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<u>NORMALIZATION OF SWEEP VEP FOR A RANGE OF ACUITY LEVELS</u>

by

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Introduction

The visual evoked potential (VEP) is an electrophysiological technique that measures some portion of the electrical activity produced by the visual cortex in response to the visual information it has received from the eye. As the eye is presented with a stimulus consisting of a succession of increasing spatial frequencies, the amplitude of the VEP is seen to decrease. It is assumed that so long as the brain is producing a measurable VEP, the visual pathway is still resolving the stimulus. The point at which the amplitude of the VEP reaches zero would be the level of cortical acuity, as measured by the VEP.

It is assumed that the VEP decreases linearly as the spatial frequency linearly increases near the limit of acuity. This was shown by Weiner et al. (1985) An estimate of the cortical acuity level can then be extrapolated by a linear regression from experimental data. Our objective was to evaluate the relationship between the VEP's measure of cortical acuity and traditional visual acuity as measured by the Tumbling E.

EXPERIMENTAL DESIGN:

EQUIPMENT:

1. Neuroscientific VENUS Model 1020
2. GRASS RPS 107 Amplifier
3. Mitsubishi Color Monitor Model HL6615TK
4. AST Premium Model 286 PC

SUBJECTS:

The total number of subjects in the study was fifteen. There were eight males and seven females ranging in age from twenty to thirty two years of age.

GENERAL PROTOCOL:

The subjects acuity was gathered using the tumbling E projecto-chart. Standard Snellen letters were not used due to familiarity of the chart to many of the subjects. A total of eight acuity measurements were taken: Four right eye and four left eye.

1. Right and Left Eye
    a. Best Corrected
    b. +1.00 Blur
    c. +2.00 Blur
    d. +3.00 Blur

Successive blurring of the patient was accomplished be placing a +1.00, +2.00, or +3.00 trial lens in front of the eye during the acuity measurements.

Following acuity measurements, the patient was taken to the electrodiagnostics room and placed 2.7M in front of the monitor. Standard protocol was used in setting up the electrodes for measurement of the Sweep VEP:

1. The patient's scalp was scrubbed with an alcohol pad and NuPrep Gel. Total resistance for each electrode was <10 Kilohms @ 30Hz.

2. Three electrodes were placed on the scalp. The active electrode was placed above the inium 10% of the total distance from the nasium to the inium. This distance was routinely two finger widths. The reference electrode was placed at the top of the scalp where an imaginary line would intersect the scalp. The ground electrode was placed in the middle of the forehead. All electrodes were secured to the scalp using TEN20 conductive EEG paste.

3. The patient was seated in a chair 2.7 meters from the monitor with their line of vision approximately parallel to the monitor. A series of 10 measurements were taken per eye with the appropriate lens in front of the eye. The other eye was occluded using a standard eye patch.

VENUS PROGRAM:

A sweep stimulus was used which presented as decreasing band widths with alternate contrast presentation. The title of the sweep stimulus was JMC27M.SWP designed for a 2.7 meter viewing distance. The following parameters of the stimulus are presented below:

MAP	1 CYCLE (cm)	VISUAL ANGLE (degrees)	CYCLES/ DEGREE	APPROX. SNELLEN EQUIV.
000	50.0	1.061	0.943	20/600
001	25.0	0.531	1.88	20/300
002	12.5	0.265	3.77	20/150
003	6.25	0.133	7.52	20/80
004	3.125	0.0663	15.08	20/40
005	1.563	0.0332	30.12	20/20
006	0.781	0.0166	60.24	20/10

Above snellen approximations are based on 20/20 = 30 cycles/deg.

TABLE I

EXPERIMENTAL DATA:

SUBJECT	OD	R	OD1	R	OD2	R	OD3	R
ADAMZAK	25	40.4	30	29.4	80	18.8	125-	19.5
BALDUS	20	37.2	50	19.6	100	16.7	200	5.4
BYERS	20-	-----	25	----	30	----	----	----
DEPINTO	20-	37.0	40-	17.5	70-	----	80-	16.4
INDOVINA	20	31.0	20	30.0	40	24.5	100	16.3
GARDNER	15	34.8	30-	36.8	100+	17.9	300+	5.0
MASTERS	20	17.1	30	10.2	60	18.4	125-	17.8
MAIER	15-	29.8	40-	8.9	100	8.3	300	8.9
MILLER	20	24.3	40	9.1	80	6.78	----	----
OPPERMAN	20	39.1	200	32.0	300	19.3	400	17.6
SARTORELLI	15	33.2	20	34.0	70	8.7	100-	5.0
SCIESZKA	20	22.1	40-	----	100-	26.2	----	----
STILL	20	37.8	25-	35.2	60-	18.7	100-	18.6
THORP	15-	40.6	30-	34.4	50	36.5	100	4.56
WECKER	20	31.6	25	17.7	40-	37.3	----	----

