UNIVERSITI PUTRA MALAYSIA

MOUSE POSITIONS AND SIZES OF MOUSE AND THEIR EFFECTS ON TASK PERFORMANCE, DISCOMFORT AND INDIVIDUAL PREFERENCE AMONG UNIVERSITY STUDENTS

BY
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ABSTRACT

MOUSE POSITIONS AND SIZES OF MOUSE AND THEIR EFFECTS ON TASK PERFORMANCE, DISCOMFORT AND INDIVIDUAL PREFERENCE AMONG STUDENTS

M. Y. Chew

Introduction: Use of notebook computer is growing rapidly worldwide and replacing desktop computer especially in the education and workplaces. Task performance and body discomfort among notebook computers user becomes a major concern, as it will directly affect the productivity and health with extensive notebook computer used in the workplace. **Objective:** The aim of this study is to evaluate the effects of using an external computer mouse with different sizes and at different positions when using notebook computer. **Methods:** 52 Subjects were recruited in this experimental study to perform text-editing task over 10 minutes using large and small computer mouse at three different mouse positions (LC, LR, LF, SC, SR and SF) in a designed workstation. Their text-editing performance were calculated as total number of words edited correctly and the individual discomfort ratings were measured using visual analogue discomfort scale (VADS). **Results:** The results showed significant mouse size effect and interaction between size and position in task performance ($p < 0.0001$). The overall highest task performance was at SC condition. However, the highest task performance for large mouse, the least self-discomfort value and the highest individual preference were at LF condition. There was no significant correlation between task performances and self-discomfort, however the relationship was negative in small mouse but positive in large mouse. **Conclusion:** In conclusion, the interaction between mouse size and mouse position has an important role in affecting task performance. The point of interest raised in this paper is selection of mouse size and mouse position and suggestion of an ergonomic posture in the usage of notebook computer together with external device.

Keywords: Computer mouse, task performance, discomfort, ergonomics, notebook computer

ABSTRAK

KEDUDUKAN TETIKUS DAN SAIZ TETIKUS SERTA KESAN MEREKA KE ATAS PRESTASI TUGAS, KETIDAKSELESAAN DAN KEGEMARAN INDIVIDU DI KALANGAN PELAJAR UNIVERSITI

M. Y. Chew

Pengenalan: Penggunaan komputer riba berkembang pesat di seluruh dunia dan berada dalam pola mengambil alih penggunaan komputer atas meja terutama dalam dunia pendidikan dan dunia kerja. Prestasi tugas dan ketidakselesaan badan di kalangan pengguna komputer riba menjadi perhatian utama, kerana ia secara langsung akan menjejaskan produktiviti dan kesihatan dengan penggunaan dalam tempoh yang panjang. **Objektif:** Tujuan kajian ini adalah untuk menentukan kesan menggunakan tetikus komputer dengan saiz yang berbeza dan pada kedudukan yang berlainan apabila menggunakan komputer riba. **Metodologi:** 52 responden telah dilantik dalam kajian eksperimen ini. Mereka dikehendaki untuk melaksanakan tugas penyuntingan teks dalam 10 minit menggunakan tetikus komputer besar dan kecil di tiga kedudukan yang berbeza (keadaan LC, LR, LF, SC, SR dan SF) dalam stesen kerja yang direka. Prestasi tugas penyuntingan teks mereka dikira sebagai jumlah perkataan disunting betul. Penilaian ketidakselesaan individu telah diukur dengan menggunakan skala ketidakselesaan *visual analog* (VADS). **Keputusan:** Keputusan menunjukkan kewujudan kesan signifikan saiz tetikus dan interaksi signifikan antara saiz dan kedudukan dalam prestasi tugas ($p < 0.0001$). Prestasi tugas keseluruhan tertinggi adalah pada keadaan SC. Walau bagaimanapun, prestasi tugas tertinggi untuk tetikus besar, tahap ketidakselesaan yang paling rendah dan kegemaran individu tertinggi adalah pada keadaan LF. Walaupun tiada perhubungan yang signifikan antara prestasi tugas dan ketidakselesaan badan, tetapi hubungan negatif dikesan di kalangan tetikus kecil tetapi positif untuk tetikus besar. **Kesimpulan:** Kesimpulannya, interaksi antara saiz tetikus dan kedudukan tetikus mempunyai peranan yang penting dalam mempengaruhi prestasi tugas. Hasil daripada kertas kerja ini adalah kepentingan pemilihan saiz tetikus dan kedudukan tetikus dan cadangan postur ergonomik dalam penggunaan komputer riba bersama-sama dengan peranti luaran.

