實驗一、生理電信號測量

107 學年度第一學期 台大電機生醫工程實驗

第三組

解正平 B04901020

劉維凱 B04901153

張景程 B04901138

助教：趙珮妤 實驗室：明達館 304 室

Physiology Lessons
for use with the
Biopac Student Lab

PC under Windows®98SE, Me, 2000 Pr
or Macintosh® OS 8.6-9.1

Manual Revision
PL3.6.7-ML3.0.7/061903

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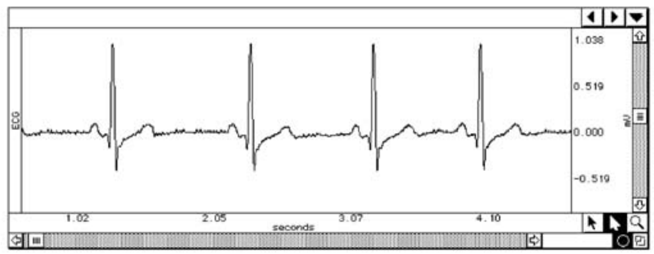
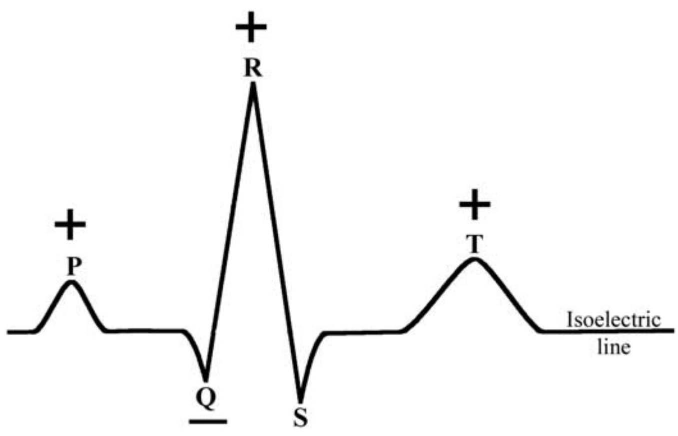
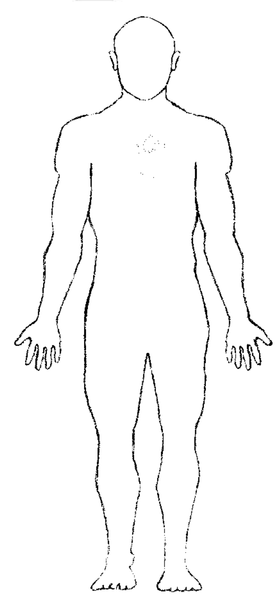
Lesson 5 Data Report

ELECTROCARDIOGRAPHY I

Components of the ECG







Lesson 5

ELECTROCARDIOGRAPHY I

ECG I

DATA REPORT

Student's Name: 解正平、劉維凱、張景程

Lab Section: MD303 Group 3

Date: 2018/3/23

I. Data and Calculations

Subject Profile

Name 張景程 Height 178cm

Age 21 Weight 67kg

Gender: Male / Female

A. Supine, Resting, Regular Breathing (using *Segment 1* data)

Complete the following tables with the lesson data indicated, and calculate the Mean and Range as appropriate.

Table 5.3

Measurement	From Channel	Cardiac Cycle 1	2	3	Mean	Range
ΔT	CH 2	0.668s	0.728s	0.745s	0.714s	0.077s
BPM	CH 2	89.82036BPM	82.41758BPM	80.53691BPM	84.25828BPM	9.28345BPM

Table 5.4

ECG Component	Duration Δ T [CH 2] Cycle 1	Cycle 2	Cycle 3	Mean	Amplitude (mV) Δ [CH 2] Cycle 1	Cycle 2	Cycle 3	Mean
P wave	0.064	0.078	0.093	0.078	0.05280	0.0732	0.0061	0.044
PR interval	0.12300	0.14100	0.143	0.135	0.07263	0.08026	0.03723	0.06337
PR segment	0.054	0.048	0.039	0.047	0.03375	0.01129	0.02136	0.02213
QRS complex	0.1	0.101	0.098	0.1	0.00641	0.05127	0.01190	0.02319
QT interval	0.349	0.326	0.334	0.336	0.00916	0.05585	0.01404	0.02635
ST segment	0.121	0.122	0.116	0.120	0.01129	0.00855	0.01221	0.01068
T wave	0.194	0.204	0.228	0.209	0.04303	0.00122	0.06195	0.0354

Table 5.5

Ventricular Readings	CH 2 Δ T			
	Cycle 1	Cycle 2	Cycle 3	Mean
QT Interval (*corresponds to Ventricular Systole*)	0.349	0.326	0.334	0.336
End of T wave to subsequent R wave (*corresponds to Ventricular Diastole*)	0.446	0.453	0.526	0.475

B. Seated, deep breathing

Table 5.6

Rhythm	CH. #	Cycle 1	Cycle 2	Cycle 3	Mean
Inspiration					
Δ T	CH 2	0.58	0.651	0.753	0.6613
BPM	CH 2	103.44828	92.1659	79.68128	91.76515
Expiration					
Δ T	CH 2	0.664	0.808	0.821	0.764
BPM	CH 2	90.3614	74.25743	73.08161	79.23348

C. Sitting

Table 5.7

Heart Rate	CH. #	Cycle 1	Cycle 2	Cycle 3	Mean
Δ T	CH 2	0.893	0.867	0.841	0.867
BPM	CH 2	67.18925	69.29415	71.34364	69.27568

D. After Exercise

Table 5.8

Ventricular Readings	CH 2 Δ T			
	Cycle 1	Cycle 2	Cycle 3	Mean
QT Interval (*corresponds to Ventricular Systole*)	0.359	0.242	0.305	0.302
End of T wave to subsequent R wave (*corresponds to Ventricular Diastole*)	0.073	0.172	0.189	0.145

II. Data Summary and Questions

160.85791、164.83516、167.13092
100.00000、101.18044、110.90573

E. Heart Rate (BPM)

Condition	Mean	Range
Supine, regular breathing	84.25828	9.28345
Seated, deep breathing, inhalation	91.76515	23.767
Seated, deep breathing, exhalation	79.23348	17.27979
Sitting, regular breathing	69.27568	4.15439
After exercise – start of recording	164.27491	6.27301
After exercise – end of recording	104.02872	10.90573

Explain the changes in heart rate between conditions. Describe the physiological mechanisms causing these changes.

