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SENTENCE STRUCTURE AND THE EYE-VOICE SPAN. STUDIES IN ORAL READING, IX. PRELIMINARY DRAFT.

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THIS STUDY INVESTIGATED THE EFFECTS OF THE GRAMMATICAL STRUCTURE OF READING MATERIALS ON THE EYE-VOICE SPAN (EVS). THE EYE-VOICE SPAN IS THE DISTANCE THE EYE IS AHEAD OF THE VOICE IN READING ALOUD. THE HYPOTHESIS OF THE STUDY WAS THAT THE EYE-VOICE SPAN IS NOT A CONSTANT OR FIXED LENGTH REGARDLESS OF THE MATERIAL BEING READ, BUT THAT, AMONG OTHER FACTORS, IT IS AFFECTED BY THE GRAMMATICAL STRUCTURE OF THE READING MATERIALS. TEN SUBJECTS FROM GRADES 2, 4, 6, 8, 10, AND ADULTS WERE TESTED WITH FOUR TYPES OF SENTENCES. THE EVS WAS MEASURED AT VARIOUS POINTS BY TURNING OUT THE LIGHT AT SOME POINT IN THE READER'S DELIVERY AND SEEING HOW FAR HE CAN CONTINUE READING WHEN THE PRINT IS NO LONGER VISIBLE. TWO SIMILAR SETS OF SENTENCES WERE PREPARED, ONE USING THE VOCABULARY OF A SECOND GRADER AND THE OTHER WITH A VOCABULARY OF A SIXTH GRADER. THE SENTENCES WERE CONSTRUCTED WITH PHRASE UNITS OF TWO, THREE, AND FOUR WORDS AND WERE ALL LONG ENOUGH TO PROVIDE AT LEAST 10 WORDS BEYOND A "LIGHT-OUT" EYE POSITION. RESULTS OF THE STUDY SUPPORTED THE HYPOTHESIS THAT SUBJECTS TEND TO READ IN PHRASE UNITS. OLDER READERS READ TO PHRASE BOUNDARIES MORE OFTEN THAN BEGINNING READERS. FAST OR GOOD READERS READ TO THE END OF PHRASE BOUNDARIES MORE OFTEN THAN THE SLOW OR POOR READERS DID. THERE WAS ALSO A SIGNIFICANT DIFFERENCE BETWEEN THE EVS ON ACTIVE AND PASSIVE SEENTENCES FOR OLDER SUBJECTS. (AL)

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Studies in Oral Reading:

IX. Sentence Structure and the Eye-voice Span[1]

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In reading aloud, the eye-voice span (EVS) is the distance, usually measured in words, that the eye is ahead of the voice. Interest in the EVS extends to the end of the last century. One consistent finding is that EVS tends to increase with age (Buswell, 1920; Tinker, 1958), and that the EVS is readily affected by the difficulty of the reading material (Buswell, 1920; Anderson, 1937; Fairbanks, 1957; Huey, 1922; Stone, 1941; and Tinker, 1958). The more difficult the reading material the shorter the EVS. Similarly, reading rate and EVS increase with more structured or constrained materials (Lawson, 1961; Morton, 1964a, b). Thus the EVS would be shorter for a word list than for sentential material or, said another way, the greater the redundancy of the material the longer the EVS.

There is contradictory evidence as to whether the position within a line has any effect on the EVS. Buswell (1920; 1936) found no effect of position within a line. Quantz (1897) and Fairbanks (1937), however, both reported that the EVS was longest at the beginning of a line, medium length in the middle of a line, and shortest at the end.

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Fairbanks (1937) found, nevertheless, that the length of the EVS was more dependent on the difficulty of the reading material than on the position within a line. Both Buswell (1936) and Fairbanks (1937) found that position within the sentence affected the EVS: that the EVS was longest at the beginning of the sentence and shortest at the end. Buswell reported this effect for good readers only, while Fairbanks found it with both good and poor readers. As subjects were reading paragraphs in most instances and since little statistical analysis was presented, it is unclear as to how position in sentence and position in line were separated. Also, if we assume that sentences are more constrained, in general, at the ends than at the beginnings, several of the above findings are contradictory.

With good and poor readers selected by a standardized reading test, Buswell (1920) found that good readers had longer EVS's and read more rapidly. Morton (1964a), using reading rate as the criterion for good and poor readers, found that the EVS for good (fast) readers is longer than for poor (slow) readers. Quantz (1897) also reported that the higher the readeng rate, the longer the EVS. Thus fast rate and long EVS seem to go hand in hand. This would seem to be due to the fact that most of the time spent in reading is in fixation or pausing, and the fewer the pauses, the more rapidly a subject reads and the more he sees in one fixation pause. In an investigation of the number of times his Ss' EVS's ended at a phrase boundary, Schlesinger (1965) did not find a difference in frequency of times good or poor readers stopped at the end of phrase units.

