can readily be distinguished from extraneous or inherent noise.

Thus encouraged that the experimental effects could be replicated, that the acoustical conditions were appropriate and that lexical difficulty was not a controlling variable for adults, additional pilot data was collected on a small sample of child Ss.

On the grounds that the Illinois test of Psycholinguistic Abilities (McCarthy and Kirk, 1961) provided a source of stimulus materials which had both established norms and high face validity for a task to be used with children, the test was searched for appropriate sentential material. Two subtests of the ITPA were selected, the Auditory-Vocal Association Test and the Auditory Decoding Test. The ITPA arranges subtest items in order of difficulty as determined from the standardization samples employed. Within a single subtest, however, the syntactic form of the items remains constant. Level of difficulty is thus controlled on the ITPA by changes in the lexical difficulty level, the variable still needing assessment for the child subject samples. The items of the Auditory-Vocal Association subtest are of the form:

((I))((sit)((on)((a)(chair))))((I))((sleep)((on)((a)(____))))

and those of the Auditory Decoding subtest:

((Do))((cars)(cry))

As can be seen, the form of the items provides for a single, quite deep syntactic boundary in each of the sentences. Both subtests require that the subject make a single lexical response which when compared to the norms for that item can be scored as either correct or incorrect. Thus it is possible to confirm understanding of the utterance and simultaneously assess the change in norm levels with the introduction of the additional task of click identification.

The non-sentential control condition to be used for comparison purposes was drawn from the items of the Auditory-Vocal Sequencing subtest which employs haphazardly ordered digits strings.

In order to assess the best response condition for children it was decided that two forms of judgment would be manipulated. In the first condition, Ss were instructed to identify the position of the tone-burst directly. In the other condition, Ss were given the task of indicating whether or not the tone-burst occurred at the same or a different position in the repeated sentence. Locii identification was used for the Auditory-Vocal Association items and same/different judgments for the Auditory-Vocal Sequencing and Auditory Decoding items. Table 2 displays the full complement of stimulus materials employed in these initial testings. All Ss were exposed to the full set of materials in the order: Auditory Vocal Association, Auditory Decoding and Auditory-Vocal Sequencing. Order of item presentation within a subtest followed that of normative difficulty level. It will be observed that for the locii identification task, half of the items contain no tone-burst at all, systematically counter-balanced against the remaining half for which there was a tone-burst. This procedure enabled a separate scoring of simple click detection in case the child could recognize the presence of a click but could not (or would not) venture an identification of its position.

The same/different judgments, similarly counter-balanced the occurrences of identical or changed position of the click instances.

TABLE 2 - Child Pilot Stimulus Materials
Auditory-Vocal Association Test (ITPA, p. 41, nos. 1-20)

1. I sit on a chair; I sleep *on a ____.
2. I eat from a plate; I drink from a ____.
3. A bird flies in the air; a fish swims in the ____.
4. I hit with my hands; I kick with my ____.
5. John is a boy; Mary *is a ____.
6. A scissors cuts; a pencil ____.
7. I cut with a saw; I pound *with a ____.
8. Soup is hot; ice cream is ____.
9. A red light says stop; a green light says ____.
10. During the day we're *awake; at night we ____.
11. I eat with a spoon; I *cut with a ____.
12. On my hands I have fingers; on my feet I have ____.
13. A boy runs; an old *man ____.
14. Cotton is soft; stones are ____.
15. An explosion is loud; a whisper is ____.
16. Mountains are *high; valleys are ____.
17. A man may be a king; a woman may *be a ____.
18. A pickle is fat; a pencil is ____.
19. Coffee is bitter; sugar *is ____.
20. Iron is heavy; feathers are ____.

---

*Objective placement of tone-burst

(TABLE 2 - cont'd.)

Auditory Decoding Test (ITPA, p. 58)

	STIMULUS STRING	CONDITION
1.	Do* you smoke?	same
2.	Do* you run#?	different
3.	Do# you fly*?	different
4.	Do you bark*?	same
5.	Do* babies eat?	same
6.	Do* bicycles drink#?	different
7.	Do apples* fly?	same
8.	Do# dresses drive*?	different
9.	Do* bananas telephone#?	different
10.	Do balls bounce*?	same
11.	Do* eagles paint?	same
12.	Do# goats eat*?	different
13.	Do pincushions* cheer?	same
14.	Do* children climb#?	different
15.	Do# lanterns shine*?	different
16.	Do daughters marry*?	same
17.	Do* dials yawn?	same
18.	Do* barometers congratulate#?	different

*First position of tone-burst in change conditions or single locus in same condition.

#Second position of tone-burst in change conditions.

