

PHYSICAL CAPABILITIES EVALUATION
GRAPHICALLY SHOWING PHYSICAL
IMPAIRMENT CAUSED BY TRAUMATIC
BRAIN INJURY

Abstract

This presentation documents the physical performance aspects of brain injured individuals which can be graphically presented in chart, media and statistical formats. The three criteria which are demonstrated include: 1) Physiological responses to work tasks and fatigue; 2) Biomechanical dysfunctions resulting from brain injury, including deficits in cognitive spatial dysfunction, abnormality in musculoskeletal functions, abnormality in neuromuscular responses, and irregular patterns of motor skill; 3) Validation of performance responses, inter test reliability, and demonstrative statistics. It is anticipated that the materials will demonstrate the means with which the severity of brain injury creates barriers to activities of daily living, barriers to employment, and barriers to quality of life. The information also includes reference to criteria for assigning impairment from the AMA Guides as a means of addressing administrative issues for case decisions. The goal of the presentation is to provide the viewer with knowledge which identifies the physical barriers that the brain injured individual will face in their life events.

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Physical Capabilities Evaluation (PCE): Graphically Showing Physical Impairment Caused By Traumatic Brain Injury

The PCE test protocol relies on physiological, biomechanical, and statistical data as a foundation for conclusions regarding the effects of the brain injury. The data collected is treated in a test and measurement function to accurately report tolerances, and predict capacity in on-going activity. The PCE formulates the restrictions and dysfunction characteristics from the quantified test results, both from the physiology and biomechanics, which can then be used to determine impairment percentages, barriers to life events, and a solid opinion on the participation of the examinee.

The validation process of the PCE is essential to eliminate the inference that the individual may have an intent to alter/manipulate the data to demonstrate dysfunction that might otherwise not exist outside of the testing environment. Once the baseline of data acceptance is established the opinion of the dysfunctions and the impact on life events can move forward without objections or other encumbrances.

The validation of the data is presented in several different ways so that redundancy of presentation can be used as a foundation of the identified dysfunction. The data can be presented in 'wave shape', which is the force response graphically recorded in real time, and preserved on strip chart or in media format. In the wave shape consistency, each and every trial of examinee performance should have a vertical rise, horizontal run, and then vertical drop to the baseline. The wave shape comparison, or force overlay, identifies consistency of the examinee effort and is explained by the phenomena of trained versus untrained subject response. The wave

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shape comparisons are used for agonist/antagonist muscle groups, right versus left muscle groups, and muscular compartment comparisons. The visualization of the data provides the graphic display which can be compared to anatomical body sections reflecting the dysfunction of the brain injured neurology. The presentation of the graphics makes it easy for the reviewer to see the comparisons and come to the conclusion as laid out in the opinions of the expert.

The outward effects of the brain injury are demonstrated by the biomechanical dysfunctions related to the musculoskeletal, neuromuscular and motor response testing. Position sense testing, both from the traditional balance tests, as well as those from the kinesthetic, and proprioceptive sense must be addressed. The literature (Fukuda, Hinoki, Kischka, Radanova) reveals that the impact absorption of biomechanically induced trauma alters the examinee's ability to recognize position and to maintain endurance tolerance for work. One of the most dramatically graphic tests of the brain injury regarding spatial orientation is the position test which is quantified by acceptance criteria. The unaffected examinee is expected to maintain position in the center of the target circle while marching in place. The examinee without trauma intervention maintains position within the first one meter circle, and moves laterally, to right or left less than 30 degrees, and has no axis of rotation about the vertical center of gravity sagittal midline. The trauma induced examinee shows angle of rotation, angle of displacement, and distance of displacement to be beyond the acceptance parameters. The examinee response to the brain injured dysfunction shows placement well beyond the target center and typically has a verbal response which reflects utter surprise in having found the end position far from where they perceive their location.

The inability of the brain injured examinee to maintain endurance tolerance for work is demonstrated by graphically charting the physiological response to tasks. The literature (Radanov), alludes to the inability of examinees to maintain focus on work issues and loss of concentration as time progresses when fatigue of tasks

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exceeds normal performance response. When an examinee's physical condition is tolerant for standard intensity of work there is a sustainable physiological response which is measurable by heart rate. When requirement of work, either physical or mental, exceeds the tolerance of the individual the heart rate elevates over time while the work function or accuracy decreases. As the task physiological requirements get closer to the examinee's maximum capacity the sustainable work performed by the examinee substantially decreases. Thus, the endurance of the work requirement would be a monitorable event as identified by the linear and longitudinal heart rate, or the aberration from that expectation. The closer the task is to the examinee's maximum capacity the shorter the length of time the examinee can perform a work bout. The oxygen demand of the body creates a direct response on heart function, which as a direct correlation with heart rate. In individuals who are well adjusted to the stresses imposed on them by activity, the heart rate maintains a steady state response and is plotted linearly as a graphic display. The examinee whose adaptation has been disrupted by brain injury has a physiological response that is elevating linearly while the motor skill performance erodes causing errors.

The quantification of function is also graphically identified in disruption of kinetic events, showing aberrations from normal patterns of response sequences. The kinetic patterns of the brain injured examinee can show both proximal and distal limb effects, right versus left limb effects, and loading versus unloading body effects. Tremors, clonus, spasms, and atrophic neuromuscular body sections cause irregularities in the patterns of performance which are identified by media display, and then confirmed by quantification processes.

The quantification function and dysfunction also is applied to the determination of percentage impairment. Age and gender relationships regarding estimates of strength and physical tolerance enable the examiner to apply the effects of the brain injury to administrative criteria, but also enable the same data to be used for

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assignment to prediction of work task appropriateness. Database references may be determined in cases of geriatric, pediatric, and adolescent subjects as well as the standard population.

One of the most important goals of the quantification process for the PCE is to provide foundation to the graphical presented data so that the reviewer is able to quickly comprehend the dysfunctions and the relevance to the examinee's life barriers. The three main topics of this presentation, biomechanical, validation, and physiological data are foundations of evidence that support the extent to which a brain injury disrupts the life of the injured examinee.

Appendix A.

