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Line isolation versus letter isolation in distance phoria and duction testing: Is there a difference?

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Thesis

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The Authors

Behnam Fouladian was born February 2, 1957 in Tehran Iran. After receiving a diploma in Biology in Iran, he continued his education in the United States. In 1980 he received an associate degree of Applied Science in Optical Technology from Portland Community College in Portland Oregon. Upon completion of his Pre-Optometry program at Portland State University, Behnam was accepted to Pacific University where he received a B.S. in Visual Science in 1984. Behnam is currently completing his Doctorate at the Pacific University College of Optometry.

Brad C. Richardson was born November 19, 1957 in Forest Grove Oregon. Brad attended Brigham Young University in Provo Utah for 2 years and completed his B.A. in French at Portland State University in 1984. While attending Portland State University, he was a member of the Phi Sigma Iota Honor Society in Foreign Languages. Brad is currently completing his Doctorate at the Pacific University College of Optometry.

Abstract

An isolated column of 20/20 letters is typically the target used to measure the distance lateral phoria and the distance lateral ductions. The above tests were run on 30 subjects and statistically compared with results of the same test procedures performed on the same subjects using an isolated 20/60 letter as the target. Analysis disclosed no statistical differences for either test target for distance lateral phorias or lateral ductions. The isolated 20/60 letter target provides not only sufficient phoria and duction information at the far point but also simplifies and facilitates the examination sequence for subject and examiner alike.

Keywords:lateral phoria, lateral duction

Acknowledgments

We appreciate the participation of all the students who cooperated as subjects in this project and took time away from their rigorous study schedules. We are also mindful of the rooms and equipment that were scheduled in our behalf. Finally, we are grateful to Dr. Preston as our advisor not only for our hypothesis but for his expert, practical and clinical insight.

Introduction

In the past, a column of 20/20 acuity letters has been used as a standard distance phoria and duction test target. A phoria describes the relative alignment of the eyes to a test target when the view of the left eye is prevented from fusing with the view of the right eye. This may be achieved through a variety of dissociation methods such as a maddox rod, polaroid filters, septums, occluders, prisms, mirrors and so forth. Ductions, on the other hand, are vergence tests which measure fusional reserves. Ductions measure the end point of fusion at a given distance when, under binocular conditions, prism is introduced base in (abduction) and base out (adduction) until diplopia is reported (i.e. the "break" measurement of the duction). At this point the prism power is reduced until "fusion" of the target is reported (i.e. the "recovery" measurement of the duction). Ductions are recorded in fractional form - break/recovery. During base out duction testing, a subjective "blur" often occurs before the "break"; this blur is termed "true advergence". In duction appraisal, as in phoria measurement, visual acuity is not a factor. Given this information, does an isolated 20/60 letter target provide the same phoria and duction information at far as the standard column of 20/20 letters?

Hypothesis: There is no statistical difference between a 20/20 column and a 20/60 isolated letter test target when measuring distance phorias and ductions.

The project consisted of a within subject design where test results were assumed to have a normal distribution. Because of the small number of subjects investigated (i.e. N=30), the small sample parametric t-test was used to analyze the data. Since the data was paired, each subject provided both the control data and the test data. The phoria and duction results obtained with the 20/20 column test target represented the control data. The test results obtained from the isolated 20/60 test target represented the test data. All subjects were randomly selected.

Subjects

30 optometry students were selected as the subject population. Their ages ranged from 22 to 42. Refractive errors ranged from +2.00D to -7.50D sphere with no more than 1.00D of cylinder. The population included 9 females and 21 males. None of the 30 subjects had ocular or systemic pathology or were currently taking any medication. The only exclusion criteria for the sample population was that a best corrected distance acuity of 20/20 or better be attainable

Methodology

Each subject was randomly selected from the Optometry Clinic patient files and screened for a minimum visual acuity potential of 20/20.

Each subject was personally contacted by Behnam Fouladian or Brad Richardson to arrange for a time of testing.

Each subject was scheduled for a 10 minute time slot in accordance with the availability of the Low Vision exam room in the Optometry Clinic. All subjects were tested in this room.

Each subject was asked to read and sign the Informed Consent form prior to testing

Each subject was seated in the examination chair and the format of the experiment briefly explained as follows:

"We will be performing 4 tests using two different test targets. You will be asked to view the target at the end of the room through the prisms in this instrument (phoroptor). You will be asked to make a response on each test based upon a set of instructions given to you prior to each test. You needn't be concerned about giving incorrect answers."