Most investigators have noticed that readers make fewer stops or pauses (fixations) per line than there are letters in the line. Thus, they concluded that reading is accomplished in terms of units of some sort and not just in terms of letters. Buswell (1920, 1936) interpreted the function of the EVS as allowing 'the mind to grasp and interpret a large meaning unit before the voice must express it (p. 41).' He thus hypothesized that the EVS takes in units of meaning similar to phrases or sentences. Although he has evidence to support the fact that reading is in larger chunks than individual letters, he did not have any evidence to substantiate the hypothesis that these larger chunks are in fact meaningful units such as phrases. Cattell (1897) thought the reading units could be words, phrases, or even sentences, because he found that subjects could recognize tachistoscopically presented individual words, phrases or even short sentences just as easily as they could recognize one letter. Anderson (1937) suggested that the reader's eye-movements are regulated by the content of the reading material so that the reader progresses by phrase units and not word by word. Along this same line, Tinker (1958) wrote more recently that reading is in terms of 'units,' in terms of groups of words and not in terms of spelling or syllabizing. Words and word groups form perceptual 'wholes.' Schlesinger (1965) stated that 'the span of the eyes ... ahead of the voice represents a unit of decoding.' He predicted that the units of reading could be defined in terms of syntactic structure. Subjects were predicted to read ahead to the end of a group of words which could exist alone as a unit or phrase. The results of Schlesinger's studies supported the hypothesis that Ss read to the end

of units, chains, or phrases, which are both syntactic and semantic "wholes." However, the exact nature of his stimulus materials is unclear.

The present study is designed to investigate the developmental effects of sentence structure on the eye-voice spans of the readers. We hypothesize that the eye-voice span is not a constant or fixed length regardless of the material being read, but that, among other factors, it is affected by the grammatical structure of the reading materials.

METHOD

Subjects. Ten Ss at each of six grade levels were used: second, fourth, sixth, eighth, tenth, and adults. The adults were Cornell University Freshmen and Sophomores: the remaining subjects were pupils at the Dryden Elementary School and the Dryden High School.

Stimulus Materials. Four types of sentences were used:

1. Active sentences made up of two-word phrases entirely.
2. Active sentences made up of three-word phrases.
3. Passive sentences made up of three-word phrases.
4. Active sentences made up of four-word phrases.

The number of sentences within each of the four types was such that the light could be turned off at all possible between-word points in the first two phrases. The light was turned off an equal number of times before and after the first major immediate constituent (IC) cut of the sentence. Table 1 shows the design for the two-word phrase sentences.

Table 1

A different sentence content was used for each of the light-out positions. Thus there was a total of eight two-word phrase sentences, 12 three-word active sentences, 12 three-word phrase passive sentences, and 16 four-word phrase active sentences. In addition, there were eight structureless word lists, making a total of 56 presentations.

Sentences were constructed with enough phrase units in them so that there would always be at least ten words in the sentences beyond the light out position. Starting with the sixth grade Ss, each of the critical sentences was embedded in a paragraph of four sentences. The critical sentence occurred an equal number of times in the first, second, third, and fourth sentence position. For the second and fourth graders, the paragraphs contained two sentences and the critical sentence occurred in either the first or second position. The light tended to be turned out toward the beginning of the line so that there would be at least ten words remaining in the critical sentence on that line for any one given sentence. A random order of presentation of sentences was used; the same order was used for each subject.

Two similar sets of sentences were used. One set was made up with the vocabulary of the second grade reader and was used with second and fourth grades; another set was made up with the vocabulary of a sixth grader and was used with the sixth grade and all older subjects.

Recognition Lists. Recognition lists were made up for half of the sentences in each of the four sentence types. Each recognition list consisted of five content words taken from the final part of the sentence, starting three words beyond the "light-out" position, and five confusion words, one for each of the five content words.

Apparatus. A wooden box (24" X 18" X 12") with a slanted front surface in which there was a one-way mirror was used to present the stimulus sentences. It was so designed that S could only see through the mirror to read the sentences on the cards when the light inside the box was turned on. A micro-switch was used to activate the light; when E released the micro-switch, the light inside the box turned off. A timer was also connected to the apparatus so that the clock started when the light inside the box was turned on and stopped when the light inside the box was turned off. Thus the timer measured the time taken by a S to read from the beginning of a passage to the light-out position.

Procedure. The S was seated in front of the apparatus and was told to focus on a red dot on the one-way mirror which designated the point where the beginning of the paragraph would appear when the light was turned on. The S was told to read at his normal rate or the rate at which he would read a storybook out loud. When the light inside the box was turned on, S began to read the passage in front of him out loud; when the light went out, S was told to report all the words he had seen beyond the word he was saying when the light went out. All the words reported by the S were recorded. The time taken by the S to read to the point at which the light was turned out was also recorded in order to get a measure of the S's reading speed. Readers were divided into two groups, slow and fast, on the basis of whether their scores were below or above the median of the distribution of words/second read.

When there was a recognition list for the sentence, the S was shown each word of the list individually and was asked if he thought he

had seen it. Both correct and incorrect recognitions were noted.

Scoring. The number of consecutive words which each S reported having seen beyond the light-out position was recorded for each sentence as a measure of his eye-voice span for that sentence. In addition, the number of times S reported having read ahead to the end of a phrase boundary versus to a non-boundary position was recorded.