First, we define the seated action for a sudden movement while the sitting is a relaxed state. Morever, the suspine is that the subject lay on the chairs and exercise is that the subject went upstairs and downstairs. Analyzing the data, we find after a sudden sitting and exercising, the heart rate is higher than any other conditions due to the use of energy for muscle and the more consumption of oxygen for cells. It is obvious that the BPM declined seriously after a while time of rest, condition 4 and 6, which means the less need for the oxygen and the reducing in metabolism. Next we focus on the condition 1 and 4 for the difference between supine and sitting. The former has a higher heart rate than the latter perhaps attributes to the uncomfortable environment for supine movement. Most importantly, it is essential to explaining the reason for the lower BPM in exhalation than inhalation. We think the higher pressure in chest cavity when inhalation causing the heart beating faster to transmit oxygen. On the other hand, when exhalation the lower pressure makes our heart relaxed.

As a result, we conclude the pressure in chest cavity and the movement with oxygen in need are the mainly factors affect the BPM.

F. Duration (Δ T)

Rhythm

Measurement	Mean	Range
Supine, regular breathing		
Inhalation	2.102	0.410
Exhalation	2.325	0.402
Supine, deep breathing		
Inhalation	3.145	0.320
Exhalation	3.275	0.304

Are there differences in the cardiac cycle with the respiratory cycle?

When observing the difference in deep breathing and regular breathing, we can find that the duration of deep breathing is longer than the regular breathing. Maybe it is resulting from the more oxygen the more time we need to exchange with the respiratory circle. According to the inhalation and exhalation, the former takes less time no matter it is regular or deep breathing since the pressure change in our chest cavity will decrease the venous return, increasing the heart rate.

Measurement	**Mean**	**Range**
Supine, regular breathing		
Ventricular systole	0.336	0.023
Ventricular diastole	0.475	0.08
After Exercise		
Ventricular systole	0.302	0.117
Ventricular diastole	0.145	0.116

What changes occurred in the duration of systole and diastole between resting and post-exercise?

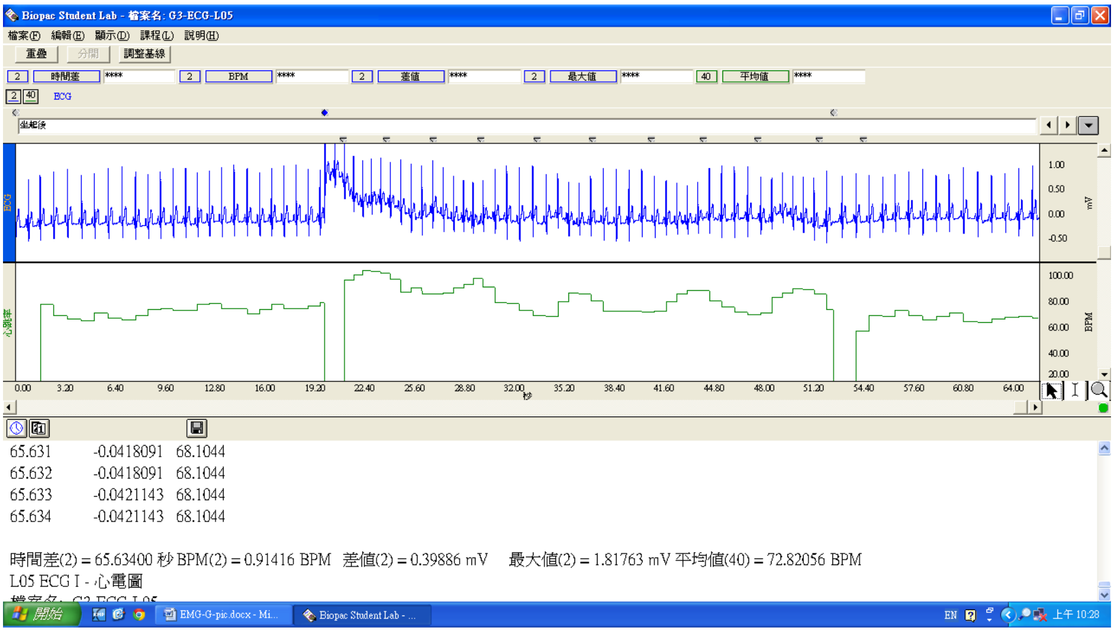
The systole duration doesn't change a lot between resting and post-exercise; however, it is even decrease. On the contrary, the diastole duration decreases sharply which resulting that the BPM is more higher after exercising.When it comes to the phenomena, we think that the duration of systole is the process transmitting blood to the whole body with a higher pressure while the processing duration can't change obviously in high pressure.

G. Review your Data

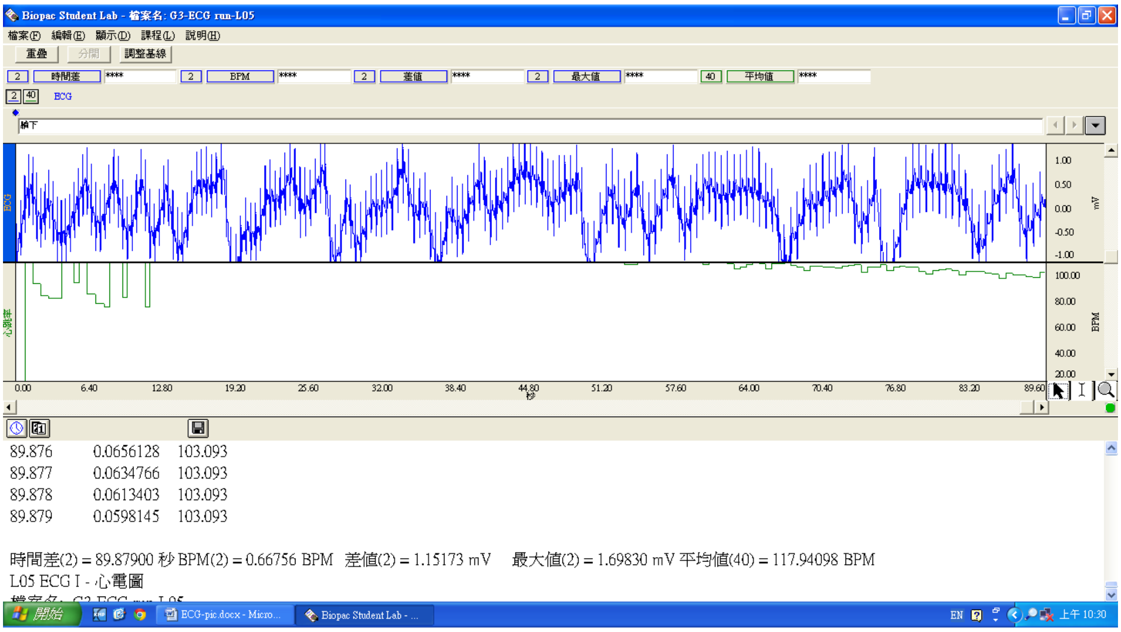
1. Is there always one P wave for every QRS complex? Yes No
2. Describe the P and T wave shapes: like a half-sine wave which the right side has a higher slope and T wave usually bigger than T wave.
3. Do the wave durations and amplitudes for all subjects fall within the normal ranges listed in Table 5.2? Yes No a little date has a deviation
4. Do the ST-segments mainly measure between –0.1 mV and 0.1 mV? Yes No
5. Is there baseline “drift” in the recording? Yes No
6. Is there baseline “noise” in the recording? Yes No

