5-1976

Correlations between the HMH Plus, Minus, and Combined accommodative rock tests

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It is my pleasure to announce your paper entitled:

"CORRELATIONS BETWEEN THE HMH PLUS, MINUS AND COMBINED ACCOMMODATIVE ROCK TESTS"

has been selected as winning the

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Dean

CORRELATIONS BETWEEN
THE HMH
PLUS, MINUS AND COMBINED
ACCOMMODATIVE ROCK TESTS

A THESIS

PRESENTED TO THE FACULTY

OF

PACIFIC UNIVERSITY

BY

DALLAS R. CARR

WILL NICOLEN

DOUGLAS V. RANDOLPH

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE

DOCTOR OF OPTOMETRY

MAY 1976

DEDICATED TO:

PROFESSOR HAROLD M. HAYNES, O.D.

BARBARA M. MONTAVICH, M.D.

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Introduction

During the brief period of a visual examination, the practitioner must evaluate the patient's adaptations to the demands of his visual environment. The standard clinical routine typically provides information involving optimum lens combinations for maximum visual acuity, total amplitude of accommodation, posturing of accommodation, amount of accommodation free of convergence at near, and amount of convergence free of accommodation at near and far. The practitioner's understanding of the patient's accommodation and convergence is then based on these tests. These tests, for the most part, represent limits, or maximum values, of motor responses to specific stimulus variables. Their relative magnitudes suggest various patterns of visual behavior. These patterns as well as the individual findings then suggest appropriate therapies to the practitioner. None of the above findings, however, directly measure the patient's facility and/or ability to change the accommodative response to varying discriminatory needs. An accommodative rock test is a direct measure of change in accommodative response to change in wavefront configuration over time. The question arises, what is the most efficient clinical means to administer one or more accommodative rock tests in a routine examination.

History of The Problem

Accommodative rock testing is a relative response time test. The subject is required to discriminate 20/20 acuity material at 40 cm as quickly as possible through changing wavefront configurations. There are three generic forms of binocular accommodative rock, namely: 1) plus rock or inhibitory procedure, 2) minus rock or stimulatory procedure, and 3) combined plus and minus technique. There are two phases in each test. The plus accommodative rock test consists of a plano phase and a +2.00 D phase OU. The minus accommodative rock test consists of a plano phase and a -2.00 D phase OU. The combined test consists of a +1.00 D phase and a -1.00 D phase OU. In the most commonly used form, the tests are conducted for one minute and the number of times the subject discriminates the 20/20 line in each phase is recorded in cycles per minute. Of the two previous studies on accommodative rocks, one sought the population mean for the minus and plus accommodative lens rocks, as well as the correlation between the minus and plus rocks.[1] The other study[2] investigated the effect of increasing the change in wavefront configuration on the rate that accommodation responds to the stimuli. This present study will determine the degree of correlation between the combined lens rock and minus lens rock, and the combined lens rock and the plus lens rock.

Problem

The purpose of this study was to determine the degree of correlation existing in the performance among three accommodative rock tests administered at 40 cm. The experiment was designed to establish if any one accommodative rock test could be substituted for the other two tests. The stimulus conditions presented to the accommodative and convergence systems in a lens rock test are different from one type of rock test to another. Each lens rock test consists of two phases. The specific conditions vary from test to test. Phase one of the plus accommodative rock test is a no lens or plano phase. The only stimulus to accommodation is provided by the -2.50 D wavefront configuration of the 40 cm testing distance. Phase two of this lens rock test provides an accommodative inhibitory stimulus of 2.00 D, accomplished by placing a +2.00 D lens before the subject's eyes. The first phase of the minus accommodative rock test, like that of the plus rock test, presents a 2.50 D stimulus to accommodation. The second phase provides an accommodative stimulus of 4.50 D accomplished by placing a -2.00 D lens before each of the subject's eyes. The first phase of the combined accommodative lens rock test provides an accommodative inhibitory stimulus of -1.50 D accomplished with +1.00 lenses OU, and the second phase provides an accommodative stimulus of 3.50 D accomplished with -1.00 lenses OU. In each of the tests, phases one and two and back to one compose a cycle, and performance is noted in cycles per minute.

The activities elicited by all three tests are similar. Each requires variation of accommodative response to changes in wavefront configuration while binocular fixation is maintained. Further, the magnitude of change in wavefront configuration is a constant 2.00 D in the three tests. These similarities suggest the possibility of a high correlation between two or more of the three tests in question.

Professor Haynes deliniated these possibilities and attendant ramifications during his treatment of accommodative rock testing in the course Optometry III on October 22, 1974. He suggested that verification of a high degree of correlation between the performance on two or more lens rocks may lend greater insight into the physiological mechanisms involved during accommodative rock testing. He further stated that such verification would be useful clinically, for it would permit the practitioner to obtain the same information from one or two tests that now requires three tests to obtain.

Equipment

The lens rocks were performed using a standard Van Orden Flipper (V. O. Flipper) and a back-lighted near point chart calibrated for 40 cm. The Van Orden Flipper is an instrument used largely in visual training. It consists of a long rod on one end of which is a reduced Snellen back-lighted chart. The other end of the rod has lens wells attached to it. A flipping device allows a pair of lenses to be placed in front of the lens wells or completely moved out of the way of the lens wells so that two alternate sets are quickly obtainable.