RESULTS

Length of Eye-voice Span. A comparison was made between the mean length of the EVS on the unstructured word lists (mean span = 2.195 words) and the mean length of the EVS on all the structured sentences (mean span = 3.910 words). The difference in the EVS for these two types of reading materials is significant at $p < .001$ ($t = 6.17$, $df = 38$, two-tailed test). Table 2 shows the mean EVS for each of the six grade

Table 2

levels, for slow and fast readers, and for the three lengths of phrase units. From this table it is evident that the sixth grade subjects are a deviant group. They were the first age group tested and were an unselected sample of sixth grade readers in a rural New York school. However, it was evident very early in the testing, that a child who was an average sixth-grade reader in this school really read poorly, for our purposes. As these Ss had extreme difficulty in reading the material presented (all with a fifth grade vocabulary), they were excluded from the analysis. The remaining subjects were divided into two groups on the basis of the experimental material which they read: the second and fourth

grades were grouped together and the eighth and tenth grades plus the college students were grouped together. Thus two three-way analyses of variance with the classifications, grade, reading speed, and chain length, were carried out on the length of the EVS. In the analysis of the second and fourth grades, the main effect of subject-grades was significant at the .01 level ($F = 26.86$, $df = 1/16$). Fourth graders had longer spans than second graders. There was also a significant difference between slow readers ($F = 5.00$, $df = 1/16$, $p < .05$). Number of words in a chain or phrase unit was not significant. However, the interaction between grades and chains was significant ($F = 3.42$, $df = 2/32$, $p < .05$). Figure 1a shows that the EVS for second graders is relatively constant for all chain

Figure 1a

lengths. Fourth grade subjects, on the other hand, show a tendency for the EVS to maximize on the three-word chains.

In the analysis of variance of the older subjects (eighth and tenth grades and adults), grade level or age was again significant ($F = 6.53$, $df = 2/24$, $p < .01$). From Table 2 it is evident that the adult subjects had longer eye-voice spans than the high school subjects. The difference in length between the mean EVS of the eight and tenth graders was not great but the eighth grade mean span was slightly longer than the tenth grade mean span. In contrast to the results with the younger subjects, the main effect of number of words in a chain or length of chain was significant in the analysis of the eye-voice span of older subjects ($F = 14.67$, $df = 2/48$, $p < .01$). Figure 1b shows that the EVS for all

Figure 1b

three older grades tends to maximize on the three-word chains, the same as it did with fourth grade subjects. No significant interactions were found.

A second set of analyses of variance was carried out to determine the effect of sentence voice--active versus passive--on EVS. The other factors investigated in these analyses were subject grades, speed of reading (slow-fast), and whether the light was turned out before or after the first major immediate constituent division of the sentence (light-out position). Again second and fourth grades and eighth and tenth grades plus adults were analyzed separately, because of the use of different stimulus materials for these groups. In the analysis of the younger subjects, the main effect of subject grade-level was significant ($F = 40.63$, $df = 1/16$, $p < .01$) as was the main effect of reader speed ($F = 7.63$, $df = 1/16$, $p < .0$). Sentence voice and light-out position were not significant ($F = .20$, $df = 1/16$, n.s. and $F = .48$, $df = 1/16$, n.s., respectively). The interaction between voice and light-out position was significant, however, ($F = 5.61$, $df = 1/16$, $p < .05$). Figure 2a shows that the EVS tended to be longer before the verb in the passive sentence and longer

Figure 2a

after the verb in the active sentence. No other interactions were significant.

For older subjects, the main effects of subject grade and reader

speed were significant ($F = 9.17$, $df = 2/24$, $p < .01$ and $F = 25.12$, $df = 1/24$, $p < .01$, respectively). Although the effect of voice was not significant at the younger grade levels, it was found to be significant for older subjects ($F = 22.65$, $df = 1/24$, $p < .01$). The mean EVS was longer for the passive than for the active sentences. The light-out position, before or after the verb, was not significant ($F = 2.62$, $df = 1/24$, n.s.). Again, the only significant interaction was between voice and light-out position ($F = 27.83$, $df = 1/24$, $p < .01$). Figure 2b shows that the eye-voice span

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Figure 2b

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is longer before the verb in the passive sentence and after the verb in the active sentence.

Unit versus Non-unit reading. In order to test whether there was a significant tendency for subjects to read in phrase groupings, the number of times each subject read to the end of a phrase unit on each of the sentence types was recorded. This score was corrected for any tendency of subjects to read to phrase boundaries only when their modal EVS took them there. The number of times a subject read to the end of a phrase with his modal EVS (with his two consecutive, most frequent EVSs) was subtracted from the overall total. If it were the case that subjects tended to read to the end of phrase units only when their modal EVS ended there, then the sum of all the scores computed as described above would be zero. The overall mean number of times subjects read to phrase boundaries, over and above the times they read to phrase boundaries with their modal EVS, was 8.20 which was found to be significantly greater than

zero ($t = 16.73$, $df = 59$, $p < .001$).

Another way of testing the hypothesis that subjects tended to read to the end of phrase boundaries more frequently than to non-boundary positions is to compare the number of times subjects read to phrase boundaries with the number of times subjects read to non-boundary positions divided by the number of chances to read to non-boundary positions in the phrase. Thus, in the case of the three-word phrase, there would be one chance to stop at a phrase boundary for every two non-phrase boundaries. Thus the number of times subjects stopped at a phrase boundary would be compared to the number of times they stopped at the non-phrase boundary divided by two. In an overall comparison of boundary versus non-boundary reading, it was found that subjects read to boundaries significantly more times than to non-boundaries ($t = 22.75$, $df = 8$, $p < .001$).

A two-way analysis of variance including all five grade levels did not show either subject grade level or the number of words in a chain to have a significant effect on the frequency with which subjects read to phrase boundaries. A t-test did, however, show a significant difference between the number of times the older subjects read to phrase boundaries as compared to the number of times second graders read to phrase boundaries ($t = 2.66$, $df = 18$, $.01 < p < .02$). Another t-test indicated a significant difference between slow and fast readers ($t = 2.84$, $df = 8$, $p < .01$), with fast readers reading in phrase units more frequently than slow readers.