Kata kunci: Tetikus computer, prestasi tugas, ketidakselesaan, ergonomik, computer riba

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LIST OF TERMINOLOGIES

et al.	And others
N	Sample size
SD	Standard deviation
mm	millimetre
LC	Large mouse at Centre position
SC	Small mouse at Centre position
LR	Large mouse at Right position
SR	Small mouse at Right position
LF	Large mouse at Far-right position
SF	Small mouse at Far-right position
SSE	Situational Self-Efficacy test
VADS	Visual Analogue Discomfort Scale
MSD	Musculoskeletal Discomfort
SOP	Standard Operating Procedures

CHAPTER 1

INTRODUCTION

1.1 Introduction

Computer use has increased enormously since last three decades. In Malaysia, more than two-fifth of computer users spent at least two and a half hours in front of computer for various activities, including those related to entertainment, social interaction, information searching and job-related activities (Jaafar and Sulaiman, 2005). Portable computers (notebook) have been increasing in popularity over the past decade, as they do not restrict the user in terms of mobility as a desktop computer would. There is an increasing trend whereby notebook computers are used as a replacement for the desktop computer (Haesman et al., 2000). As quoted from Chin and Yow (2010), notebook will continue to be the catalyst of computer sales in Malaysia markets with sales of desktop computer decreasing sharply.

Notebook computer is essential multipurpose equipment for higher education students. Despite of mobility, a notebook computer is useful in word-processing,

Internet surfing and entertainment, which helps them in academic area as well as for relax and social purposes. Therefore, the computer users among tertiary education students are estimated to increase by years (Chin and Yow, 2010).

More recently, portable computers are being used as replacements for desktop computers, even for workers who do not require portable computer mobility (Sommerich et al., 2002). Since most of these students will work in office environment after leaving educational institutions, it is crucial to understand the notebook computer use among them. Performance of notebook computer use becomes a doubt to be questioned on, as it will directly affect the working performance related with extensive computer tasks in the future working environment.

Computer mouse is the most widely used peripheral pointing device associated with notebook computer use. Typical software programs for word processing, spreadsheet, database and graphics operations may require computer mouse use for up to two-third of the time (Johnson et al., 1993; Karlqvist, et al., 1994). The factors influencing computer work performance, which indirectly due to ergonomics issues, ranging from the workstation design, types of input tasks, mouse positions (Occupational Health and Safety unit, 2009), mouse design (Hedge et al., 1999) to sizes of mouse (Karen et al., 2008).

In the real world experience, notebook computers are used in diverse environments, such as non-adjustable table and chair sets, reclining chairs or laps (Kelaher et al., 2001). Peripheral input device especially mouse has been encouraged the integrated use in order to decrease muscular discomfort and indirectly increase task performance (Sommerich et al., 2002). Whilst the present study is designed to document the optimal selections of mouse position and size of mouse for notebook computer users where only adjustable chair is provided.

1.2 Problem Statement

There is increasing numbers of notebook computers in developing countries like Malaysia, as the compact design of notebook computer makes it a more preferable choice over the non-moveable desktop computer among not only working groups but also university students.

All notebook computers are designed to have integrated monitor, keyboard and touchpad for compactness. However, the use of computer mouse as an alternative input device upon touchpad is common regarding the purpose and location of notebook computer use. For university students, a computer mouse helps extensively in doing academic tasks as well as web browsing activities, as they are the extensive users compared to other age populations. Despite the non-adjustable working environments such as table and chair sets in library, dormitory and other

learning environments that university students may exposed to, narrower context on position of mouse and selection of size of mouse is to be studied on their effects on task performances.

1.3 Study Justification

There are few research studies on computer mouse positions and size selection in developing countries, like Malaysia, though its use is rapidly increasing in both industrial sectors and educational institutions. Little research concerning mouse task performance on notebook computer use has been conducted, so recommendations for use are currently limited and not strongly supported by sufficient evidence. There are currently neither standards or guidelines established nor baseline study in Malaysia for the suitability of mouse position and size selection for task performance.

The compact design of notebook computer provides ergonomic challenges for the user. Report of discomfort when using a notebook computer outweighs that of desktop computer (Straker et al., 1997; Villanueva et al., 1998). In addition, using of internal pointing device, i.e. touchpad of a notebook computer led to more discomforts (Sommerich et al., 2002). As a result, current prevalence methods have focused on using external input devices with notebook computers, and there are

different external notebook designs on the market that are usually small in size to improve portability.