**Graphic presentation of
objective data**

GRIP STRENGTH SINCERITY

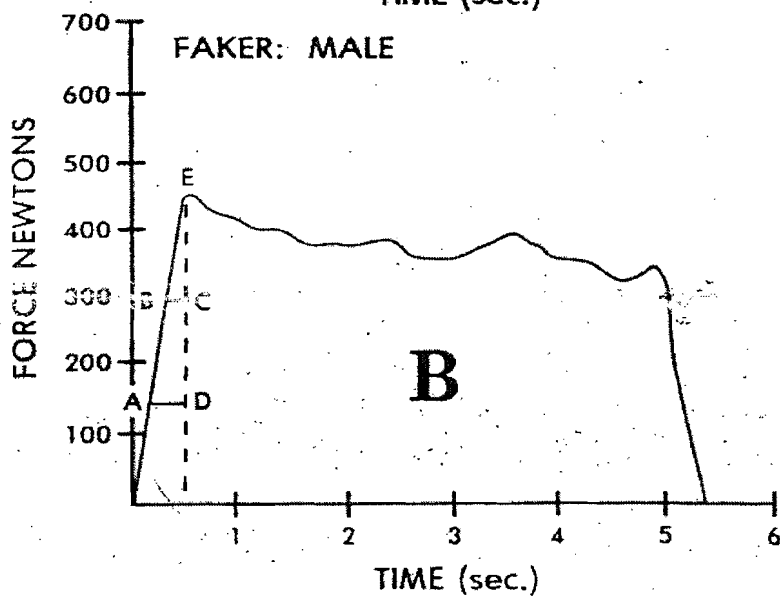
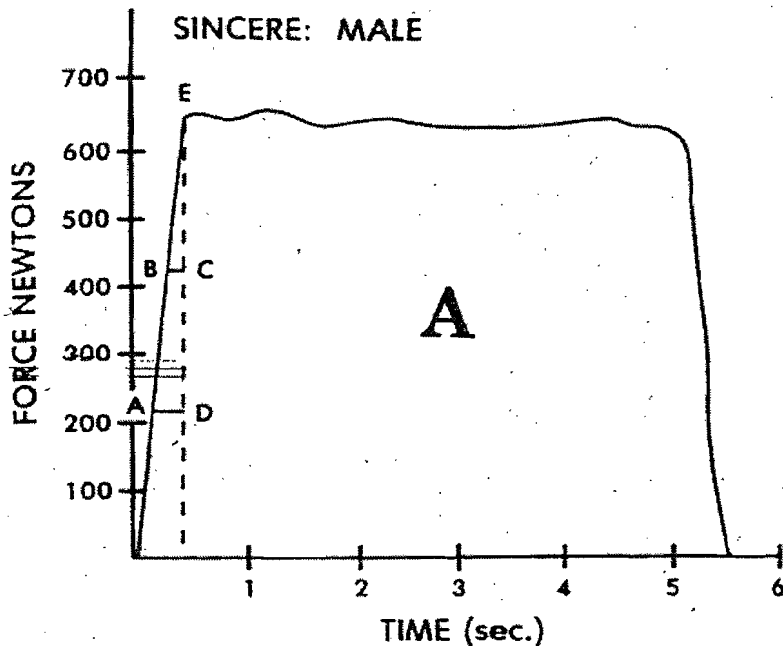
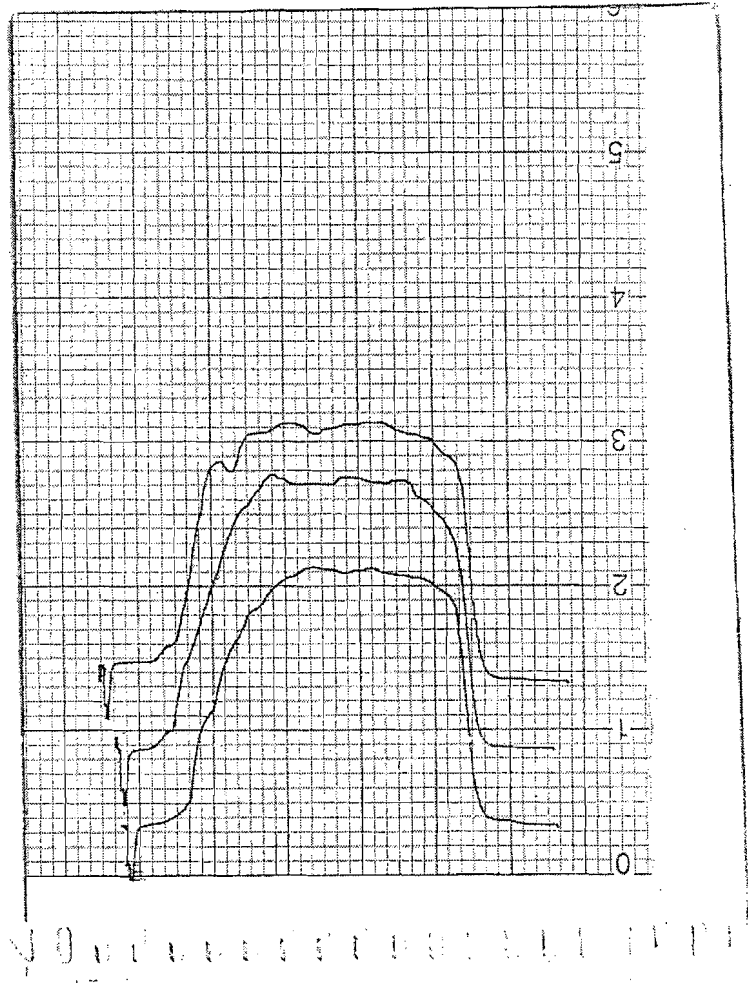
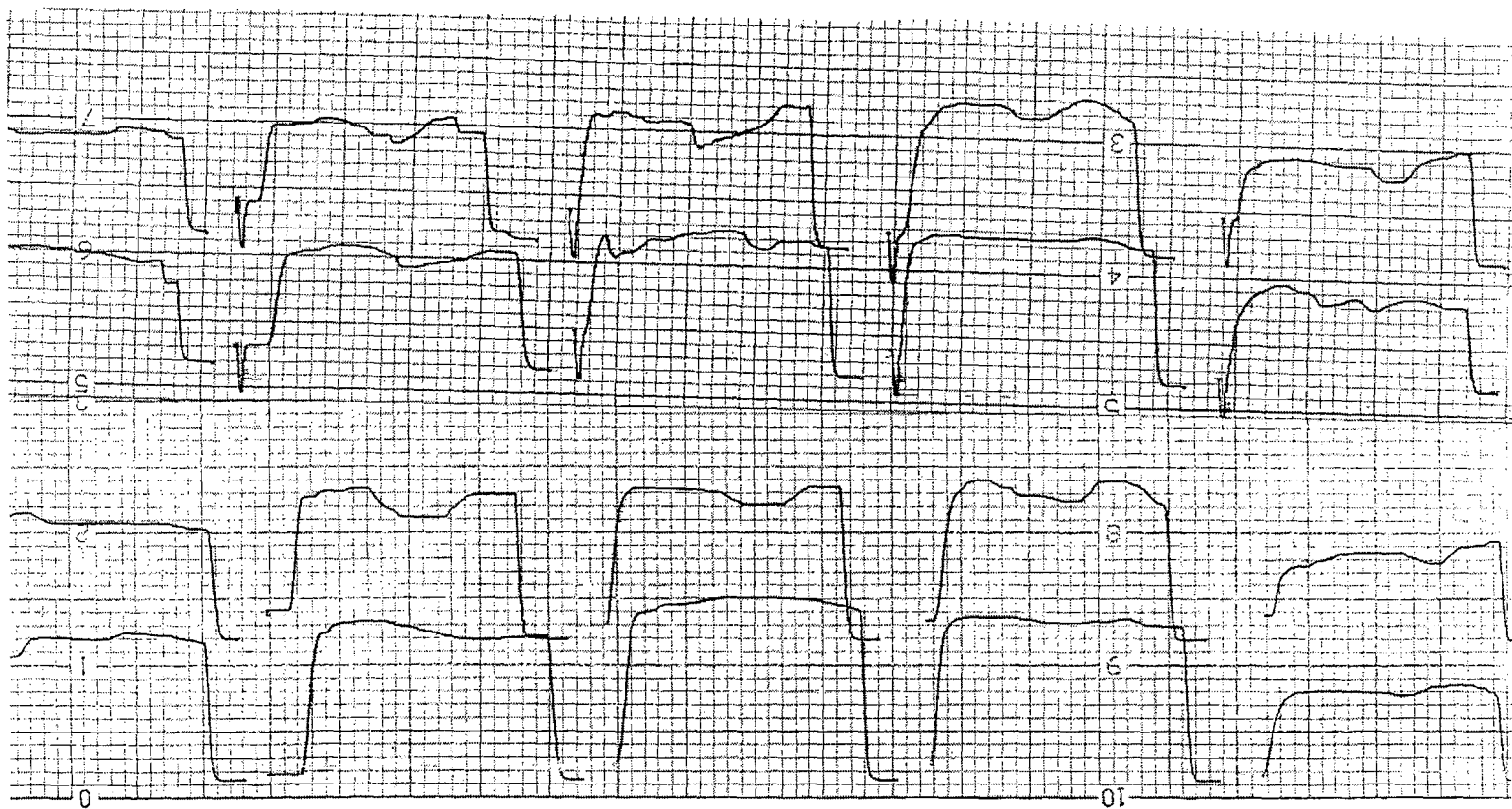
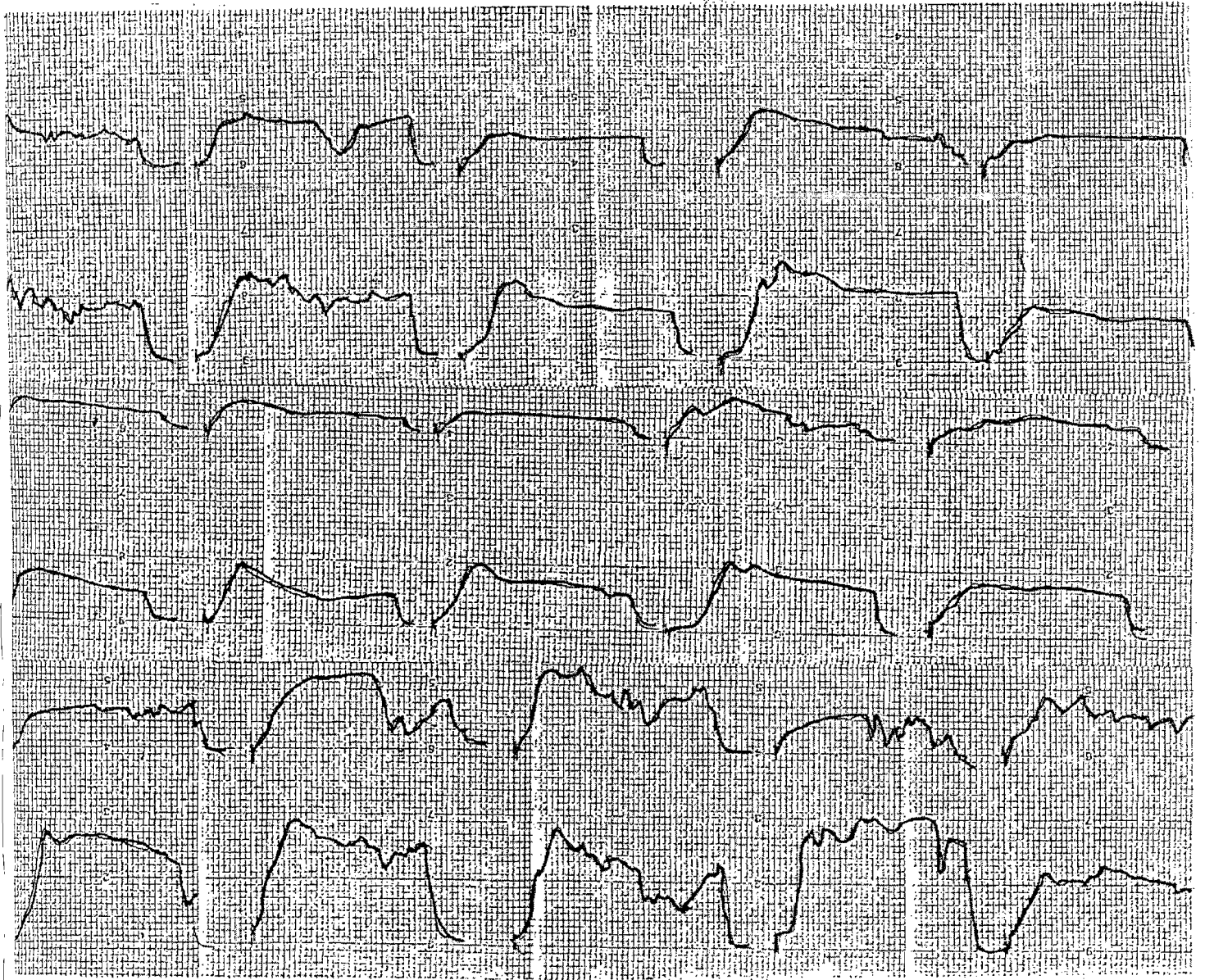
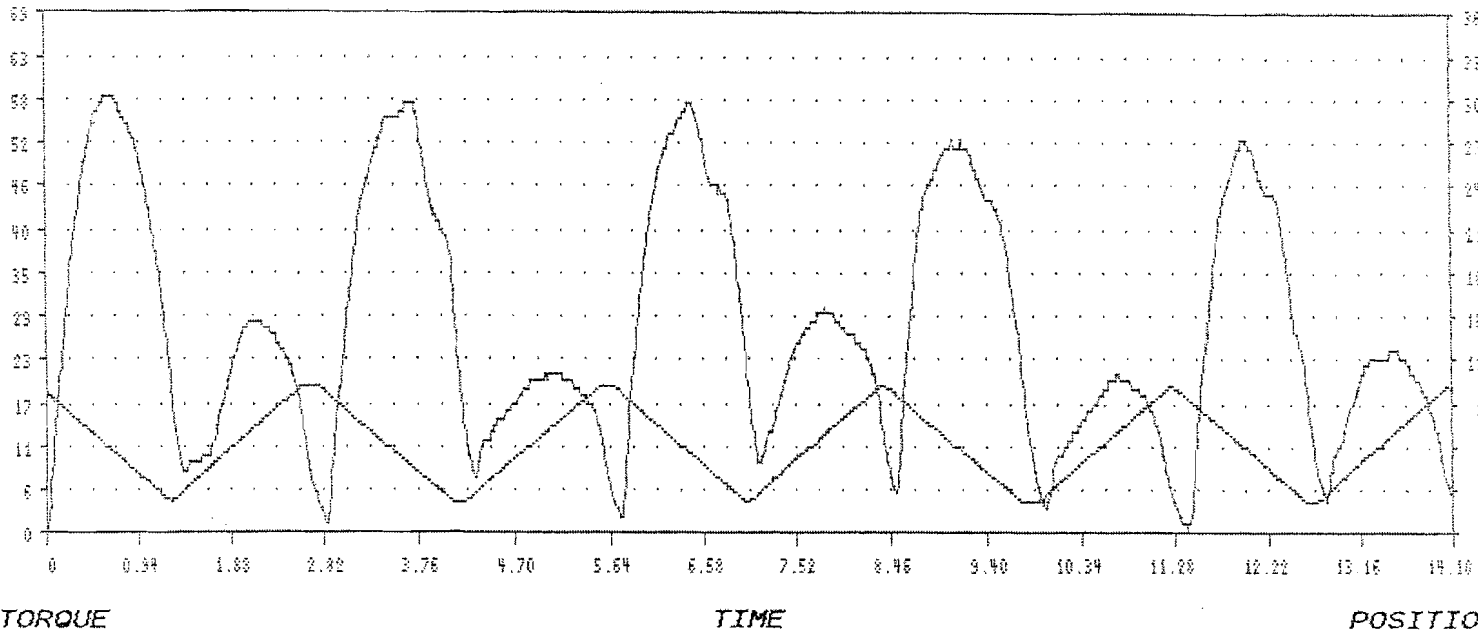


