LABORATORY REPORT COVER PAGE

GROUP NUMBER T1

EXPERIMENT NUMBER 1

TITLE Cardiovascular System – Blood Pressure and Heart Sounds

DATE SUBMITTED 9/21/00

ROLE ASSIGNMENTS

ROLE	GROUP MEMBER
FACILITATOR………………………..	Alice Wu
TIME & TASK KEEPER………………	David Kim
SCRIBE………………………………..	Mina Wu
PRESENTER………………………….	Christopher Hack

SUMMARY OF CONCLUSIONS

Blood pressure, heart rate and heart sounds of two different subjects are recorded under various conditions. Results show that the most significant difference, as proven by the paired means t-tests, was between the blood pressure of the right arm versus the blood pressure of the left arm of subject one. Under all other conditions tested, such as varying the position of the subjects, paired means t-tests showed no significant differences between the varying conditions and the control.

In the second portion of the lab, activities such as inhalation, exhalation, and exercise, were shown to have significant effects on the heart rate and intensity on the subject, as shown by the paired means t-tests. However, the effects of these activities were highly specific to the subjects themselves due to many external factors such as regular exercise, weight, etc. that were beyond the control of this lab.

GOOD- GRADE 20/20

RESULTS

PROTOCOL DEMANDS NEVER TO USE A SUBJECT'S NAME- USE INITIALS

Subject 1: David Kim, sex: male, weight: 135lbs, height 5'7''

Figure 1.a

Systolic, according to marker

	Average mmHg	StDev	Critical T value	95% Confidence	variance
L, sitting up	103.76482	0.041325013	4.302655725	0.102657095	0.001707757
R, sitting up	108.45394	1.945717571	4.302655725	4.83343376	3.785816867
R, lying down	111.66419	1.795757035	4.302655725	4.460910877	3.224743328
R, post ex	114.83836	2.976158987	4.302655725	7.393193922	8.857522314

Figure1.b

Paired T-Test for two means, systolic marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-4.105969201	No
R, sitting vs. R, lying	-1.632463115	No
R, sitting vs. R, post ex	-3.400226003	No

Figure1.c

Systolic, according to microphone

	Average mmHg	StDev	Critical T value	95% Confidence	variance
L, sitting up	105.55794	0.00237	4.302656	0.00588	0.00001
R, sitting up	112.03391	0.65841	4.302656	1.63557	0.43350
R, lying down	114.12598	1.00107	4.302656	2.48679	1.00213
R, post ex	119.26617	7.37437	4.302656	18.31896	54.38131

Figure1.d

Paired T-Test for two means, systolic microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-16.98901	Yes
R, sitting vs. R, lying	-9.709006	Yes
R, sitting vs. R, post ex	-1.575458	No

Figure1.e

Diastolic, according to marker

	Average mmHg	StDev	Critical T value	95% Confidence	variance
L, sitting	75.37761	0.920315288	4.302655725	2.286191506	0.84698023
R, sitting	83.47533	0.148992199	4.302655725	0.370117397	0.022198675
R, lying	79.94048	2.665611335	4.302655725	6.621750251	7.105483788
R, post ex	74.28649	3.563661609	4.302655725	8.852632356	12.69968406

Figure1.f

Paired T-Test for two means, diastolic marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-14.12933437	Yes
R, sitting vs. R, lying	2.385932371	No
R, sitting vs. R, post ex	4.31728853	Yes

Figure1.g
Diastolic, according to microphone

	Average mmHg	StDev	Critical T value	95% Confidence	variance
L, sitting	74.43076	1.35596	4.302655725	3.36840	1.83863
R, sitting	81.00455	1.16839	4.302655725	2.90244	1.36513
R, lying	74.56603	6.55736	4.302655725	16.28940	42.99901
R, post ex	71.11231	4.47689	4.302655725	11.12121	20.04251

Figure1.h
Paired T-test for two means, diastolic microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-5.5452	Yes
R, sitting vs. R, lying	1.4498	No
R, sitting vs. R, post ex	3.0352	No