In addition to the 492 times subjects read to phrase boundaries when the phrase boundary was <u>not</u> at the end of the modal EVS, subjects changed the sentence structure or the last word read 107 times in such a way as to make a phrase boundary. Thus, for example, if the final stimulus

phrase was "... next to the house," the subjects might read "....next-door."

The number of times subjects were able to correctly recognize words beyond the point at which they stopped reading minus the incorrect recognitions was 578 times. An analysis of variance was carried out on the recognition scores for all five grade levels of slow and fast readers on the four chain types. Both the main effect of subject grades and reader speed were significant ($F = 7.62$, $df = 4/12$, $p < .01$ and $F = 22.6$, $df = 1/12$, $p < .001$, respectively). The main effect of length of phrase was not significant. It is evident from Figure 3 that the number of times

Figure 3

subjects recognized words correctly which were beyond their stopping points increased from second grade through adults for both slow and fast readers.

SUMMARY AND DISCUSSION

The results of the present study support the hypothesis that subjects tend to read in phrase units. Subjects read to phrase boundaries a significant number of times over and above the number of times their modal EVS took them to the end of a phrase. This suggests that readers have an elastic span, which stretches or shrinks far enough to read to phrase boundaries. There was no difference in the number of times subjects read to phrase boundaries on the four different types of sentences; thus, the finding that subjects read to phrase boundaries cannot be a function of the facilitative effect of a particular chain length. The finding that older subjects read to phrase boundaries more times than did the second

grade subjects, suggests that beginning readers tend to read more perceptually, more word by word, than do older subjects.

The phrase-unit reading hypothesis was further supported by the observation that subjects, not infrequently, made up unit or phrase endings so that they stopped reading at the end of a completed unit even if they had not actually seen the end of the phrase boundary on the printed page.

Fast or good readers read to the end of phrase boundaries more often than did slow or poor readers. Thus good readers seem to be processing more in terms of units or phrases and their EVS seems to be more adaptable to the structure or content of the reading material. The slow readers, like the beginning readers, may be reading more in terms of what Anderson and Swanson (1937) call "perceptual" factors, i.e. they tend to be reading every word individually and taking advantage of the contextual constraints.

The findings with respect to the length of the EVS tend to support earlier findings. The EVS did tend to increase with age. There was, however, a slight inconsistency in this trend in that eighth grade subjects tended to read with longer spans than did the tenth graders. As she subjects volunteered from their study halls for a reading experiment, there was no control as to the ability of the readers obtained. Therefore, this deviation from the tendency for the EVS to increase with age is probably due to a biased sample at both grade levels.

Another finding which confirms previous research is that the EVS for unstructured or word list material is significantly shorter than for structured sentences. The fact that this difference exists suggests that all readers, both slow and fast, must take advantage, to some degree, of the contextual constraints of the material they are reading. The more

structured the material is, the less the subject has to focus, in detail, on every letter or every word in its entirety, as he reads across the page.

The older subjects recognized more words beyond the point at which they stopped reading than did the younger subjects. This suggests that the older subjects seem to be taking in more of the peripheral material, beyond the EVS, than do the younger subjects. It has been shown that older subjects have longer spans, but now it seems that in addition to these longer spans they have more highly developed peripheral vision or that their memory for material which has been picked up peripherally decays more slowly than that of younger subjects. The difference between the recognition scores of slow and fast readers was also highly significant. Fast readers recognized significantly more words beyond their EVSs than did slow readers. Thus the more skilled and experienced reader can pick up more information peripherally.

An interesting finding which is difficult to explain is that subjects at all grade levels, except the youngest grade--the second grade--tended to have the longest EVS on the three-word phrase sentences. If it is the case that subjects are reading in terms of one phrase or two phrases grouped together, they would make more fixations with shorter spans ahead in getting through a two-word phrase sentence than in getting through a three-word phrase sentence. However, it should then be the case that the reader would have fewer fixations and longer spans still in getting through a four-word phrase sentence. This was not the case; the EVS is longest on the three-word phrase sentences and shorter on both the

two-word phrase sentences and the four-word phrase sentences. A possible explanation might be that if the subject is "phrase-reading" in a four-word phrase sentence and the light is turned out before or after the first word in a phrase, he would have to read either four or eight (or three or seven) words in order to read in phrase units. The seven or certainly the eight words would most likely be well beyond the subject's EVS, and beyond the elastic limits of the EVS. Therefore, the subject would probably tend to shrink his EVS one or two words and read only to the end of the nearest phrase boundary. As the longest two phrase sequence in a three word phrase sentence would be six words (much nearer the modal EVS of most subjects), it would be more likely that the subject's EVS would stretch to take in the two phrase sequence rather than shrink to take in just the two or three word sequence. In the two-word phrase sentence, the longest sequence for two phrases would be four words. The fact that the tendency for the longest EVS to be found on three-word phrase sentences was absent in the second grade in addition to the fact that second graders read to phrase boundaries less frequently than did older subjects, suggests that beginning readers are less sensitive to the grammatical and semantic structure of what they are reading than are older subjects.