Lenses used were: +2.00 and plano, -2.00 and plano, and +1.00 and -2.00 (when combined this gives -1.00).

Subject Selection

One hundred-thirty college students served as subjects. Ten of these could not participate because they failed the selection criteria (see below). The remaining sample of one hundred-twenty subjects consisted of 47.5% females and 52.5% males. Their average age was 21.4 years with a range from 17 years to 26 years. The following selection criteria for subjects were used:

1) Ability to read 20/20 line at 40 cm OU and OD & OS. A subjective comparison between the clarity of the letters OD and OS was made to insure that no large aniso was present.
2) Phoric response on alternating cover test. No subjects with strabismus were accepted.
3) Adequate relative accommodative facility and adequate relative convergence facility to read singly 20/20 material at 40 cm through +2.00 and -2.00 diopter spheres. (This was a necessary requirement to perform the test.)

To insure the subjects met these criteria, the following questions were asked of each potential subject:

1) Do you wear glasses? If so, when?
2) Are you seeing well through your glasses? (Omit subjects with complaints of not being able to see well through their glasses.)
3) Are there any problems with near work? (Point of information)

4) Have you ever seen double?

(Detection of strabismus, constant or intermittant)

5) Have you ever undergone visual training?

(Detection of past strabismus or binocular dysfunction)

6) Do you have any other visual complaints?

(Point of information)

Subject Instruction

Prior to the actual experimental run, the subjects were instructed to read the 20/20 line OU, OD, and OS. The subjects were then asked to read it again through a +2.00 D lens, and then through a -2.00D lens. After this, the following specific instructions were given: "You are to read the bottom line for us. Your goal is to see it singly and clearly so that you can read it. When it is single and readable, tap with your finger and I will flip in a different pair of lenses before your eyes. Tap again when you can once more see the bottom line singly and read it. The process will be repeated for two minutes."

As the initial trial minute proceeded, some subjects asked whether it was all right to concentrate on a single letter in the 20/20 row and clear it. Subjects who so asked were told that this was acceptable performance. Finally, for those subjects who suddenly couldn't read the 20/20 letters after having done so for a few rocks, we suggested that they read the large single 20/200 E and read right on down the chart to the bottom row. In the majority of cases, this instruction enabled the subject to read the 20/20 letters. The few subjects who still couldn't read the bottom row after doing this were eliminated from the study.

Experimental Sequence

An initial one-minute combined rock was performed on each subject so as to aquaint them with the procedure and instructions. After the demonstration testing, a one-minute rest period occurred prior to the first test run. Between each of the three test runs, one-minute rest intervals were used.

In order to control for sequence practice effects, the one hundred and twenty subjects were divided into three groups of forty. One group performed the plus phase first, followed by the minus and then the combined phase. The second group performed the minus, then the plus and finally the combined. Our third group performed the combined followed by the plus, then the minus phase. Each phase was tested for two continuous minutes. The two minute experimental runs were used instead of a one minute run for these reasons: 1) it was necessary to correlate test reliability of first to second minute results, 2) increased reliability for inter-test comparison, and 3) determination of possible decay in accommodative performance over time.

Actual lens combinations used in the testing were:

1) Plus Rock-- +2.00/plano giving absolute dioptric vergence at the spectacle plane of -2.50/-0.50.
2) Minus Rock-- -2.00/plano giving absolute dioptric vergence at the spectacle plane of -2.50/-4.50.
3) Combined Rock-- +1.00/-2.00 giving absolute dioptric vergence at the spectacle plane of -1.50/-3.50.

Results

First and second minute findings were correlated to determine reliability of each test. This data is found in Tables I, II, and III. Comparison to the Milne correlations for the minus and plus rocks is shown in these tables. The inter-test correlations in our study are listed in comparison to the Milne inter-test results. The first minute, second minute, and average of first and second minute means are listed for this study and Milne's study.

In Scattergram I, the first minute's cycles per minute is on the y-axis, second minute is on the x-axis. Inspection confirms a linear correlation (r=.86) between first and second minutes found on the plus rock.

In Scattergram II, first minute's cycles per minute is on the y-axis, second minute's is on the x-axis. Inspection confirms a linear correlation (r=.84) between first and second minutes found on the minus rock.

In Scattergram III, the first minute's cycles per minute is on the y-axis, second minute's is on the x-axis. Inspection confirms a linear correlation (r=.85) between first and second minutes found on the combined rock.

Scattergram IV shows cycles per minute on plus rock on the y-axis vs cycles per minute score on the combined rock on the x-axis. Inspection confirms a linear correlation (r=.73) between the plus rock and combined rock.

In Scattergram V, each subject's cycles per minute on the minus rock vs subject's combined phase cycles per minute is shown. Inspection confirms a linear correlation (r=.70) between minus and combined rocks.

