DOCUMENT RESUME

ED 259 318 CS 008 102

AUTHOR Werker, Janet F.; And Others
TITLE Consonant Errors of Severely Disabled Readers.
PUB DATE Apr 85
NOTE 21p.; Paper presented at the Meeting of the Society for Research in Child Development (Toronto, Ontario, Canada, April 25-28, 1985).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Aptitude; Comparative Analysis; *Consonants; Decoding (Reading); Error Analysis (Language); *Phoneme Grapheme Correspondence; Reading Ability; Reading Achievement; *Reading Difficulties; *Reading Processes; *Reading Research; Reading Strategies; Spelling

ABSTRACT

Two studies were conducted to determine whether the consonant errors displayed by readers with severe reading disabilities are the result of phonetic rather than visual substitutions. In the first study, the reading and spelling performance of three groups of readers with average IQs but with reading levels two years below grade level, was compared with that of matched controls, using a list of 96 one-syllable nonsense words. Subjects in all groups made more phonetic than visual substitutions, showing that even among those with severe reading disabilities linguistic confusions account for reading problems. Also, subjects from all three test groups, but not from the control groups, made as many or more consonant additions than they did phonetic substitutions in both the reading and spelling tasks. A qualitative, post-hoc analysis of the errors suggested that these additions may have resulted from the test subjects attributing phonemic status to the intermediate articulations approximated when sounding out a nonsense word (such as, ope to olpe). It was thought that subjects might rely on such an articulatory strategy if they had an inaccessible or poorly developed phonological system. The second study was designed to test this articulatory strategy explanation. A list of 262 one-syllable nonsense words was developed to test specific predictions emerging from the study. Results from the second study replicated those of the first, and were consistent with predictions. (HTH)

Consonant Errors of Severely Disabled Readers

Janet F. Werker*, Susan E. Bryson, and Karen Wassenberg

Dalhousie University

Paper presented at the Society for Research in Child Development. Toronto, Canada, April 1985.

*Requests for reprints should be sent to Janet F. Werker who is currently visiting at the Department of Psychology, University of British Columbia, 2509 - 2136 West Mall, Vancouver, B.C., Canada V6T 1Y7.

Abstract

Previous research has indicated that consonant errors made by both good and poor readers are the result of phonetic rather than visual substitutions, suggesting a linguistic rather than visual basis for reading difficulties. The present research was designed to determine whether a similar pattern would be displayed by severely disabled readers. In our first study, three groups of severely disabled readers were compared to both age- and reading-level matched controls on their performance reading and spelling a list of 96 one-syllable nonsense words. Subjects in all five groups made more phonetic than visual substitutions showing that even among severely disabled readers, linguistic confusions account for reading problems. Also, subjects from all three reading disabled groups, but not from the control groups, made as many or more consonant addition errors than they did phonetic substitutions in both the reading and the spelling tasks. A qualitative, post-hoc analysis of the errors suggested that these additions may have resulted from the reading disabled subjects attributing phonemic status to the intermediate articulations approximated when sounding out a nonsense word (e.g., ope to olpe). We reasoned that subjects might rely on such an articulatory strategy if they had an inaccessible or poorly developed phonological system. The second study was designed as a first test of this articulatory strategy explanation. A list of 262 one-syllable nonsense words was developed to test specific predictions emerging from the qualitative analysis in the first study. Results from the second study replicated those from the first, and were consistent with the predictions.

Introduction

It is commonly believed that the consonant errors made by severely disabled, or "dyslexic" readers result from specific visual deficits caused by mixed cerebral lateralization, as suggested by Orton (1937). However, previous research examining both good and poor (but not severely disabled) readers has indicated that consonant errors are the result of phonologic rather than visual difficulties, suggesting a linguistic rather than visual basis for reading difficulties (Fowler, Liberman, & Shankweiler, 1977; Liberman, Shankweiler, Orlando, Harris, & Bell-Berti, 1971). In this previous work, it was shown that reversals of orientation (reading b for d) are caused by phonetic feature substitutions rather than visual reversals. Furthermore, it was shown that reversals of orientation are not correlated with sequencing reversals as would be expected if both resulted from visual orientation difficulties. There is still a controversy, however, as to the derivation of consonant errors among severely disabled (rather than simply slow) readers. The present research was designed to determine whether the consonant errors made by severely disabled readers indicate difficulties with the phonologic or visual aspects of reading. To address this question, severely disabled readers were compared to average readers on their ability to read and spell nonsense words. All types of consonant errors were analyzed. The scoring scheme is shown in Table 1.

Experiment 1

Method

Three groups of severely disabled readers were compared to both age- (AMC) and reading-level (RMC) matched control groups on their performance reading and spelling stimuli from a list of 96 one-syllable nonsense words. The reading disabled subjects were divided on the basis of their relative Performance (P) and Verbal (V) IQ scores in an effort to achieve some degree of homogeneity within groups. All reading disabled subjects were reading at least 2 years below grade level. All had average IQ's, and no evidence of primary emotional or neurological disturbance. All subjects were male. Average subject characteristics are shown below.