Each subjects best correction was then dialed into the phoroptor and their visual acuity verified by asking them to call out the letters of a 20/20 line. If a 20/20 visual acuity was not obtained, the following auxillary tests were then performed:

1) Retinoscopy
2) J.C.C. for cylinder axis and power check
3) Binocular balance

If a 20/20 visual acuity was still not obtained, the subject would be dismissed since a minimum 20/20 visual acuity is essential to the test. None of the subjects in the experiment were dismissed.

Contact lens wearers were tested through their contact lenses.

Each subject drew 4 cards in sequence. Each card designated the test target and the instruction set to be used with the target. The order in which the cards were drawn represented the testing order. This randomized the testing sequence so as to avoid systematic errors and

learning effects.

Phoria Testing

Each subject was dissociated with rotary prisms for all phoria tests in the following manner:

12-14 prism dioptors base in OD 6-8 prism dioptors base up OS

Each subject while viewing the distal test target was presented the following sequence of instructions:

1) "How many targets do you see?" (Two)
2) "Which target disappears?" The examiner then covered the prism over the right eye. (The one on the right)
3) "Keep the bottom target clear and say 'now' when the two targets line up one directly over the other." (Now)

This procedure was repeated until two measurements had been recorded from both the base in and base out side.

Subjects exhibiting supression were tested using the flash phoria technique.

Duction Testing

Each subject viewed the distal target with zero prism power in the rotary prisms before each eye.

Each subject while viewing the distal target was presented the following sequence of instructions:

1) "How many targets do you see?" (One)
2) "Keep the target single and clear and tell me when it first blurs, then doubles, and then becomes single again." The examiner added base out prism then reduced it. (Blurs, Doubles, Single)
3) "Now this time tell me when the target doubles and then is single again." The examiner added base in OU and then reduced it. (Doubles, Single)

The above procedure was repeated until two blur, break and recovery values were recorded for both the base out ductions and the base in ductions.

All tests were performed under standard room illumination using the same A.O. Ultramatic Phoroptor, the same examination room, the same instruction sets and the same examiner. This was intended to standardize the tests and testing conditions to minimize confounding variables.

Data

Four phoria test readings were obtained on each test target: two from the base out side and two from the base in side. For the purpose of this experiment, all four values were averaged and recorded on the Subject Phoria Data Sheet. Each of the 30 subjects initials are found in the first column of the Data Sheet. The second column, column X, corresponds to each subjects averaged phoria values for the 20/20 column test target. The third column, column Y, corresponds to each subjects averaged values for the isolated 20/60 test target. The phoria data was then analyzed using the McIntosch STAT 512+ program for:

1) Statistical differences between phoria test targets (t-statistic).
2) Correlation coefficient between phoria test targets.

The duction findings were analyzed in a like manner. Four duction readings for each subject were averaged and recorded on the appropriate Data Sheets. Separate t-statistics were run on each blur/break/recovery on base out ductions and on each break/recovery on base in ductions.

The data and an analysis of the data are compiled on six Data Sheets on the pages that follow. The Data Sheets are organised as follows:

Data Sheet #1:
1) Subject Phoria Data Sheet
2) T-Statistic for Lateral Phoria Comparisons
3) Phoria Correlation and Scattergram

Data Sheet #2:
1) Subject Duction Base Out Blur Data Sheet
2) T-Statistic for Base Out Blur Comparisons
3) Base Out Blur Correlation and Scattergram

Data Sheet #3:
1) Subject Duction Base Out Break Data Sheet
2) T-Statistic for Base Out Break Comparisons
3) Base Out Break Correlation and Scattergram

Data Sheet #4:
1) Subject Duction Base Out Recovery Data Sheet
2) T-Statistic for Base Out Recovery Comaprisons
3) Base Out Recovery Correlation and Scattergram

Data Sheet #5:
1) Subject Duction Base In Break Data Sheet
2) T-Statistic for Base In Break Comparisons
3) Base In Break Correlation and Scattergram

Data Sheet #6:
1) Subject Duction Base In Recovery Data Sheet
2) T-Statistic for Base In Recovery Comparisons
3) Base In Recovery Correlation and Scattergram

Results

For all six sets of data, a p-value was calculated so that it may be left to the reader to determine the significance of the results. The advantage of this is that it allows the reader to choose the maximum value they are willing to tolerate. For all six sets of data, the experimenters found the associated p-values to be much greater than .05 ($p>.05$). This means the experimenters can be sure that 95 times out of 100 there is no statistical difference between the results obtained using a 20/20 letter column test target versus an isolated 20/60 letter test target for distance phoria and duction testing. Furthermore, all six sets of data showed strong correlations.