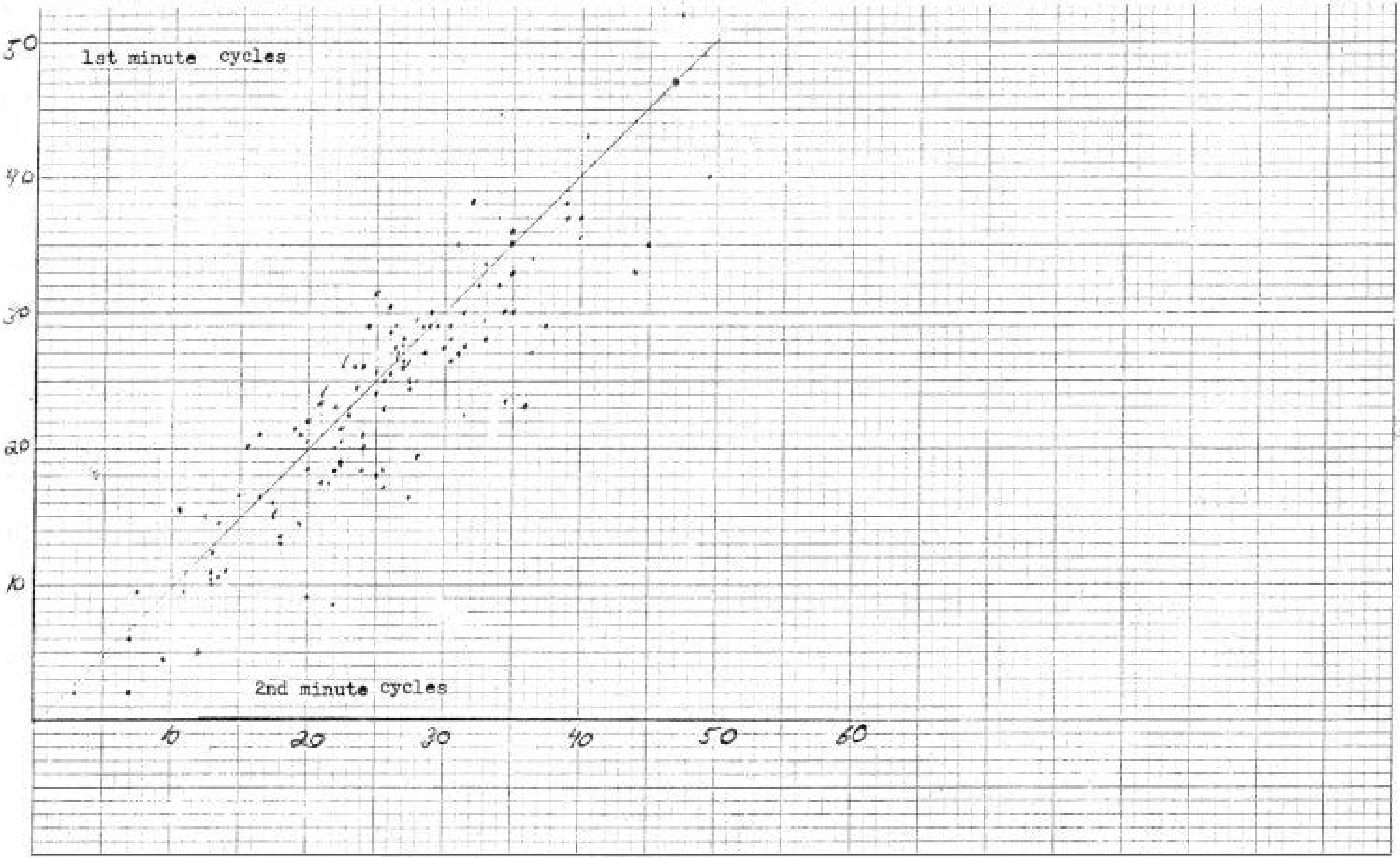
Scattergram VI shows each subject's cycles per minute on the minus rock on the y-axis versus the subject's cycles per minute on plus rock on the x-axis. Inspection confirms a linear correlation (r=.52) between minus and plus rocks.

Histograms I, II, and III show the frequency of occurrence of lens rocks at specific cycles per minute. The mean, mode, median and standard deviation are given for the various lens rocks on each respective histogram.