Average Subject Characteristics

	N	Age	IQ	Reading
Reading Disabled Subjects				
P > V (> 10 points)	15	14.4	98	4.45
V > P (> 10 points)	4	13.9	95	4.94
P = V (< 7 points)	13	14.3	110	4.8
Control Subjects				
RMC	14	9.6	104	5.02
AMC	16	14.1	109	8.5

The 96 nonsense syllables used in this task were developed by Fowler, Liberman, and Schankweiler (1977). They include the 21 most common vowel graphemes and the six English stop consonants, b, p, d, t, g, and k. These 96 stimuli were presented to the children one at a time on 3" by 5" index cards. In the reading task, children read all 96 stimuli aloud, and their responses were tape recorded for later transcription. In the spelling task, 20 of the words were pronounced to the children for spelling.

Results

The results from the analysis of the reading task are shown in Figure 1 below. There was a main effect for error type, $F(1, 4) = 49.196$, $p < .001$) but no significant group effect and no significant interaction. These results show that subjects in all groups made significantly more phonetic feature substitutions than they did orientation reversals. When the orientation reversals were removed from the analysis (due to redundancy in scoring with the phonetic feature substitutions), and the other four error types were compared, the ANOVA indicated a main effect for error type, $F(3, 12) = 28.25$, $p < .001$), but no main effect for group. In addition, there was a significant interaction between groups and error types, $F(12, 171) = 26.7$, $p < .02$. Post-hoc comparisons on the difference scores using the Scheffé method showed that the three reading disabled groups together made equally as many addition as phonetic feature substitutions, and significantly more addition errors than any other error type (and significantly more additions than did the normal readers). In contrast, children in each control group made equally as many omissions as they did additions, and significantly more phonetic feature substitutions than they did additions.

This data replicates and extends previous work indicating that phonetic rather than visual substitutions cause consonant errors. It also shows that reading disabled subjects consistently add consonants when attempting to read (and spell - see Figure 4). In examining these data, it appeared that reading disabled subjects may have been relying on an articulatory strategy. For example, when attempting to read the stimulus ope, reading disabled subjects wold pronounce it as olpe. Similarly, they would read an open syllable such as ap as pap. To explore this data further, a qualitative analysis of the consonant errors was performed. Errors were classified as either Closure Additions (closing an open syllable) or Intrasyllabic Additions (adding a consonant within a syllable). Closure additions included five categories, and intrasyllabic four categories. The categories and the data are shown in Figures 2 and 3. All category labels are self-explanatory except homorganic which we used to mean "reusing the consonant sound which was already present".

The strongest support for an articulatory strategy explanation would be provided by a preponderance of continuants (e.g., liquids) as Intrasyllabic additions, and mostly homorganic and other stops as Closure additions. Results show this to be the case for all three groups of reading disabled but not for control subjects.

Spelling Data

The results from the analysis of the spelling task used in Experiment 1 are shown in Figure 4. As in the case of the reading, there was a main effect for error type, $F(1, 4) = 8.505$, $p < .005$, but no significant group effect and no significant interaction. As in the reading, this indicates that subjects in all groups made more phonetic feature substitutions than they did orientation reversals - suggesting visual difficulties are not the source of difficulty for either disabled or normal readers. When the orientation reversals were removed from the analysis (due to redundancy in scoring of the phonetic feature substitutions), and the other four error types were compared, the AMOVA yielded a main effect for error type, $F(3, 12) = 12.112$, $p < .001$), no main effect for group, and no signficant interaction. Although the interaction was not significant, it can be seen that the error pattern is in the same direction as that of the reading. Since the lack of significance could have been due to the small number of items (20 in the spelling as opposed to 96 in the reading), post hoc comparisons of the difference scores were computed using the Scheffé method. These results showed that reading disabled, but not normal subjects, made significantly more additions than they did any of the other three error types.

Experiment 2

Method

The second experiment was designed to replicate and extend the first using new stimulus items and additional subjects. Data consistent with that in Experiment 1 would be seen as support for the articulatory explanation. Average subject profiles for the four groups are shown below (there were no new V > P subjects available, so that group was omitted).

Average Subject Characteristics

	N	Age	IQ	Reading
Reading Disabled Subjects				
P > V (> 10 points)	13	14.9	102.2	4.34
V = P (< 7 points)	7	14.1	100.5	4.43
Control Subjects				
RMC	13	8.5–10	113	4.12
AMC	13	14.5	108.3	8.9

Stimuli consisted of 240 nonsense syllables: 176 CV and VC syllables, and 64 CVC syllables. The CV and VC syllables were made up of the six English stop consonants paired with the 16 most common double-grapheme vowels (with real words omitted). The CVC syllables paired the stop consonants with the following four double-grapheme vowels (AU, AQ, OU, and OW) in all possible combinations. Experimental conditions were identical to those used in the reading task in Experiment 1.