Auditory-Vocal Sequencing Test (ITPA, p. 50)

STIMULUS STRING	CONDITION
1. $\overset{*}{1}$ 2	same
2. $\overset{*}{9}$ $\overset{\#}{6}$	different
3. $\overset{\#}{5}$ $\overset{*}{2}$ 1	different
4. 6 $\overset{*}{8}$ 9	same
5. 9 7 $\overset{*}{6}$	same
6. $\overset{*}{4}$ 3 $\overset{\#}{4}$	different
7. 6 $\overset{*}{6}$ 1 6	same
8. 6 $\overset{\#}{3}$ 5 8	different
9. $\overset{*}{4}$ 4 $\overset{\#}{2}$ 4	different
10. 5 7 $\overset{*}{4}$ 5	same
11. 2 5 4 9 $\overset{*}{9}$	same
12. 6 $\overset{\#}{1}$ 6 $\overset{*}{3}$ 7	different
13. $\overset{*}{4}$ 5 9 1 4	same
14. 9 $\overset{*}{1}$ 7 5 $\overset{\#}{3}$ 3	different
15. $\overset{\#}{8}$ 9 6 3 $\overset{*}{4}$ 8	different
16. 6 3 $\overset{*}{9}$ 7 3 5	same
17. 6 9 2 8 $\overset{*}{7}$ 9	same
18. 3 $\overset{*}{8}$ 9 1 7 $\overset{\#}{5}$ 5	different
19. 6 4 5 $\overset{*}{5}$ 8 4 1	same
20. 8 2 $\overset{\#}{9}$ 4 7 5 $\overset{*}{3}$	different

*First position of tone-burst in change conditions or single locus in same condition.

#Second position of tone-burst in change conditions.

Unfortunately, given the intricate stimulus controls and the desirability of using the ITPA test items, no useful results were forthcoming. It was discovered that the kindergarten Ss could not sufficiently comprehend what it was that was required of them to complete the task. The Ss, their full attention focused upon correctly answering the sentence items; i.e., in comprehending the stimulus materials, were confused as to what was meant by a "click". That the difficulty was produced by the nature of the stimulus materials and not poor instruction is confirmed by their grasp of the task when the number sequences were employed. It was clear that the level of difficulty of these materials had pushed the children to the maximum information loading they could tolerate even for those items having lowest age norms. (Scoring norms for the ITPA go down to a language-age score of two years four months). Accordingly further testing with this stimulus sample was abandoned. The success obtained with the digit task, however, led the experimenters to believe that it was possible for the young Ss to identify the locus of the click in the speech stream, an important consideration if magnitude of displacement was to be measured. Thus, in the subsequent testings only the procedure involving identification of click locus was employed.

The experimenters are aware that up to this point in the research nothing of a substantive nature had been accomplished. Procedural issues, however, had been defined and solved. Other investigators had, in fact, attempted to use children as respondents in a task of this type and had failed to even progress to the meager point at which this ancillary research had left us.

Experimental Task

Stimulus Materials and Subjects. A total of eight practice utterances and 20 test items were devised such as to be well within the linguistic competence of each of two subject samples of eight children drawn from kindergarten and second grade classes of a local elementary school. The test materials are displayed in Figures 1 and 2. The eight practice items which always preceeded the test items were repeated twice, once at low reading speed and then again at normal rate. These eight utterances are displayed in Table 3.

It will be observed that each of the 10 test sentences has a corresponding non-sentence produced by randomly ordering the lexical items. Objective placement of the tone-bursts was on the identical lexical item in either version. This position is noted by the "0" line of the plots of Figures 1 and 2. As before, the tone-burst was a 60 msec., 1K Hz. signal. Administration of the test items was in a counter-balanced order which controlled for sentence or non-sentence position.

Procedure. Each subject was brought to the testing room by the experimenter and was seated at a small table opposite the experimenter. The subject was told that in a minute, he would put on the earphones and he would hear a voice saying some words. He would also hear a "click" or "beep" and was to raise his hand as soon as he heard it. This was done to insure that the child knew what the click or beep sound was. Both the subject and the experimenter then put on earphones and word group #1 was played. In case the child did not raise his hand when the click occurred, the word group was repeated until he did so.

The S was then told "Now, I'm going to play the same words again. This time, instead of raising your hand, tell me what word the man is saying when you hear the click. Tell me when the man is through speaking." Word Group #1 was then replayed. In case the S did not respond or replied with several words rather than one word, he was told "Was the man saying 'house', 'lion', 'mountain', 'chicken', or 'letter', (the words in the first item of Word Group #1). Word

TABLE 3 - Practice Stimulus Materials

1. House, lion, *mountain, #chicken, letter.

2. Table, *chair, desk, chimney, man.

3. One, #four, zero, nine, *two, three, seven.

4. Ten, *seventeen, twentyseven, #fiftysix, twentyeight, fiftynine.

5. The *house was on #top of the mountain.

6. The #chicken was *eating the grain.

7. The *letter was #written to the man.

8. The #teacher *thought it was Sunday.

---

*Location of tone-burst for slow reading.