In addition to individual factors, task performance with a notebook computer is also influenced by environmental conditions, including lighting and visual conditions, variations in temperature and humidity, furniture ergonomics and acoustics. Apart from selection of mouse according to its size, the position of computer mouse on the worktable is another essential variable influencing comfort levels of the users (Kalqvist et al., 1998; Cook and Kothiyal, 1998; Dennerlein and Johnson, 2006). Dennerlein and Johnson (2006) agreed with Karlqvist et al. (1998) in advocating a centred position of computer mouse along the centre line between the user and the keyboard provide the least muscle strain. However, this placement is dependent on the task. Therefore, study is to be carried out to document the most preferable mouse position according to type of task. This is to investigate which position of mouse can enhance task performance.

Therefore, it will be interesting to determine the optimal combination of mouse position and size of mouse towards task performance and discomfort scale, as it may instill knowledge among computer users.

1.4 Conceptual Framework

This study is to determine the most suitable combination of mouse position and size of mouse for notebook computer users. The extraneous factors like workstation environment, individual characteristics and notebook computer devices, which will affect the task performance and comfort level, will be controlled in the design of experimental study.

The interaction between human and notebook computer is through the operation of keyboard, mouse and screen. The focus of this study is on mouse, as the most popular peripheral input device after keyboard. The design, size and position of computer mouse will cause musculoskeletal and non-musculoskeletal effects on the users especially after prolonged exposure. Non-musculoskeletal effects include changes of the individual task performance, preference, and comfort level and cause mental stress. Besides, individual characteristics such as age, gender, height, and weight are to be considered. The mouse position and size of mouse, which affect the task performance, comfort level and individual preference, will be focused in this study. The conceptual framework of the proposed research is as in Figure 1.