Results

The results are entirely consistent with those of Experiment 1. In the ANOVA comparing phonetic feature substitutions to orientation reversals, there was a main effect for error type, $F(1, 3) = 33.910$, $p < .001$, but no main effect for groups and no significant interaction. In the analysis comparing phonetic feature substitutions, additions, omissions, and sequencing errors, there was a main effect for error type, $F(3, 9) = 5.056$, $p < .001$, and a significant interaction, $F(9, 126) = 4.70$, $p < .001$, but no main effect for groups. As in Experiment 1, post hoc analyses of the difference scores were performed using the Scheffé method. Results showed that the reading disabled children made as many or more addition errors than they did phonetic feature substitutions, and more addition errors than either ommissions or sequencing errors. In contrast, the control children made more phonetic feature substitutions than any other error type, and made very few additions. These results are shown in Figure 5. As can be seen, the results are very similar to those obtained in Experiment 1. The only difference is that the younger children (RMC), made more sequencing errors in Experiment 2 than in Experiment 1. This high mean score was accounted for by only 3 children in the RMC group, however.

The qualitative analysis of the data shows an almost perfect replication of Experiment 1, providing additional support for the articulatory strategy explanation. As can be seen, subjects in the reading disabled but not the control groups made more liquid Intrasyllabic additions, and more homorganic and stop Closure additions. One unpredicted result was that in Experiment 2, reading disabled but not control subjects made significantly more liquid Closure additions.

Conclusions

These results confirm and extend previous studies suggesting that consonant errors made by poor readers are, like vowel errors, the result of difficulties in using the linguistic system and are not caused by specific visual deficits. Problems occur when the child has some sort of difficulty mapping written material on to the underlying phonological system. In young poor readers, this difficulty might be manifest by an excess of phonetic feature substitutions. While our work showed that older disabled readers are no more likely to make phonetic feature substitutions than normal readers (suggesting that the encoding of individual letters has been mastered), both made more phonetic feature than orientation reversal errors. This refutes Orton's "visual-deficit" hypothesis. In our study, older disabled readers did have difficulty reading strings of letters, however The results show that severly disabled readers tend to add consonants when attempting to read new words. The qualitative analysis of the data suggests that the additions are caused by reliance on an articulatory strategy when approaching a new word. Such a strategy might ensue from difficulty mapping the written word onto the underlying phonological representation. If the phonological rule system is poorly developed or inaccessible, the disabled reader might rely on sensorimotor information obtained from the articulatory configurations approximated when attempting to sound out new words. Since sensorimotor learning is often the first step in the development of a more abstract, representational rule system, it is entirely possible that reliance on an articulatory strategy may be a useful first step for the severely disabled reader.

References

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Liberman, I. Y., Shankweiler, D., Orlando, C., Harris, K., & Bell-Berti, F. (1971). Letter confusions and reversals of sequence in the beginning reader: Implications for Orton's theory of development dyslexia. Cortex, VII, 127-142.

Orton, S. T. (1937). Reading, writing, and speech problems in children. New York: W.W. Norton.

Table 1

Consonant Error Scoring System

Addition - Any error resulting from adding a consonant when reading. For example, reading bep as benp.

Omission - Any error resulting from leaving a consonant out when reading. For example, reading bep as be.

Sequencing - Any consonant error resulting from reversing the sequence of the consonants in a nonsense word. For example, reading bep as peb.

Phonetic Feature Substitution - Any consonant which was confused as another consonant differing in only a single phonetic feature. A phonetic feature chart of the 6 English stop consonants is shown in Table 2.

Orientation Reversals - Any consonant which was read as another letter differing in either a left/right or an up/down reversal. For example, b/d or b/p.

Table 2

Phonetic Feature Chart

	Place of Articulation		
	Bilabial	Alveolar	Velar
Voicing			
Voiced	b	d	g
Voiceless	p	t	k

Figure Headings

Figure 1. Mean number per group of each type of consonant error. Reading task: Experiment 1.

Figure 2. Mean number per group of each type of consonant error. Spelling task: Experiment 1.

Figure 3. Mean number per group of each type of Closure Addition. Reading task: Experiment 1.

Figure 4. Mean number per group of each type of Intrasyllabic Addition. Reading task: Experiment 1.

Figure 5. Mean number per group of each type of consonant error. Reading task: Experiment 2.

Figure 6. Mean number per group of each type of Closure Addition. Reading task: Experiment 2.

Figure 7. Mean number per group of each type of Intrasyllabic Addition. Reading task: Experiment 2.