#Location of tone-burst for normal reading.

Group #1 was repeated until the child responded with only one word. Most Ss did this one in one trial and all Ss did so within three trials. The next seven items were then played, all at the slower than normal speaking rate and the instructions were repeated in case any questions arose.

After the first eight word groups (slow rate) were played, the next eight were played. This section is the same as the first except it is spoken at a normal speaking rate. The subject was told "Now the man is going to tell you to do something. Do what he tells you to do and also tell me what the man is saying when you hear the click." These instructions were repeated before each of the twenty following items, ten items being commands requiring a motor response. When a nonsense string, of which there were also ten, was played, the child was first told "Here are some words. Just tell me what the man is saying when you hear the click." The full twenty items were then played and when completed, the subject's response to a particular item was recorded by the experimenter immediately after the response. Upon completion of the twenty items, the subject was returned to his classroom.

Results. The displacement data was analyzed by means of two separate analysis of variance models each employing three classification variables, viz., (1) grade at two levels, kindergarten and second, (2) word order at two levels, sentence and non-sentence orders and (3) utterance composition at 10 levels, i.e., the various lexical compositions. Both models of the analysis of variance were of the mixed type in which the three classification variables were assumed to be fixed, with subjects serving as random replications. The analyses are of the partially hierarchial type in that subject effects are necessarily nested within grade level but form complete replications for all levels of all other variables. "Never pool" procedures were practiced in the choice of error terms in all analyses.

The major two analyses were based upon separate scorings of the displacement data which either coded (1) direction of displacement as a signed value (left displacement from the objective locus scored as minus, right displacement as plus) or (2) magnitude of displacement as an absolute measurement. The former scoring procedure will henceforth be referred to as the algebraic scoring and the latter as absolute scoring. Consider the sample observation:

Stand up/and then s*it down.

where the slash mark, /, indicates the perceived location of the click placed upon the word sit. In scoring this observation by the algebraic criterion, the S would receive a score of -2.5, that is to say, one-half unit of displacement for each word and word-division unit from the objective position of the click. In absolute scoring, the S would receive a score of simply 2.5.

Tables 4 and 5 detail the variance contributions for the classification effects with respect to algebraic and absolute scores, respectively.

It will be observed that the two analysis confirm each other with regard to the significance of all effects with only the exception of the sentence by utterance interaction, (B)(C), it being significant when algebraic scores are considered and non-significant for absolute scores. Discussion of this difference will be deferred for the moment.

Sentence and utterance composition are clearly the two significant contributions controlling the observed variation in responding. The replicated effects under the two forms of scoring are most easily seen by reference to Figures 3 and 4. The plots for the combined groups scored algebraically or as absolute displacements are nearly identical. What discrepancy exists between the two plots is

TABLE 4 - Summary of Analysis of Variance of Algebraic Displacement Scores

Variance Source	SS	df	MS	F
Between Ss	240.49	15		
Grade (A)	12.02	1	12.02	-----
Ss within A (SwA)	228.47	14	16.32	
Within Ss	1515.04	304		
Sentence/Non-Sentence (B)	200.03	1	200.03	22.94*
(A) (B)	.90	1	.90	-----
(B) (SwA)	122.07	14	8.72	
Utterance Composition (C)	165.35	9	18.37	5.48*
(A) (C)	40.03	9	4.45	1.33
(C) (SwA)	422.62	126	3.35	
(B) (C)	114.27	9	12.70	3.86*
(A) (B) (C)	35.27	9	3.92	1.19
(B) (C) (SwA)	414.50	126	3.29	

* p less than that for alpha level .05

TABLE 5 - Summary of Analysis of Variance of Absolute Displacement Scores

Variance Source	SS	df	MS	F
Between Ss	235.52	15		
Grade (A)	5.52	1	5.52	-----
Ss within A (SwA)	230.00	14	16.43	
Within Ss	712.71	309		
Sentence/Non-sentence (B)	18.53	1	18.53	5.36*
(A) (B)	1.95	1	1.95	-----
(B) (SwA)	48.39	14	3.46	-----
Utterance/Composition (C)	54.52	9	6.06	2.49*
(A) (C)	29.43	9	3.27	1.35
(C) (SwA)	306.72	126	2.43	-----
(B) (C)	22.11	9	2.46	1.51
(A) (B) (C)	25.26	9	2.81	1.72
(B) (C) (SwA)	205.80	126	1.63	