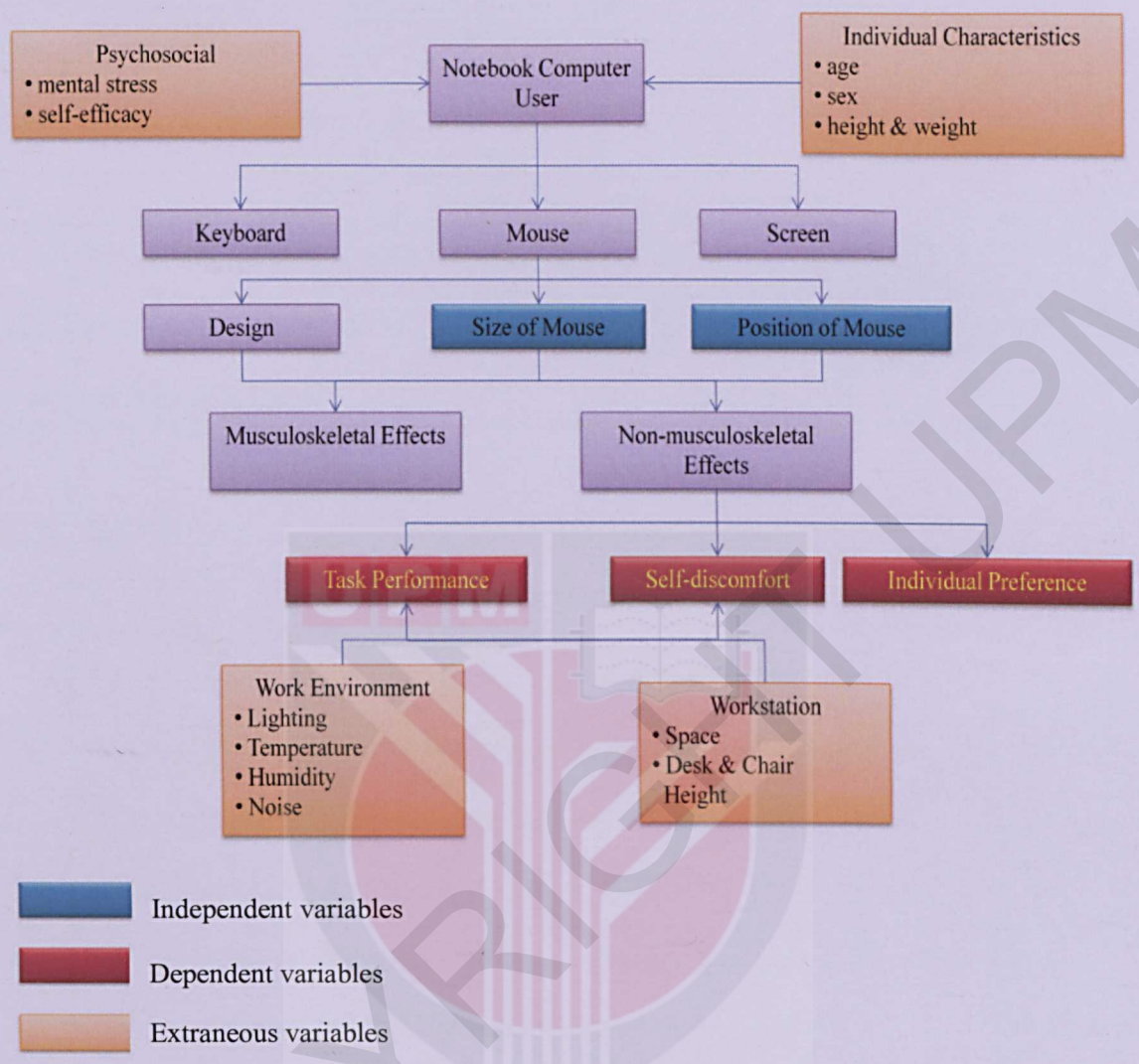


Figure 1: Conceptual Framework

1.5 Study Objective

1.5.1 General Objective

To determine mouse positions and sizes of mouse and their effects on task performance, discomfort and individual preference among the 17th College students, Universiti Putra Malaysia

1.5.2 Specific Objectives

I. To determine the socio-demography of the respondents

II. To determine the individual preference among the six combinations of three different positions of mouse and two different sizes of mouse

III. To determine the relationship between task performance and self-discomfort among the six combinations of three different positions of mouse and two different sizes of mouse

IV. To compare the task performance of respondents using mouse of different sizes

V. To compare the task performance of respondents using mouse at different positions

VI. To determine the interaction between sizes of mouse and its position based on respondents' task performance

VII. To compare the self-discomfort of respondents using mouse of different sizes

VIII. To compare the self-discomfort of respondents using mouse at different positions

1.6 Research Hypotheses

I. There is significant correlation between task performance and self-discomfort at each combination of mouse position and size of mouse

II. There is a significant difference in task performance using mouse of different sizes

III. There is a significant difference in task performance using mouse at different positions

IV. There is a significant interaction effect between mouse size and mouse position based on respondents' task performance

V. There is a significant difference in self-discomfort using mouse of different sizes

VI. There is a significant difference in self-discomfort using mouse at different positions

VII. There is a significant interaction effect between mouse size and mouse position based on respondents' self-discomfort

1.7 Definition of Term

1.7.1 Conceptual Definition

1.7.1.1 Mouse Position

Mouse position is the position of the computer mouse on a workstation surface when individual is operating the computer mouse as an external pointing input device.

1.7.1.2 Size of Mouse

Size of mouse refers to the length, width, height and weight of the computer mouse (Hengel et al., 2008).

1.7.1.3 Task Performance

Task performance is defined as the detailed examination of observable activity or behavior associated with the execution or completion of a required function or unit of work (U.S. National Library of Medicine).

1.7.1.4 Discomfort

Discomfort is defined as slight pain from physiological perspective (Oxford Dictionaries).

1.7.1.5 Individual Preference

Individual preference is one's greater liking for one alternative over another or others (Oxford Dictionaries). In this context, it refers to the individual preference for the specific mouse position and size of mouse.

1.7.2 Operational Definition

1.7.2.1 Mouse Position

The three different placement of mouse that being center position (Centre, C = Mouse is placed 15cm from the desk edge and in the mid-sagittal plane), right position (Right, R = Mouse is placed at just right side of the notebook and 15cm from desk edge), and right and far condition (Far-right, F = Mouse is placed at just right side of the notebook but at far distance (25cm) from the desk edge).

1.7.2.2 Size of Mouse

Size of mouse is determined by the measurement of length, width, height, and weight of computer mouse. The unit used for measuring length, width and height is millimeter (mm) and gram (g) for measuring weight of computer mouse.

1.7.2.3 Task Performance

Task Performance will be determined by the number of words edited correctly within the specific time (10 minutes).

Task Performance = Total number of words edited – Total number of errors

1.7.2.4 Discomfort

Discomfort is the complaint of an individual of certain body region after performing text-editing task for 10 minutes. It will be determined by Visual Analogue Discomfort Scale (VADS).

CHAPTER 2

Literature Review

2.1 Overview of Computer Mouse

Modern personal computer operating systems, such as Windows and Mac OS, present the user with a graphical user interface (GUI) that requires the use of an input device, along with a keyboard, to successful navigate and operate the system. Varieties of manual input devices are available, such as the computer mouse, touchpad, trackpoint, trackball, and joystick. Modern personal computers typically offer a computer mouse in conjunction with a keyboard as the preferred input device configuration.

