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By-Greenough, Diane

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The ability of 31 institutionalized trainable mentally retarded mongoloid and nonmongoloid subjects (mean IQ=27.5) to comprehend and imitate verbally presented sentences of varying levels of grammatical complexity was examined. Eight stimulus sentences were spoken for four pairs of pictures, simple declarative or kernel, negative, passive, and negative passive. Subjects were asked to select one of a pair of pictures for each sentence and then to repeat the sentences. They correctly comprehended kernel sentences significantly more often than other kinds of sentences. Among nonmongoloid subjects, imitation of sentences to which one optional transformation had been applied was significantly better than imitation of sentences modified by two potential transformations. Chronological age was significantly associated with imitation ability in nonmongoloids (p .04); IQ and imitation ability were significantly associated in mongoloids (p .05), indicating that the ability to store verbal material for immediate recall is associated with general intellectual or cognitive abilities. (Author/RJ)

COMPREHENSION AND IMITATION OF SENTENCES BY INSTITUTIONALIZED TRAINABLE MENTALLY RETARDED CHILDREN AS A FUNCTION OF TRANSFORMATIONAL COMPLEXITY[1]

Diane Greenough

Center for Research on Language and Language Behavior
The University of Michigan
Mount Pleasant State Home and Training School

The ability of 31 trainable mentally retarded (TMR) mongoloid and nonmongoloid Ss ($\bar{X}_{IQ}$ = 27.5) to comprehend and imitate verbally presented sentences of varying levels of grammatical complexity was examined in two studies. Comprehension ability was tested by asking each S to indicate which of 2 pictures was being described in the sentence spoken by E. Eight stimulus sentences were spoken by E for each pair of pictures--simple declarative or kernel (K), negative (N), passive (P), and negative passive (NP) for each picture. S's ability to imitate sentences of varying levels of complexity was tested by having him repeat the sentences used in the comprehension task, with passive forms truncated so that stimuli would be nearly equal in length. Ss correctly comprehended kernel sentences significantly more often than chance expectancy. Among nonmongoloid Ss, imitation of sentences to which one optional transformation had been applied was significantly better than imitation of sentences modified by two optional transformations. CA was significantly associated with imitation ability in nonmongoloid Ss; IQ and imitation ability were significantly associated in mongoloid Ss. Results are discussed in terms of competence and performance variables which might affect the ability of TMR Ss to deal with verbal stimuli.

The theory of transformational grammar states that the knowledge which a speaker has of his language may best be described in terms of a deep or base structure component plus an additional set of operations called transformations (Chomsky, 1965). It is not claimed that such a model describes how the speaker generates the sentences he uses, but rather that it describes the intrinsic knowledge that a speaker must have to use the language correctly (Chomsky, 1965). It appears likely, however, that the grammatical complexity of a sentence is inversely related to the ease with which it can be uttered and understood by speakers of the language. Results of studies in which Ss indicated the truth-value of a sentence in relation to a picture presented by E have been offered as evidence that speed of comprehension is inversely proportional to the number of transformations separating a sentence from its base structure. In experiments with normal adults (Gough, 1965, 1966; Slobin, 1966) and children (Slobin, 1966), it was found that latencies of correct responses increased in the following order: kernel-passive-negative-negative passive. Simple declarative (kernel) sentences result from obligatory transformations of the base structure (Chomsky, 1965) and are thought to be the simplest sentence forms. Addition of the semantic element of negation apparently creates more difficulty for comprehension than do grammatical transformations. Thus, Slobin and Gough found slowest comprehension rates when the negative (semantic) transformation was applied. Slobin also reported that chronological age (CA) interacts significantly with syntactic structure--suggesting developmental changes in linguistic competence. IQ and reaction time to sentences did not correlate significantly.

Semmel and Greenough (1968) tested the generalizability of the findings of Gough and Slobin to trainable mentally retarded (TMR) mongoloid children. Ss were able to comprehend kernel sentences at levels significantly beyond chance expectancy. They seemed to treat simple negative strings as affirmatives and so they were correct significantly less often than would be expected by chance. Their responses to passive and negative-passive strings appeared to be random. Imitation of simple declarative sentences (strings whose base structure had been modified by obligatory transformations only) was significantly better than imitation of sentences to which optional transformations (negative and/or passive) had been applied. All strings to which optional transformations had been applied were imitated equally well. IQ was highly correlated with imitation ability.