ACUITIES (OD/OS): Denominator of Snellen Fraction.
R = Regression : Cycles/Degree.

TABLE 2

EXPERIMENTAL DATA:

SUBJECT	OS	R	OS1	R	OS2	R	OS3	R
ADAMZAK	25-	17.0	30	32.0	100	18.5	160	17.7
BALDUS	20	42.9	50	15.8	125	8.4	200	4.3
BYERS	20-	----	40-	----	60-	----	----	----
DEPINTO	20-	32.2	30-	21.2	70-	30.5	80-	18.7
INDOVINA	20	20.4	20	28.3	40	----	50-	11.7
GARDNER	15	33.5	20	40.6	50+	19.3	200	9.9
MASTERS	25	35.0	50-	10.9	100	----	200	17.6
MAIER	15-	29.5	60-	8.10	150	11.6	300	18.2
MILLER	20	33.2	40	17.9	100	10.6	----	----
OPPERMAN	15	37.3	200	19.1	300	33.2	400	12.8
SARTORELLI	15	37.1	25	17.4	100	16.4	200	8.22
SCIESZKA	20	46.9	30-	42.0	80-	9.8	----	----
STILL	20	40.7	30-	17.9	100-	19.1	100-	4.50
THORP	15-	34.5	30+	43.9	40	24.0	80-	23.4
WECKER	20	31.5	40	19.2	80+	23.6	----	----

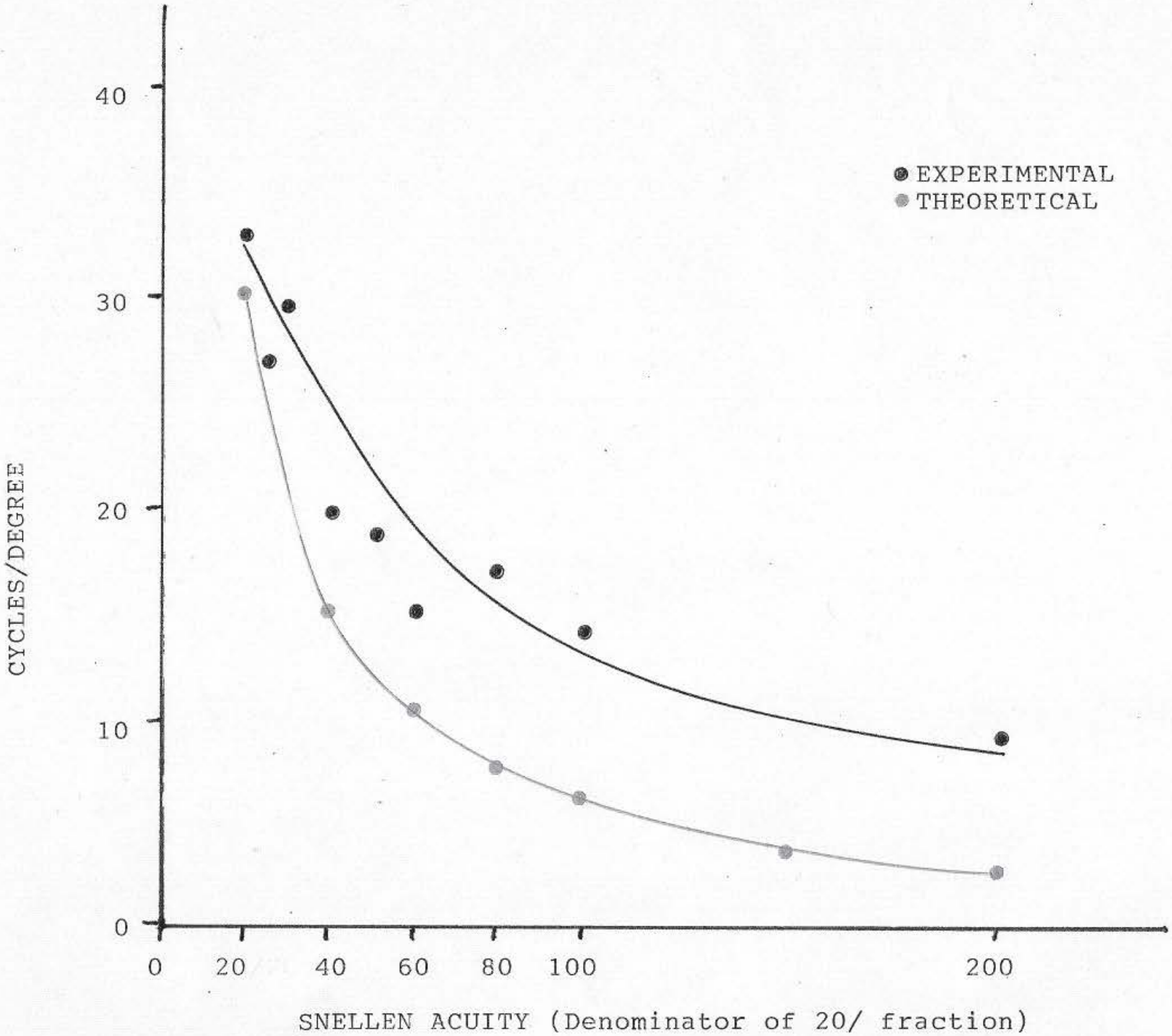
ACUITIES (OD/OS): Denominator of Snellen Fraction.
R = Regression : Cycles/Degree.