Another factor which had a significant effect on the EVS was sentence voice. There was no significant difference between the lengths of the EVS on the active and passive sentences for second and fourth grade subjects, but there was a significant effect for older subjects. In the latter cases, the EVS tended to be longer for passive voice

sentences than for active voice sentences. There was, in addition, a significant interaction between position of light out (before or after the verb) and sentence voice for both sets of subjects. In active sentences, the longest EVS tended to occur after the verb, while in passive voice sentences the longest EVS tended to occur before the verb. In both cases, the part of the sentence in which the longest EVS occurred, was in the part containing the object. In the active sentence the order of elements is "actor--verb--object" and in the passive sentences the order is "object--verb--actor." In an investigation of the uncertainty of various elements in active and passive voice sentences, Clark (1965) found that in both the active and passive sentences, the verb was significantly more constrained by the object than by the actor and that the object was significantly more constrained by the verb than by the actor. This suggests a possible explanation for the differences in length of EVS before and affer the verb in active and passive sentences. The longer EVS occurs in both sentence types in that part of the sentence where the mutual constraints of the elements are strongest. This interpretation would agree with the findings of Morton (1946a) and Lawson (1961) who found that the EVS increased with an increase in contextual constraint.

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Table 1

Positions of Light Out for Two-word Phrases

/	1	2	3	4		5	6	7	8
	1	/	2	3	4		5	6	7	8
	1	2	/	3	4		5	6	7	8
	1	2	3	/	4		5	6	7	8
	1	2	3	4		/	5	6	7	8
	1	2	3	4			5	/	6	7	8
	1	2	3	4			5	6	/	7	8
	1	2	3	4			5	6	7	/	8

First Major IC

/ = light out position

Table 2

Summary of Mean Eye-voice Spans for Experimental Conditions

Reader Speed:	Second Grade		Fourth Grade		Sixth Grade		Eighth Grade		Tenth Grade		Adults	
	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Chain Length												
2-word chain	2.70	3.62	4.18	4.30	1.97	2.98	3.45	4.53	3.45	4.18	4.74	5.05
3-word chain	2.73	3.63	4.57	4.87	2.47	3.42	3.62	5.33	4.14	4.60	4.67	6.17
4-word chain	2.89	3.65	4.21	4.32	2.03	3.11	3.16	5.02	3.51	3.81	4.49	4.99
Mean by Grade	3.19		4.41		2.66		4.18		3.95		5.02	