In the present studies the comprehension and imitation abilities of institutionalized TMR children were tested. It was predicted that the institutionalized Ss would not be able to process syntactically or semantically complex sentences so as to understand their content (comprehension) or store them efficiently in immediate memory for later retrieval (imitation). In both the comprehension and imitation tasks, Ss would presumably perform much better on K (kernel) sentences than on N (negative), P (passive), or NP (negative-passive) sentences. The negation marker was stressed in the reading of N and NP sentences in the comprehension task, in order to reduce the likelihood that Ss were missing this cue and treating the strings as affirmative statements.

Both mongoloid and nonmongoloid Ss were used so that possible effects of biological differences between Ss on comprehension and imitation abilities, as well as effects of factors associated with institutionalization, might be discovered.

Study I: Comprehension

Method

Subjects. Ss were 31 children ranging in CA from 7-7 to 20-8, all residents of the Mt. Pleasant State Home and Training School and classified as trainable in a recent educational evaluation program there. Ss were selected so that the mean CA and IQ in the mongoloid and nonmongoloid subsamples would be similar. Peabody Picture Vocabulary Test scores from tests administered in 1966 served as measures of IQ in the selection of Ss. There were 16 mongoloids ($\bar{X}_{CA}$ = 15-3, s.d. = 12.4 mos.; $\bar{X}_{IQ}$ = 26, s.d. = 2.90) and 15 nonmongoloids ($\bar{X}_{CA}$ = 15-5, s.d. = 11.7 mos.; $\bar{X}_{IQ}$ = 29, s.d. = 2.53) in the total sample. There were five females in each of the two subgroups.

Procedure. Four pairs of pictures, each pair representing both aspects of a reversible situation, were used as stimuli. The pictures were brightly colored and were drawn on 8 1/2 x 11-inch white paper. The following situations were depicted: (a) Boy pushing girl in wheelbarrow; girl pushing boy in wheelbarrow; (b) Ball hitting clown; clown hitting ball; (c) Donkey kicking clown; clown kicking donkey.

For each pair of pictures, two kernel, i.e. declarative affirmative, two negative declarative, two passive, and two negative passive sentences were presented to S. Order of presentation was randomized for each pair of pictures. The sentence stimuli are reproduced in Table 1.

Insert Table 1 about here

Ss were tested individually by E in an empty classroom or office. After seating S at a small table across from E, E encouraged S to interact with him for a short time, so as to habituate S to the experimental environment. Three pictures, one from each pair, were placed before S, who was asked to point to the one he liked best. S's choice determined which pair of stimuli was presented first. E then said, "See these pictures? Point to the one where..." and gave the first sentence for that pair of pictures. Eight sentences were presented for each pair of pictures. In presenting N and NP sentences, E stressed the word "not".

Responses were recorded as correct or incorrect. E also recorded the position of stimuli as they were placed before S, so that any position preference could be detected.

The Leiter International Performance Scale was administered to each S in order to provide a non-verbal measure of IQ.

Results

Responses of three mongoloid and two nonmongoloid Ss had to be discarded because they could not be induced to perform the task.

Analysis of responses in terms of the position of the picture selected revealed no tendency of Ss to favor a specific position or to follow a set pattern of responses.

A two-way analysis of variance for experiments with repeated measures revealed no significant differences between mongoloid and nonmongoloid subgroups in their responses to the comprehension items ($F_{1,24} = .12$). Thus, responses of the two subgroups were analyzed together in subsequent tests of the hypotheses of this experiment.

Figure 1 shows mean percentage of correct responses on the comprehension task as a function of sentence type.

Insert Figure 1 about here

Since the comprehension task required Ss to select one of a pair of pictures for each sentence given, the probability of the observed mean percentage of correct responses for each sentence type was determined by means of binomial test, given a chance probability of success, $p = .50$.