FIG. 2. Force curves of sincere and faking subjects. A (upper) force curve simulated from a sincere subject during an isometric contraction. B (lower) force curve simulated from a faking subject during an isometric strength test at 75% of maximal contraction. Curve components include: E=peak force; $SLP=CD/AD$.





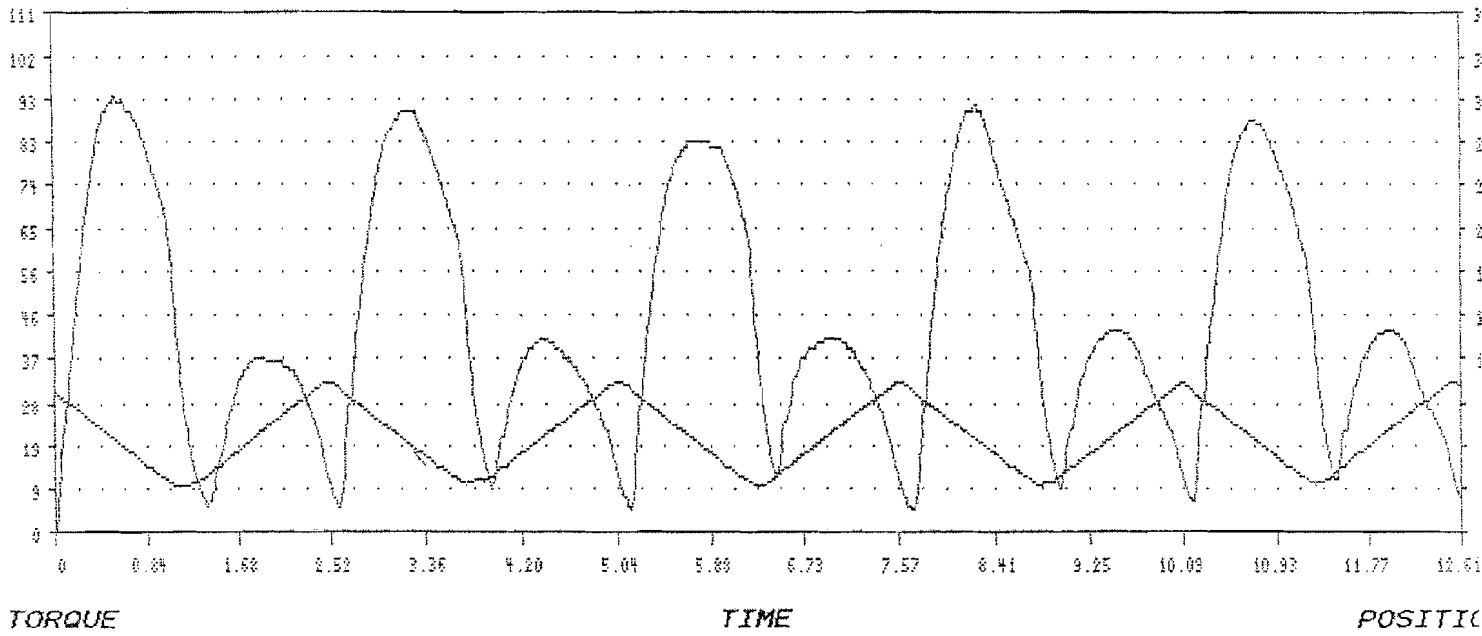




TORQUE

TIME

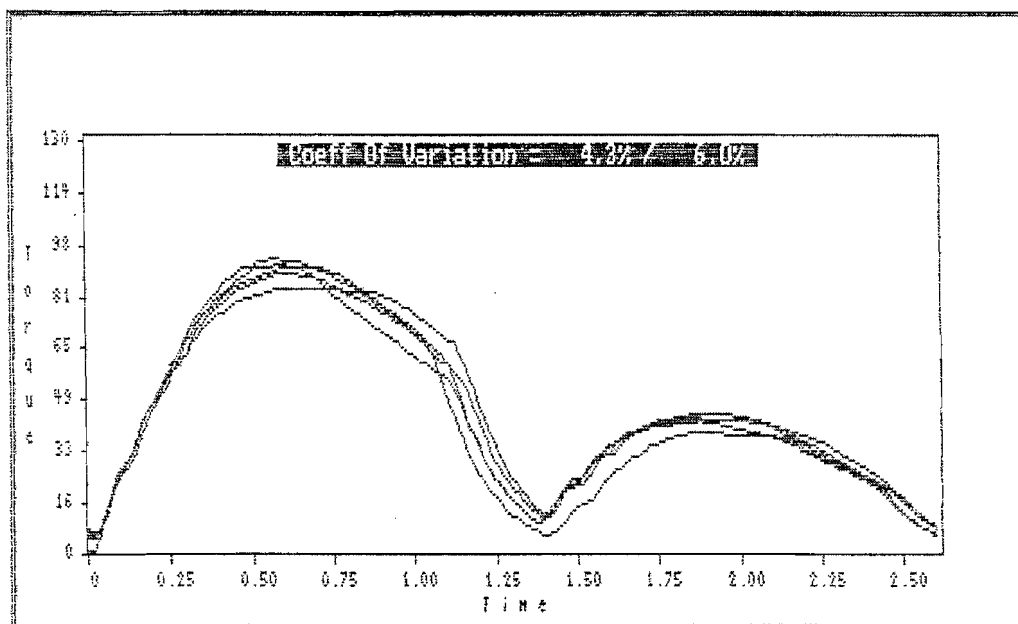
POSITION



TORQUE

TIME

POSITION



Appendix B.