Figure1.i

	systole	Diastole	BPM	MAP	Pulse pressure
Left arm, sitting up	105.55794	74.43076	48.99667	84.806487	31.12718
Right arm, sitting up	112.0339	81.00455	56.75	91.34767	31.02936
Right arm, lying down	114.126	74.566	47.52667	87.75266	39.55998
Right arm, after exercise	119.2662	71.11231	58.78333	87.163597	48.15386

Figure1.j
Paired t-test for two means, MAP marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-12.5693	Yes
R, sitting vs. R, lying	1.877314	No
R, sitting vs. R, post ex	3.460097	No

Figure1.l
Paired t-test for two means, MAP microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-8.069011	Yes
R, sitting vs. R, lying	1.205001	No
R, sitting vs. R, post ex	3.88924	No

Subject 2: Chris, sex: male, weight: 175lbs, height: 5’ 11’’

Figure2.a
Systolic, according to marker

	mmHg	StDev	Critical t-value	95% Confidence	variance
L, sitting	103.98124	0.406994	4.302656	1.01103	0.165644
R, sitting	106.46107	2.662904	4.302656	6.615026	7.09106
R, lying	111.19528	2.071308	4.302656	5.145418	4.290317
R, post ex	116.92141	2.446132	4.302656	6.076533	5.983562

Figure2.b

Paired T-Test for two means, systolic marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-1.89602	No
R, sitting vs. R, lying	-7.0149	Yes
R, sitting vs. R, post ex	-5.97558	Yes

Figure 2.c

Systolic, according to microphone

	mmHg	StDev	Critical t-value	95% Confidence	variance
L, sitting	105.58605	0.32807	4.302656	0.81498	0.10763
R, sitting	107.71450	3.45960	4.302656	8.59412	11.96882
R, lying	113.33243	2.00451	4.302656	4.97949	4.01808
R, post ex	116.15492	2.86992	4.302656	7.12927	8.23642

Figure 2.d

Paired T-Test for two means, systolic microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-1.14189	No
R, sitting vs. R, lying	-4.97589	Yes
R, sitting vs. R, post ex	-2.31225	No

Figure 2.e

Diastolic, according to marker

	mmHg	StDev	Critical t-value	95% Confidence	variance
L, sitting	75.39564	1.593117	4.302656	3.957525367	2.538023
R, sitting	80.76108	4.695817	4.302656	11.66506462	22.0507
R, lying	75.57599	4.837074	4.302656	12.01596536	23.39728
R, post ex	74.46684	3.719744	4.302656	9.240363645	13.8365

Figure2.f

Paired T-Test for two means, diastolic marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-2.99403	No
R, sitting vs. R, lying	1.07558	No
R, sitting vs. R, post ex	10.72325	Yes

Figure 2.h

Diastolic, according to microphone

	mmHg	StDev	Critical t-value	95% Confidence	variance
L, sitting	76.10803	0.55727	4.302656	1.38432	0.31054
R, sitting	80.46350	4.95117	4.302656	12.29940	24.51410
R, lying	74.90870	5.12096	4.302656	12.72117	26.22419
R, post ex	73.84466	3.35326	4.302656	8.32997	11.24437

Figure 2.i

Paired T-Test for two means, diastolic microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-1.71225	No
R, sitting vs. R, lying	1.59121	No

R, sitting vs. R, post ex	5.538641	Yes

Figure 2.j

	systole	diastole	BPM	MAP	Pulse pressure
Left arm, sitting up	105.5861	76.10803	49.69444	85.93404	29.47802
Right arm, sitting up	107.7145	80.4635	55.42667	89.54717	27.251
Right arm, lying down	113.3324	74.9087	46.29	87.71661	38.42373
Right arm, after exercise	116.1549	73.84466	61.12	87.94808	42.31026

Figure2.k

Paired t-test for two means, MAP marker value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-2.89144732	No
R, sitting vs. R, lying	0.578269445	No
R, sitting vs. R, post ex	0.73308777	No