The history of the use of computer mouse can be traced back to four decades ago, since its innovation Douglas Engelbart in the year of 1968 (Bardini, 2000). With introduction of graphical user interface (GUI) in 1970s and it is fast widespread in 1980s, the frequency of computer mouse use had increased steeply (Jacko & Sears,

2003). Typical software programs for word processing, spreadsheet, database and graphics operations may require computer mouse use for up to two-thirds of the time (Johnson et al., 1993).

The main instrument of input into a GUI type environment is the mouse. The mouse controls the cursor and moves it around the screen as opposed to the CLI environment where the cursor would generally move in linear motions from left to right during typing, or up, down, left, or right using the directional cursor keys. The mouse has from one to three buttons for use in selecting items on the screen to move, copy, or delete.

2.2 Task Performance

2.2.1 Factors Affecting Task Performance

2.2.1.1 Individual Factors

I. Age

Muscle strength generally attains peak level in an individual's late 20s or early 30s, and begins to decline after that period. In general, the strength of the 40 years old individual is around 5% less than that achieved at its peak. However, the strength training may influence the muscular strength decline rate (Astrand et al., 1977).

II. Sex

There is a distinct difference between males and females in terms of muscular strength. On the average, the females' muscle strength is about two thirds that of males. However, females prompt to perform better while doing task involving lower extremity muscle groups and poorer when the exertion requires great deal of upper body strength (Gallagher et al., 1998). Therefore, the different performance level of muscle activity in both sexes predicts different levels of task performance.

III. Self-Efficacy

Self-efficacy (Bandura, 1977) conceptualizes a person's perceived ability to perform on a task as a mediator of performance on future tasks. Self-efficacy have been identified as important factor of motivation which influence performance and leaerning (Eccles & Wigfield, 2002). Participants were asked to rate (from 1 to 10) their level of confidence in their ability to do well. There is extensive evidence that self-efficacy is associated with 7 higher levels of motivation and performance for civilian and military populations (Fatkin & Hudgens, 1994; Potosky, 2002).

2.2.1.2 Workplace Environment

I. Lighting

The ease of viewing a display is affected by lighting conditions. The most famous study regarding performance and lighting conditions was done at Western Electric's Hawthorne Plant in Chicago (Mayo, 1933). The researcher found that when lighting level was increased, the productivity increased and vice versa.

II. Temperature

Decrease in blood flow causes the coldness feeling of forearms and hands (Pritchard et al., 1999). Cold temperatures reduce the dexterity and sensitivity of the hand where a reduced local blood flow restraints supply of metabolites. Cold temperatures also result in application of greater grip force to hold and control objects thus influence performance (Enander and Hygge, 1990).

III. Noise

Noise from visual display units comes from the ultrasound or high-pitch noises from electrical components, such as fan, disk drive, printer, and other supplementary equipments. This kind of noises has insignificant auditory effects but can be annoying and therefore relates to mental stress (Kenen and McLeish, 1995).

IV. Workspace

According to Piccoli and his colleagues in 2000, enough space is to be provided for the notebook computer can be moved forward, backward, left, and right, in order to eliminate the necessity of holding the same posture for long periods.

2.2.1.3 Work Posture

Notebook personal computer use can affect user posture, increase discomfort and muscle activity, and hamper performance in comparison to desktop personal computer. Poor posture means posture that distorts from human natural posture. There are a minimum of three possible mechanisms for posture to affect performance. Enoka (1988) and Riccio (1993) found that poor posture could change the mechanical advantages of muscles requiring a sub-optimal neuromuscular utilization. In addition, poor posture could accelerate the onset of muscular fatigue leading to a decrement in movement coordination (Gage, 1974). Thirdly, poor posture could also lead to discomfort which could act as a distractor.

2.3 Visual Analogue Discomfort Scale (VADS)

This is a tool to measure subjective discomfort by using a 100mm VADS with labels of "no discomfort" and "extreme discomfort" (Visser and Straker, 1994) for the anterior and posterior aspects of head, neck, shoulder, and arm.

2.3.1 Neck Discomfort

Neck flexion is a risk factor leads to neck pain (Black et al., 1996). Due to less flexibility of notebook display screen and position of computer mouse, the users would have to compromise their postures when operating a notebook computer with computer mouse. Study by Kalqvist and colleagues shown that neck flexion changed significantly with different mouse positions while Straker and colleagues in 1997 found that compromise caused constraint mainly in head and neck area.