**Graphic presentation
Of raw data**

Section 4-7: Physiological Testing**Gait Physiology Evaluation****March 28, 2006****Session 1**

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	88	N/A	N/A
10 min.	2.55	88	N/A	N/A
15 min.	2.55	96	N/A	N/A

Recovery to RHR: 4 min

Session 2

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	88	N/A	N/A
10 min.	2.55	92	N/A	N/A
15 min.	2.55	96	N/A	N/A

Recovery to RHR: 4 min

Session 3

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	92	N/A	N/A
10 min.	2.40	96	N/A	N/A
15 min.	2.30	104	N/A	N/A

Recovery to RHR: 4 min

March 29, 2006**Session 1**

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.20	96	N/A	N/A
10 min.	2.20	96	N/A	N/A
15 min.	2.10	104	N/A	N/A

Recovery to RHR: 4 min

Session 2

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.15	96	N/A	N/A
10 min.	2.15	100	N/A	N/A
15 min.	2.10	104	N/A	N/A

Recovery to RHR: 5 min

Section 4-7: Physiological Testing**Gait Physiology Evaluation****March 28, 2006****Session 1**

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	88	N/A	N/A
10 min.	2.55	88	N/A	N/A
15 min.	2.55	96	N/A	N/A
Recovery to RHR:	4 min			

Session 2

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	88	N/A	N/A
10 min.	2.55	92	N/A	N/A
15 min.	2.55	96	N/A	N/A
Recovery to RHR:	4 min			

Session 3

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.55	92	N/A	N/A
10 min.	2.40	96	N/A	N/A
15 min.	2.30	104	N/A	N/A
Recovery to RHR:	4 min			

March 29, 2006**Session 1**

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.20	96	N/A	N/A
10 min.	2.20	96	N/A	N/A
15 min.	2.10	104	N/A	N/A
Recovery to RHR:	4 min			

Session 2

	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp/min.)
5 min.	2.15	96	N/A	N/A
10 min.	2.15	100	N/A	N/A
15 min.	2.10	104	N/A	N/A
Recovery to RHR:	5 min			

Isoinertial Strength Carry Test

March 28, 2006

Session 1

Load (lbs): 5.00

	Distance (ft.)	Interval Rest (min./sec.)	Completion Time (min./sec.)	Heart Rate (bpm.)	Blood Pressure (mm/Hg)	Respiration (resp./min.)
1	100.00	1:30	0:23	92		
2	100.00	1:30	0:23	92		
3	100.00	1:30	0:23	96		
4	100.00	1:30	0:23	96		
5	100.00	1:30	0:23	96		
6	100.00	1:30	0:23	96		
7	100.00	1:30	0:23	104		
8	100.00	1:30	0:22	104		
9	100.00	1:30	0:23	104		
10	100.00	1:30	0:23	104		

March 29, 2006

Session 1

Load (lbs): 5.00

	Distance (ft.)	Interval Rest (min./sec.)	Completion Time (min./sec.)	Heart Rate (bpm.)	Blood Pressure (mm/Hg)	Respiration (resp./min.)
1	100.00	1:30	0:25	96		
2	100.00	1:30	0:25	96		
3	100.00	1:30	0:25	96		
4	100.00	1:30	0:25	104		
5	100.00	1:30	0:26	104		
6	100.00	1:30	0:26	104		
7	100.00	1:30	0:26	104		
8	100.00	1:30	0:26	108		
9	100.00	1:30	0:26	108		
10	100.00	1:30	0:26	108		

Functional Physiological Profile

March 28, 2006

Session 1

	Task	Time (hh:mm:ss)	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp./min.)
Trial 1	Sitting Pegboard	5:00		72		
Trial 2	Stand	5:00		88		
Trial 3	Sitting Block Turning	5:00		80		

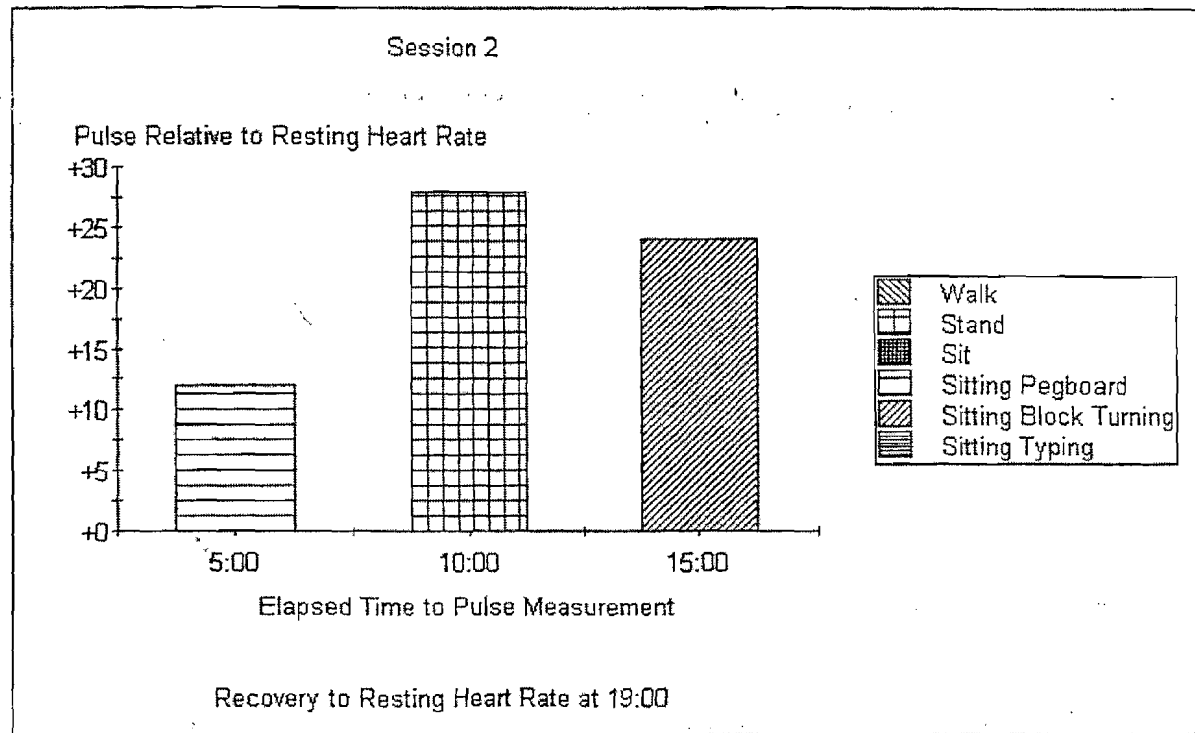
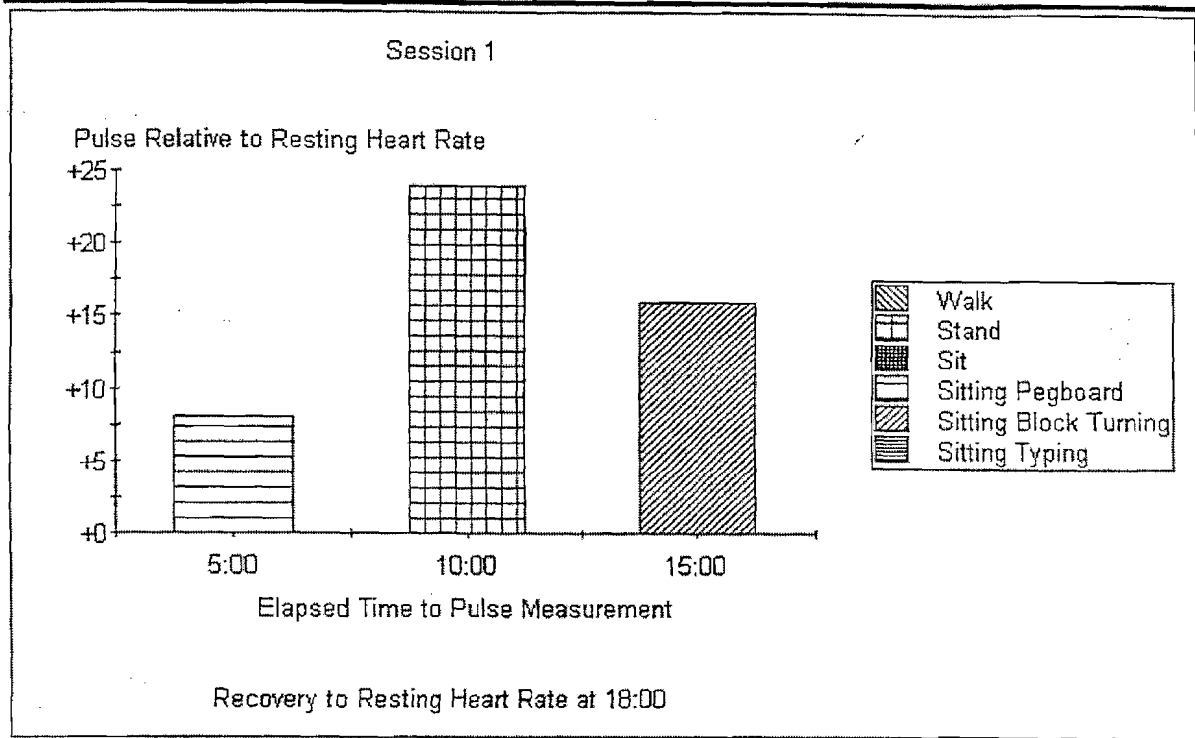
Recovery to RHR: 3 min

Session 2

	Task	Time (hh:mm:ss)	Speed (mph)	Heart Rate (bpm)	Blood Pressure (mm/Hg)	Respiration (resp./min.)
Trial 1	Sitting Pegboard	5:00		76		
Trial 2	Stand	5:00		92		
Trial 3	Sitting Block Turning	5:00		88		