FIGURE 1

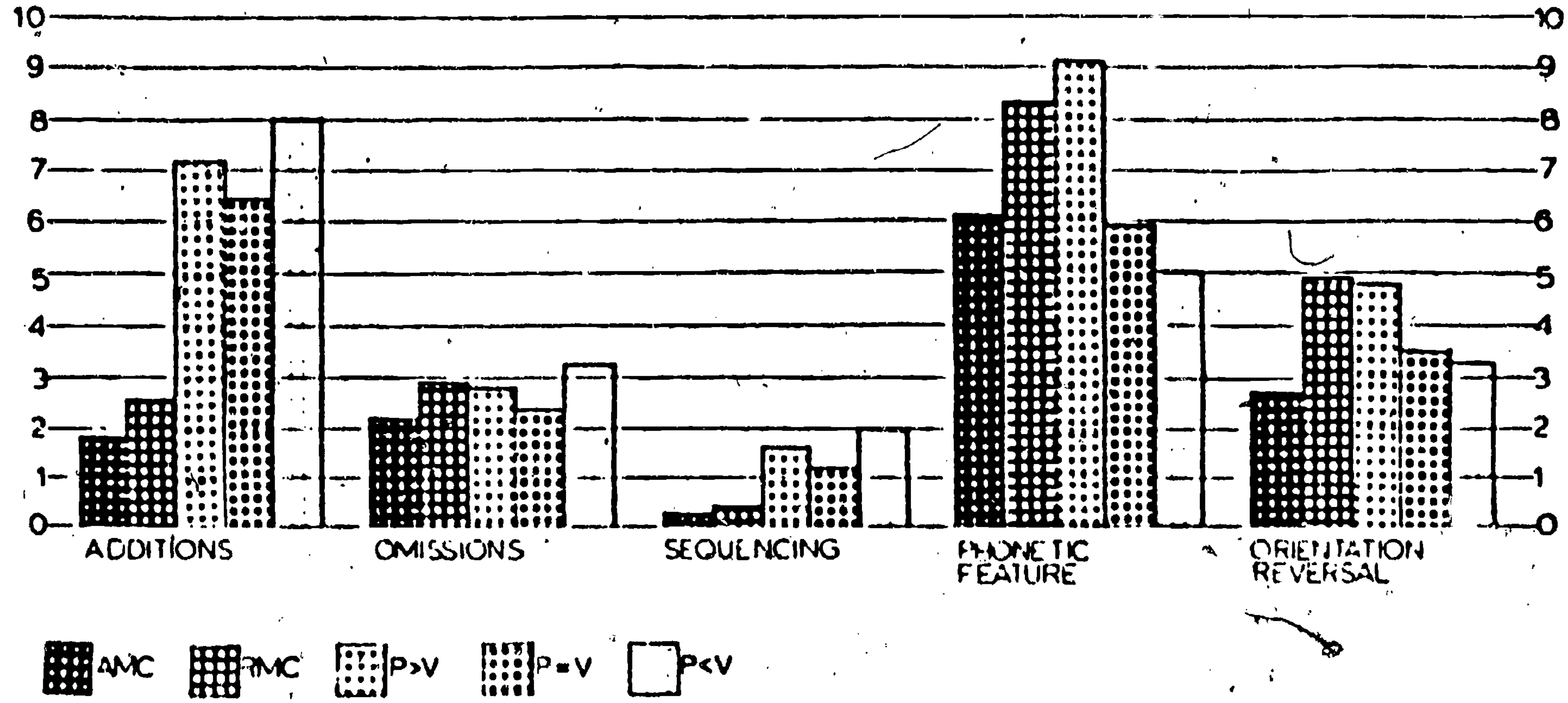


FIGURE 2