Discussion

Since the test target results are not statistically different and are highly correlated, this implies that either test target may be used for distance phoria and duction testing. The use of an isolated 20/60 letter target provides several advantages over the standard 20/20 column letter target. These advantages are discussed below:

An isolated letter target makes phoria and duction testing more efficient. Since the horizontal and vertical dimensions of the test target are essentially the same, one test target can be used for both lateral and vertical phoria testing as well as both lateral and vertical duction testing. Generally, the examiner in the past has had to continually change the projected letter chart targets back and forth depending on the the phoria or duction being performed. This is not only confusing to the patient and cumbersome for the examiner, it is

extremely inefficient from an ergonomic stand point and can result in a substantial loss of time over the course of a day.

An isolated letter target provides a simpler visual display for the patient. This especially becomes important when performing phoria tests on younger children. An isolated "O" of 20/60 visual acuity can be used metaphorically to instruct the patient to tell the examiner when the "circles" line up "like buttons on a shirt" (lateral phorias) or "wheels on a bike" (vertical phorias). It is naturally and perceptually easier for children to visualize what the examiner is asking for when the phoria tests are presented in this fashion.

In summary, an isolated 20/60 letter target makes distance phoria and duction testing more efficient by reducing extraneous target changes, facilitating the examination seguence, and simplifying the test target thereby enhancing patient understanding and compliance.

PHORIA

T- STATISTIC FOR LATERAL PHORIA COMPARISONS

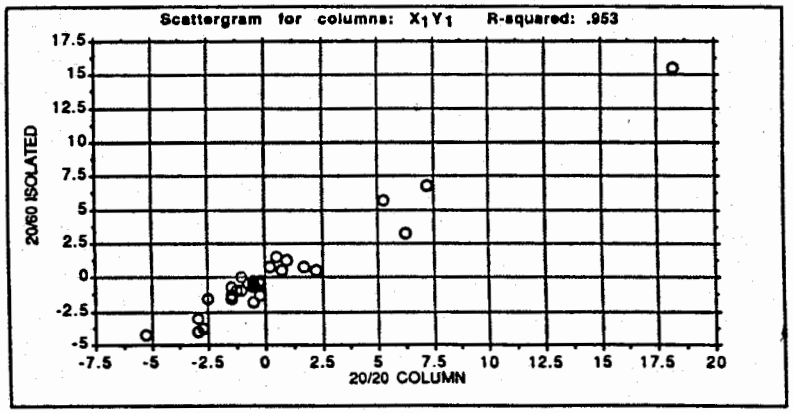
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	.225	1.221	.2319

PHORIA CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	15.529	.976	.953



	SUBJECTS	20/20 COLUMN X_1	20/60 ISOLATED Y_1
1	B.F.	-1.000	0
2	B.R.	.500	1.500
3	D.C.	-.500	-.750
4	K.B.	-3.000	-3.000
5	L.S.	-3.000	-4.000
6	S.M.	-1.500	-.750
7	S.B.	18.250	15.500
8	N.G.	-1.500	-1.500
9	C.D	6.250	3.250
10	M.T.	1.000	1.250
11	T.W.	5.250	5.750
12	J.C.	-1.000	-1.000
13	G.E.	.750	.500
14	S.G.	-.250	-.500
15	M.H.	-1.500	-1.250
16	D.L.	1.000	1.250
17	J.S.	7.250	6.750
18	T.S	1.750	.750
19	M.M.	.250	.750
20	P.C.	-.500	-.250
21	T.J.	-.500	-1.750
22	G.Y.	-.500	-.500
23	G.E.	2.250	.500
24	B.C.	-2.500	-1.500
25	J.D.	-.750	-.500
26	S.D.	-.250	-.250
27	M.O.	-5.250	-4.250
28	P.K.	-.250	-1.250
29	P.G.	-1.250	-1.000
30	L.F.	-2.750	-3.750