Figure 2.l

Paired t-test for two means, MAP microphone value

	T-test value	Significantly different?
L, sitting vs. R, sitting	-1.61127	No
R, sitting vs. R, lying	0.524451	No
R, sitting vs. R, post ex	0.796966	No

Figure 3.a

Subject 1 David		at rest vs. inhalation		at rest vs. exhalation		at rest vs. post exercise	
			sig difference?		sig difference?		Sig difference?
BPM	t Stat	4.857		4.424		10.547	
	t Critical two-tail	2.776	Yes	2.776	yes	2.776	yes
delta T R-wave to first sound (sec)	t Stat	1.811		1.372		1.414	
	t Critical two-tail	2.776	no	2.776	no	2.776	no
delta T R-wave to second sound	t Stat	19		3.162		10.783	
	t Critical two-tail	2.776	yes	2.776	yes	2.776	yes
delta T second sound to next first sound	t Stat	3.491		3.132		3.775	
	t Critical two-tail	2.776	yes	2.776	yes	2.776	yes
delta T first to second	t Stat	2.964		2.092		9.058	
	t Critical two-tail	2.776	yes	2.776	no	2.776	yes
p-p first sound	t Stat	2.718		1.619		12.205	
	t Critical two-tail	2.776	no	2.776	no	2.776	yes

p-p second sound	t Stat	2.451		.557		1.015	
	t Critical two-tail	2.776	no	2.776	no	2.776	no

Figure 3.b

Subject 2 Chris		at rest vs. inhalation		at rest vs. exhalation		at rest vs. post exercise	
			sig difference?		sig difference?		sig difference?
BPM	t Stat	-0.9749		1.53411		-4.870069	
	t Critical two-tail	3.18245	No	3.182449	No	3.1824493	Yes
delta T R-wave to first sound (sec)	t Stat	-1.5962		5		3.0869745	
	t Critical two-tail	4.30266	No	3.182449	Yes	2.7764509	Yes
delta T R-wave to second sound	t Stat	3.03109		2.04939		25.041093	
	t Critical two-tail	4.30266	No	3.182449	No	2.7764509	Yes
delta T second sound to next first sound	t Stat	26.2218		-1.63721		2.8892381	
	t Critical two-tail	4.30266	Yes	3.182449	No	2.7764509	Yes
delta T first to second	t Stat	5.24951		1.132557		35.8392	
	t Critical two-tail	4.30266	yes	3.182449	no	2.7764509	yes
p-p first sound	t Stat	-0.9639		0.986728		-1.9590322	
	t Critical two-tail	4.30266	No	3.182449	No	3.1824493	No
p-p second sound	t Stat	1.70993		8.347186		0.8855339	
	t Critical two-tail	4.30266	No	12.70615	No	3.1824493	No

RESULTS GRADE 40/40

DATA ANALYSIS AND CONCLUSION.

Figure 4.a: Comparison of significant differences

The first response correlates to marker value, the second to microphone value.

Subject 1: David	Systolic – significant difference?	Diastolic – Significant diference?	MAP = significant difference?
L, sitting vs. R, sitting	No, Yes	Yes, Yes	Yes, Yes
R, sitting vs. R, lying	No, Yes	No, No	No, No
R, sitting vs. R, post ex	No, No	Yes, No,	No, No

Subject 2: Chris	Systolic – significant difference?	Diastolic – Significant diference?	MAP = significant difference?
L, sitting vs. R, sitting	No, No	No, No	No, No
R, sitting vs. R, lying	Yes, Yes	No, No	No, No
R, sitting vs. R, post ex	Yes, No	Yes, Yes	No, No

As seen on the chart above (Fig 4a), no consistent conclusion can be drawn about whether changing test location, position and post exercise produces a significant difference in blood pressure measurements with regards to systolic and diastolic pressures. While significant changes are detected by the marker value, such differences are sometimes not detected by the microphone, and visa versa. MAP values return more consistent data.