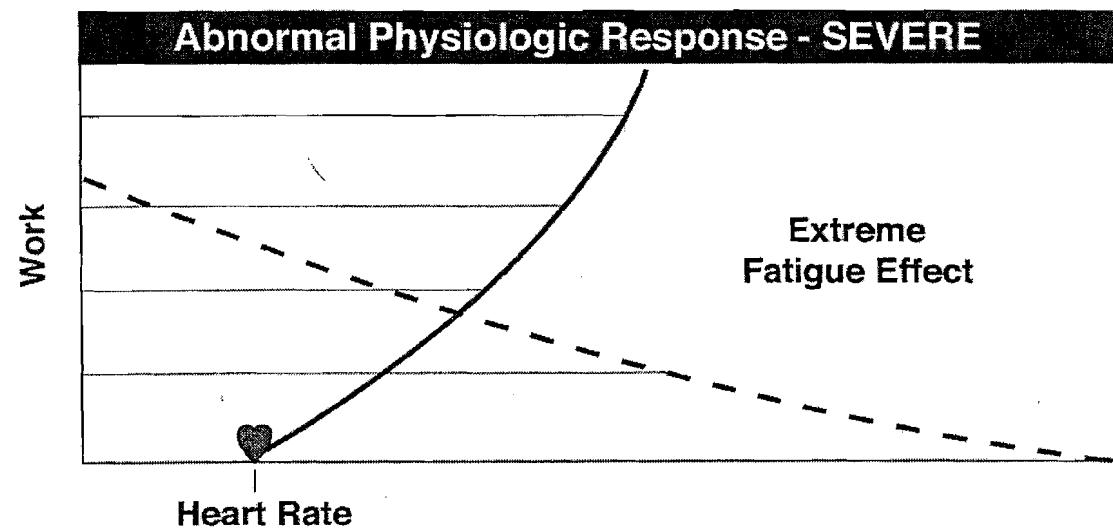
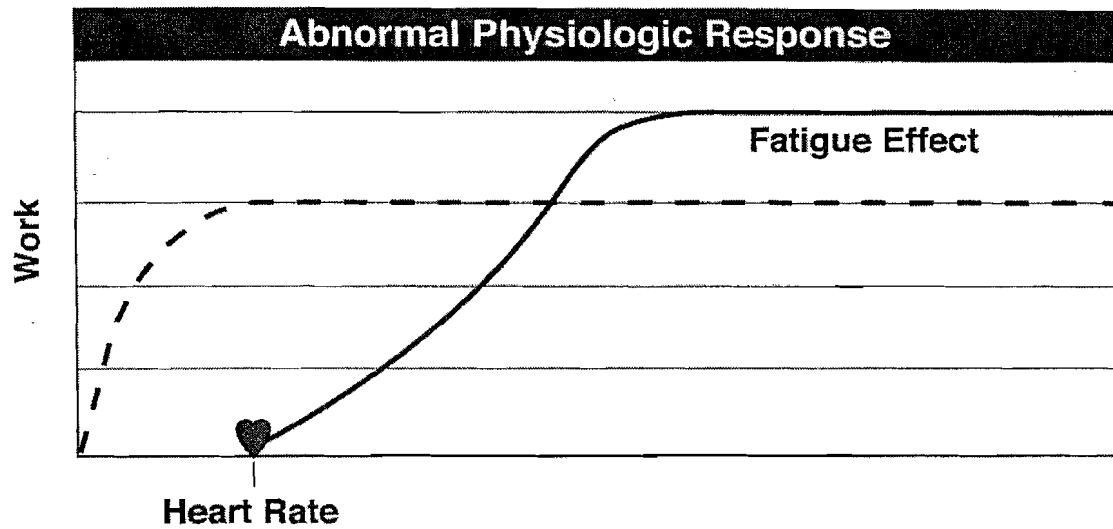
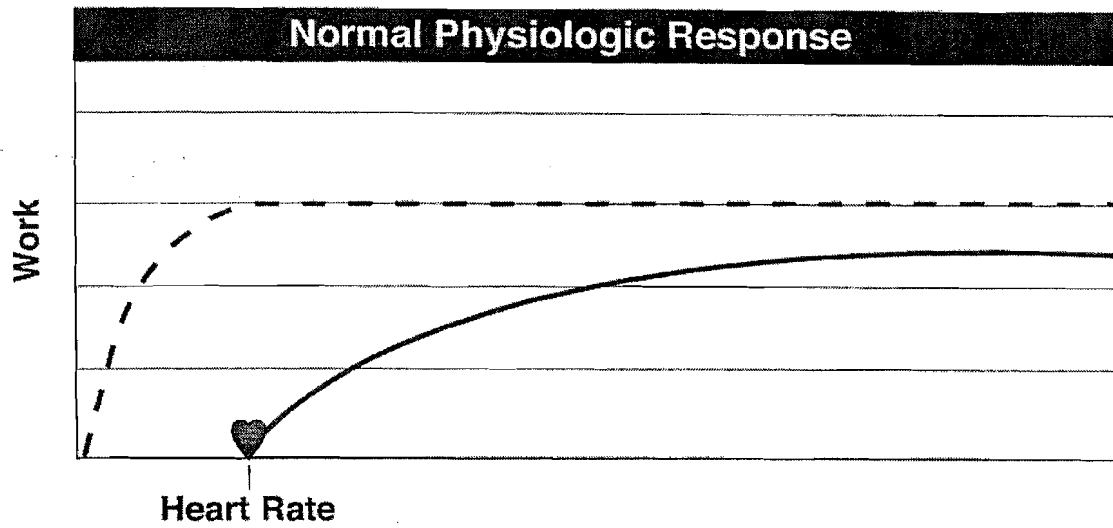
Recovery to RHR: 4 min

Functional Physiological Profile

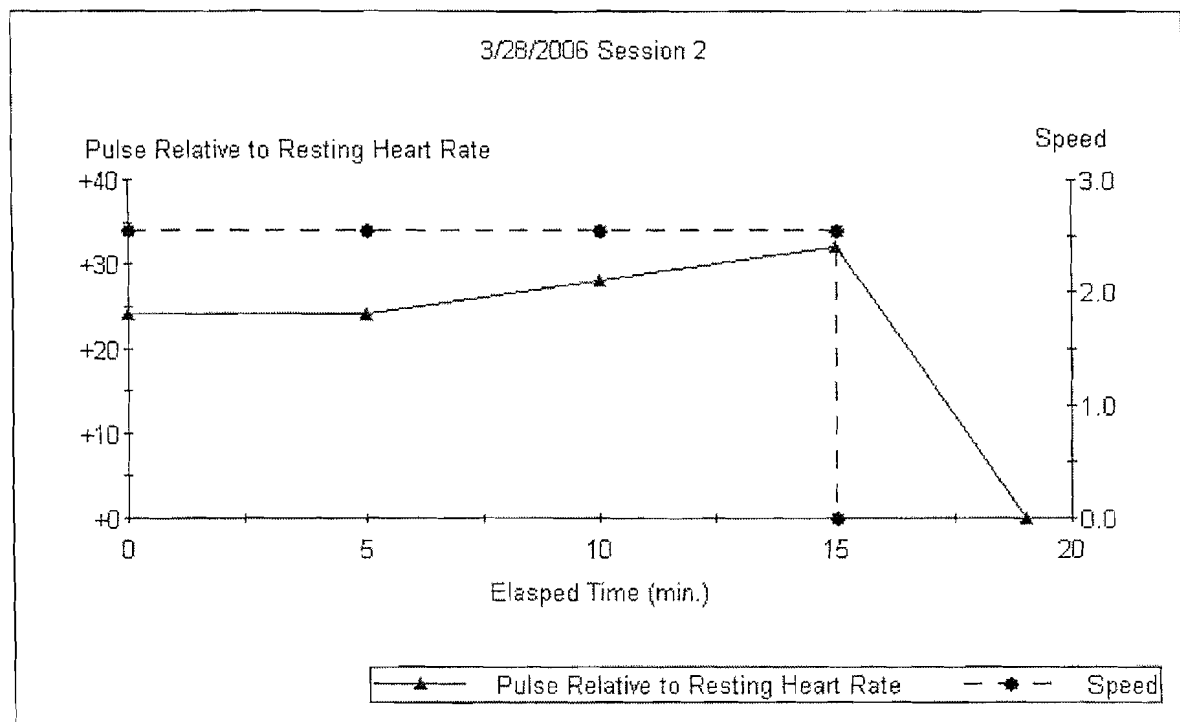
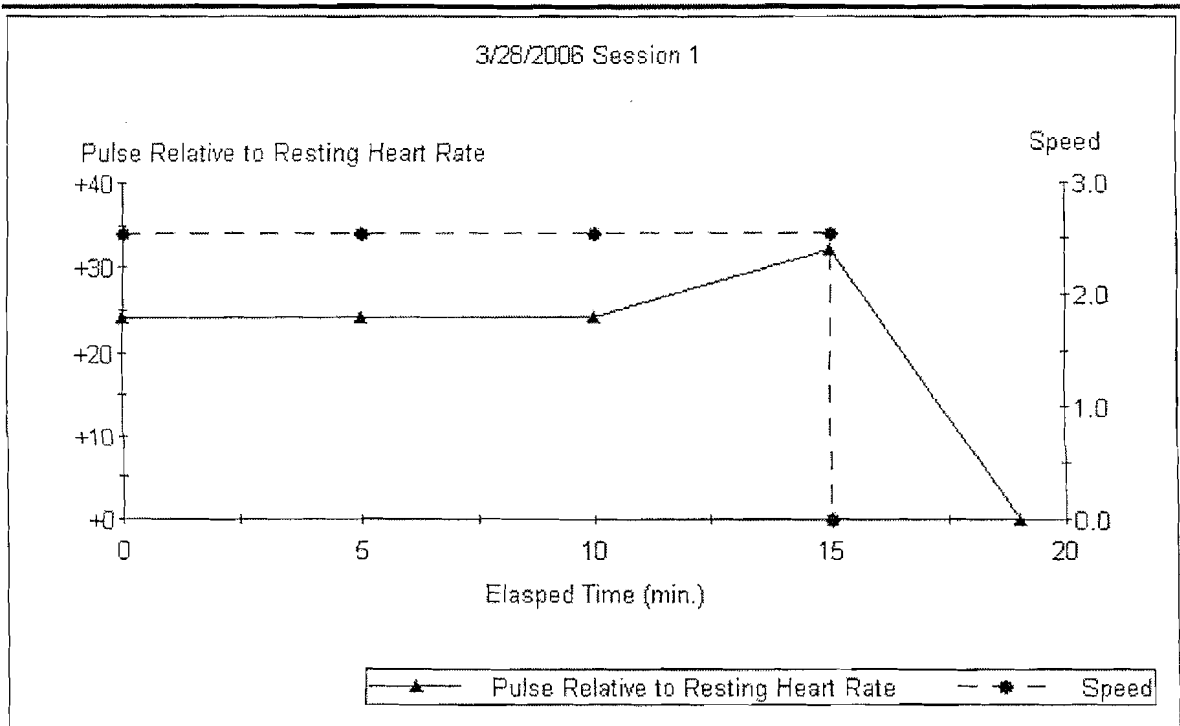


Appendix C.