End of Lesson 5 Data Report

Spine，Seated (deep breathing)，Sitting(regular breathing)



After exercise



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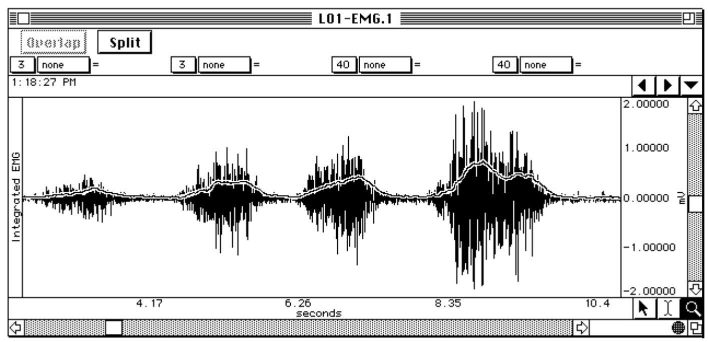
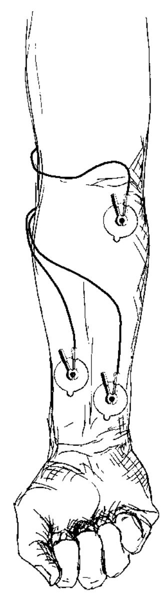
Lesson 1 Data Report
ELECTROMYOGRAPHY I
Standard and Integrated EMG





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ELECTROMYOGRAPHY I

Standard and Integrated EMG

DATA REPORT

Student's Name: 解正平、劉維凱、張景程

Lab Section: MD303 Group 3

Date: 2018/3/23

I. Data and Calculations

Subject Profile

Name 張景程 Height 178cm

Age 21 Weight 67kg

Gender: Male / Female

A. EMG Measurements

Cluster #	Forearm 1 (Dominant)				Forearm 2			
	Min [3 min]	**Max [3 max]**	**P-P [3 p-p]**	**Mean [40 mean**	**Min [3 min]**	**Max [3 max]**	**P-P [3 p-p]**	**Mean [40 mean]**
1	-0.13977	0.10925	0.24902	0.02701	-0.14282	0.10742	0.25024	0.02504
2	-0.19403	0.19470	0.38513	0.05098	-0.18433	0.14587	0.33020	0.03544
3	-0.40466	0.34119	0.74585	0.07619	-0.20569	0.21362	0.41931	0.05761
4	-0.48462	0.51514	0.99976	0.11153	-0.37109	0.42175	0.79285	0.08358

Note: "Clusters" are the EMG bursts associated with each clench.

B. Use the mean measurement from the table above to compute the percentage increase in EMG activity recorded between the weakest clench and the strongest clench of Forearm 1.

Calculation:

(0.11153 - 0.02701) / 0.02701 = 3.1292

Answer: 312.92 %

C. Tonus Measurements

Cluster #	Forearm 1 (Dominant)		Forearm 2	
	P-P [3 p-p]	Mean [40 mean]	P-P [3 p-p]	Mean [40 mean]
1	0.04028	0.00890	0.00916	0.00146
2	0.03601	0.00411	0.01526	0.00196
3	0.04028	0.00717	0.02319	0.00314
4	0.02441	0.00741	0.03418	0.00517

II. QUESTIONS

D. Compare the mean measurement for the right and left maximum clench EMG cluster. Are they the same or different?

_____ Same ✓ Different

Which one suggests the greater clench strength?

✓ Right _____ Left _____ Neither

Explain.

一般而言，在日常生活中慣用手的使用率和鍛煉會比非慣用手要來得多，以至於慣用手的肌肉會較為發達、肌纖維數量較多，且肌肉的運動是由於肌肉纖維群受到刺激，以電位差的形式傳遞訊號，因此具有較多肌纖維的慣用手離子交換量越大，所產生的總電位差也較高，也能產生較大的力量，和我們實驗結果也較為符合。

E. What factors in addition to sex contribute to observed differences in clench strength?

1. 年齡：尚未發育完全的兒童和青少年，其肌肉纖維較少，所以肌力也會比較少；此外，當人從中壯年逐漸步入老年時，肌力也會隨著年齡的增加而逐漸下降。 2. 肌肉組成：包含肌纖維的面積、肌肉纖維收縮時的長度、肌肉收縮時所牽扯的肌纖維數量、肌腱連接的方式等等也會影響肌力的表現。 3. 受試者的心理狀態：如果受測者處在壓力、疲勞、緊張、肌肉傷害的狀態下，也會影測響試結果。 4. 其他：環境的溫度、濕度、體溫、皮膚含水量等等因素也會影響測量時所量測到的肌肉電位。

F. Does there appear to be any difference in tonus between the two forearm clench muscles?

✓ Yes _____ No

Would you expect to see a difference? Does subject’s sex influence your expectations? Explain.