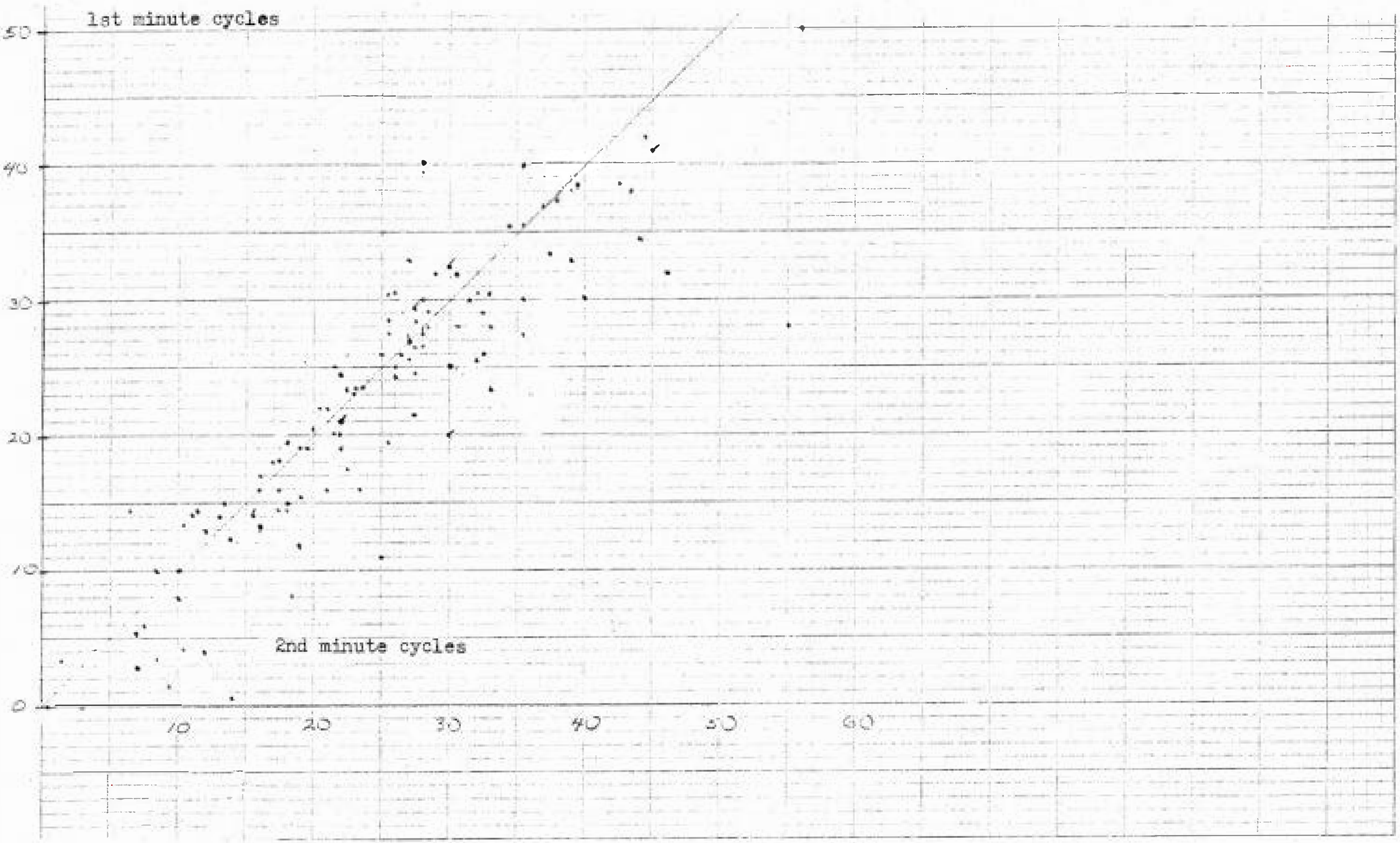
SCATTERGRAM I

PLUS ACCOMMODATIVE LENS ROCK number of cycles in 1st minute vs number of cycles in 2nd minute