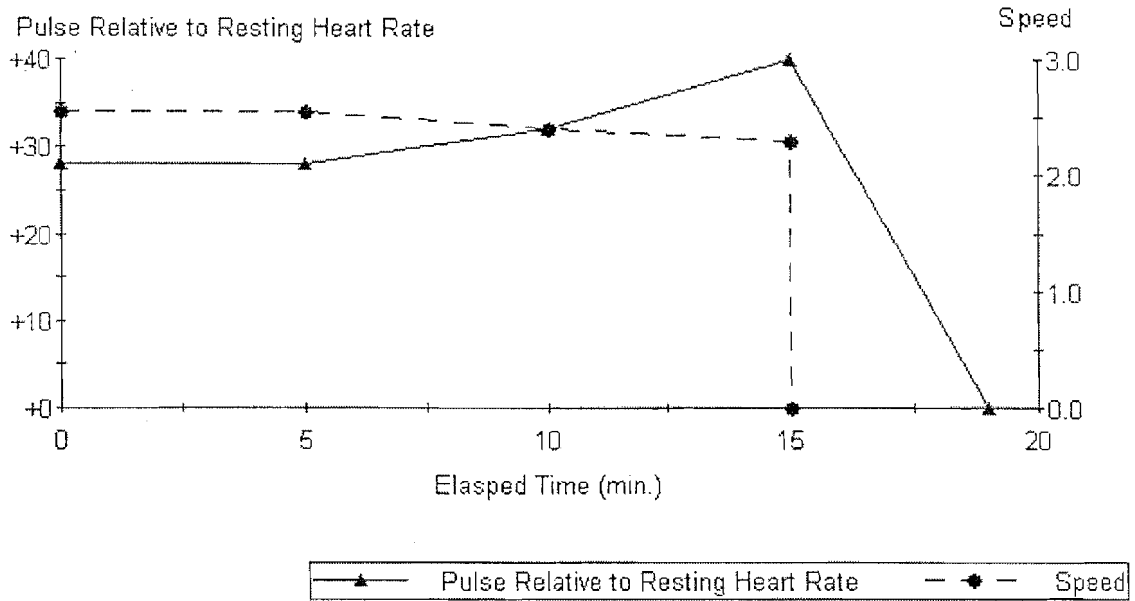
Physiologic Response data



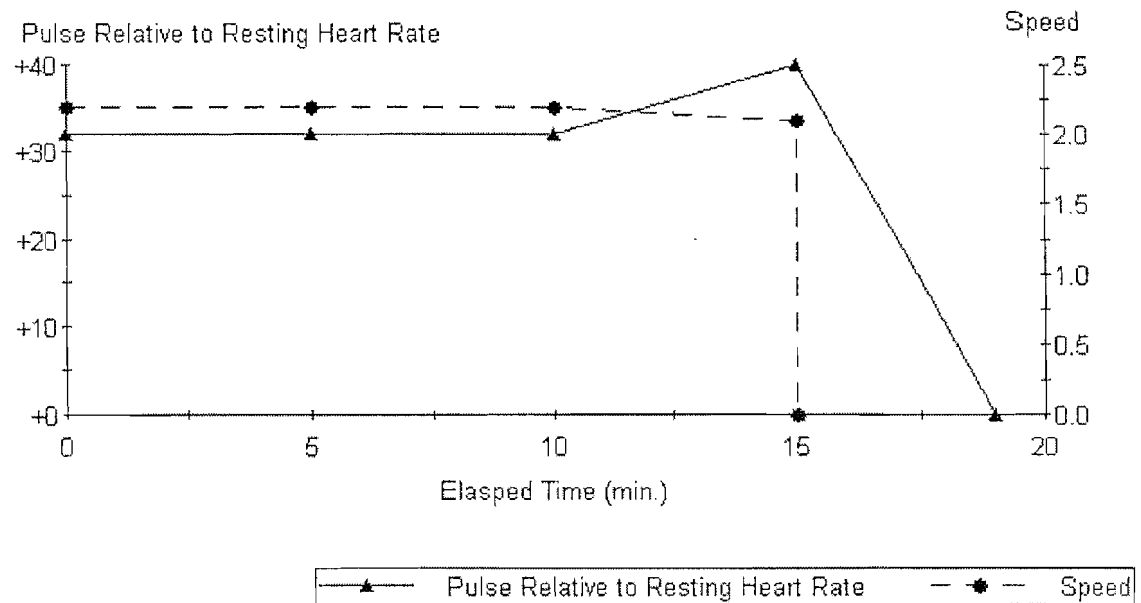
Gait Physiology Evaluation



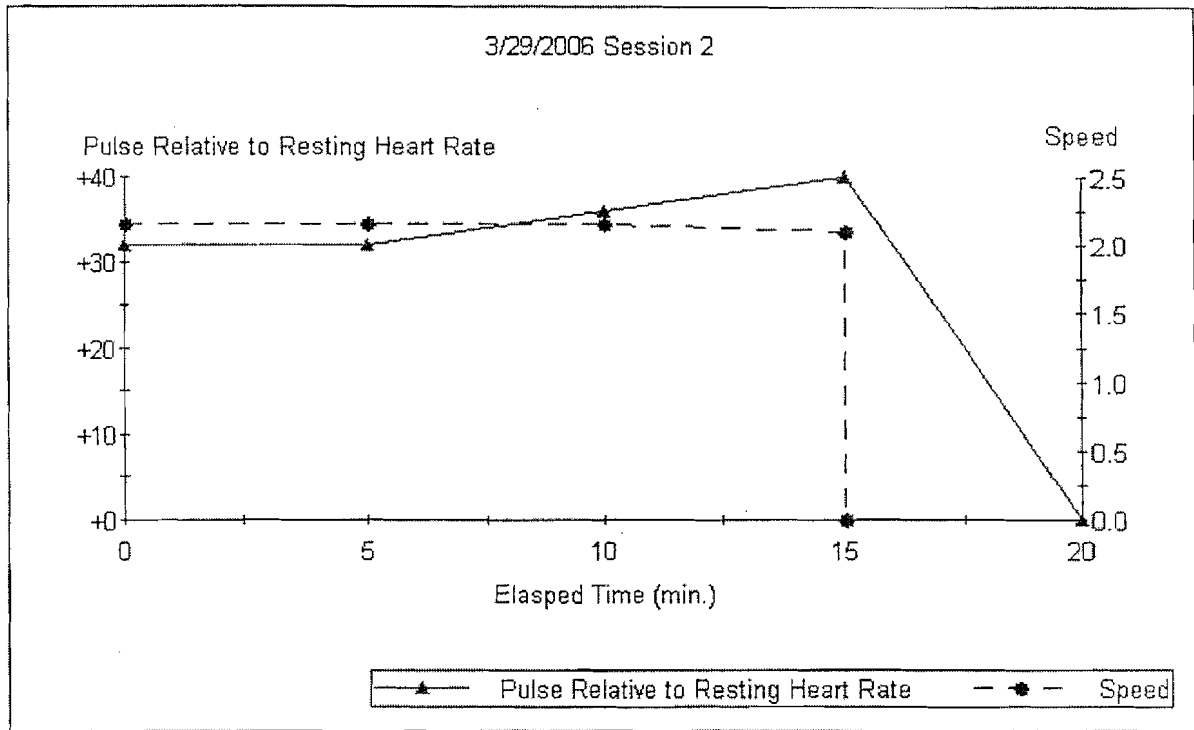
3/28/2006 Session 3



3/29/2006 Session 1



3/29/2006 Session 2

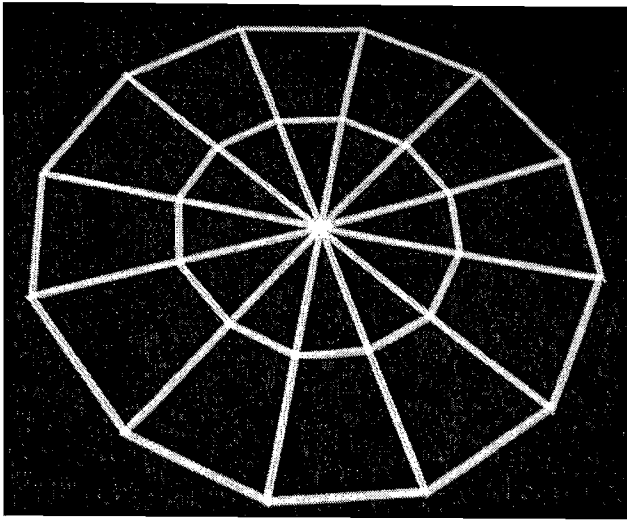


Appendix D.