從實驗數據可觀察出慣用手(右手)的力量明顯大於非慣用手，由於慣用手較常受到刺激，藉由去極化和再極化產生動作電位傳遞之後，需要更快速地恢復以便進行下一個動作。

此外，和女性所量測到的數據相比，由於男性的肌纖維較多，因此量測到的肌力較大。

G. Explain the source of signals detected by the EMG electrodes.

此訊號的產生是由於肌肉收縮時，肌肉兩端的電位差所產生出來的訊號，而造成肌肉纖維群收縮的原因主要是因為動作電位 (Action Potential)的傳遞。透過細胞膜內外離子的進出使細胞膜產生電位差而產生「去極化」、「再極化」的現象，其中去極化為細胞膜上鈉離子通道打開使鈉離子進入膜內，造成細胞膜電位上升，膜內外電位差由負轉為正，反之則為再極化。

肌肉收縮時，這些現象都會產生不同的動作電位，所以EMG所量測的就是這些不同頻率的動作電位所組成的肌電訊號。

H. What does the term “motor unit recruitment” mean?

motor unit recruitment可看作為肌肉逐漸增加運動單元(motor unit)來達到充足力量的過程。一個運動單元(motor unit)是由一個motor neuron和附近受它刺激的肌肉纖維群所組成，而肌肉是由數個motor unit組成，肌肉纖維則分散在motor unit之中，當某個motor unit被刺激後，周遭與其相連的unit也會逐漸被刺激起來，因而使肌肉纖維產生足夠的電位。

I. Define skeletal muscle tonus.

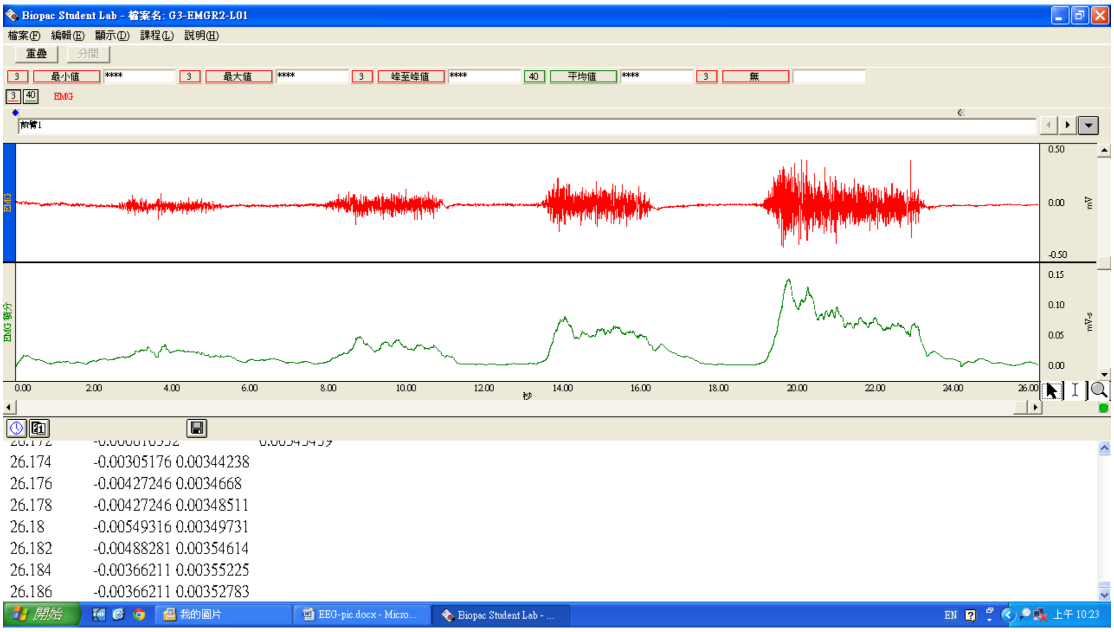
skeletal muscle tonus 是指在正常情形下，骨骼肌收縮放鬆時仍然會保持在準備狀態而維持一定的輕微張力，並不會一次達到最大力量限度，一般而言此種現象是由中樞神經所控制，使舒張肌肉得以維持正常的長度和張力並保持靈活性，以便進行快速的反應。

J. Define electromyography.

Electromyography is a technique which can detect and record the muscle’s electrical activities by measuring the voltage changes of the muscle cells when these cells are electrically or neurologiclly activated with electrodes.

End of Lesson 1 Data Report

Boy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0.15 0.10 0.05 0.00 mV-s
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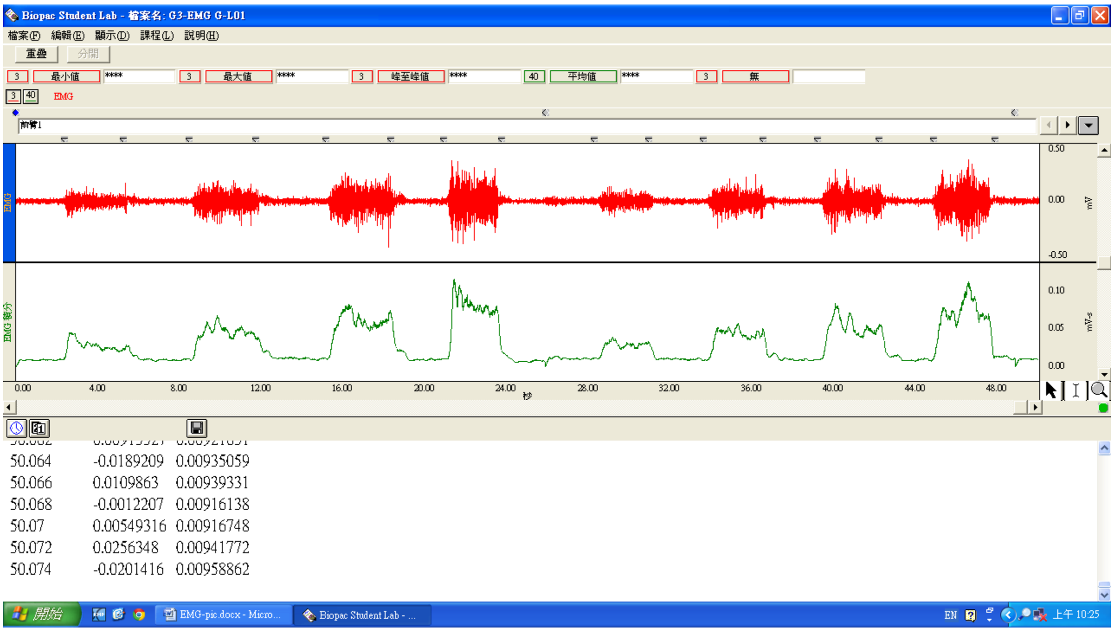
Girl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Manual Revision
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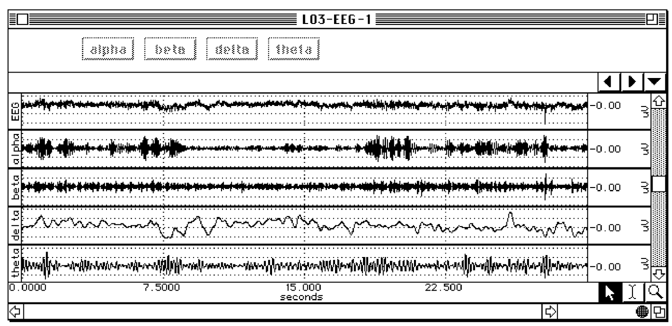
Lesson 3 Data Report