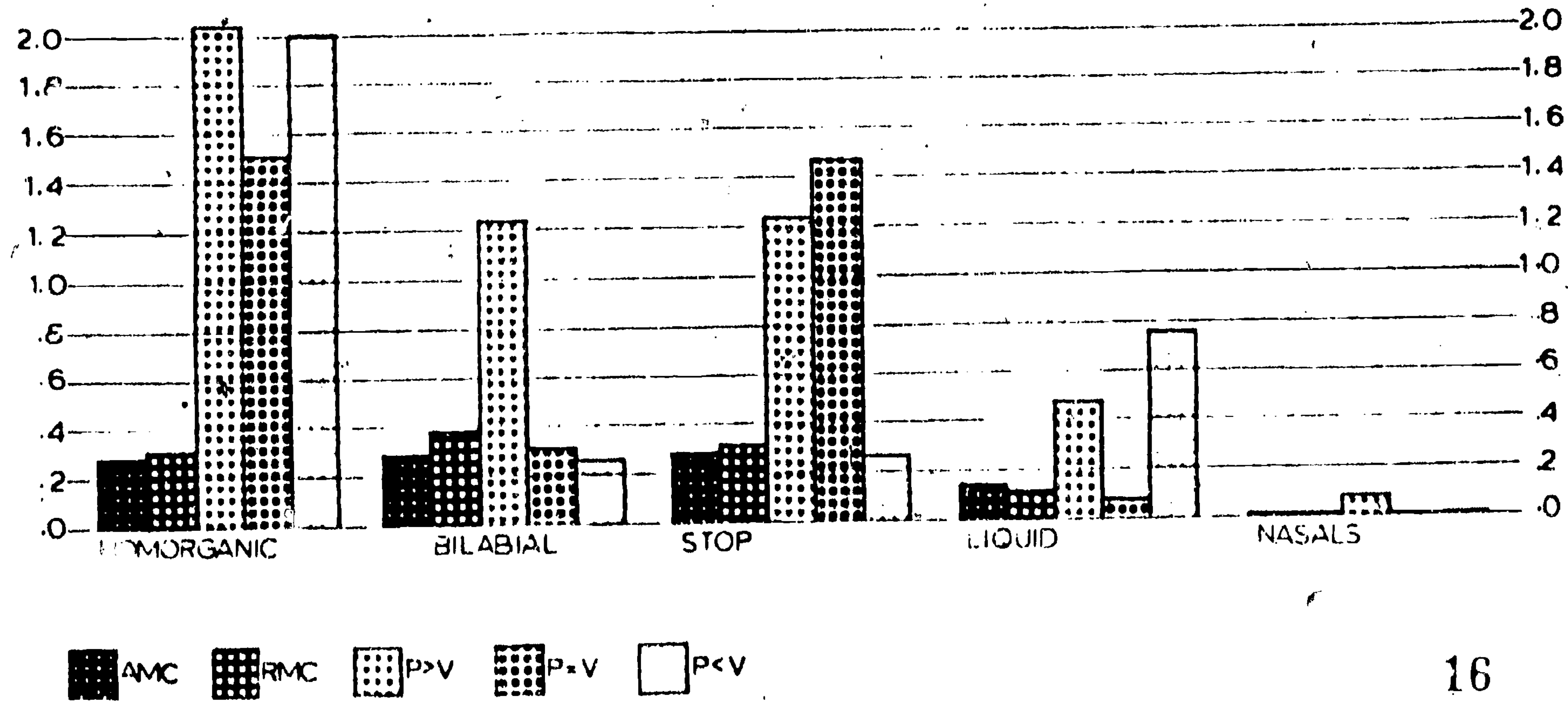


FIGURE 3