Cognitive spatial orientation data

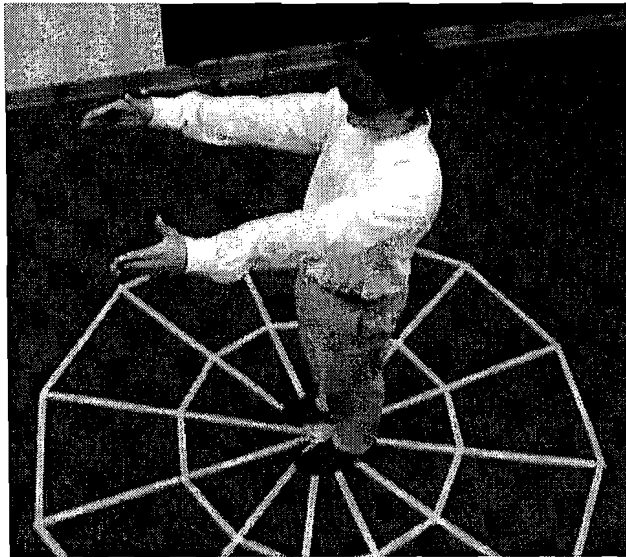
Cognitive Spatial Orientation Test

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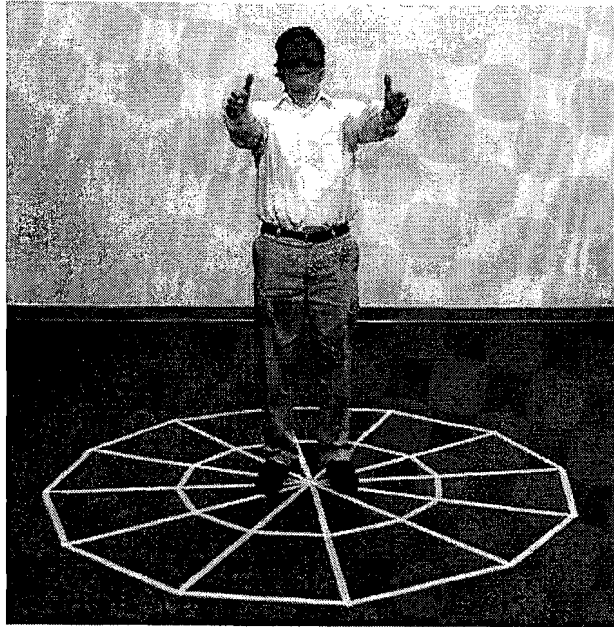
Cognitive Spatial Orientation Test

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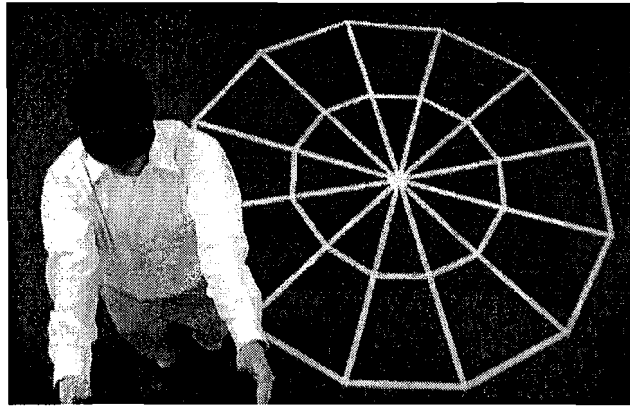
Cognitive Spatial Orientation Test

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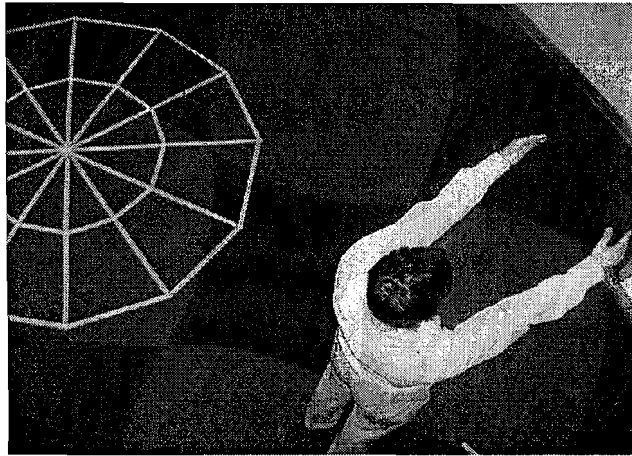
Cognitive Spatial Orientation Test

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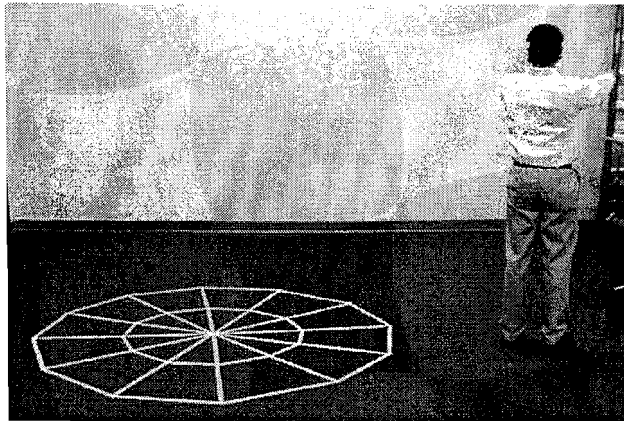
Cognitive Spatial Orientation Test

5



Cognitive Spatial Orientation Test

6



Appendix E.

Biomechanical data

Objective Muscle Test - Thumb / Extension

March 22, 2006

Session 1

R v. L %25.6

	Trial 1 (kg.)	Trial 2 (kg.)	Trial 3 (kg.)	Mean (kg.)	Std.Dev. (kg.)	Coef.Var. (%)
Left	4.50	3.70	4.30	4.17	0.42	9.99
Right	3.20	2.90	3.20	3.10	0.17	5.59

Objective Muscle Test - Thumb / Abduction

March 22, 2006

Session 1

R v. L %31.5

	Trial 1 (kg.)	Trial 2 (kg.)	Trial 3 (kg.)	Mean (kg.)	Std.Dev. (kg.)	Coef.Var. (%)
Left	2.90	3.20	2.60	2.90	0.30	10.34
Right	4.20	4.30	4.20	4.23	0.06	1.36

Objective Muscle Test - Hip Flexion / Supine

March 22, 2006

Session 1

Norms: Objective Muscle - 31 kg

R v. L %18.9

	Trial 1 (kg.)	Trial 2 (kg.)	Trial 3 (kg.)	Mean (kg.)	Std.Dev. (kg.)	Coef.Var. (%)	vs. Norm
Left	23.40	24.00	23.90	23.77	0.32	1.35	23%
Right	32.20	30.30	25.50	29.33	3.45	11.77	5%

Session 2

Norms: Objective Muscle - 31 kg

R v. L %16.5

	Trial 1 (kg.)	Trial 2 (kg.)	Trial 3 (kg.)	Mean (kg.)	Std.Dev. (kg.)	Coef.Var. (%)	vs. Norm
Left	26.60	28.30	31.30	28.73	2.38	8.28	7%
Right	34.00	38.40	30.90	34.43	3.77	10.95	10%

Objective Muscle Test - Ankle / Dorsi Flexion

March 22, 2006

Session 1

R v. L %11.6

	Trial 1 (kg.)	Trial 2 (kg.)	Trial 3 (kg.)	Mean (kg.)	Std.Dev. (kg.)	Coef.Var. (%)
Left	27.50	29.90	30.50	29.30	1.59	5.42
Right	25.20	26.20	26.30	25.90	0.61	2.35

Limb Specific Strength Test - Forward Reach Vertical / Up

March 22, 2006

Session 1

R v. L %8.15

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	16.30	16.80	17.20	16.77	0.45	2.69
Right	14.40	16.40	15.40	15.40	1.00	6.49

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Limb Specific Strength Test - Side Reach Vertical / Up

March 22, 2006

Session 1

R v. L % 4.09

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	16.30	14.80	15.80	15.63	0.76	4.89
Right	15.50	16.00	17.40	16.30	0.98	6.04

Limb Specific Strength Test - Lateral Lift

March 22, 2006

Session 1

R v. L % 12.5

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	82.50	105.50	99.50	95.83	11.93	12.45
Right	108.50	107.70	112.70	109.63	2.69	2.45

Limb Specific Strength Test - Seated Overhead Vertical / Up

March 22, 2006

Session 1

R v. L % 0.97

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	42.80	42.00	37.50	40.77	2.86	7.01
Right	38.20	43.00	42.30	41.17	2.59	6.30

Limb Specific Strength Test - Shoulder Flexion / No Grip - Ext. Rotated

March 22, 2006

Session 1

R v. L % 0.07

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	52.30	49.40	49.80	50.50	1.57	3.11
Right	52.20	51.00	48.40	50.53	1.94	3.84