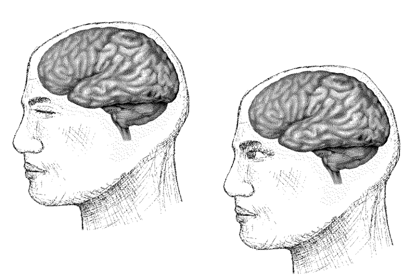
ELECTROENCEPHALOGRAPHY I

EEG I

Relaxation and Brain Rhythms

Alpha, beta, delta, and theta rhythms





Lesson 3

ELECTROENCEPHALOGRAPHY I

EEG I

DATA REPORT

Student's Name: 劉維凱 解正平 張景程

Lab Section: 3

Date: 3/23

I. Data and Calculations

Subject Profile

Name 解正平 Height 173

Age 21 Weight 66

Gender: Male or Female

A. EEG Amplitude Measurements

Complete Table 3.2 with Standard Deviation measurements:

Table 3.2 Standard Deviation [stddev]

Rhythm	Channel	Eyes Closed	Eyes Open	Eyes Re-closed
Alpha	CH 2	2.278586uV	1.293577	2.081121
Beta	CH 3	2.372860uV	1.264416	1.496023
Delta	CH 4	5.843241	6.523869	6.383193
Theta	CH 5	1.597178	1.568636	1.262293

B. EEG Frequency Measurements

Complete Table 3.3 with the frequencies for each rhythm and calculate the mean frequency:

Table 3.3 Frequency (Hz)

Rhythm	Channel	Cycle 1	Cycle 2	Cycle 3	Mean
Alpha	CH 2	10.8	11.2	11.5	11.2
Beta	CH 3	22.9	21.8	19.8	21.5
Delta	CH 4	0.35	0.23	0.25	0.28
Theta	CH 5	5.8	5.2	5.5	5.5

II. Questions

C. List and define two characteristics of regular, periodic waveforms.

1.週期是波行經介質時，介質上一個質點完成一次振動的時間

2.峰對峰值是波的最大值和最小值的差距

D. Compare and contrast synchrony and alpha block.

synchrony occurs when wave patterns & electrical activity occur at the same time.

Alpha block occurs when Beta waves dominate and mask alpha waves causing them to be desynchronized

E. Examine the alpha and beta waveforms for change between the "eyes closed" state and the "eyes open" state.

i. Does **desynchronization** of the alpha rhythm occur when the eyes are open?

Yes,because our brains will receive more inference and stimulation.

ii. Does the beta rhythm become more pronounced in the "eyes open" state?

No,it does not become more pronounced but decline in the eyes open state

F. The amplitude measurements (stddev) are indicative of how much alpha activity is occurring in the subject. But, the amplitude values for beta do not truly reflect the amount of mental activity occurring with the eyes open. Explain.

Because beta is concerned with anxiety, activity, and concentration, it will not truly reflect whether eyes open or not

G. Examine the delta and theta rhythm. Is there an increase in delta and theta activity when the eyes are open? Explain your observation.

delta波在深度睡眠時較明顯，theta波則是在成人情緒受到壓力時出現，從波形中也看不出來在眼睛睜開時有什麼特別的現象產生，我們認為delta和theta rhythm的變化可能在不同人的狀況下差異也會比較大

H. Define the following terms:

i. Alpha rhythm

brainwave with a frequency range of between 8and 13Hz with a pattern in normal persons at rest with closed eyes

ii. Beta rhythm

brainwave with a frequency range of between 13 and 30 Hz. Beta waves can be split into three sections : Low Beta Waves; Beta Waves ; and High Beta Waves

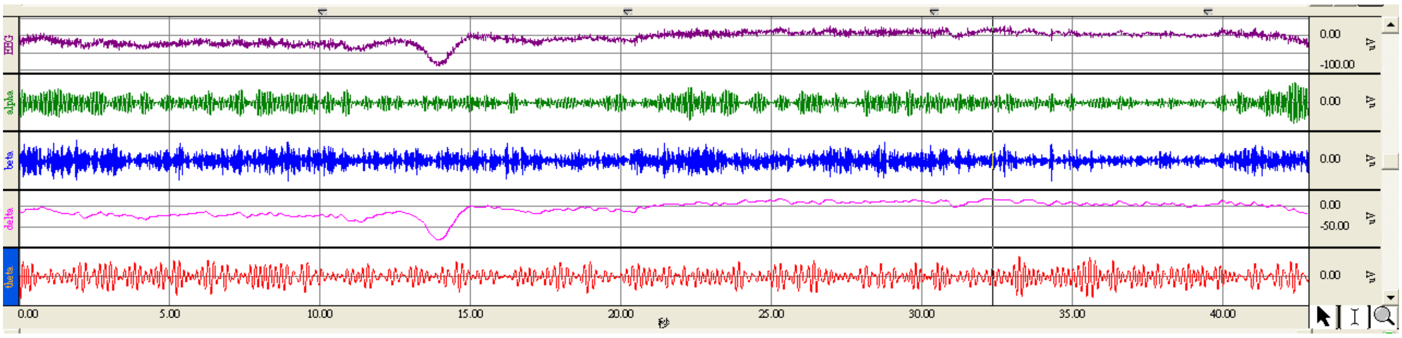
iii. Delta rhythm

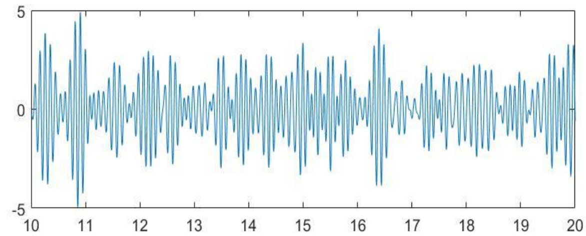
brainwave with a frequency of oscillation between 0.5–4 Hz.