T-STATISTIC FOR DUCTION BASE OUT BLUR COMPARISONS

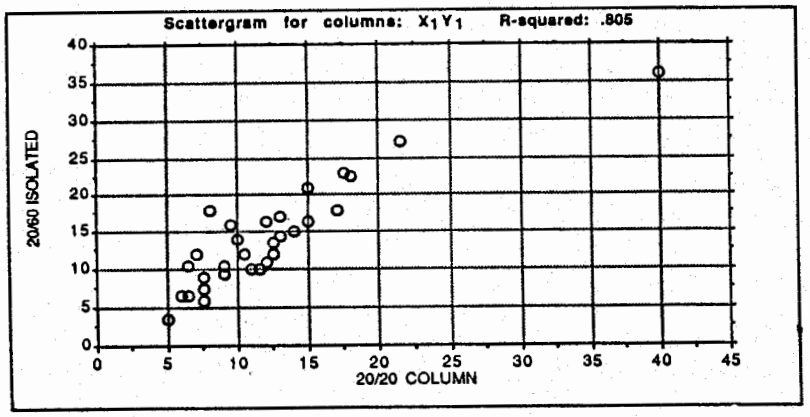
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	-1.233	-1.774	.0865

BASE OUT BLUR CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	40.713	.897	.805



BASE OUT BLUR

	SUBJECTS	20/20 COLUMN	20/60 ISOLATED
		X_1	Y_1
1	B.F.	10.000	14.000
2	B.R.	17.500	23.000
3	D.C.	15.000	21.000
4	K.B.	15.000	16.500
5	L.S.	30.500	27.000
6	S.M.	6.000	6.500
7	S.B.	18.000	22.500
8	N.G.	7.500	9.000
9	C.D	10.500	12.500
10	M.T.	7.000	12.000
11	T.W.	13.000	14.500
12	J.C.	8.000	18.000
13	G.E.	6.500	10.500
14	S.G.	11.000	10.000
15	M.H.	9.000	9.500
16	D.L.	12.000	11.000
17	J.S.	25.000	18.000
18	T.S	9.500	16.000
19	M.M.	14.000	15.000
20	P.C.	11.500	10.000
21	T.J.	13.000	17.000
22	G.Y.	5.000	3.500
23	G.E.	12.500	12.000
24	B.C.	7.500	6.000
25	J.D.	7.500	7.500
26	S.D.	9.000	10.500
27	M.O.	12.500	13.500
28	P.K.	40.000	36.000
29	P.G.	12.000	16.500
30	L.F.	6.500	0

T-STATISTIC FOR DUCTION BASE OUT BREAK COMPARISONS

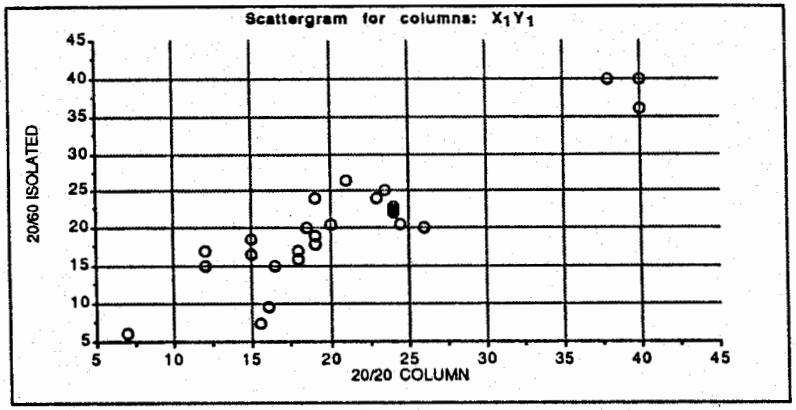
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	.35	.594	.5568

BASE OUT BREAK CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	87.409	.944	.891



BASE OUT BREAK

	SUBJECTS	20/20 COLUMN X_1	20/60 ISOLATED Y_1
1	B.F.	23.000	24.000
2	B.R.	40.000	40.000
3	D.C.	40.000	40.000
4	K.B.	26.000	20.000
5	L.S.	38.000	40.000
6	S.M.	24.000	22.000
7	S.B.	40.000	40.000
8	N.G.	20.000	20.500
9	C.D	16.000	9.500
10	M.T.	18.000	17.000
11	T.W.	19.000	19.000
12	J.C.	23.500	25.000
13	G.E.	12.000	15.000
14	S.G.	19.000	18.000
15	M.H.	15.000	18.500
16	D.L.	18.000	17.000
17	J.S.	24.000	23.000
18	T.S	19.000	24.000
19	M.M.	24.000	22.500
20	P.C.	16.500	15.000
21	T.J.	18.500	20.000
22	G.Y.	7.000	6.000
23	G.E.	18.000	16.000
24	B.C.	15.500	7.500
25	J.D.	15.000	16.500
26	S.D.	24.500	20.500
27	M.O.	40.000	40.000
28	P.K.	40.000	36.000
29	P.G.	21.000	26.500
30	L.F.	12.000	17.000