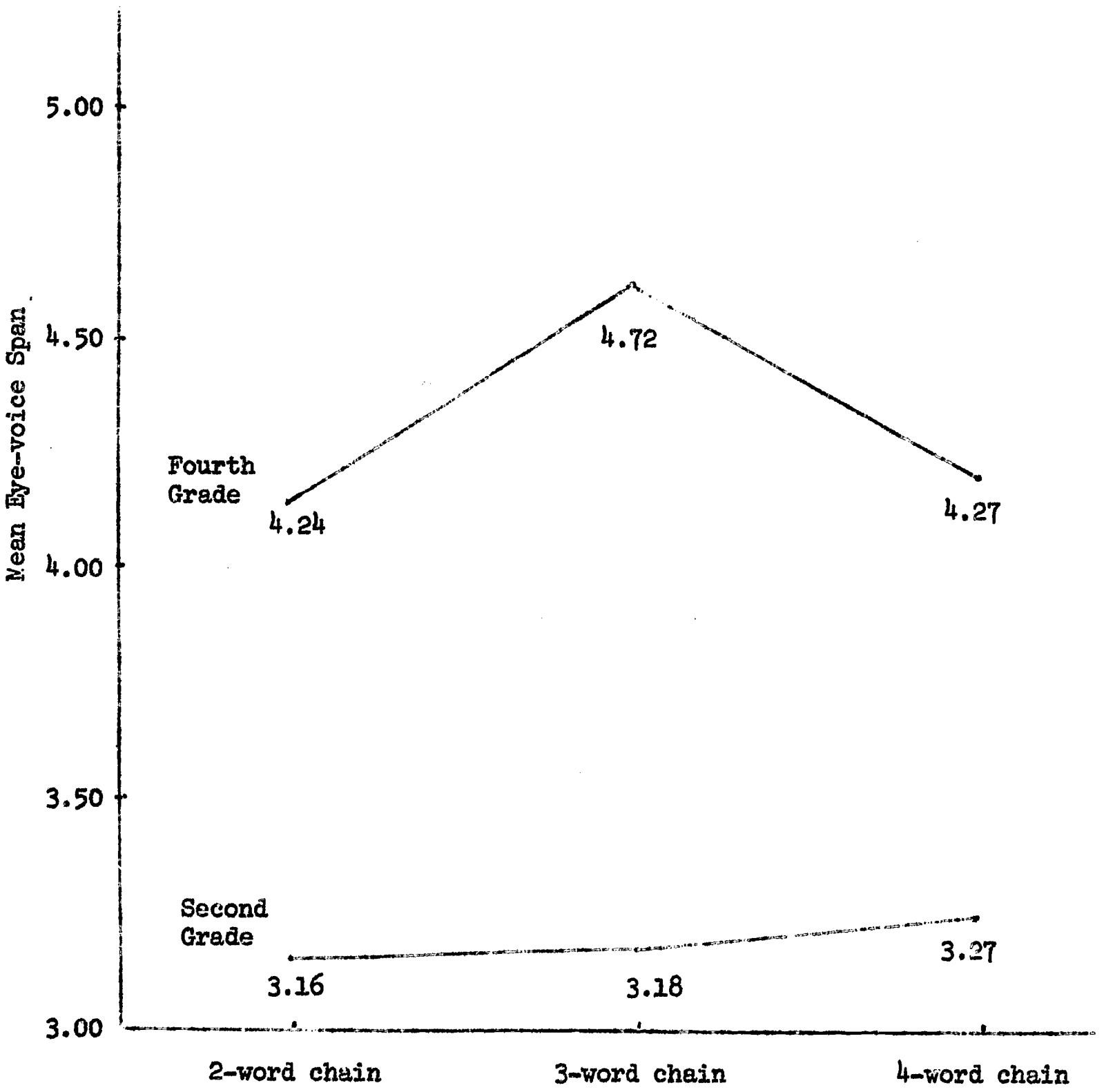

Figure 1a. Second and Fourth Grade Mean Eye-voice Spans for All Chain Lengths

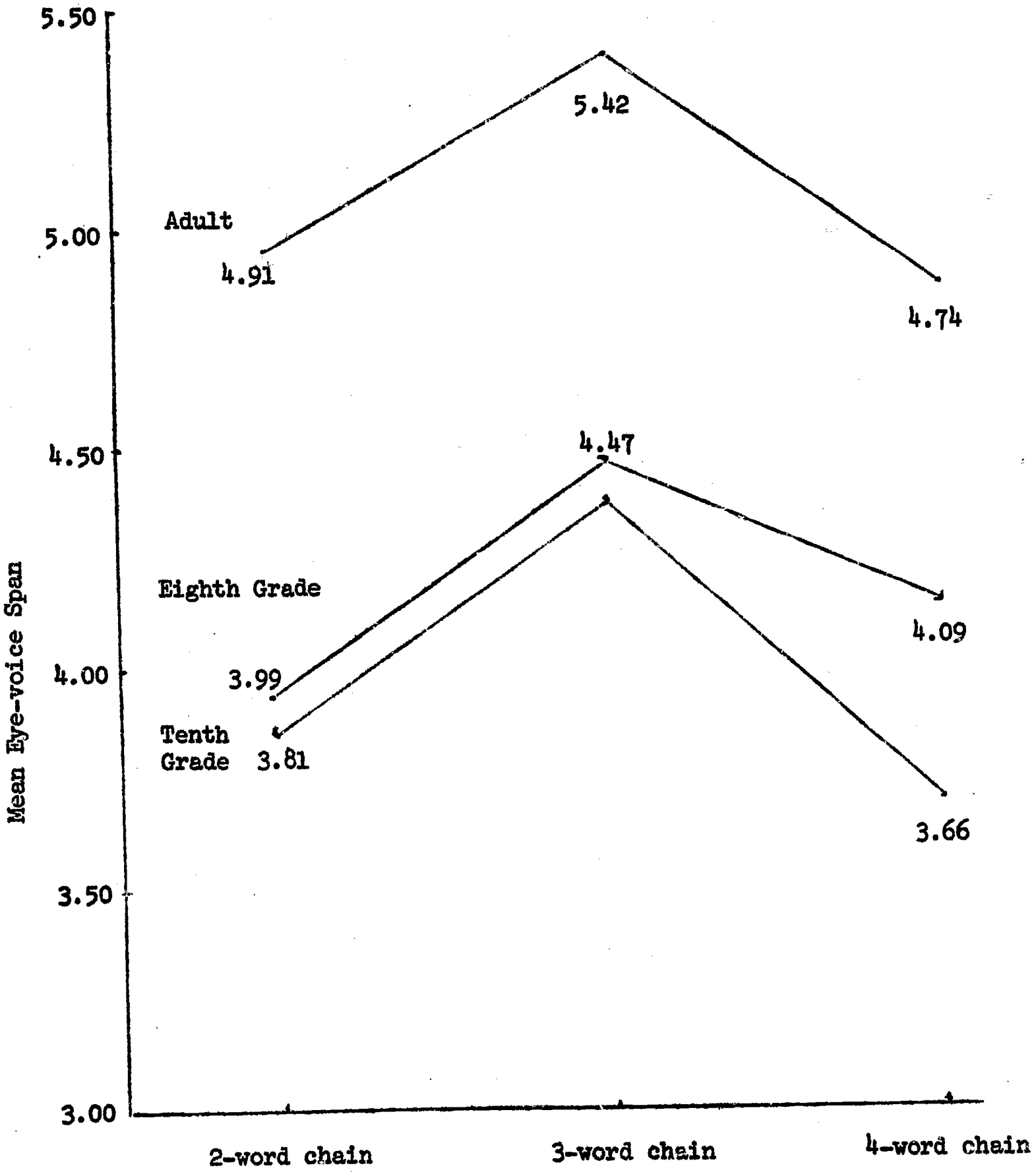

Figure 1b. Eighth, Tenth, and Adult Level Mean Eye-voice Spans for all Chain Lengths