* p less than that for alpha level .05

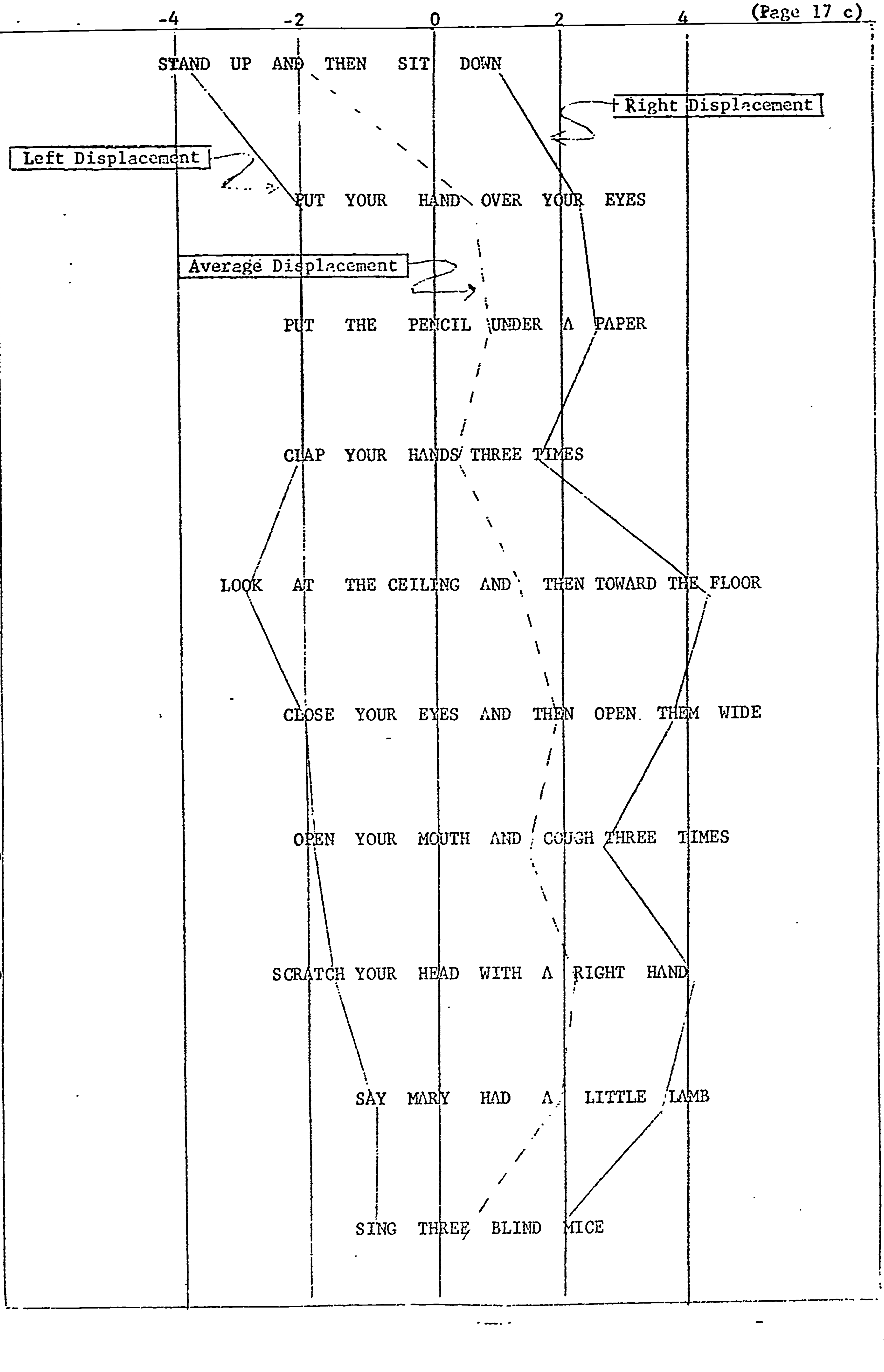


Figure 1 - Signed and Averaged Displacemements for Sentence Strings

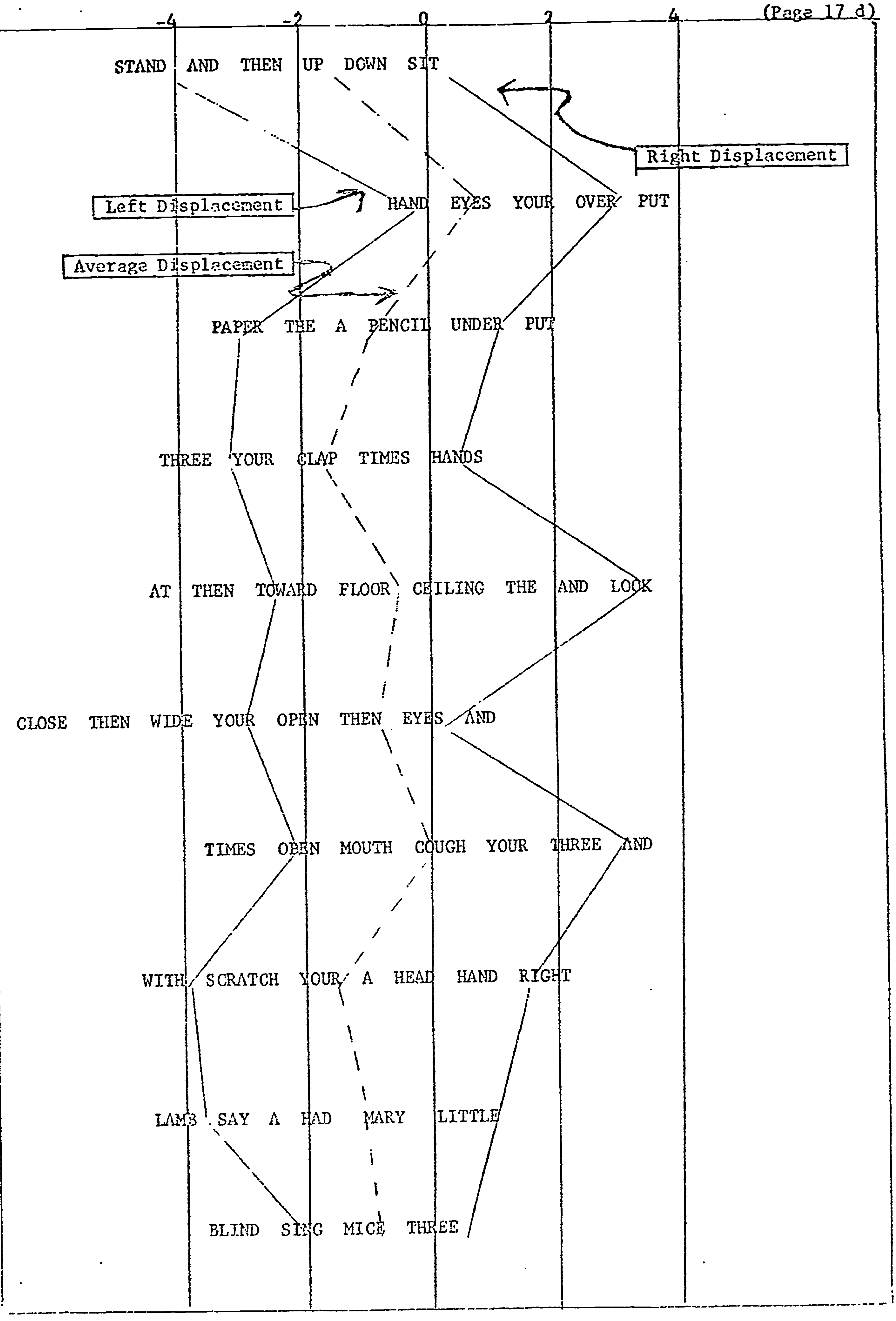