The probabilities of the observed mean percentage of correct responses to negative ($\bar{X} = 50.58$, s.d. = 5.34, $p < .46$), passive ($\bar{X} = 49.38$, s.d. = 4.48, $p < .46$), and negative passive ($\bar{X} = 54.42$, s.d. = 3.87, $p < .24$) sentences were within chance levels. The probability of the observed mean percentage of correct responses was less than .006 for declarative sentences ($\bar{X} = 62.81$, s.d. = 4.65) under the null hypothesis.

Kendall's coefficient of concordance, corrected for ties, was used to discover whether Ss' comprehension scores were ordered similarly across different levels of grammatical complexity. Significance levels were determined by calculation of χ^2. The coefficient of concordance obtained ($\omega = 2.59$) was not significant ($\chi^2 = 25.9$, d.f. = 25, $p > .05$). Since there was no significant association of scores across sentence types, it was not possible to use a single comprehension score to test for association of IQ and CA with comprehension ability. Instead, Kendall's τ, corrected for ties, was used to test the association of CA and IQ with the percentage of correct responses on each type of sentence. Significance of these coefficients was determined by calculation of z (Siegel, 1956). Table 2 shows rank correlation coefficients (Kendall's τ) and significance levels for the association of CA and IQ with each sentence type.

Insert Table 2 about here

Neither CA nor IQ was significantly associated with any of the comprehension scores.

Discussion

Simple declarative sentences appear to be within the comprehension ability of the TMR Ss in this study. They seem not to have understood the negative, passive, and negative-passive sentence stimuli. Instead, they appeared to respond randomly to such strings or to use decoding strategies leading to responses not correlated with those demanded by the task.

In the study by Semmel and Greenough (1968), mongoloid Ss who were enrolled in public school programs for the TMR appeared to treat negative sentences as if they were affirmatives by ignoring the negation marker. This phenomenon, it was felt, could represent an attention deficit: Ss ignored or missed the negation marker and processed the sentence as a kernel string. Alternatively, it could represent inadequate competence: Ss could not correctly process the negative sentence into its base structure and extract the meaning from this representation. The response of Ss in the present study, in which E stressed the word "not" in the N and NP sentences, suggest that both hypotheses are, to some extent, correct. When the negation marker was stressed and thereby S's attention presumably directed to it, comprehension responses to simple negative sentences were random; in other words, Ss lacked the competence to process the strings correctly once they perceived that they were not simple declarative ones.

The lack of association between IQ or CA and comprehension scores indicates that for these Ss, as for the public school TMR Ss in the study by Semmel and Greenough (1968), the ability tested is not one which can be expected to develop with increased CA or to be more pronounced at relatively higher IQ levels. These results offer little support for the claim made by Lenneberg (1967), based on the findings of Lenneberg, Nichols, and Rosenberger (1964), that even in the mentally retarded, language development is more strongly associated with CA and other aspects of biological development than with intellectual level.

Study II: Imitation

Method

Subjects. The same subjects were used for both the comprehension and imitation tasks.

Procedure. Following presentation of all eight stimulus sentences in the comprehension task (See Table 1), the pictures were removed and E said, "Now say just what I say. O. K.?" The eight sentences were repeated, with the passives and negative passives truncated by deletion of the "by-agent" phrase to make all sentences stimuli more nearly equal in length.

A sentence was scored as correctly imitated if the nouns serving as subject and object were present and connected by a verb expression in the appropriate form (i.e., "be" or "being" plus the main verb for passive sentences: the verb in either a present or present progressive form for the active sentences). For negative strings the word "not" had to be present before the main verb or "be".

Results

Responses of three mongoloid and two nonmongoloid Ss were not available because they were unwilling or unable to perform the task.

A two-way analysis of variance for experiments with repeated measures revealed a difference between mongoloid and nonmongoloid subgroups in their responses to the imitation items that was significant at the .001 levels ($F_{1,24} = 30.52$). Responses of the two subgroups were therefore analyzed separately in subsequent tests of the hypotheses of this experiment.

Figure 2 shows mean percentage of correct responses on the imitation task as a function of sentence type.

Insert Figure 2 about here

The following orthogonal breakdowns of the hypotheses relative to the comparisions between K, N, P, and NP sentences on the imitation task were made:

1. Imitation of kernel (K) sentences (obligatory transformations only) is on the average significantly better than imitation of sentences to which one or more optional transformations are applied (N, P, and NP sentences).