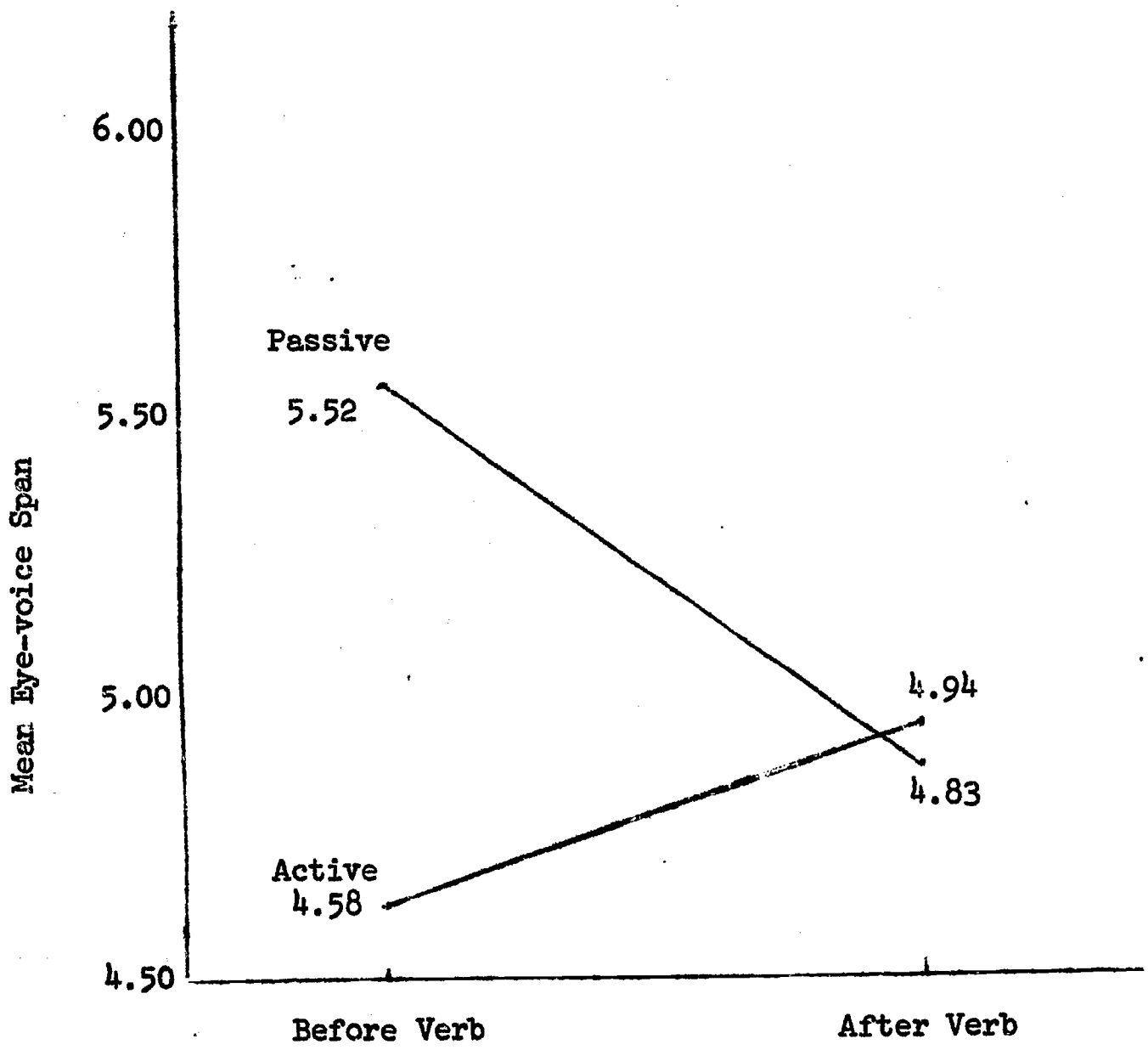

Figure 2a. Second and Fourth Grade Mean Eye-voice Span for Light-out Position by Voice.