iv. Theta rhythm

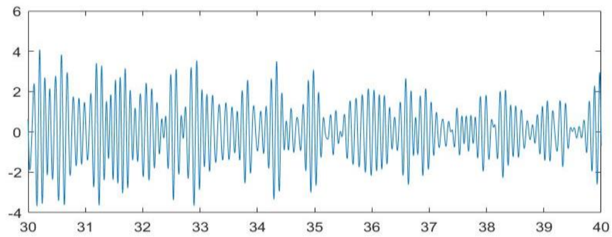
brainwave with a frequency of oscillation between 4-8 Hz.It is associated with drowsiness, childhood, adolescence and young adulthood

End of Lesson 3 Data Report

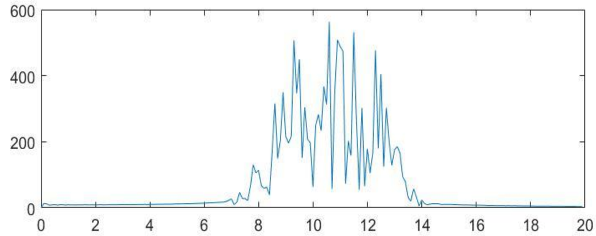


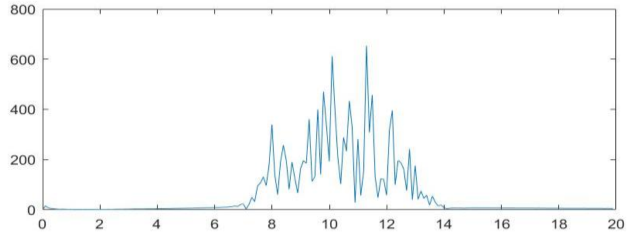


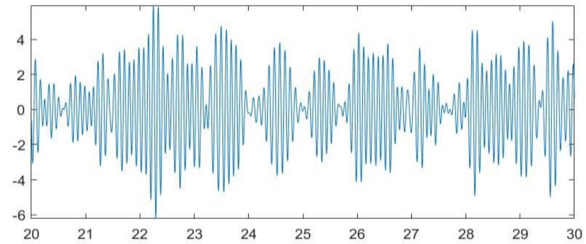
Alpha 10-20sec time and frequency domain

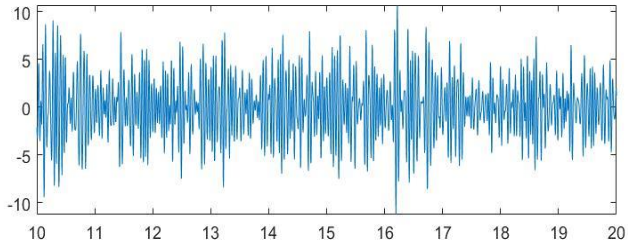


Alpha 20-30sec time and frequency domain

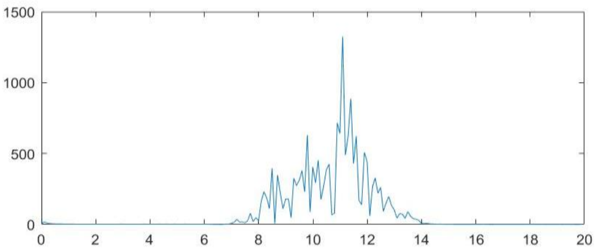




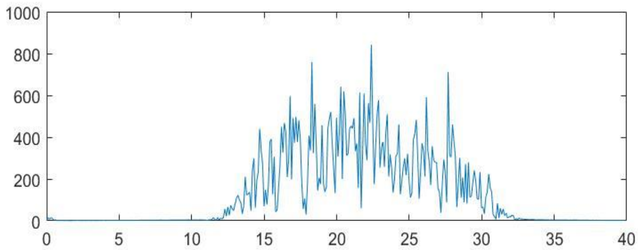


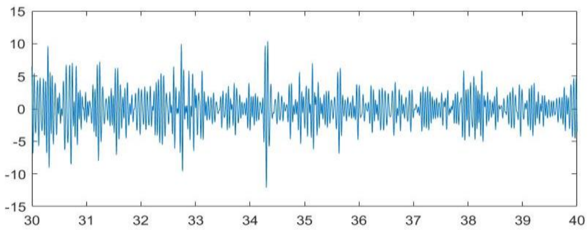


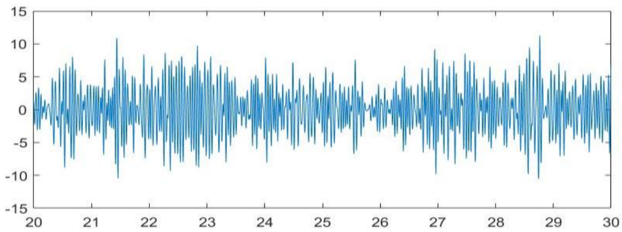
Alpha 30-40sec time and frequency domain



Beta 10-20sec time and frequency domain







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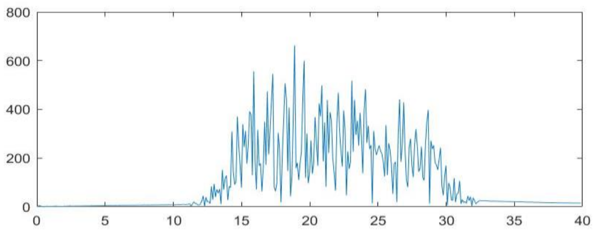