2. Imitation of sentences to which one optional transformation is applied (N and P sentences) is significantly better than imitation of sentences to which two optional transformations are applied (NP sentences).

3. Imitation of sentences to which a passive (P) transformation is applied is significantly better than imitation of sentences to which a negative (N) transformation is applied. These hypotheses were tested through a priori individual comparisons among sample means (Hays, 1963). Percentage of correct responses was used as the measure of performance. Table 3 shows the means and standard deviations of these scores for the mongoloid and nonmongoloid samples across different sentence types.

Insert Table 3 about here

Table 4 summarizes the results of the individual comparisons among sample means.

Insert Table 4 about here

Sentences to which one optional transformation had been applied (N and P sentences) were correctly imitated with significantly greater success by nonmongoloid Ss than were sentences to which two transformations had been applied (NP sentences). Among the mongoloid Ss, none of the hypothesized differences was significant; in fact, imitation of NP strings was slightly better than imitation of N or P strings.

Kendall's coefficient of concordance, corrected for ties, was used to discover whether Ss' imitation scores were ordered similarly across different levels of grammatical complexity. Significance levels were determined by calculation of χ^2. The coefficient of concordance obtained for scores of mongoloid Ss (ω = .715) was significant at the .001 level (χ^2 = 34.32, df = 12) For nonmongoloid Ss, the coefficient of concordance (ω = .635) was significant at the .01 level (χ^2 = 30.48, df = 12). Since the association of scores across sentence types was significant, the mean percentage of correct responses for each S across all sentence types was used as a summary score in testing the association of CA and IQ with imitation ability in both mongoloid and nonmongoloid Ss. The association of CA and IQ with imitation performance was tested by means of Kendall's τ, corrected for ties, with significance levels determined by calculation of z (Siegel, 1956). CA and imitation scores were significantly associated in the nonmongoloid subgroup ($\tau = .34$, $\sigma_\tau = .2$, $p < .04$) but not in the mongoloid subgroup ($\tau = .05$, $\sigma_\tau = .2$, $p < .40$). The association of IQ and imitation scores was significant for mongoloid Ss ($\tau = .33$, $\sigma_\tau = .2$, $p < .05$) but not for nonmongoloid Ss ($\tau = .08$, $\sigma_\tau = .2$, $p < .34$). The association of CA and IQ was not significant for either group (mongoloids: $\tau = .28$, $\sigma_\tau = .2$, $p < .10$; nonmongoloids: $\tau = .03$, $\sigma_\tau = .2$, $p < .50$).

Discussion

In the present study, mongoloid and nonmongoloid Ss seem to have been affected differently by variation in grammatical complexity. Nonmongoloid Ss were able to imitate significantly more sentences to which one optional transformation had been applied than sentences modified by two optional transformations. None of the comparisons of imitation ability at different levels of complexity was significant for mongoloid Ss. Results also suggest that CA is significantly associated with imitation ability in nonmongoloid Ss and that IQ and imitation ability are significantly associated in mongoloid Ss.

It is possible that sentence length is the important factor in the imitation task, with Ss unable to hold the longer, transformed sentences in immediate memory. However, the length of stimuli cannot be the only factor influencing performance. The shortest sentence form in the imitation task was the truncated passive sentence (five words). Next longest were the simple declarative and negative passive forms (six words each). The longest form was the simple negative (seven words). Therefore, if length of sentence stimuli were the only factor affecting imitation ability in this task, we would expect to find scores ordered as follows: P > K = NP > N. Instead, the scores of the nonmongoloid Ss were ordered: K > NP > N = P. They imitated negative and passive sentences (the longest and shortest strings) significantly better than negative-passive forms, and they imitated the declarative sentences significantly better than the negative-passive sentences even though both sets of strings were of equal length. The poorer performance on truncated passive or negative-passive sentences than on simple declarative strings of equal or greater length suggests that Ss cannot readily decode and store sentences in which information from the base structure has been omitted from the surface structure. Since the difference between performance on kernel strings containing optional transformations was nonsignificant, the poorer performance does not seem to be caused by the presence of optional transformations per se. It may be that nonmongoloid Ss have a limited competence and can process sentences of moderate complexity but are unable to deal with more complex strings such as the P or NP strings of this study.