The comparison between MAP values return consistent data indicating that while mean pressures taken in the Subject David's left and right arms are significantly different (the t-test value are –8.069 for the microphone and –12.569 for the marker, with a t-critical value of 4.303) other difference in test conditions in both subjects are not significantly different.

In David, significantly different data in MAP between right and left arms is probably due to difference in the muscle tone of the two arms. Since the subject is right-handed, his right arm is more toned than the left arm and therefore has greater blood pressure value. Chris, however, is ambidextrous and thus the pressures in the two arms are comparable.

No other significant change is detected, or is detected consistently, under different experimental variables (difference in test location, position, and following exercise). This is due to large confidence intervals that are registered. The data is not precise (explained later).

The precision of the repeated runs for the first subject, David, is expressed through the 95% confidence interval of the values. The 95% confidence interval of the systolic pressure, according to marker, of David's left arm while sitting up is 103.76 +/-0.10 mmHg. The experimental variables: sitting up, lying down, and post-exercise greatly influenced the repeatability of the results. While sitting up and taking the pressure reading from David's right arm was 108.45 mmHg with a 95% confidence interval of +/- 4.83 mmHg.

Although the 95% confidence level value of the right arm is greater than the left arm reading, when compared to the right arm post-exercise pressure of , it is considerably lower, indicating greater precision in the readings, 114.84 mmHg +/-7.39 (95% CI). The readings taken while David was lying down are very similar in precision to those taken of his right arm while he was sitting up (111.66 mmHg , with a 95% CI of +/- 4.46 mmHg).

The microphone results for systolic pressure, in the sitting, lying and the post exercise positions that were more precise than that of the marker. For example, David's left-arm-sitting-up readings had a confidence interval of only 105.56 mmHg, with a 95% CI of +/-0.006, which, in comparison to the marker values, is 17X smaller. The systolic marker often times is placed after the first microphone sound (for example, David sitting-up-left arm: the marker value is 103.76482mmHg while the microphone sound indicates a pressure of 105.55794mmHg) **Note: the pressure starts @160mmHg and is decreased by 2-3mmHg per second.**

The diastolic marker, however, is often placed before the Korotkoff sound (for example, David sitting-up-left arm: the marker value is 75.37761mmHg while the Korotkoff sound is detected @ 74.43076mmHg). Contrary to measuring the Systolic pressure, the marker when measuring the diastolic pressure is more precise than the microphone. David right-arm-sitting-up, his pressure measured by markers, is 83.48 mmHg with a 95% confidence interval of +/-0.37 mmHg, while the microphone value is 81.00 mmHg +/-2.90 (95% CI). The greater precision in the marker value in the diastolic pressure is probably due to the fact that the microphone is more sensitive and detects sounds that are less intense (lower decibels) than the human ear can. Because the experimental protocol calls for stopping of the experiment when the Director (human) hears diastolic sounds, the trial is often abruptly stopped while the microphone still detects a sound. The pressure at which each trial ends is inconsistent through the trials, resulting in imprecise microphone diastolic pressure. Precision of the diastolic measurement can be improved by simply delaying the time at which each trial is stopped.