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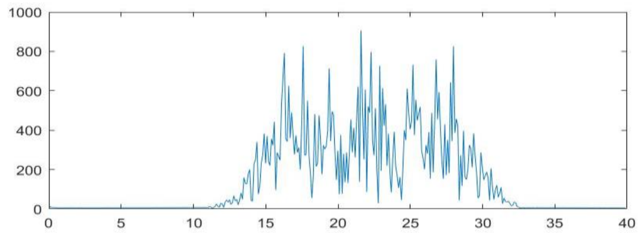
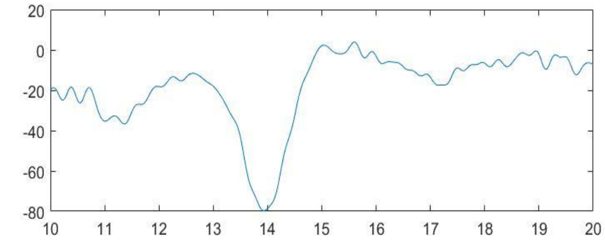
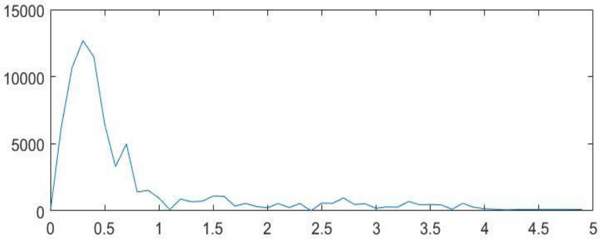
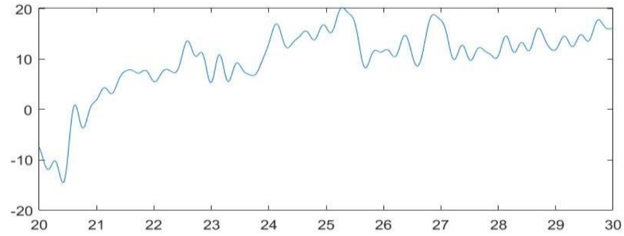




delta 10-20sec time and frequency domain





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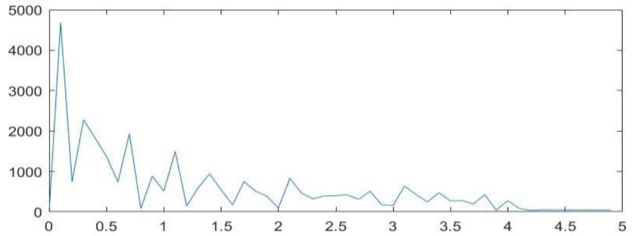

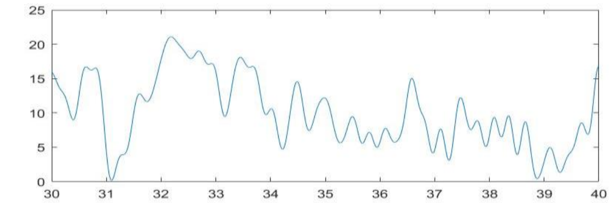

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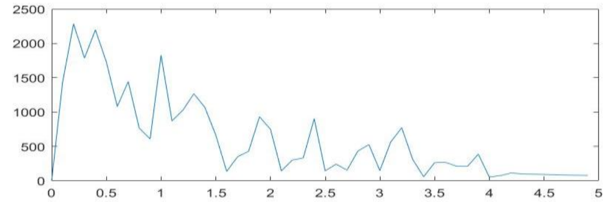
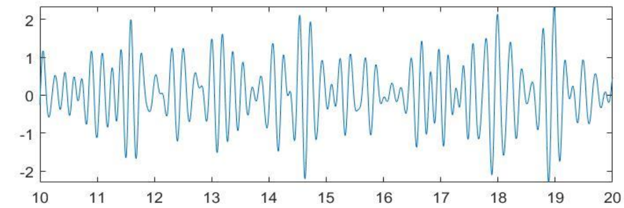
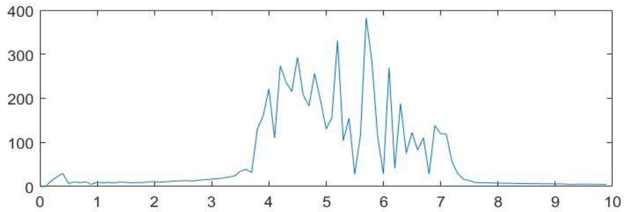
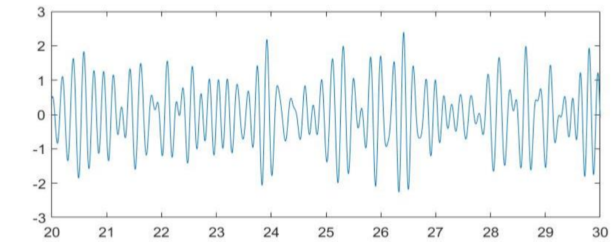




theta 10-20sec time and frequency domain





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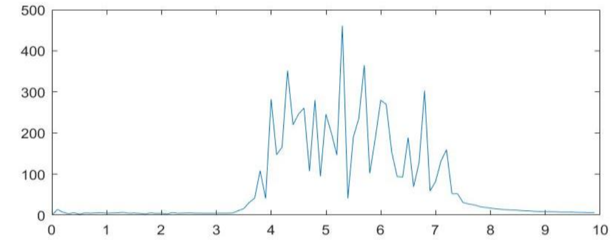