T-STATISTIC FOR DUCTION BASE OUT RECOVERY COMPARISONS

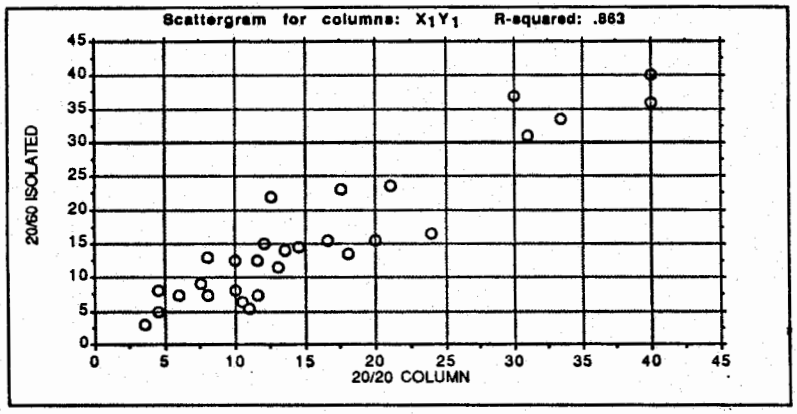
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	.001	.002	.9985

BASE OUT RECOVERY CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	97.439	.929	.863



BASE OUT RECOVERY

	SUBJECTS	20/20 COLUMN X_1	20/60 ISOLATED Y_1
1	B.F.	12.000	15.000
2	B.R.	33.500	33.500
3	D.C.	40.000	40.000
4	K.B.	20.000	15.500
5	L.S.	24.000	16.500
6	S.M.	6.000	7.500
7	S.B.	31.000	31.000
8	N.G.	7.500	9.000
9	C.D	4.500	5.000
10	M.T.	13.000	11.500
11	T.W.	13.500	14.000
12	J.C.	17.500	23.000
13	G.E.	10.000	8.000
14	S.G.	11.000	5.500
15	M.H.	8.000	13.000
16	D.L.	10.000	12.500
17	J.S.	16.500	15.500
18	T.S	12.500	22.000
19	M.M.	18.000	13.500
20	P.C.	8.000	7.500
21	T.J.	14.500	14.500
22	G.Y.	3.500	3.000
23	G.E.	10.500	6.500
24	B.C.	11.540	7.500
25	J.D.	11.500	12.500
26	S.D.	10.500	6.500
27	M.O.	30.000	37.000
28	P.K.	40.000	36.000
29	P.G.	21.000	23.500
30	L.F.	4.500	8.000

T-STATISTIC FOR DUCTION BASE IN BREAK COMPARISONS

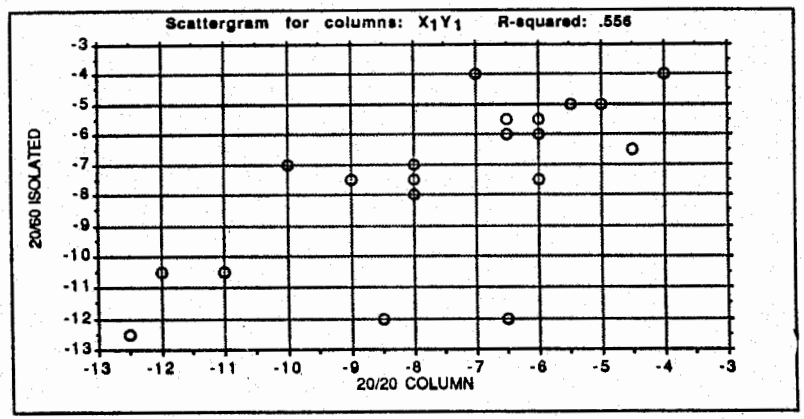
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	-.067	-.227	.8218

BASE IN BREAK CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	3.717	.745	.556