Figure 2 - Signed and Averaged Displacements for Random Strings

Figure 3 - Algebraic Displacements for the Combined Subject Groups

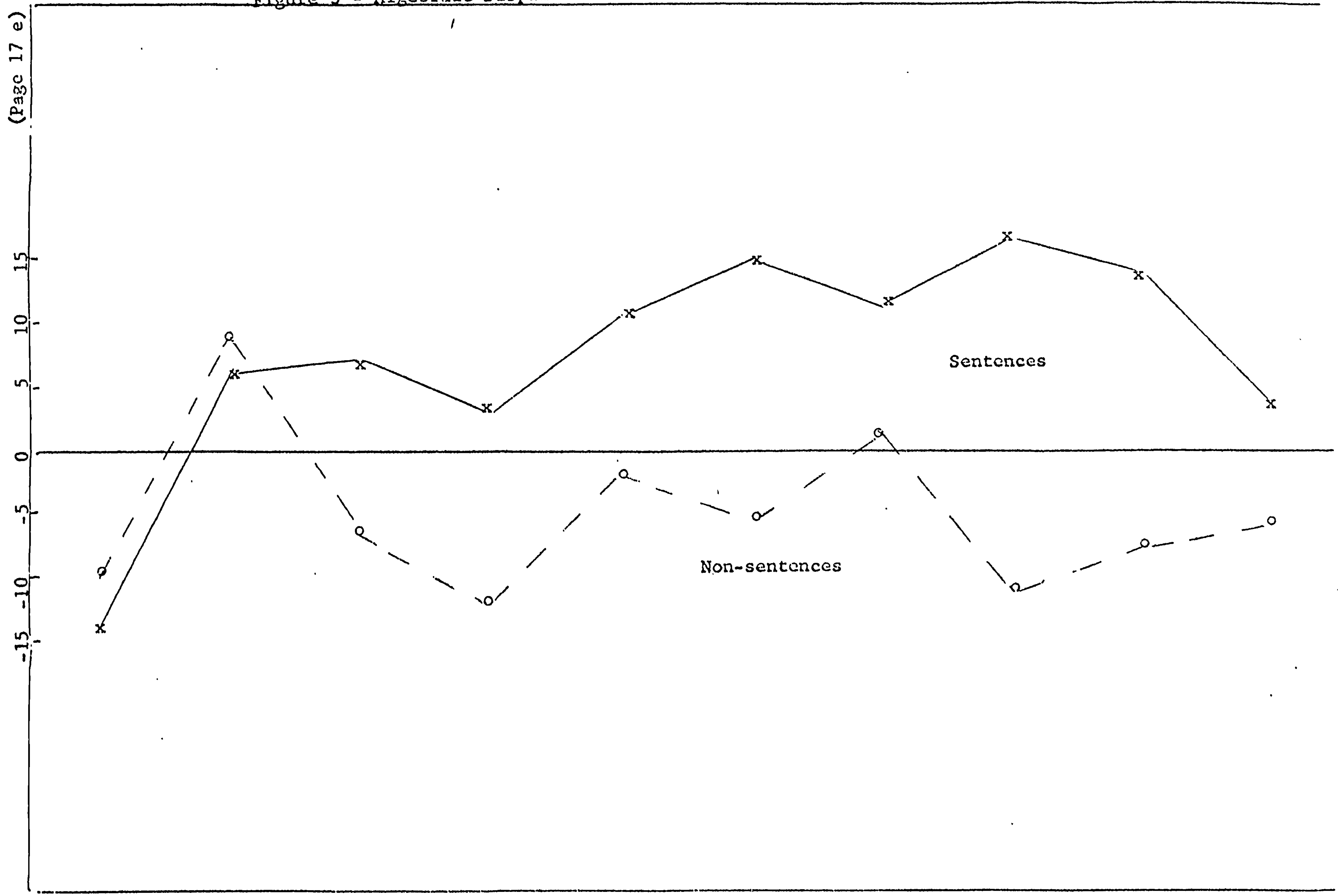


Figure 4 - Signed Absolute Displacements for the Combined Subject Groups