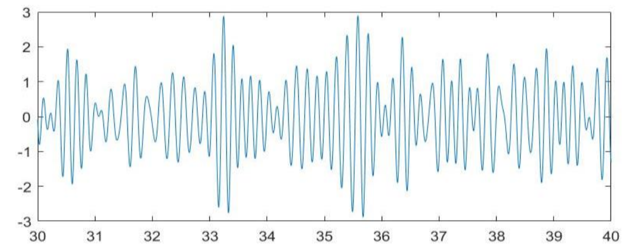

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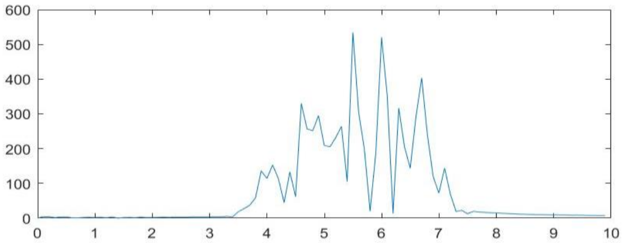
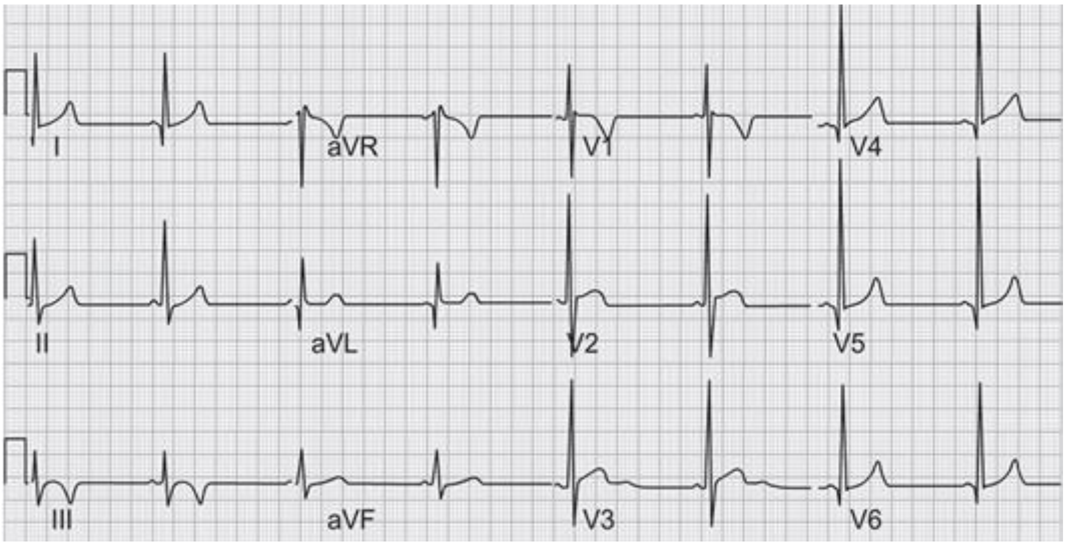


Additional questions

Question 1

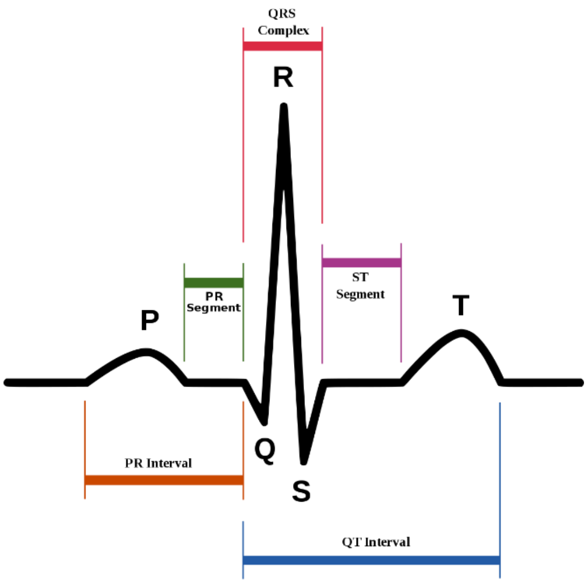
The most common configuration used in measuring ECG is Lead II. What are the key features and advantages of this configuration? What are the key features and advantages of other configurations?

Lead	key features	advantage
Lead I	R (with seeable but relatively small P and T)	One can focus on the change of R wave.
Lead II	P, QRS, T	Convenience to observe the complete diagram.
Lead III	S (with seeable but relatively small P and T)	The S wave is emphasized, which allows people to analyze the s wave easier.
aVR	S and negative T	Increase the signal of right arm
aVF	R	Increase the signal of left arm
aVL	R (relatively smaller) and T	Increase the signal of left leg
V1	R, S, T	These six leads are used to observe the electrical activity of the transverse plane of the heart.
V2	R, S, T	
V3	R, S, T(relatively bigger)	
V4	R, S, T	
V5	P, R, S, T	
V6	P, R, S, T	



■ Question 2

Based on the ECG observation, please discuss the relationship between the 'heart sounds' (心音) and the 'ventricular pressure' (心室壓力)



第一心音發生在心縮期，是其開始的標誌。音調低而時間長。這是由於血液衝擊血管，及產生的渦流，還有房室瓣的突然關閉引起的。第二心音發生在心室舒張期，音調高而時間短。是因為主動脈瓣膜與肺動脈瓣膜關閉而產生的。第三心音發生在快速充盈期末，低頻低振幅。它可能是由於心室快速充盈期末血流速度的改變，引起心壁和瓣膜的震動而造成的。第四心音又稱為心房音，它是由於心房收縮，心室主動充盈所引起的心壁和瓣膜震動引起的。

P 波對應到的是心房收縮此時心室壓力較小； QRS 是心室收縮，約在第一心音之前，此時血液被心臟打往主動脈，心室壓力最大；T 波則是心室舒張，血液由心房注入心室，心室壓力低。

■ Question 3

The simple bipolar configuration was used in measuring EEG of a specific brain region in this experiment. Please compare and discuss on the different kinds of configuration used in measuring EEG.

腦波的量測方式分為「單極誘導」與「雙極誘導」兩種類型。

單極誘導使用一個探查電極和一個參考電極黏貼固定於頭皮表面，又稱參考極之聯結組合。為對基準電極不位導出活性電極之方法。使用探查電極與參考電極之相對值作為比較，故能獲得最大的腦波振幅，一般以耳朵作為基準電極之黏貼單位。

雙極誘導使用兩個探查電極和一個參考電極黏貼固定於頭皮表面，又稱差異法之連接組合。是把頭皮上兩活性電極電位間腦波電位差經腦波計增幅後記錄下來之方法。兩探查電極皆能反映腦波訊號，故腦波振幅較小。

- Question 4

It is a consensus that EEG has better temporal resolution than the functional MRI, however, functional MRI has better spatial resolution. Please explain

FMRI 利用磁振造影來測量神經元活動所引發之血液動力的改變以生成反映脑血流变化的图像。EEG 則是將人體腦部自身產生的微弱生物電於頭皮處收集，並放大記錄而得到的曲線圖但是一個電極所覆蓋的範圍可能包含超過 10 萬個神經元，因此在空間的解析度上並不是一種理想的工具。EEG 測量來自大腦中神經元的離子電流產生的電壓波動，因此是隨時間變化的訊號，而 FMRI 則是腦中血液變化的分布圖。因此在時間解析度上來說是 EEG 比較好，反之則是 FMRI。