The scores of mongoloid Ss were differently ordered: K > NP > N = P. They imitated the six-word kernel and negative-passive sentences somewhat more accurately than either the seven-word negative or the five-word passive sentences. Since these differences were not significant and since performance on the imitation task by mongoloid Ss was greatly inferior to that of nonmongoloid Ss, it may be that the nature of the task was different for them. These Ss appeared to perform as they would in recall of strings of unrelated words, and did not seem to be utilizing syntactic or semantic relationships to aid recall.

The effect of Ss' presumed familiarity with sentences of each type used in the study may partially explain the results obtained. Siegel (1963) studied the language behavior of adults and retarded children in interpersonal associations. The mean length of adult response (MLR) was considerably lower than the norms provided by Mildred Templin (1957) for normal eight-year-olds. Siegel also found that adults used more responses, greater MLRs, higher type-token ratios (TTR), and significantly fewer questions with high-level MR children than with low-level MR Ss. Hence, it may be that the adults associating with mongoloid TMR children limit their verbal interaction to simple statements and questions and so provide an impoverished verbal environment for TMR children. However, since Siegel did not classify adult utterances in terms of their syntactic structure, we cannot be sure what sentence types occur most often in the experience of TMR children. In fact, we do not know whether adults typically use complete and grammatically well-formed sentences with such children. Nevertheless, we may assume that adult utterances are much more likely to be active than passive.

The performance on imitation of negative declarative sentences by both groups of Ss was no better than performance on affirmative passive strings, even though it appears likely that Ss would be more familiar with the negative declarative type of sentence. The observation by Gough (1965) and Slobin (1966) that addition of the semantic element of negation apparently creates more difficulty for comprehension than do grammatical transformations is probably relevant to the imitation problems of Ss in this study. Since the negative strings were the longest stimuli administered, it is also possible that the effects of familiarity and sentence length interacted for the Ss in this task. Such an interaction would result in depressed performance on long familiar sentence forms over shorter forms of equal or greater familiarity. Thus, the shortest sentences may be performed relatively well, even though they are framed in a way that is unfamiliar to S. Since the word "not" in the N and NP strings was not emphasized in the imitation task, it is also possible that Ss missed this cue to the content of the sentence and omitted it along with other function words such as "the".

The significant association of IQ and imitation scores for mongoloid Ss replicates the findings of Semmel and Greenough (1968) with public school mongoloid children and suggests that, for these children, the ability to store verbal material for immediate recall is not one which shows developmental changes but is, rather, associated with the general intellectual or cognitive abilities of the individual. In contrast, with the nonmongoloid Ss, this ability shows developmental changes similar to those found by Lenneberg, Nichols, and Rosenberger (1964) with non-institutionalized mongoloid children and may provide further support for maturationally-based theories of language development.

General Discussion

The Ss in the present studies were older than those in the study by Semmel and Greenough (1968), although their IQs were generally lower. It was posited that the institutionalized Ss were exposed to a much less adequate linguistic environment and that the effects of institutionalization would result in a depressed rate of language development (Butterfield, 1967).

In the imitation task, the performance of mongoloid Ss was somewhat more primitive than that of the noninstitutionalized mongoloid Ss studied by Semmel and Greenough (1968). It was not clear that nonmongoloid Ss were affected by grammatical complexity, since an interaction of the effects of sentence length and familiarity with sentence forms could have yielded the observed results. Institutionalized and public school Ss apparently performed the comprehension task equally well.

Fraser, Brown, and Bellugi (1963) found that, with normal children, the ability to imitate sentences regularly preceded their ability to comprehend which of two pictures a sentence referred to. These findings were replicated with language-retarded and normal children by Lovell and Bradbury (1967) and Lovell and Dixon (1967).

In the present studies, the higher level noninstitutionalized children appear to have developed sufficient comprehension ability to show differences from the lower level institutionalized Ss; on the other hand, both groups were at such a primitive level with regard to imitation ability that no differences between them were apparent in that respect. The comparison between the performance of institutionalized and public school TMR children on the experimental tasks suggests that maturational factors may be less important for the acquisition of language than intellectual capability (as measured by IQ) and environmental adequacy.