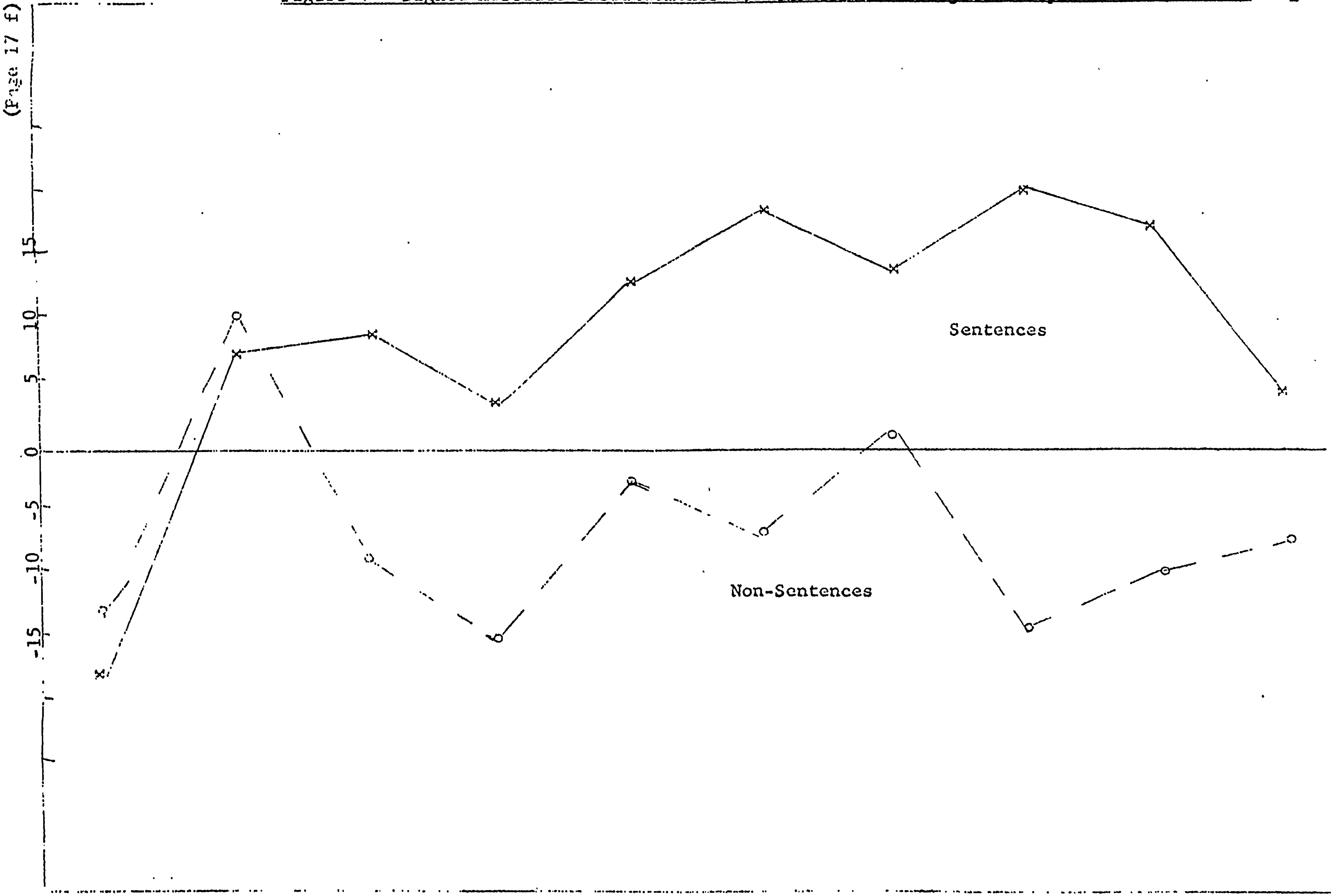
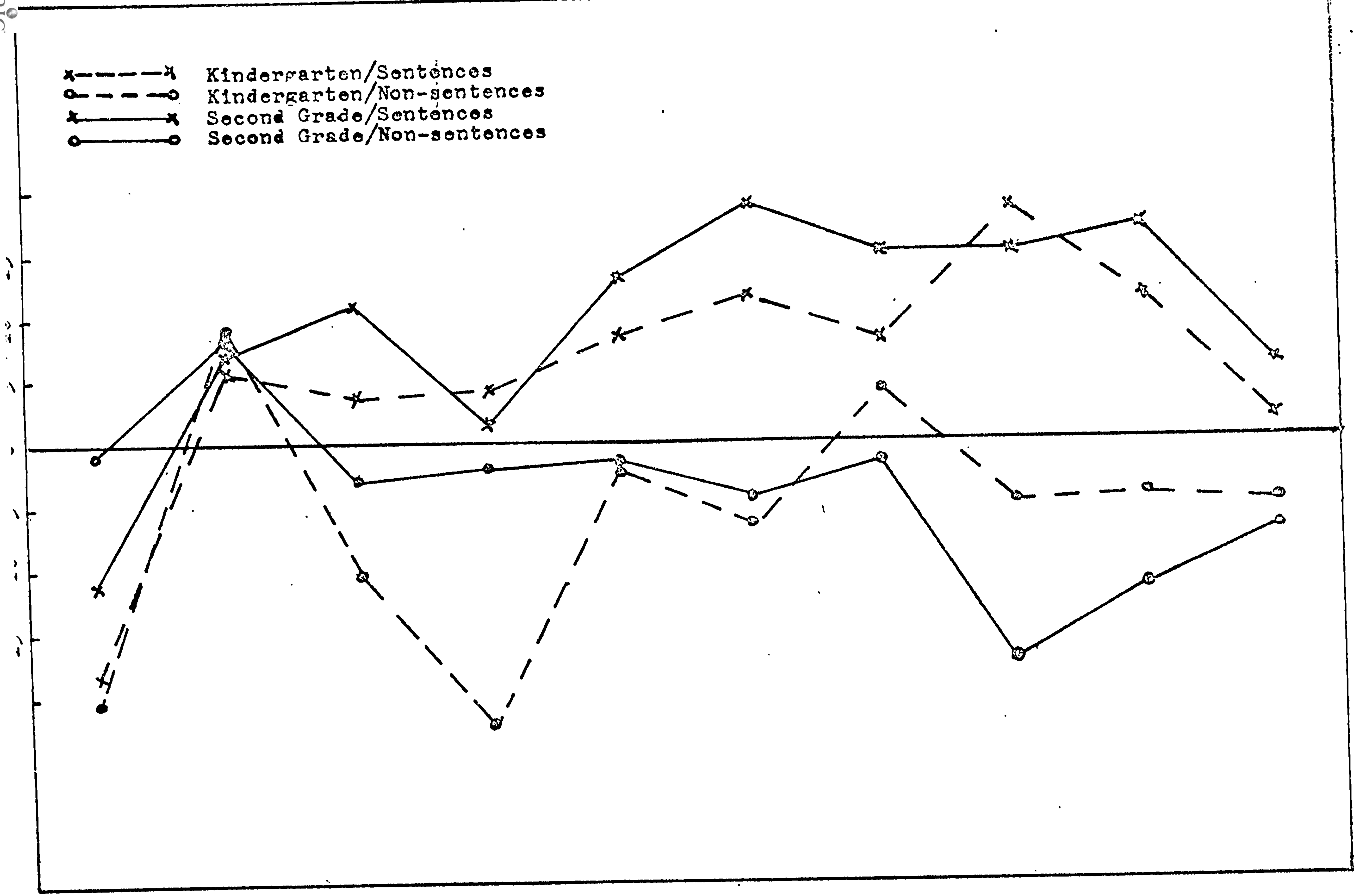


Figure 5 - Signed Absolute Displacements for All [illegible]



in the direction of slightly greater displacement scores when direction of displacement (Figure 4) is preserved in summation. This lack of difference between the two forms of scoring is produced by a consistent tendency for Ss within a sentence or utterance type to displace the click locus in one direction.