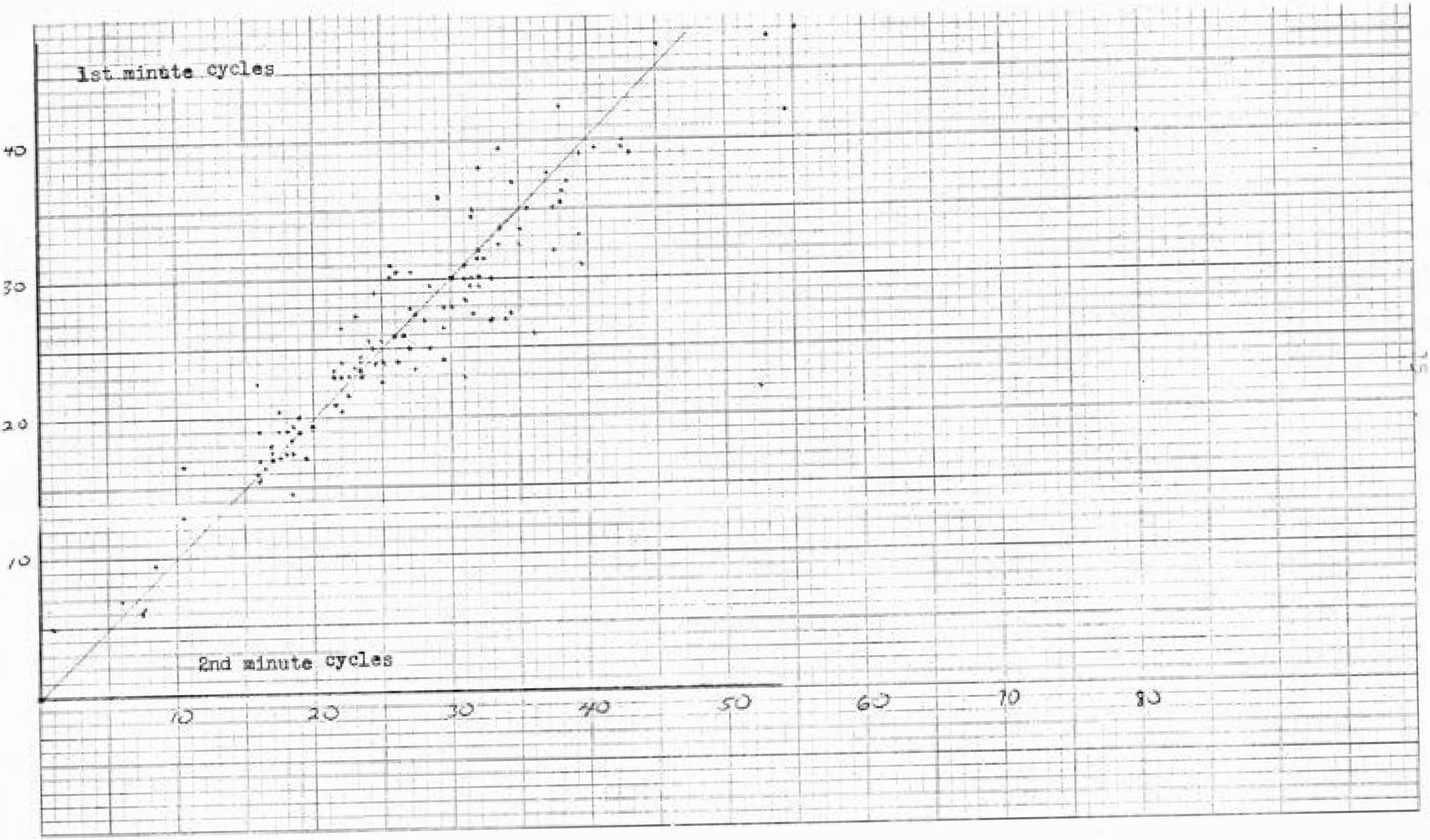
r=.86



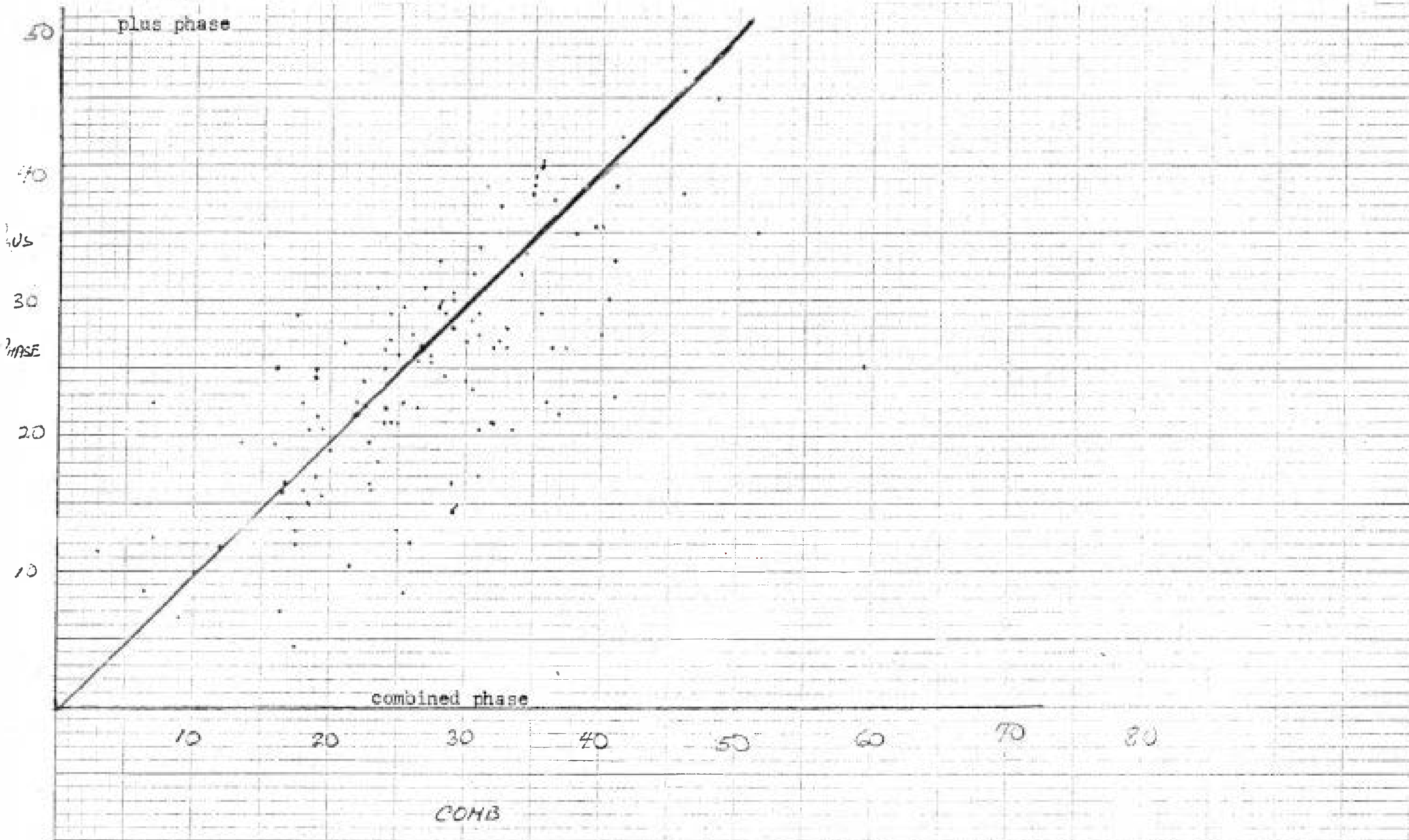
SCATTERGRAM II
MINUS ACCOMMODATIVE LENS ROCK number of cycles in 1st minute vs number of cycles in 2nd minute
r=.84