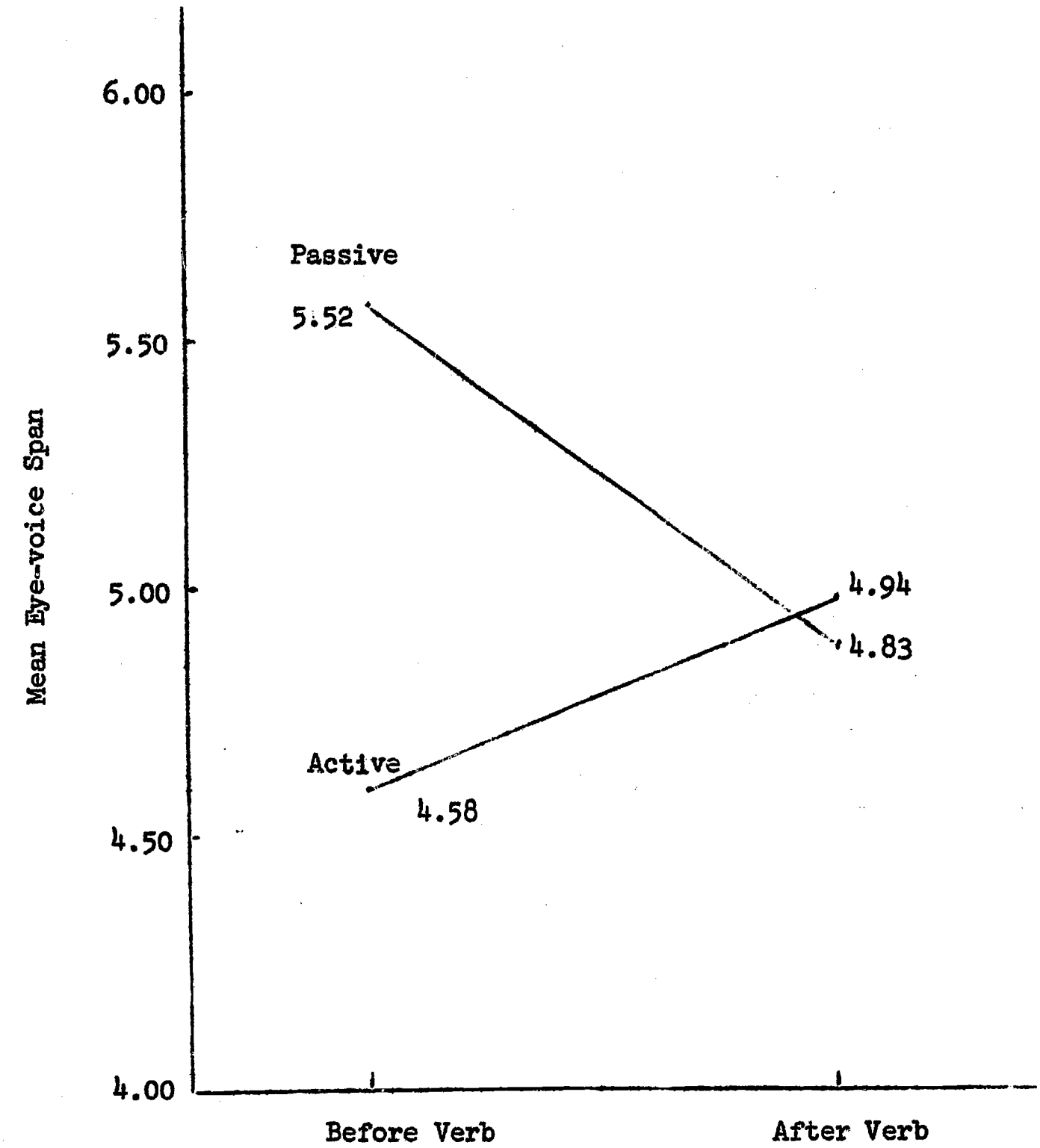

Figure 2b. Eighth, Tenth, and Adult Level Mean Eye-voice Span for Light-out Position by Sentence Voice.

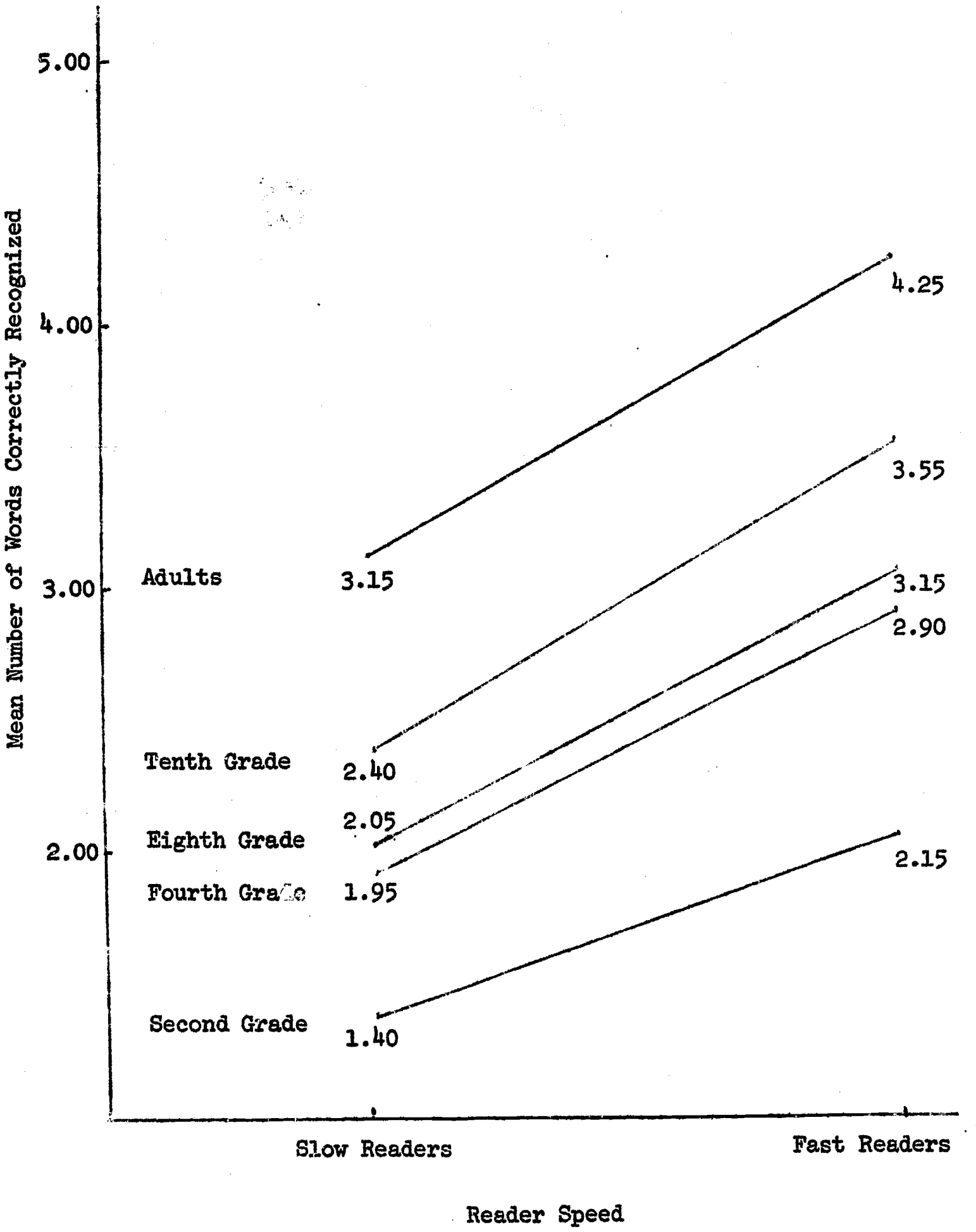

Figure 3. Mean Number of Words Correctly Recognized for All Grade Levels of Slow and Fast Readers