EXPERIMENTAL DATA:

ACUITY	# DATA PTS.	MEAN	RANGE
20/20	26	33.2	22.1-42.9
20/25	6	27.2	17.0-44.4
20/30	9	29.8	10.2-43.9
20/40	8	19.7	8.9-37.3
20/60	3	15.0	8.1-18.7
20/80	7	16.8	6.78-23.4
20/100	15	14.0	4.5-26.2
20/200	8	8.9	4.3-17.6

MEAN: Cycles/Degree
RANGE: Cycles/Degree

GRAPH 1



EXPERIMENTAL
THEORETICAL
CYCLES/DEGREE
40
30
20
10
0
0
20
40
60
80
100
200
SNELLEN ACUITY (Denominator of 20/ fraction)

FIGURE 1a

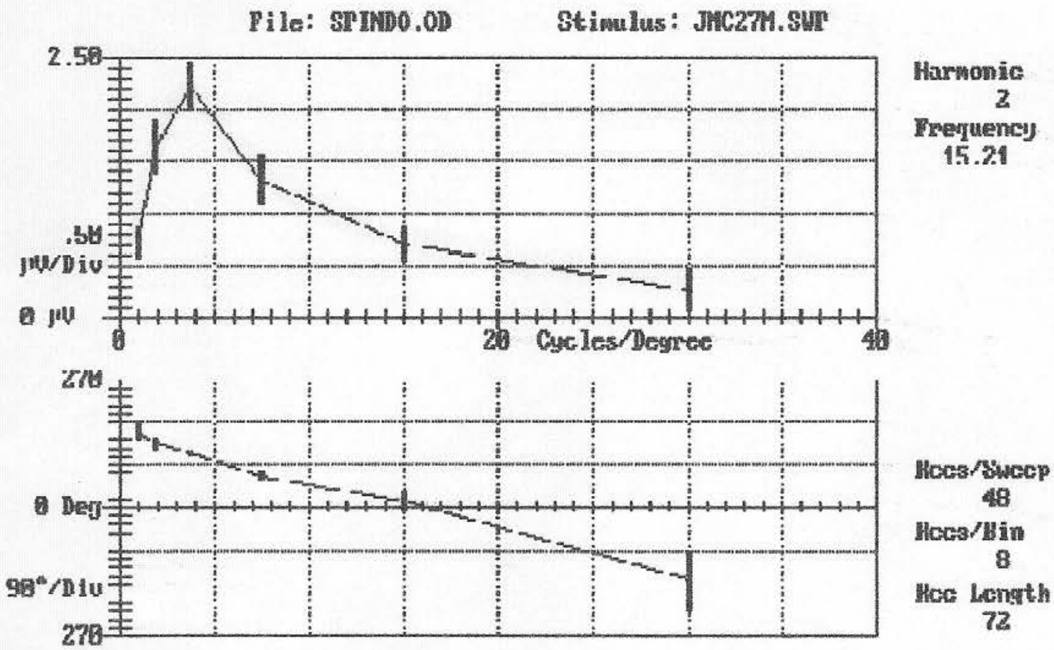


FIGURE 1b

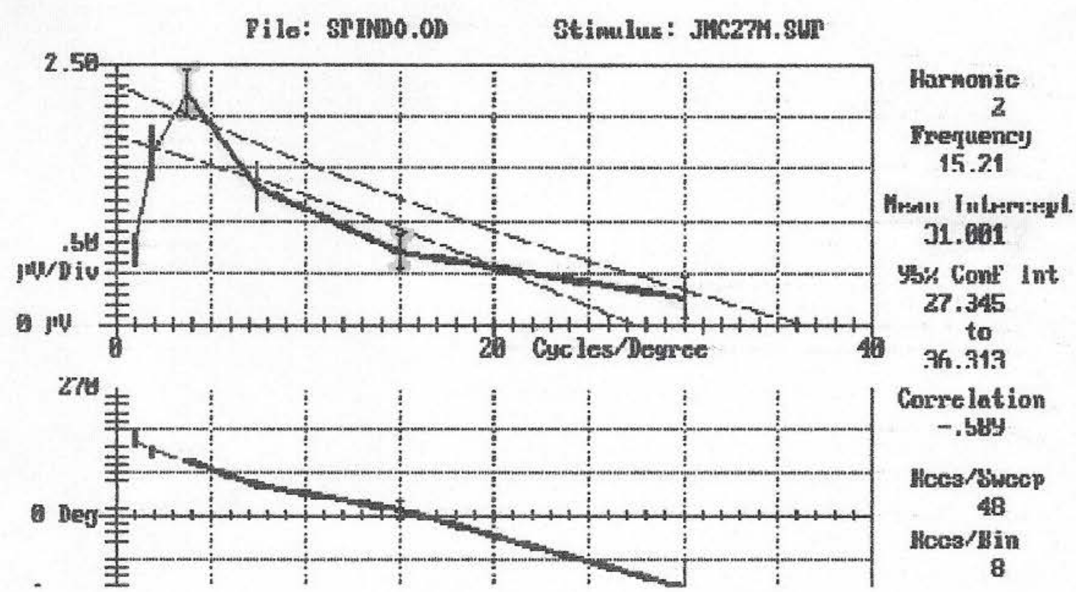


FIGURE 2a

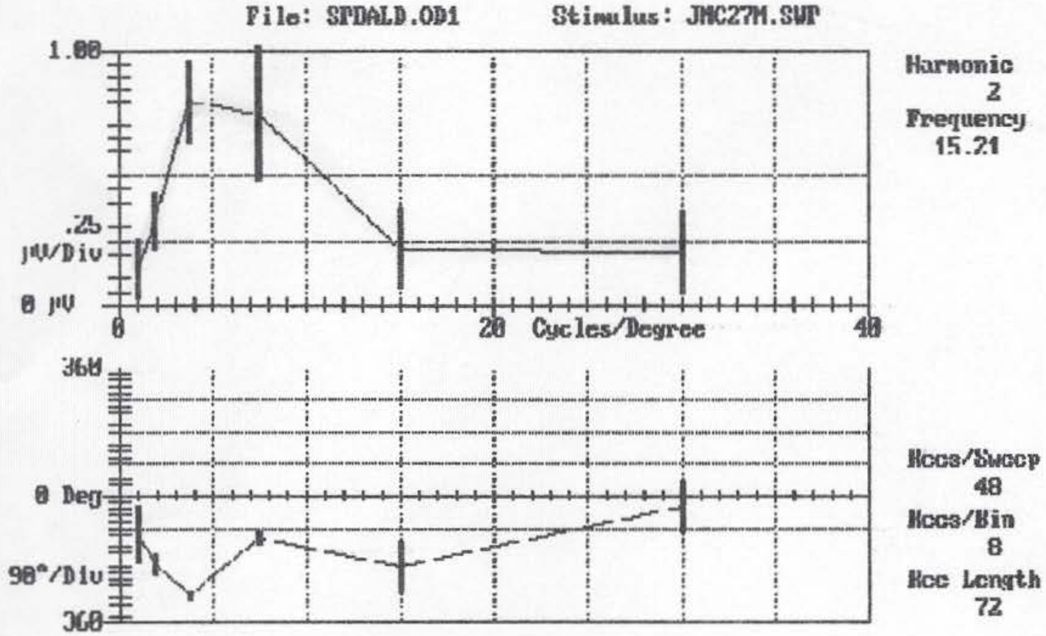


FIGURE 2b

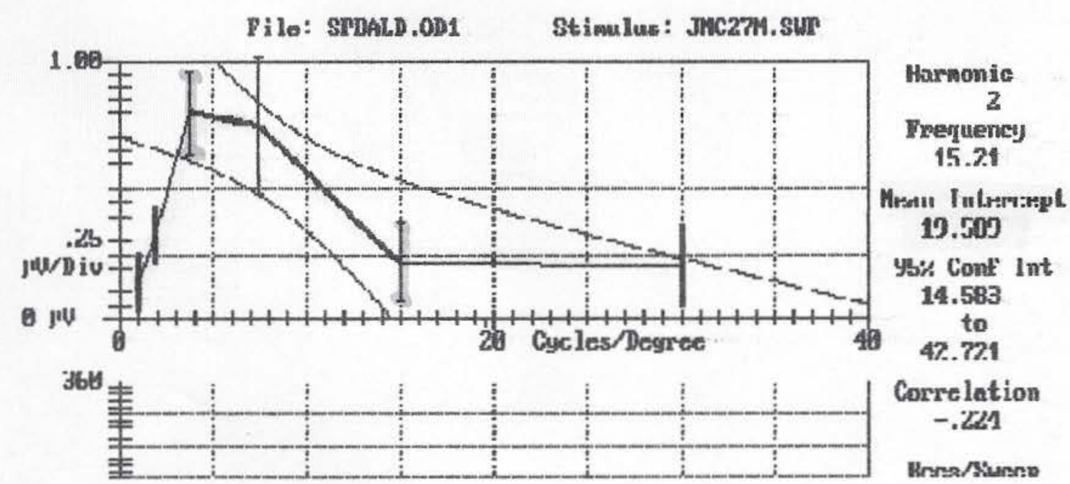


FIGURE 3a

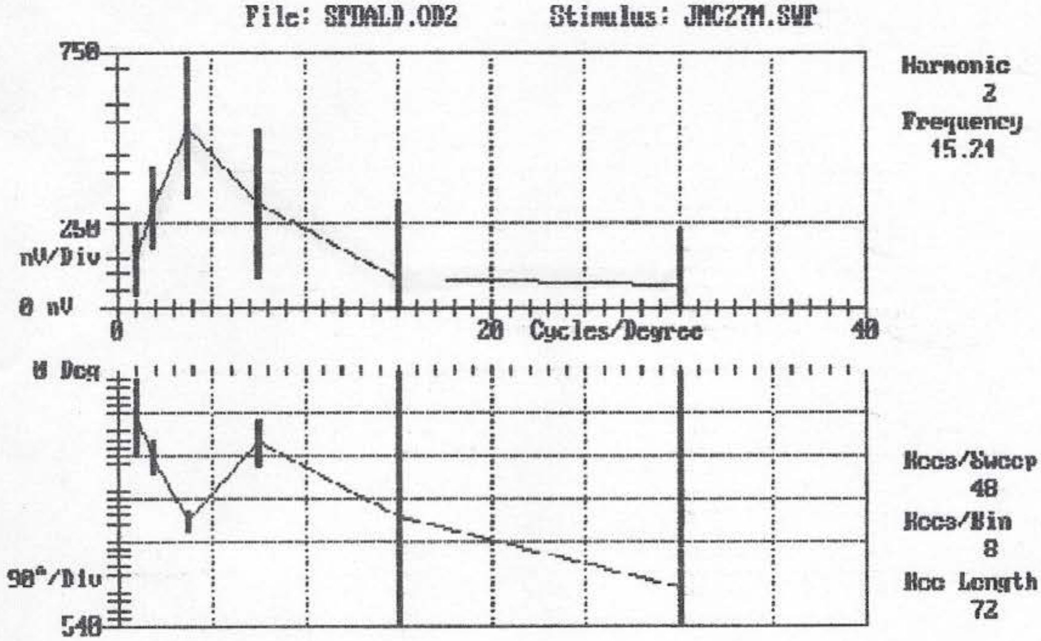