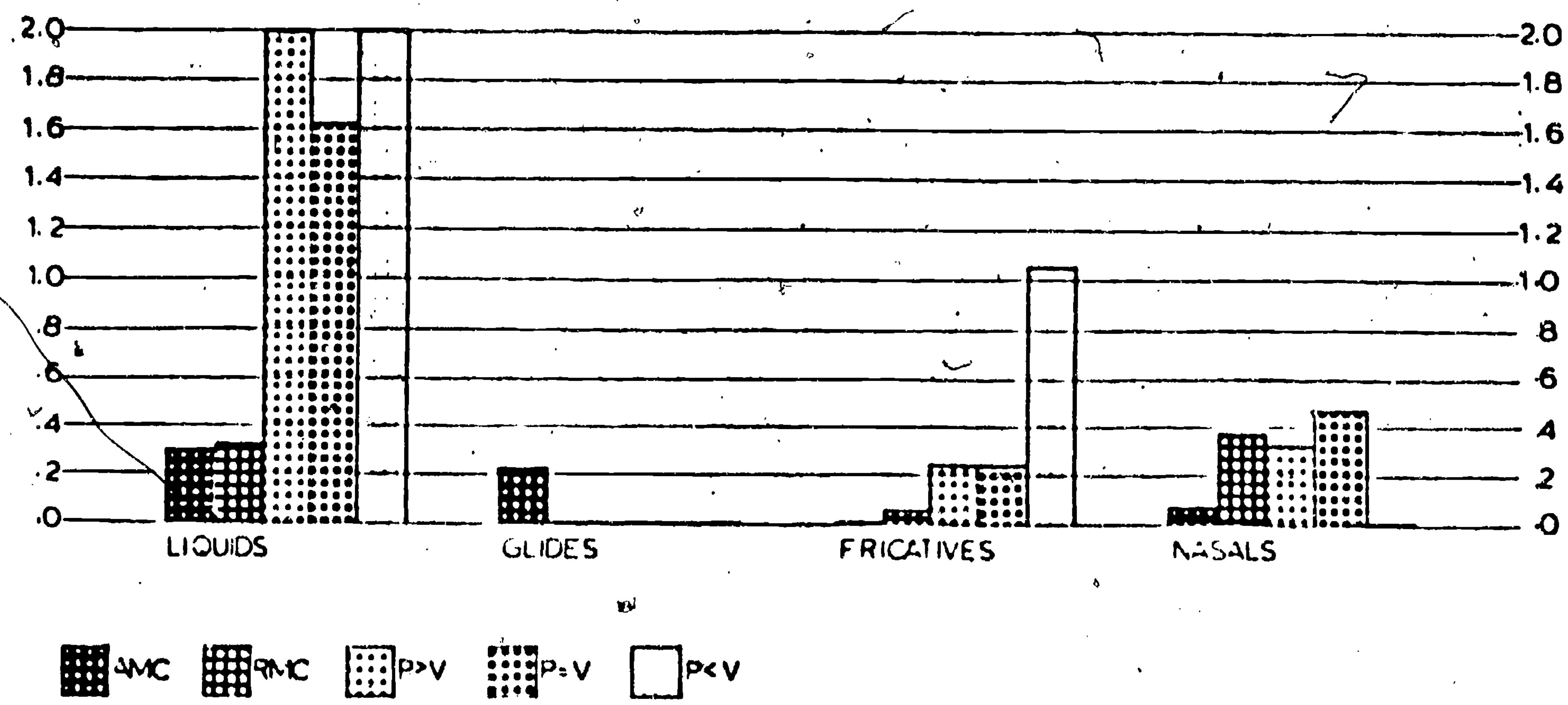
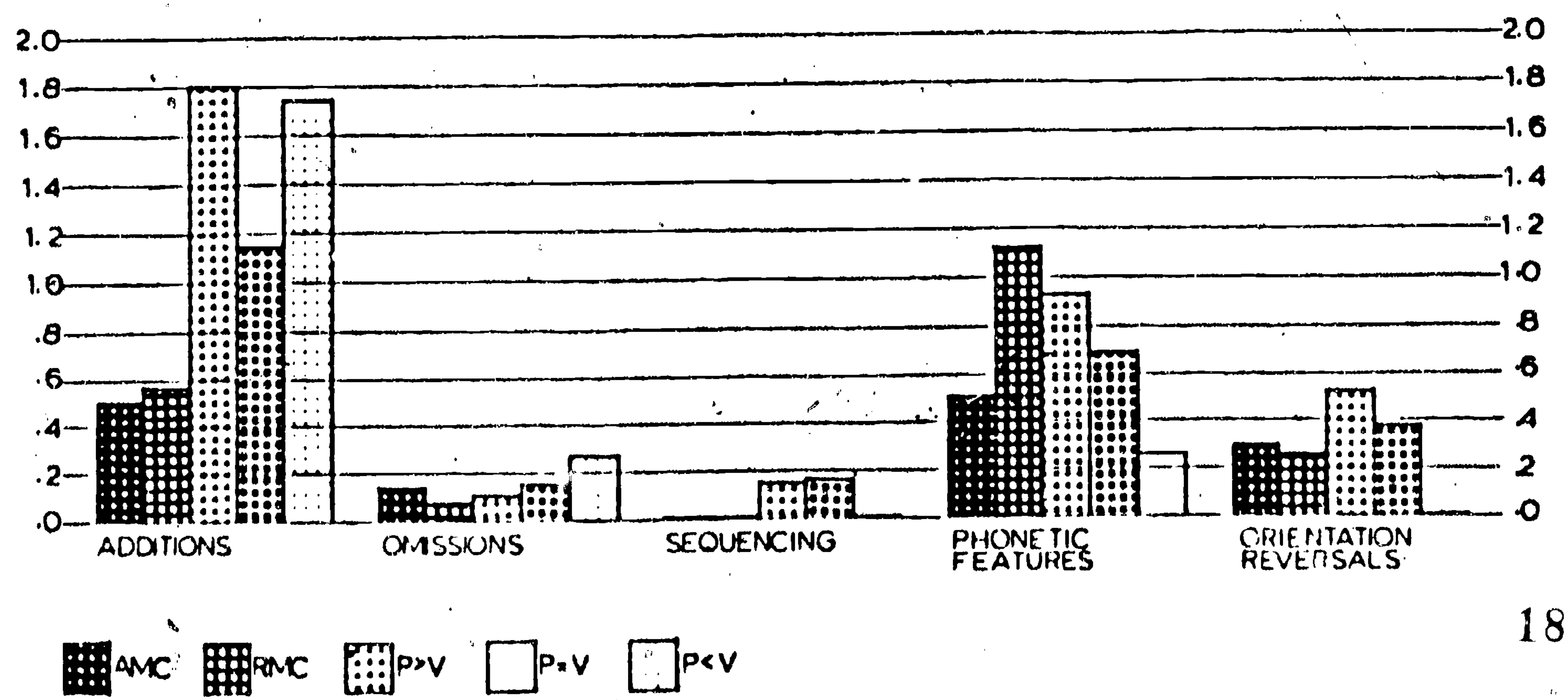