2.3.2 Shoulder and Arm Discomfort

Sigholm and colleagues found that the shoulder muscle load depends on the degree of flexion and abduction of the upper arm in the shoulder joint and the loads in the hands. Shoulder discomfort was expected to be reduced by putting mouse at the centre position in central line as suggested by Kalqvist and colleagues (1998) as this position promoted more neutral shoulder-arm join position. In addition, Kalqvist, Hagberg, and Selin (1994) found that computer mouse operators had greater outward

rotated posture of the upper arm in the shoulder joint compared with non-mouse users.

2.3.3 Hand Discomfort

Keir and colleagues (1999) found that smaller mouse had higher wrist ulnar deviation. However, in term of different mouse positions, Kalqvist and colleagues (1998) found that there was no significant difference of wrist deviation.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This was an experimental study, which was to to determine the effects of different combinations of mouse position and size of mouse on task performance, discomfort and individual preference.

3.2 Study Location

This study was conducted in a windowless room, in Occupational Safety and Health Laboratory, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. The room was controlled in terms of lighting, room temperature and layout of furniture.

3.3 Study Population

The study population was the university notebook computer users from the 17th College, Universiti Putra Malaysia.

3.4 Sampling

3.4.1 Sampling Frame

A name list was obtained from the management office of the 17th College, Universiti Putra Malaysia to recruit students who fulfill the inclusive criteria.

3.4.2 Sampling Unit

Those students, who fulfilled the inclusion criteria, males and females, aged 18 to 25 years, participated in this study. All respondents were voluntarily participating in this study by signing an informed consent prior to participation. Respondents were selected based on the following inclusive criteria:

Inclusion Criteria:

- Right hand as dominant hand
- At least one year experience of using computer mouse together with notebook computer
- No history of neck, shoulder, arm, forearm, and hand injury over the past one year
- Normal eyesight or have been corrected with eyeglasses or contact lens
- Not pregnant

3.4.3 Sampling Method

The method used to select the respondents was purposive sampling. The respondents were selected based on the inclusion criteria from a name list obtained from management office by using this sampling method.

3.4.4 Sampling Size

Since this study did not examine prevalence value, the sample size was calculated by using GPOWER version 3.1.3, statistical power analysis software, written by Franz Faul at University of Kiel, Germany. The type of statistical analysis, inputs and outputs are shown as below:

F tests – ANOVA: Repeated measures, within factors
Analysis:
A priori: Compute required sample size
Input:

Effect size f	=	0.1998768
α err prob	=	0.05
Power (1–β err prob)	=	0.8
Number of groups	=	1
Number of measurements	=	2
Corr among rep measures	=	0.5
Nonsphericity correction ε	=	1

Output:

Noncentrality parameter λ	=	8.3097529
Critical F	=	4.0303926
Numerator df	=	1.0000000
Denominator df	=	51.0000000
Total sample size	=	52
Actual power	=	0.8073112

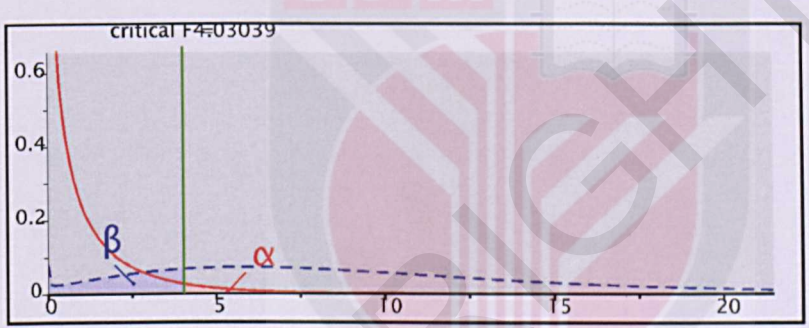


Figure 2: Central and Noncentral Distribution of Statistical Analysis using GPOWER software

Therefore, the sample size required was 52 respondents.

3.5 Method and Instrumentation

3.5.1 Study Variables

A notebook computer with 15.4 inches LCD screen was used in the study. The independent variables in this study are size of mouse, at two sizes: Large (L) and Small (S) and position of mouse placement, at three positions: Centre (C), Right (R), and Far-right (F) The dependent variables included task performance (number of words edited correctly), self-reported discomfort (VADS, mm) and individual preference.

In order to control extraneous variables, an experimental workstation with an adjustable chair with a backrest was used in the study. The seat height was adjusted according to individual preferred setting. The backrest was adjusted to accommodate individual comfort. The desk height will not be adjustable, instead a footrest was provided if the respondents would not have their feet resting flat on the floor. The contrast and brightness of the notebook computer was constant for all respondents. The experiment was conducted in a controlled room with the lighting level and room temperature maintained for all.