SCATTERGRAM III
COMBINED ACCOMMODATIVE LENS ROCK number of cycles in 1st minute vs number of cycles in 2nd minute
r=.85



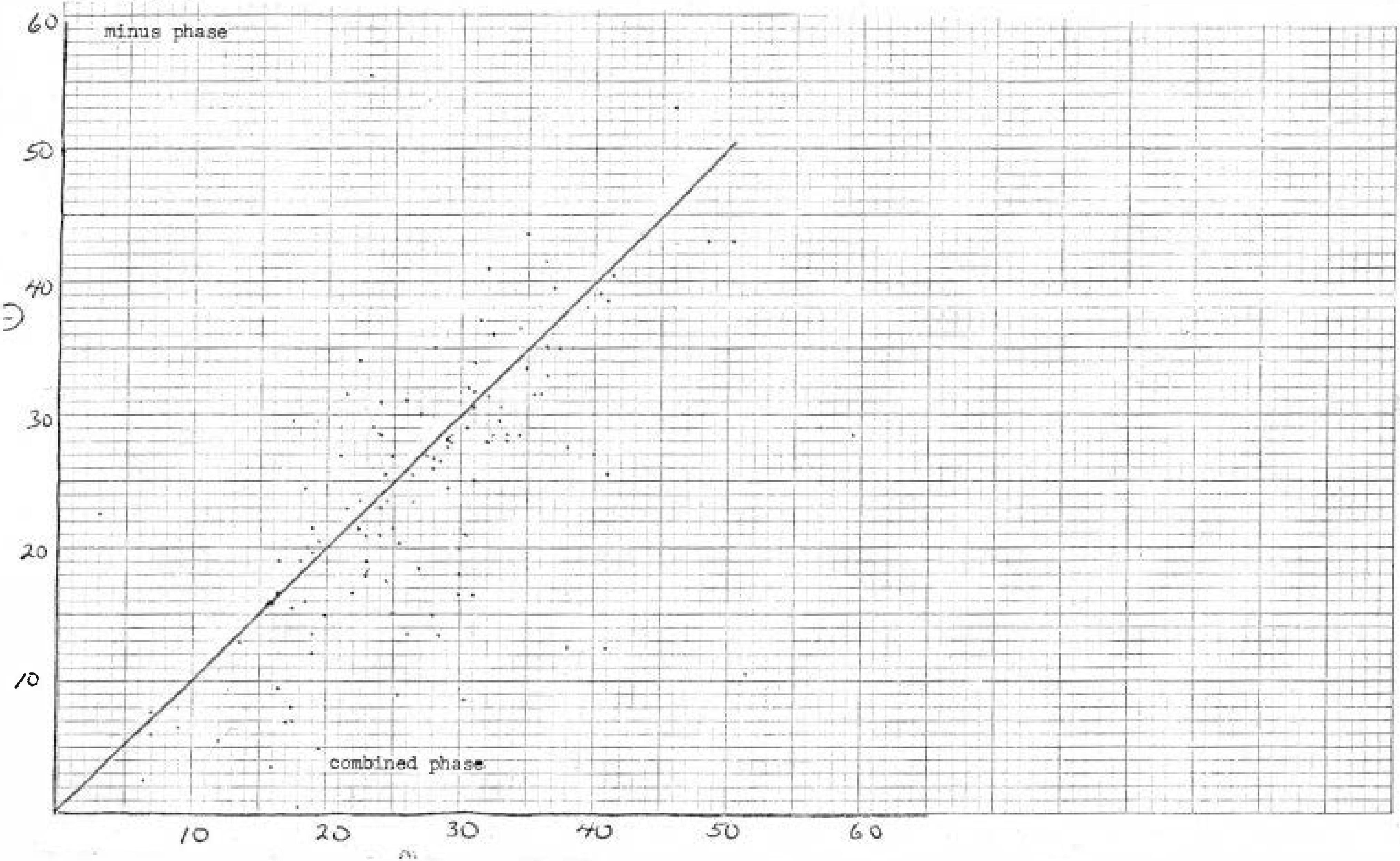
SCATTERGRAM IV
PLUS ACCOMMODATIVE LENS ROCK VS COMBINED ACCOMMODATIVE LENS ROCK in cycles per minute
r=.73