FIGURE 4



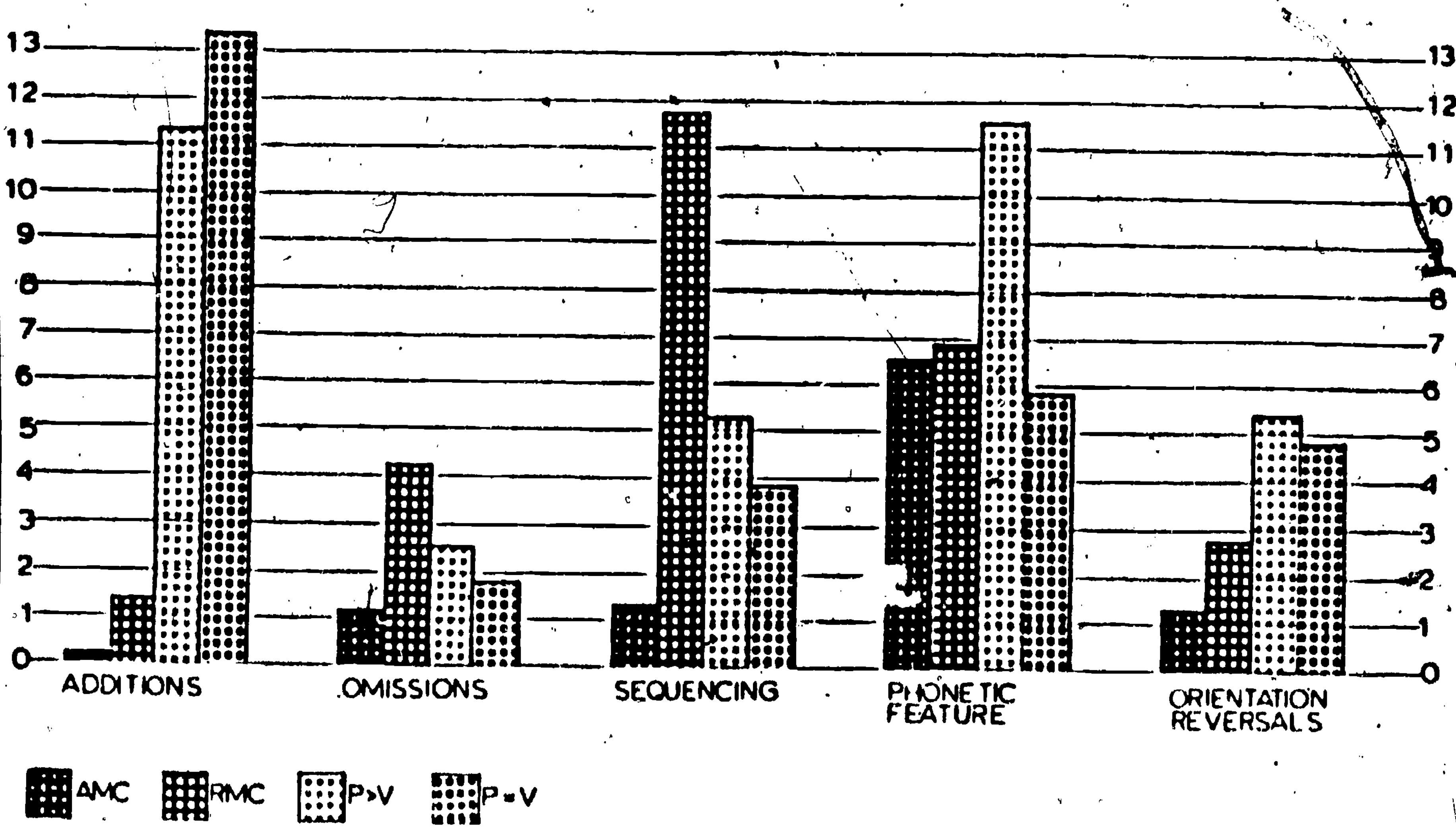

13
12
11
10
9
8
7
6
5
4
3
2
1
0
ADDITIONS
OMISSIONS
SEQUENCING
PHONETIC FEATURE
ORIENTATION REVERSALS
AMC
RMC
P>V
P=V

FIGURE 5

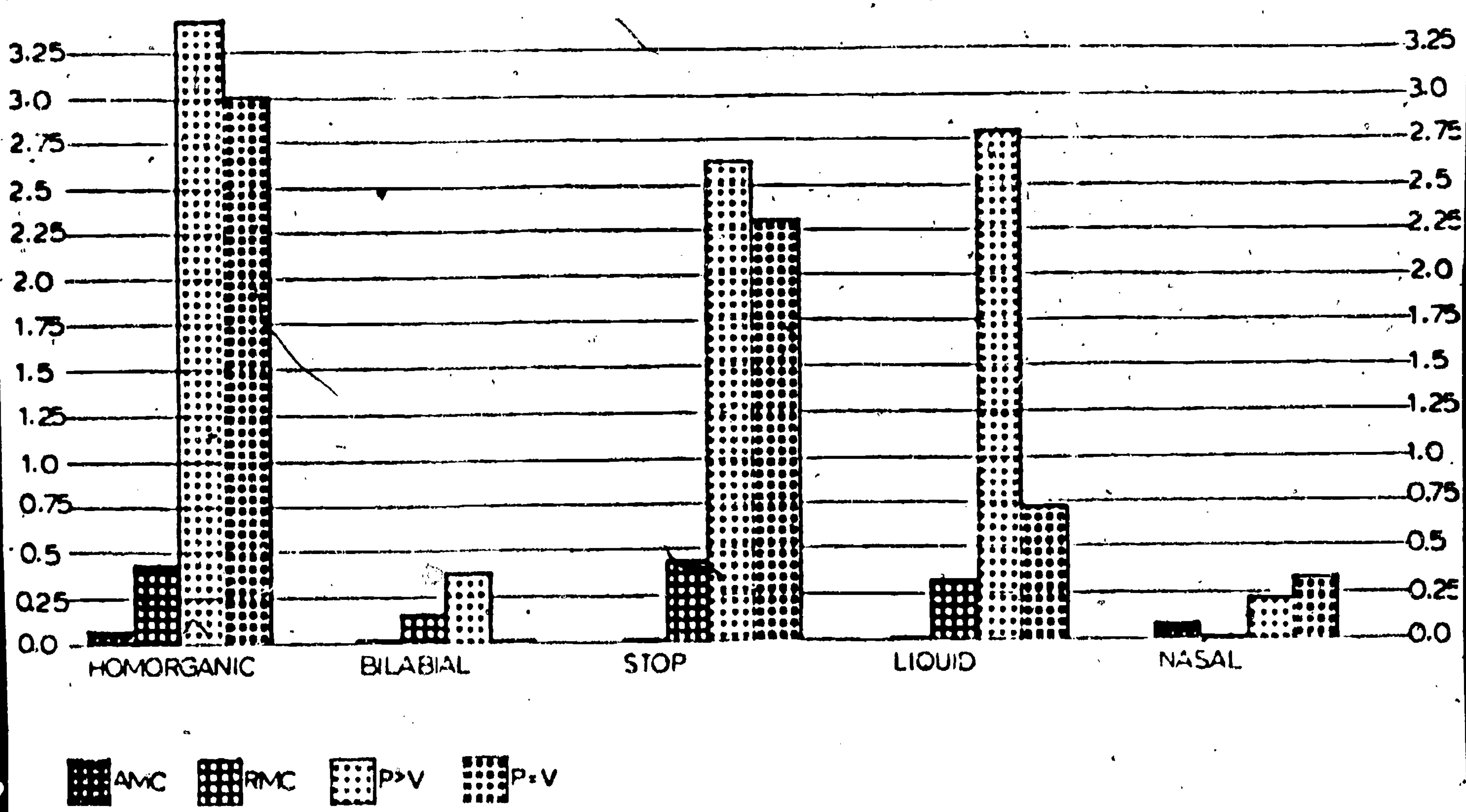

3.25
3.0
2.75
2.5
2.25
2.0
1.75