3.5.2 Workstation Setting

Every respondent was asked to perform text-editing task in a quiet room, which will be air-conditioned at 26°C with enough lighting to see the notebook screen clearly with minimum glare.

The workstation was adjusted according to their preferred setting with the seat height was adjustable, moveable and large enough to allow the respondents to have freedom of movement and variation of position (Pavika, 2004). The chair was provided with armrest. The backrest will allow the respondents to occasionally resting the back muscles (Granstrom et al., 1985). The room humidity was kept around 60-70% and room noise level maintained at 50 dB(A) or less.

3.5.3 Subject Information Sheet and Informed Consent

All of the participants enrolled in the research with full voluntary. Before distributing questionnaires to the respondents, a brief description of study with a consent form was distributed to the respondents in order to ensure all potential respondents gain full understanding on the research study to be done on them, regarding side effects, potential dangers, benefits, and consequences. The potential respondents were required to sign the consent form as evidence showing their willingness to participate in the research.

3.5.4 Questionnaire

Questionnaire was distributed to respondents as an instrument to obtain respondents' socio-demographic information, health status, notebook computer usage information, discomfort level, and their individual preference towards the placement of mouse position and size of mouse.

3.5.5 Workstation

3.5.5.1 Notebook Computer with Windows 7 Operating System

To perform text-editing task using ASUS notebook installed with Microsoft Words software.

3.5.5.2 Mouse Size and Position

Two mice with different sizes were used in the study, including Large, L and Small, S.

Table 1: Properties of computer mice

Size of Mouse	Length (mm)	Width (mm)	Height (mm)	Weight (g)
LARGE	100	65	40	110
SMALL	80	50	30	60

The mouse was placed at three different positions (Centre, C; Right, R, Far-right, R). The notebook computer was placed at 25cm from the desk edge for every experimental condition.

a) Centre, C

Mouse was placed 15cm from the desk edge and in the mid-sagittal plane

Figure 3: (left) LARGE mouse at CENTRE position (LC); (right) SMALL mouse at CENTRE position (SC)

b) Right, R

Mouse was placed at just right side of the notebook and 15cm from desk edge

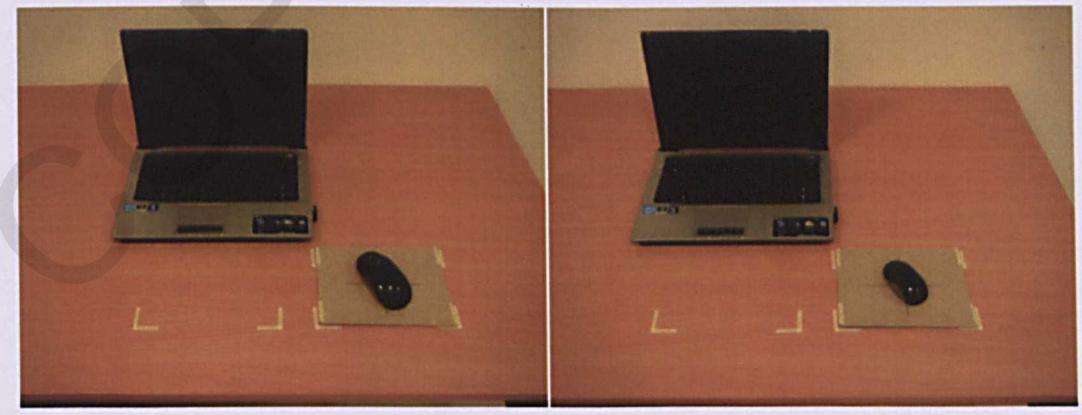


Figure 4: (left) LARGE mouse at RIGHT position (LR); (right) SMALL mouse at RIGHT position (SR)

c) Far-right, F

Mouse was placed at just right side of the notebook but at far distance (25cm) from the desk edge