In lesson 17, the effects of different physical activities on the heart rate and sounds was shown to have different magnitudes of impact on the two different subjects. A t-paired test comparing the average heart rate (BPM) for subject 1, David, showed that there were significant differences between the BPM at rest (Rest was designated as the control in order for comparison) and each of the other three activities: inhalation, exhalation, and post-exercise. In all three t-pair tests of the BPM at rest when compared with the three other activities, the t-stat was greater than the t-critical, which denotes significant difference. However, in the case of subject 2, Chris, only one t-test comparing the BMP at rest with the BMP post exercise, yielded a significant difference. Based on these results, one would conclude that inhalation and exhalation affects David's BPM but not that of Chris. However, further analysis of Chris's BPM results during the various activities show that there was much uncertainty in the measured values of BPM during inhalation and exhalation. During Chris's inhalation, his BPM had an average value of 69.67, with a 95% confidence interval of +/- 33.1580 BPM (or 47.6% CI, percentage-wise). During Chris's exhalation, his BPM measure averaged 55.748 +/- 9.188 BPM (or 16.5% CI, percentagewise). In comparison, David's inhalation and exhalation BPM was 80.66 with a 95% CI of +/- 9.14 (or 11.3%) and 70.236 with a 95% CI of +/- 4.0482 (or 5.75%). Due to Chris's wide confidence interval, there is more uncertainty in his measured values of BPM for the various conditions. Therefore, David's BPM values have less uncertainty, and one can conclude that inhalation, exhalation, and exercise all affected his heart rate. However, you cannot conclude that inhalation and exhalation did not affect Chris's heart rate due to the high uncertainty. GOOD POINT

The effects of these three activities did show similar effects on both subjects in the delta T between the first and second heart sound. Based on the T-test, there is a significant difference in the delta T between the first and second heart sound, when comparing the rest stage with inhalation and exercise stages. This shows that the time, which passes between the first and second heart sound is affected by the activity of inhaling and exercising. This can be mechanically explained as an increase in the heart rate, causing the heart to beat at a faster frequency. Inhaling causes uptake of excess oxygen which needs to be circulated throughout the body, thus signaling the heart to pump blood faster. THIS DOES NOT NECESSARILY FOLLOW – IT'S MORE COMPLICATEDExercise has a similar effect on the heart. Due to the increased heart rate, the delta T between the first and second heart sound is shown to be smaller than the delta T during the rest stage. THAT'S OK

The intensity or how "hard" the heart was beating was reflected by the peak to peak (p-to-p) values. Higher p-to-p values reflects greater pressure as the valves of the heart closes. In both subjects, inhalation, exhalation, nor exercise seemed to affect the "intensity" or loudness of the second heart sound (affiliated with the closing of the semilunar valve). However, exercise was shown to affect the intensity of the first heart sound (affiliated with the closing of the atrioventricular valves) in subject one, as shown by the paired t-tests. The first heart sound of subject two, Chris, was not affected by any of the three activities. This discrepancy can be attributed to the different levels of regular physical activity. Subject one, David, is not an active individual on a normal basis, causing his heart to beat harder when exposed to exercise. Subject 2, Chris, however, in an active person on a normal basis so his heart rate is less sensitive to small changes in the level of physical activity. GOOD POINT

Qualitatively, between the two subjects, the frequency that was heard was similar in all places (aortic, pulmonic, tricuspid, and mitral positions). The pitch that was heard was comparable in the two subjects: moderate, low, low, moderate pitches in the four positions respectively. There is, however, a difference in the intensity of sound heard. While for Subject 1 David, the tricuspid and the mitral position had the greatest intensity, the opposite was the case for Subject 2 Chris. This is probably due to the fact that Subject 2 had greater muscle tone in the chest area around the tricuspid and mitral positions, and as a result sound cannot be heard as clearly.

With the stethoscope, heart sounds can be heard as a distinctive "lub-dub" sound, with the second sound ("dub") more intense than the first. These two sounds appear as two peaks in the electronic record, with the second peak higher than the first peak, correlating to its stronger intensity.

GOOD WRITEUP- I THINK YOU EXTRACTED ABOUT WHAT ONE COULD WITH THE QUALITY OF THE ORIGINAL DATA AND LEVEL OF EXPERIENCE, AND SOMEWHAT RESTRICTED DEMANDS OF THE LESSONS.
GRADE 40/40

References:

Pflanzer, Richard. Physiology Lessons for use with the Biopac Student Lab V3.0: Blood Pressure. 42 Aero Camino, Santa Barbara, CA, 1998, pp. 1-38.

Pflanzer, Richard. Physiology Lessons for use with the Biopac Student Lab V3.0: Heart Sounds. 42 Aero Camino, Santa Barbara, CA, 1998, pp. 1-24.