Footnote

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Figure Captions

Fig. 1. Comprehension task: Mean percentage of correct responses as a function of sentence type.

Fig. 2. Imitation task: Mean percentage of correct responses as a function of sentence type.

Table 1

Sentence Stimuli

A. 1. The boy is being pushed (by the girl).
2. The boy is not pushing the girl.
3. The boy is pushing the girl.
4. The girl is being pushed (by the boy).
5. The boy is not being pushed (by the girl).
6. The girl is not pushing the boy.
7. The girl is not being pushed (by the boy).
8. The girl is pushing the boy.

B. 1. The ball is not being hit (by the clown).
2. The ball is not hitting the clown.
3. The ball is hitting the clown.
4. The clown is hitting the ball.
5. The ball is being hit (by the clown).
6. The clown is not hitting the ball.
7. The clown is not being hit (by the ball).
8. The clown is being hit (by the ball).

C. 1. The donkey is not kicking the clown.
2. The donkey is not being kicked (by the clown).
3. The clown is being kicked (by the donkey).
4. The clown is not kicking the donkey.
5. The donkey is kicking the clown.
6. The clown is not being kicked (by the donkey).
7. The donkey is being kicked (by the clown).
8. The clown is kicking the donkey.

The expressions in parentheses were omitted from the truncated forms of the passive and negative-passive sentences used in the imitation task.

Table 2

Association of CA and IQ with sentence type in the comprehension task and with each other

Association	Kendall's τ	z	Probability Level
IQ-K	-.06	.158	.44
IQ-N	-.12	.326	.38
IQ-P	-.17	.460	.33
IQ-NP	-.13	.347	.37
CA-K	-.16	.430	.36
CA-N	-.05	.134	.45
CA-P	-.003	.008	.50
CA-NP	-.13	.670	.25
CA-IQ	.17	1.37	.08

Table 3

Means and standard deviations of imitation scores for monogoloid and nonmongoloid Ss

Sentence Type	Monogoloids		Nonmongoloids	
	Mean	Standard Deviation	Mean	Standard Deviation
K	10.31	4.44	55.08	7.86
N	5.15	3.96	50.08	10.99
P	5.15	3.96	52.62	8.17
NP	6.38	3.52	38.46	9.51

Table 4

Summary of orthogonal comparisons of relationship between level of grammatical complexity and imitation scores for mongoloid and nonmongolid Ss

	Comparisons		
	Obligatory Transformation vs. Optional Transformation	One Transformation vs. Two Transformation	Syntactic Transformation vs. Semantic Transformation
Mongoloids			
$\hat{\Psi}$	4.75	-1.23	0
Est. Var. $(\hat{\Psi})$	7.45	8.40	11.17
F	3.03	.18	0
Nonmongoloids			
$\hat{\Psi}$	8.03	25.78	-2.54
Est. Var. $(\hat{\Psi})$	52.87	59.61	79.30
F	1.22	11.15*	.08

*$p < .01$

Table 2

Association of CA and IQ with sentence type in the comprehension task and with each other

Association	Kendall's τ	z	Probability Level
IQ-K	-.06	.158	.44
IQ-N	-.12	.326	.38
IQ-P	-.17	.460	.33
IQ-NP	-.13	.347	.37
CA-K	-.16	.430	.36
CA-N	-.05	.134	.45
CA-P	-.003	.008	.50
CA-NP	-.13	.670	.25
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Table 3

Means and standard deviations of imitation scores for monogoloid and nonmongoloid Ss

Sentence Type	Monogoloids Mean	Monogoloids Standard Deviation	Nonmongoloids Mean	Nonmongoloids Standard Deviation
K	10.31	4.44	55.08	7.86
N	5.15	3.96	50.08	10.99
P	5.15	3.96	52.62	8.17
NP	6.38	3.52	38.46	9.51

Table 4

Summary of orthogonal comparisons of relationship between level of grammatical complexity and imitation scores for mongoloid and nonmongolid Ss