BASE IN BREAK

	SUBJECTS	20/20 COLUMN X_1	20/60 ISOLATED Y_1
1	B.F.	-8.000	-7.500
2	B.R.	-10.000	-7.000
3	D.C.	-8.000	-8.000
4	K.B.	-8.000	-7.000
5	L.S.	-12.500	-12.500
6	S.M.	-6.000	-5.500
7	S.B.	-6.000	-6.000
8	N.G.	-6.000	-6.000
9	C.D	-4.500	-6.500
10	M.T.	-5.000	-5.000
11	T.W.	-6.500	-12.000
12	J.C.	-8.000	-8.000
13	G.E.	-4.000	-4.000
14	S.G.	-6.500	-6.000
15	M.H.	-6.500	-5.500
16	D.L.	-6.500	-6.000
17	J.S.	-8.500	-12.000
18	T.S	-6.000	-6.000
19	M.M.	-4.000	-4.000
20	P.C.	-6.000	-6.000
21	T.J.	-6.000	-7.500
22	G.Y.	-6.000	-5.500
23	G.E.	-5.500	-5.000
24	B.C.	-7.000	-4.000
25	J.D.	-6.000	-6.000
26	S.D.	-11.000	-10.500
27	M.O.	-12.000	-10.500
28	P.K.	-9.000	-7.500
29	P.G.	-6.000	-6.000
30	L.F.	-6.000	-6.000

BASE IN RECOVERY

T-STATISTIC FOR DUCTION BASE IN RECOVERY COMPARISONS

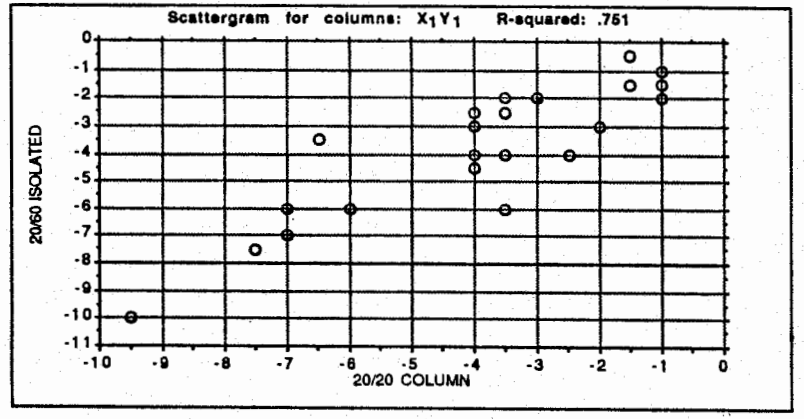
Paired t-Test X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

DF:	Mean X - Y:	Paired t value:	Prob. (2-tail):
29	-.167	-.823	.4171

BASE IN RECOVERY CORRELATION

Corr. Coeff. X_1: 20/20 COLUMN Y_1: 20/60 ISOLATED

Count:	Covariance:	Correlation:	R-squared:
30	3.977	.868	.751



	SUBJECTS	20/20 COLUMN	20/60 ISOLATED
		X_1	Y_1
1	B.F.	-6.000	-6.000
2	B.R.	-6.500	-3.500
3	D.C.	-6.000	-6.000
4	K.B.	-3.500	-6.000
5	L.S.	-9.500	-10.000
6	S.M.	-1.500	-1.500
7	S.B.	-2.500	-4.000
8	N.G.	-4.000	-4.000
9	C.D	-2.000	-3.000
10	M.T.	-3.500	-2.000
11	T.W.	-2.500	-4.000
12	J.C.	-7.000	-6.000
13	G.E.	-1.000	-2.000
14	S.G.	-3.500	-2.500
15	M.H.	-3.000	-2.000
16	D.L.	-4.000	-4.000
17	J.S.	-1.500	-.500
18	T.S	-1.000	-1.000
19	M.M.	-1.000	-1.500
20	P.C.	-4.000	-4.000
21	T.J.	-4.000	-4.500
22	G.Y.	-4.000	-3.000
23	G.E.	-4.000	-2.500
24	B.C.	-3.000	-2.000
25	J.D.	-4.000	-2.500
26	S.D.	-7.500	-7.500
27	M.O.	-7.000	-7.000
28	P.K.	-6.000	-6.000
29	P.G.	-4.000	-3.000
30	L.F.	-3.500	-4.000