1.5
1.25
1.0
0.75
0.5
0.25
0.0
HOMORGANIC
BILABIAL
STOP
LIQUID
NASAL
AMC
RMC
P>V
P=V

FIGURE 6

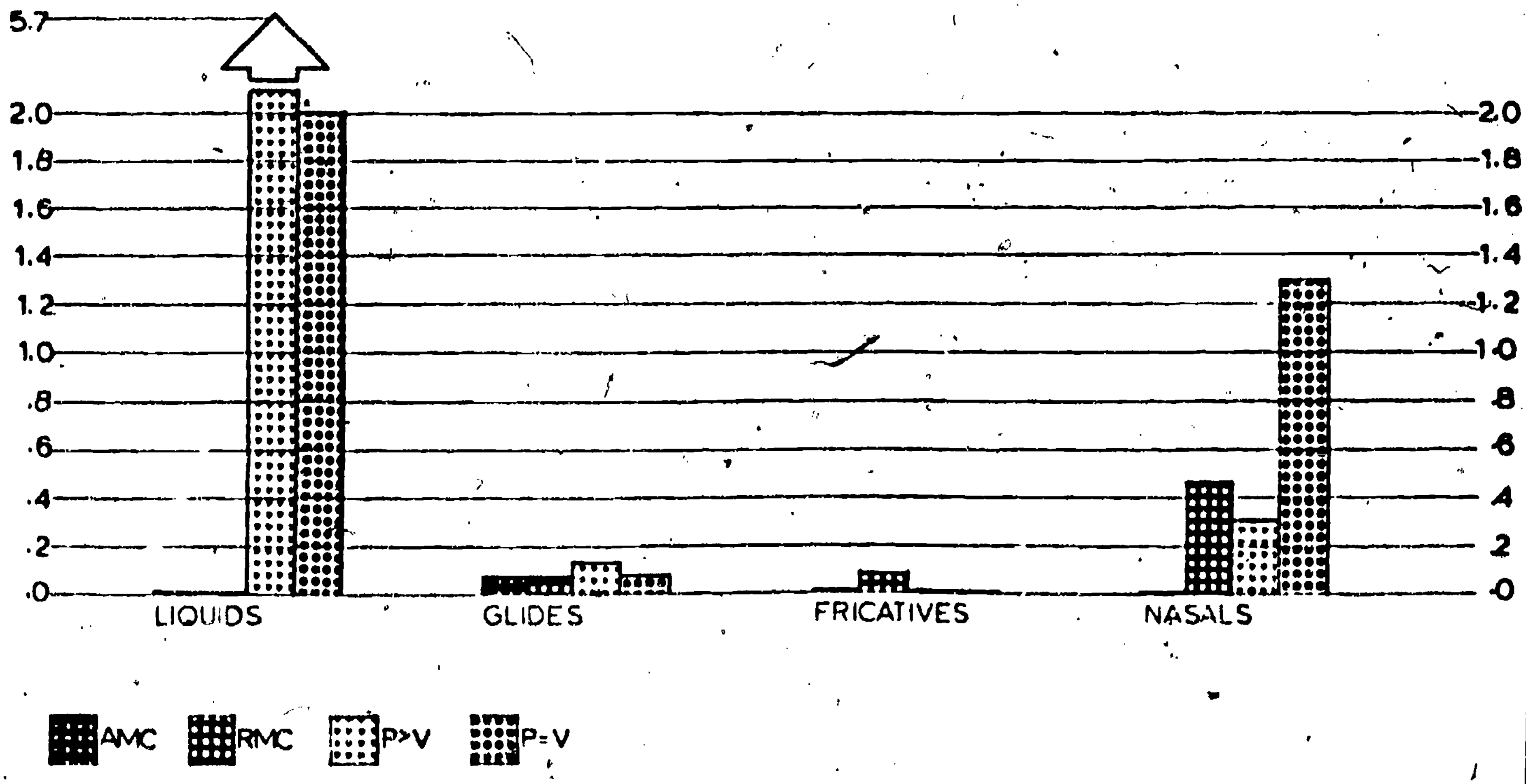

5.7
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.0
LIQUIDS
GLIDES
FRICATIVES
NASALS
AMC
RMC
P>V
P=V

FIGURE 7