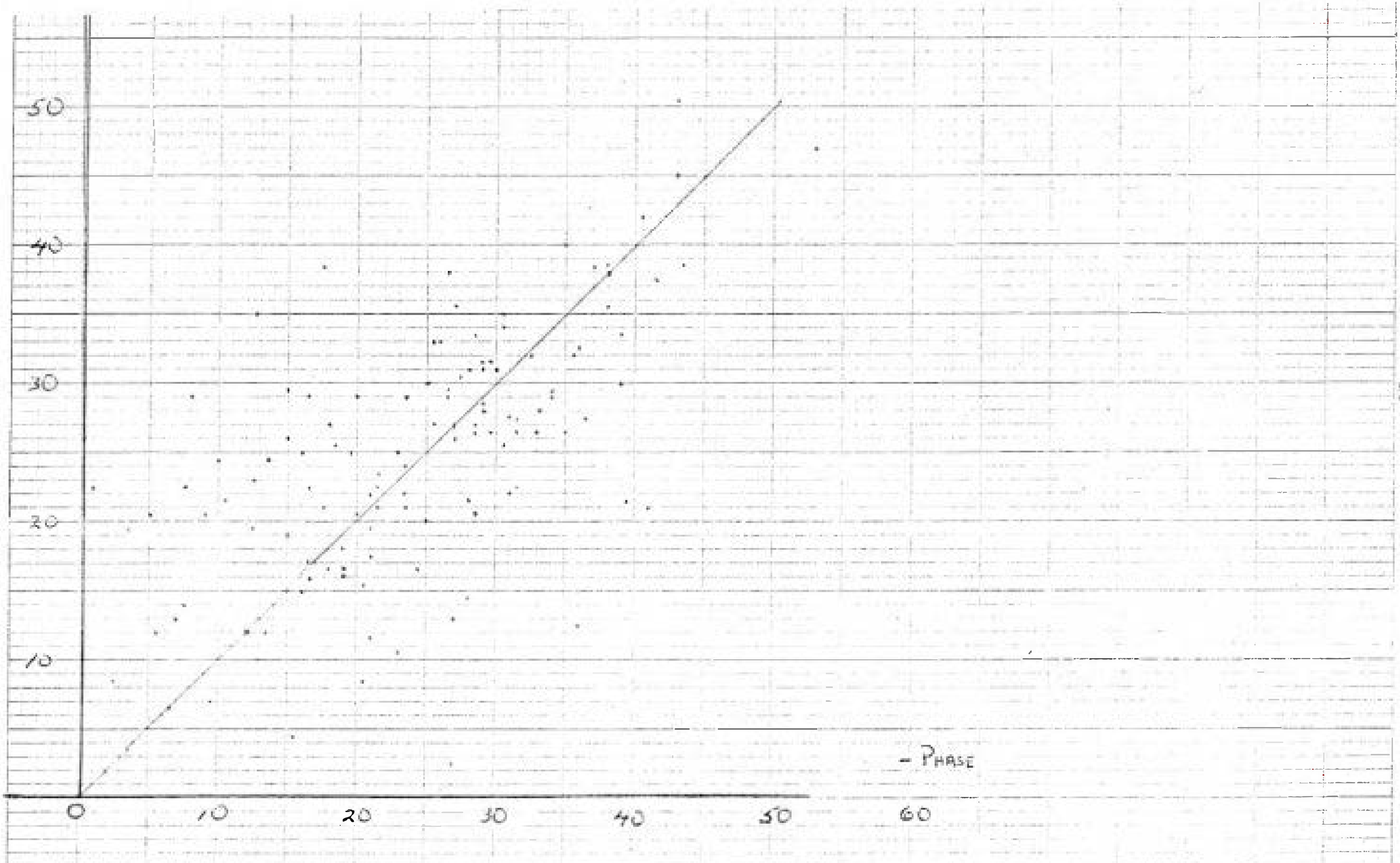
SCATTERGRAM V

MINUS ACCOMMODATIVE LENS ROCK VS COMBINED ACCOMMODATIVE LENS ROCK in cycles per minute

r=.70



SCATTERGRAM VI
PLUS ACCOMMODATIVE LENS ROCK VS MINUS ACCOMMODATIVE LENS ROCK in cycles per minute
r=.70



HISTOGRAM I
Frequency Distribution Of Responses On The Plus Accommodative Lens Rock Test

n=120
mean=24 cpm
median=25.5 cpm
mode=29 and 26.5 cpm
standard deviation=9.4 cpm

1st quartile 0 to 19.5
2nd quartile 20 to 25.5
3rd quartile 26 to 29.5
4th quartile 30 to 54

cycles per minute	frequency of response
0-3	XX
3.5-6	XXXX
6.5-9	XXXXXX
9.5-12	XXXX
12.5-15	XXXXXXXXX
15.5-18	XXXXXXXXXXX
18.5-21	XXXXXXXXXXXX
21.5-24	XXXXXXXXXX
24.5-27	XXXXXXXXXXXXXX
27.5-30	XXXXXXXXXXXXXXX
30.5-33	XXXXXXXXXXXXX
33.5-36	XXXXXX
36.5-39	XXXXXX
39.5-42	XXXX
42.5-45	XXX
45.5-48	
48.5-51	
51.5-54	X

HISTOGRAM II
Frequency Distribution of Responses on the Minus Accommodative Lens Rock Test

n=120
mean=24 cpm
median=23.5
mode=31.5
standard deviation=10.5 cpm

1st quartile 0 to 16.5
2nd quartile 17 to 23.5
3rd quartile 24 to 29.5
4th quartile 30 to 51

cycles per minute	frequency of response
0-3	X
3.5-6	X
6.5-9	XXXX
9.5-12	XXXX
12.5-15	XXXXXXXX
15.5-18	XXXXXXXXX
18.5-21	XXXXXXXXXXXXX
21.5-24	XXXXXXXXXXXXXX
24.5-27	XXXXXXXXXXXXXXXXXXXX
27.5-30	XXXXXXXXXXXXXXXXXX
30.5-33	XXXXXXXXXX
33.5-36	XXXXXXX
36.5-39	XXXXXX
39.5-42	XX
42.5-45	X
45.5-48	X
48.5-51	X
51.5-54	