FIGURE 3b

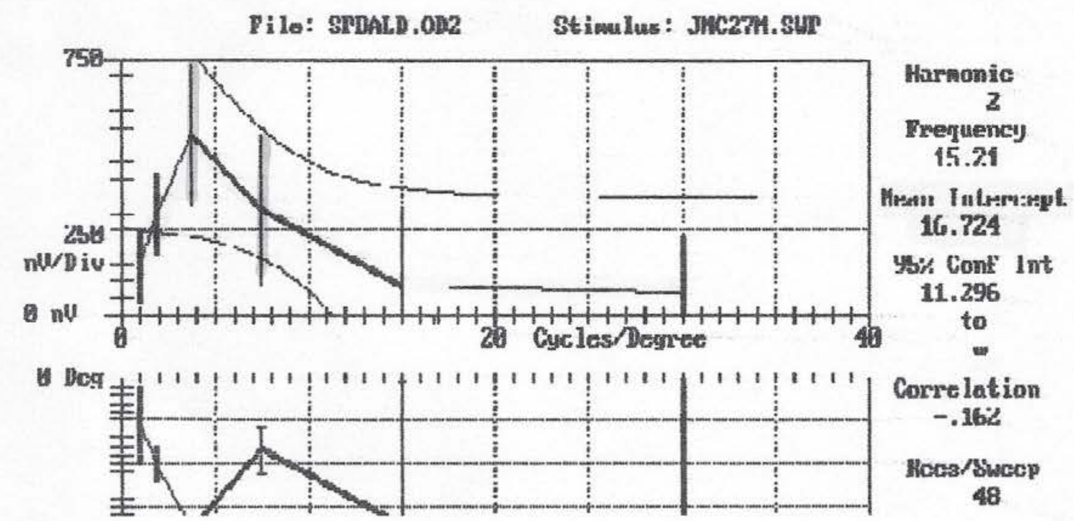


FIGURE 4a

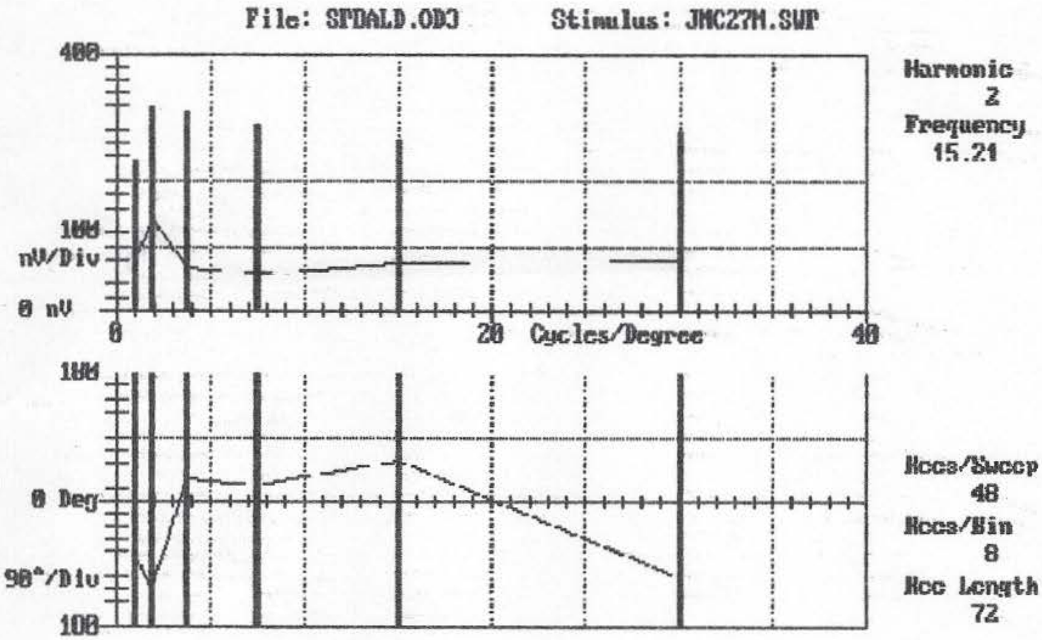
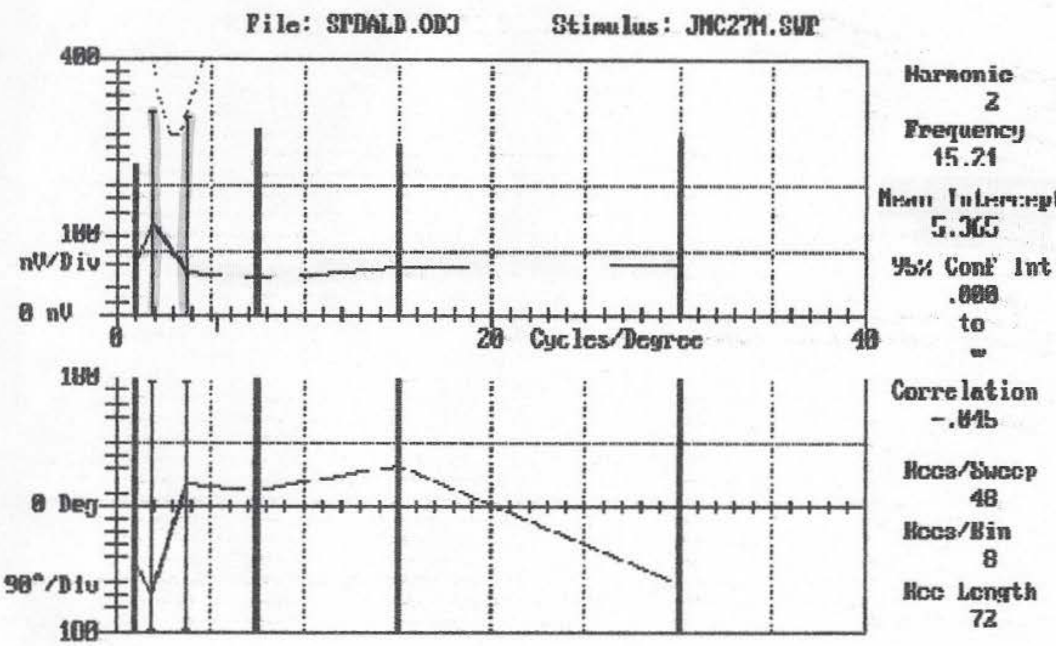


FIGURE 4b



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RESULTS AND DISCUSSION:

DATA CRUNCHING AND METHODS ANALYSIS:

Listed in tables 1 and 2 are the resultant visual acuities and regression values for the experiment. Table 1 contains all data taken from the subjects' left eye and table 2 taken from the right eye.

Table 3 contains a summary of the regressions expressed in cycles/degree for each of the acuity levels shown in tables 1 and 2. This data is also expressed in graph form in graph 1.