The significant interaction between utterance composition and sentence in the algebraic analysis is very suggestive. The sentence/non-sentence contrasts of this experiment used exactly the same lexical stock. That is to say, in order to produce a non-sentence the words of a given sentence were simply randomly ordered. When one looks at the collapsed variance contribution of utterance composition, one is abstracting the effects of lexical content summed over its appearance in both sentences and non-sentences. Thus the (B)(C) interaction confirms the fact that the particular ordering of lexical content which produces a meaningful English utterance is peculiar in its effects upon displacement and that effect varies as a function of the particular lexical stock which is used to construct the sentence or non-sentence.

Figures 1 and 2 summarize the amount and direction of displacement for each of the utterances. These figures display each utterance in the scale units used for scoring, with the objective click locus centered on the zero displacement line. Both subject groups are combined in these displays. It is immediately apparent that there is a uniform tendency for the click location to be preposed from its objective location when non-sentences are used as stimuli and post-positioned when the utterances are well formed. This suggestive difference, however, must be qualified by the equally clear caveat that the condition of identical lexical locus for the click produced more clicks near the ends of non-sentences and at the beginnings of sentences. Thus the potential range of displacement scores is unequally limited in the two instances.

The reader will note from Figure 5, however, that there remains a distinct tendency for the kindergarten Ss to prepose click locations for both sentences and non-sentences and for the second grade Ss to post-position the click. The limitation of potential scoring range cited above is not an influence in this case, since the comparison involves both utterance types and is relative across grade level. As a post hoc check on this tendency a simple *t* was calculated for the difference between the grade levels for the average differences between the sentence types. This t=4.34 and is significant beyond the 5% level. The test confirms what inspection of Figure 5 makes striking, that is, that although there is greater average displacement for sentences than for non-sentences at both grade levels, there is a greater tendency for kindergarten Ss to preposition the click in non-sentences than there is for second grade Ss.

It should be observed that the *t* test just discussed is not a duplication of the (A)(B) interaction effect of the analyses of variance. The lack of significance in the ANOVAE merely indicates that the sentence and grade level functions are roughly parallel in their effects. The *t* test by contrast declares that the differences in level of these functions, as displayed in Figure 5, are on the average significantly different.

Summary and Conclusions. In view of the relatively small N size employed in these experiments, the following general conclusions are subjectively strengthened in their prepotence as determiners of judgments of the locii of extraneous distortions in speech. For children, displacement of a tone-burst is controlled, at least in part, by the syntactic organization of lexical material, and by the nature of the lexical stock comprising that material. Greater magnitude of displacement is found for sentences, lesser magnitude for non-sentences. For younger children there is a significant tendency to preposition the disturbed click location in both sentences and non-sentences. For both groups of children there is a tendency for click location to be preposed in non-sentential material and post-positioned in sentential material.

Procedural modifications involving the nature of the click distortion, its mode of presentation and the nature of the response task do not appear to delimit the generality of the observed findings. Locii identification for relatively young children is within their competence repetoire.

Children appear to be more sensitive to lexical modification within syntactic forms than do adults. And finally, as has been observed with adults, perceived click locii migrate towards the major constituent boundaries of sentential material.

Further research which would systematically vary the nature of the syntactic and lexical forms of the stimulus materials is clearly called for. The results of these experiments have indicated the fruitfulness and feasibility of such further research.

REFERENCES

Bellugi, U. The child's acquisition of grammar. Paper read at Eastern Association for Verbal Learning, 1967.

Chomsky, N. Syntactic Structures. The Hague, Mouton, 1957.

Fodor, J. A. and Bever, T. G. The psychological reality of linguistic segments. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 414-420.

Garrett, M. F. Syntactic Structures and Judgments of Auditory Events: A study of the Perception of Extraneous Noise in Sentences. Unpublished Ph.D. Dissertation, University of Illinois, Urbana, Illinois, 1965.

Garrett, M.F., Bever, T.G., and Fodor, J.A. The active use of grammar in speech perception. Journal of Perception and Psychophysics, 1966, 1, 30-32.

Ladefoged, P. and Broadbent, D. Perception of sequence in auditory events. Quarterly Journal of Experimental Psychology, 1960, 12, 162-170.

McCarthy, J. J. and Kirk, S. A. Illinois Test of Psycholinguistic Abilities: Experimental Edition. Urbana, University of Illinois, 1961.

Wells, R. Immediate constituents. Language, 1947, 23, 81-117.

Yngve, V. H. The depth hypothesis. IN: Jakobson (Ed.) Structure of Language and its Mathematic Aspects. Proceedings of Symposia in Applied Mathematics, 1961.