HISTOGRAM III
Frequency Distribution of Responses on The Combined Accommodative Lens Rock Test

n=120
mean=28 cpm
median=27 cpm
mode=31 cpm
standard deviation=10.5 cpm

1st quartile 0 to 21.5
2nd quartile 22 to 27
3rd quartile 27.5 to 33
4th quartile 33.5 to 59.5

cycles per minute	frequency of response
0-3	X
3.5-6	
6.5-9	XXXX
9.5-12	
12.5-15	XX
15.5-18	XXXXXXXXXXXX
18.5-21	XXXXXXXXXX
21.5-24	XXXXXXXXXXXXXXX
24.5-27	XXXXXXXXXXXXXXXX
27.5-30	XXXXXXXXXXXXXXX
30.5-33	XXXXXXXXXXXXXXX
33.5-36	XXXXXXXXXXX
36.5-39	XXXXXX
39.5-42	XXXXXXX
42.5-45	
45.5-48	XX
48.5-51	XX
51.5-54	X
54.5-57	
57.5-59	
59.5-62	X

Discussion of Results

Ten subjects were excluded because of failure to clear the 20/20 line or doubling of the targets while performing the test run. One subject was excluded because of a hypertropic posture exhibited at near. Thus one hundred twenty subjects were selected out of the first one hundred thirty people tested.

Graphical Results

Scattergrams I, II, and III were made for the first versus second minutes of each phase to determine reliability of first and second minute testing in cycles per minute. In all cases inspection of these graphs indicates a high correlation between the first and second minutes. There is not too much scatter of the data and that which does occur appears at either extreme of the data as might be expected. There is a slight practice effect evident on each graph which is seen by the larger number of data points falling below the 45^{o} line as opposed to the number avove that line.

Scattergrams IV, V, and VI show correlations among three different rocks plotted as a function of the average cycles over two minutes. A moderate correlation is evident from visual inspection of the graphs between the plus and combined and minus and combined lens rocks. The plus versus minus rock shows less correlation than the two previous ones and a marked amount of scatter.

The scores on the rocks themselves had a wide variation. In the minus phase the poorest subject performed at .5 cycle in one minute while the best attained 53 cycles in one minute. Mean for the minus phase on all subjects was 23.0 cycles/minute for the first minute, 24.5 cycles/minute for the second minute and 24.0 cycles/minute for the two minutes combined. Likewise, the plus phase showed a range from 2.5 cycles/minute to 47 cycles/minute. Here the means were 23.5 cycles/minute for the first minute, 24.5 cycles for the second minute and 24 cycles for the two minutes combined. Finally, the range on the combined phase was from 3 to 50 cycles/minute, with a mean of 27.5 cycles for the first minute, 28.0 cycles for the second and 28.0 for the two minutes.

The first and second minute findings were correlated for the plus, minus and combined phases. Scattergrams of the data were made. Correlations and scattergram plots of the inter-test relationships were made between the plus and minus, plus and combined and minus and combined phases.

In designing this experiment, we were concerned that a sharp fall-off in the second minute might, if not detected, lead to erroneous data. This is one of the reasons why each lens rock phase was done continually for two minutes. We did not find a significant difference in performance between the two parts of each rock. Correlations for the first versus the second minute were .86 for the plus phase, .84 for the minus phase, and .85 for the combined phase. The correlations between different lens rocks were as follows: .52 for plus vs minus,

.73 for plus vs combined and .70 for minus vs combined.

Subjects scoring in the lowest quartile on the combined plus and minus rock test were compared with their respective scores on the minus and plus accommodative rock tests. In 28 out of 30 subjects the scores were in the lowest quartile. In the remaining two subjects, their scores were less than the population mean (second lowest quartile). These results suggest that the lower the performance on the combined phase the less probable that performance on the minus and plus phase will be equal to or greater than mean performance.

Conclusion

We had hoped that we would find a single type of lens rock which correlated highly with the two others. In this way it might be easier to influence optometrists to include this rock in their basic exam and get a relative idea of the patient's performance on the other rocks. Without a doubt, the lens rock is an important dynamic test in the optometrist's arsenal. In spite of this fact, many clinicians tend not to use this test. One of the reasons is the time involved and the implicit assumption on the part of many that they must do a plus, minus, and combined rock test in order to have results with any validity. Our results show that a definite correlation exists between the combined phase and the plus phase and also between the combined phase and the minus phase. By doing a combined rock one can obtain a reasonable estimate on the other two phases. Unfortunately, the results we obtained do not permit us to make individual predictions. To come to a completely accurate conclusion, the performance on each type of lens rock must be measured. The combined phase is potentially a good single indicator for either clinical practice or screening.

In an individual patient, the lowest quartile performance on the combined phase becomes significant when dealing with groups of patients for screening and diagnóstic purposes.

Summary

One hundred-twenty college students were tested on three binocular accommodative lens rock tests. The rocks included a plus, a minus and a combined plus and minus phase. Each test had a 2.00 D interval between each test phase. Reliability and inter-test correlations were determined. Reliability for each test was approximately .85 between the first and second minute. Inter-test scores were not correlated highly enough with each other for individual prediction of performance to be made, but there was a substantial positive correlation between tests.

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