Limb Specific Strength Test - Shoulder Abduction / No Grip - Ext. Rotated

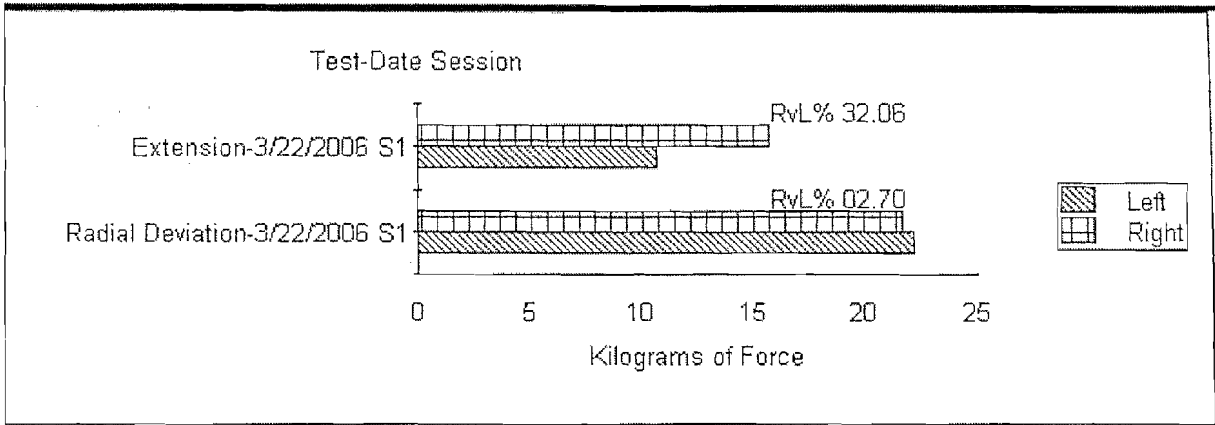
March 22, 2006

Session 1

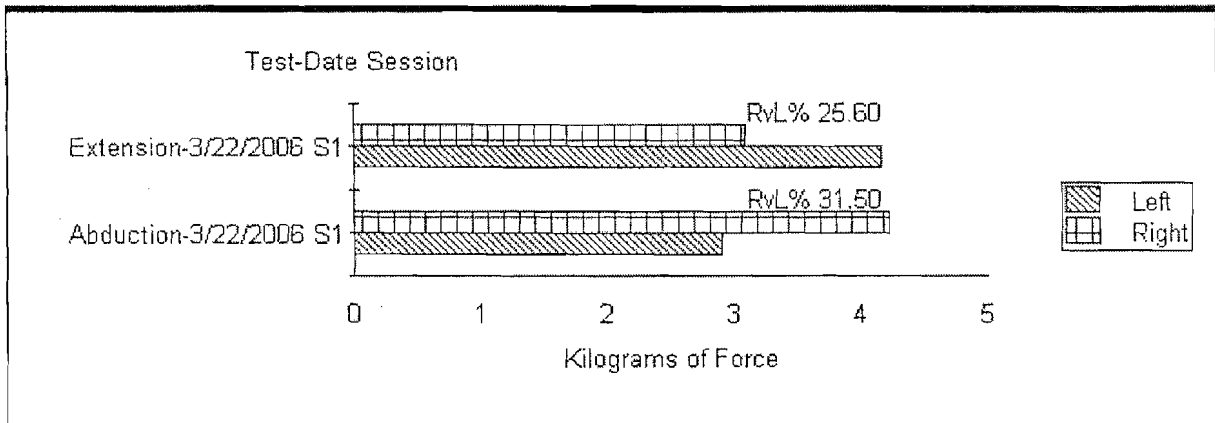
R v. L % 11.7

	Trial 1 (lbs.)	Trial 2 (lbs.)	Trial 3 (lbs.)	Mean (lbs.)	Std.Dev. (lbs.)	Coef.Var. (%)
Left	52.60	48.90	43.80	48.43	4.42	9.12
Right	52.50	57.40	54.70	54.87	2.45	4.47

Objective Muscle Strength Testing - Wrist

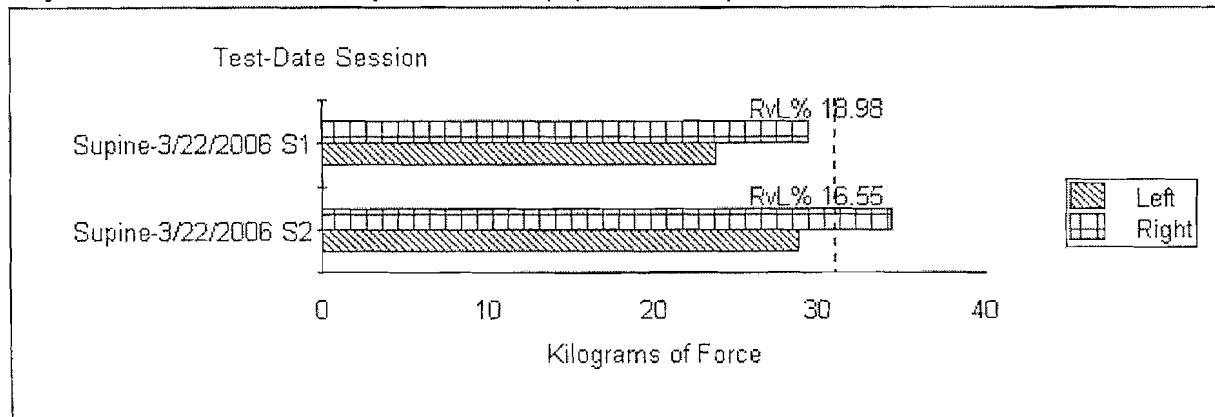


Objective Muscle Strength Testing - Thumb

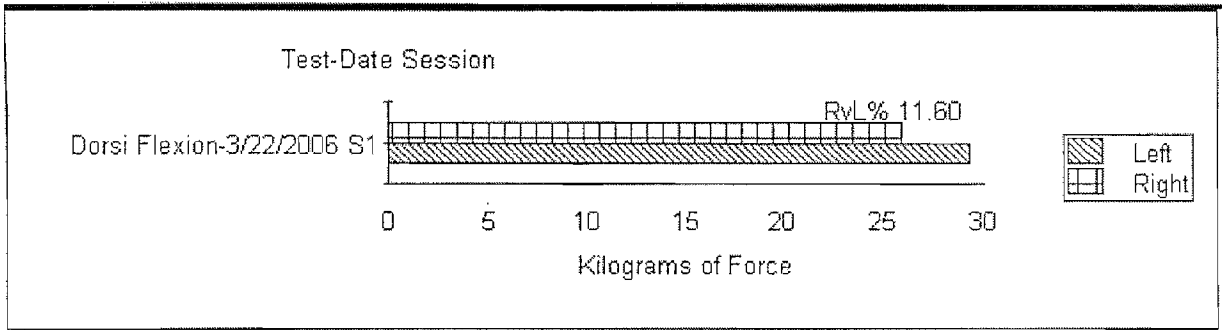


Objective Muscle Strength Testing - Hip Flexion

Key: Dashed line indicates Objective Muscle population comparison.

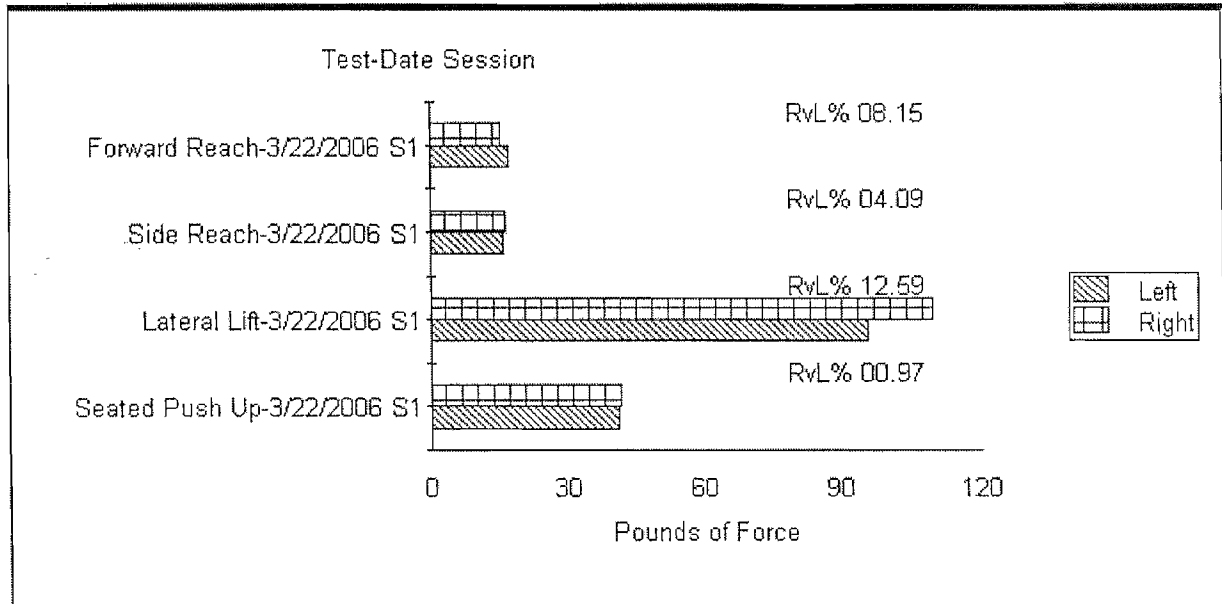


Objective Muscle Strength Testing - Ankle / Foot



Section 3: Limb Specific Strength Testing

Limb Specific Strength Testing - General



Limb Specific Strength Testing - Shoulder Flexion