	Comparisons		
	Obligatory Transformation vs. Optional Transformation	One Transformation vs. Two Transformation	Syntactic Transformation vs. Semantic Transformation
Mongoloids			
$\hat{\Psi}$	4.75	-1.23	0
Est. Var. $(\hat{\Psi})$	7.45	8.40	11.17
F	3.03	.18	0
Nonmongoloids			
$\hat{\Psi}$	8.03	25.78	-2.54
Est. Var. $(\hat{\Psi})$	52.87	59.61	79.30
F	1.22	11.15*	.08

*$p < .01$

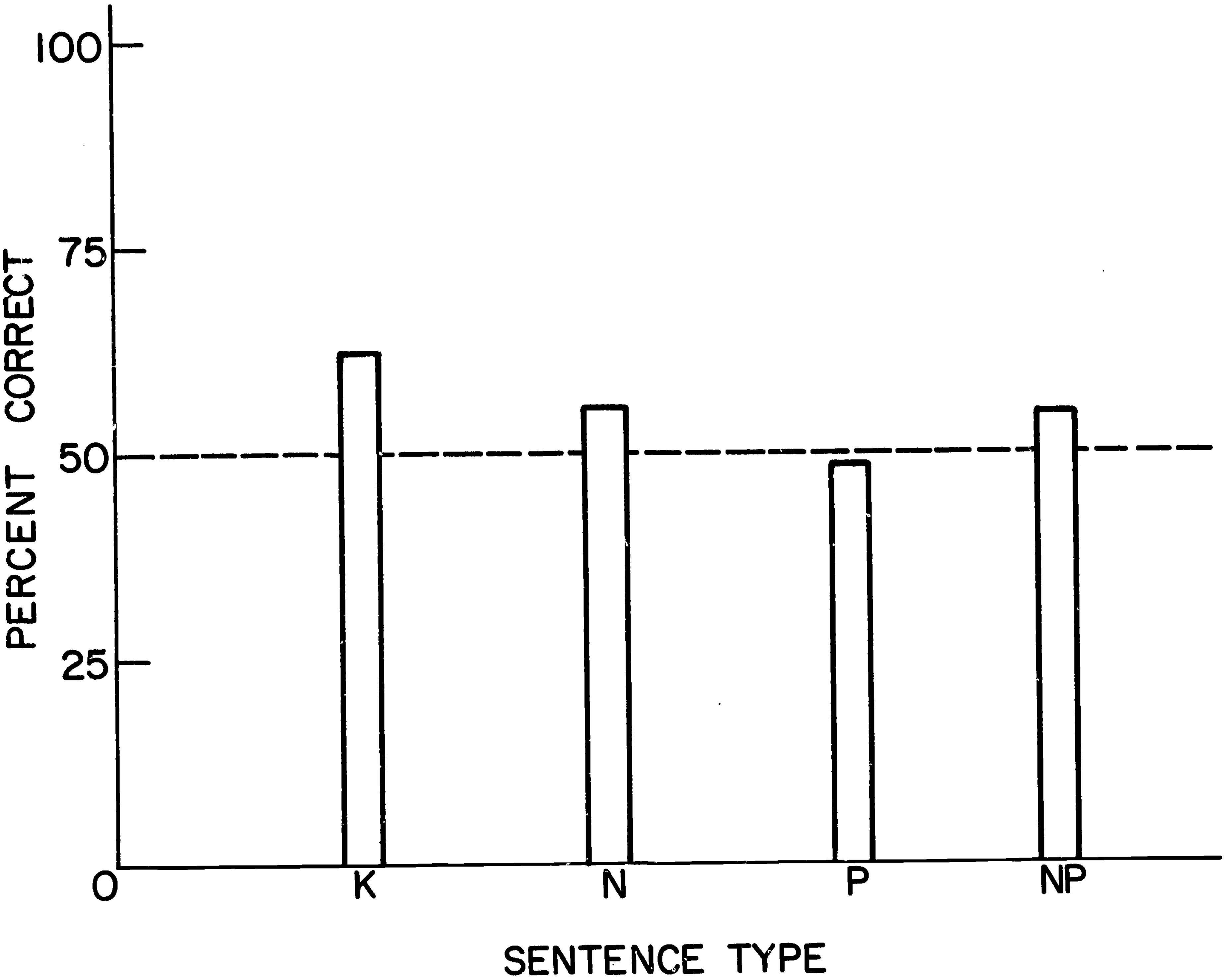

Figure 1

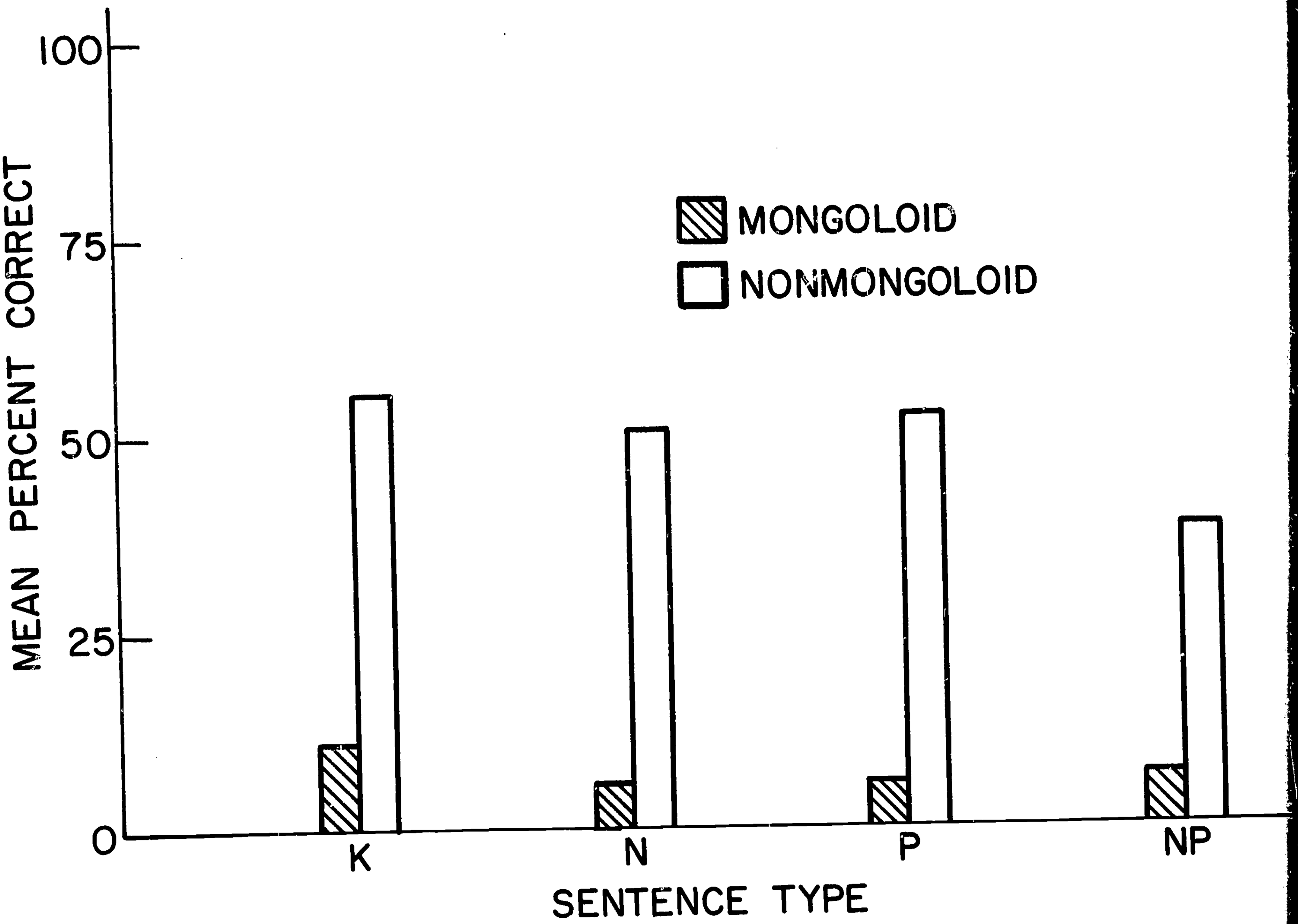
MEAN PERCENT CORRECT
100
75
50
25
0
MONGOLOID
NONMONGOLOID
K
N
P
NP
SENTENCE TYPE

Figure 2