The regressions were performed on the data using the manual regression function within the Venus system menus. Figures 1a-4a show typical profiles of patients using plano (1a), +1.00 (2a), +2.00 (2a), and +3.00 (3a) lenses. The subsequent regressions performed on each of these profiles is shown consecutively in Figures 1b-4b. A method was devised to normalize the placement of the cursors when performing a manual regression to try and minimize the arbitrary nature of this task. The first cursor was always placed at the peak of the profile. The second cursor was placed at the lowest point of the profile that represented the highest cycles/degree (i.e. furthest to the right) that was within reasonable error. For example, looking at Figure 2a: The first cursor was placed at the peak of the profile which is at 3.5 cycles/degree. The second cursor was placed at 15 cycles/degree. Although the actual lowest point of the profile is at the 30 cycles/degree point the error range (error bars) for that point include the previous lowest point (i.e. 15 cycles/degree). Any low point with an error range that includes the data point of a lesser cycles/degree value (i.e. further to the left) is not considered a lowest point within reasonable error. The lowest point must be out of the error range of any previous point in the profile. Hey, and if your real confused right now I can't blame you. Just read the above passage 10 times, close your eyes and let it massage your cortex.

DISCUSSION/CONCLUSIONS:

From table 3 and graph 1 we can see that there definitely is a relationship between the acuity levels and the cycle/degree values. However, the error ranges for these data points is quite large at each of the acuity levels shown.(The error bars were not plotted on graph 1 for the sake of simplicity.)
We conclude from this study that we would be able to make gross judgments of potential visual acuity following our protocol but that we could not estimate acuity within very narrow ranges.