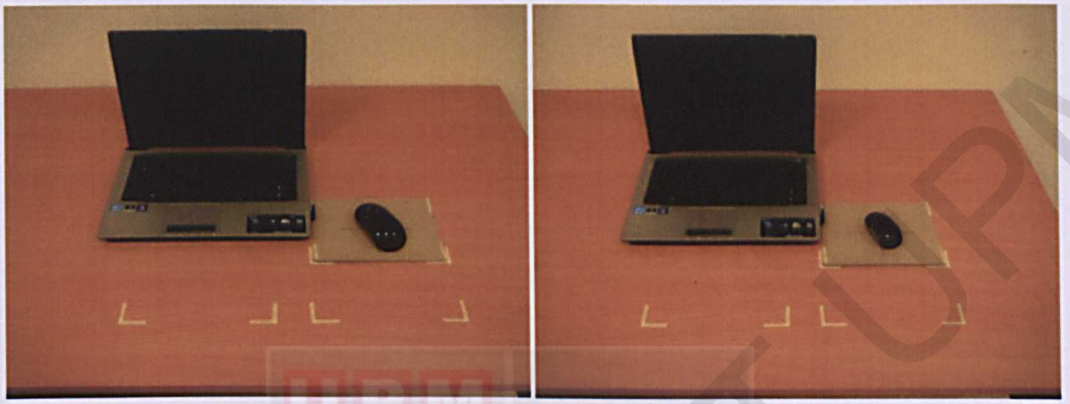


Figure 5: (left) LARGE mouse at FAR-RIGHT position (LF); (right) SMALL mouse at FAR-RIGHT position (SF)

3.5.5.3 Desk and Chair

The desk height was not adjustable while the chair height was adjustable with backrest. The chair height can be adjusted to respondents' preferred posture to accommodate the anthropometric dimensions of the respondents.

3.5.4 Visual Analogue Discomfort Scale (VADS)

Visual Analogue Discomfort Scale (VADS) was used as a tool in the questionnaire to access discomfort of the respondents (Visser and Straker, 1999). The VADS is a 100mm horizontal line, with "no discomfort" at the left side of the scale (0) and "extreme discomfort" on the right side of the scale (100).

3.5.5 Body Meter and Weighing Scale

SECA 206 Body Meter was used as the instrument to measure the body height whereas the instrument for measurement of body weight was Tanita Electronic Weighing Scale.

3.5.6 Measuring Tape

Measuring tape was used to measure the distance of placement of the workstation such as mouse position and distance with notebook computer.

3.6 Procedure

At the beginning of the study, the respondents were required to answer the pre-survey questionnaire to determine whether they meet inclusive criteria before deciding to participate voluntarily in the study. The respondent, who fulfilled the inclusive criteria and was voluntary to participate in the study, was given the information sheet and informed consent form and socio-demographic questionnaire to be filled in before the beginning of the study. Body weight and body height were measured.

Prior to performing the task, respondents were required to sit on the adjustable chair and adjust to their preferred setting in accordance with the height non-adjustable desk. Respondents was given assistance on how to adjust the display tile angle and chair height but will be given no information on recommended display tilt angle and chair height. Figure 6 showed the condition of respondent during experiment. After the respondents achieved their preferred display tilt angle and chair height, respondents was offered a familiarization period on text-editing task using a mouse which was not included in the study with mouse placement according to respondent's preference. A try-out test was given. The respondents was instructed to select highlighted characters (random location) in a word processing document, delete the text with the delete key on the keyboard using the mouse-using hand, and then enter corrected text, consisting of one to six letters, using both hands. The correct text was displayed with the work-processing document in parentheses next to the highlighted text. The respondents were instructed to work at the speed they normally used. They were also informed that the number of characters edited and the number of errors would be calculated. The reason to select text-editing task was that forces applied to the computer mouse during text editing tasks are highly correlated with regular computer mouse work task forces (Johnson et al., 1998).

After familiarization period, the respondents answered the Situational Self-efficacy test (SSE) with a scale 0 to 10 to show their confidence level to carry out the following given tasks. The respondents started the experiment with the 10 minutes text-editing task. The methodology was adopted from a number of researches

(Karlqvist et al., 1988; Gustafsson and Hagberg, 2002; Dennerlein and Johnson, 2006). The position of mouse was shown to the respondent and they were allowed to adjust the distance between them and desk before starting the task. Respondents were asked to keep the center of the mouse as close as possible within each of the three positions when correcting the given text. The testing sequence of the two mouses in each of the three mouse positions was randomized among respondents. After 10 minutes, respondents rated their discomfort on VADS immediately within 1 minute. Then, respondents were given 5 minutes break. After 5 minutes break, respondents were shown the next randomly selected size and position of mouse. They were asked to readjust the distance between them and desks based on their subjective comfort posture and complete another 10 minutes text-editing task. These processes were done every 15 minutes and overall it took 1 hour and 30 minutes to finish the tests.

At the end of each experimental condition, the respondents were required to rate their discomfort level on the VADS. Finally, at the end of the entire experimental study, the respondents were required to determine which combination of mouse size and mouse position was most preferable. The summary of data collection workflow was as shown in Figure 7.

Figure 6: Condition of respondent during experiment

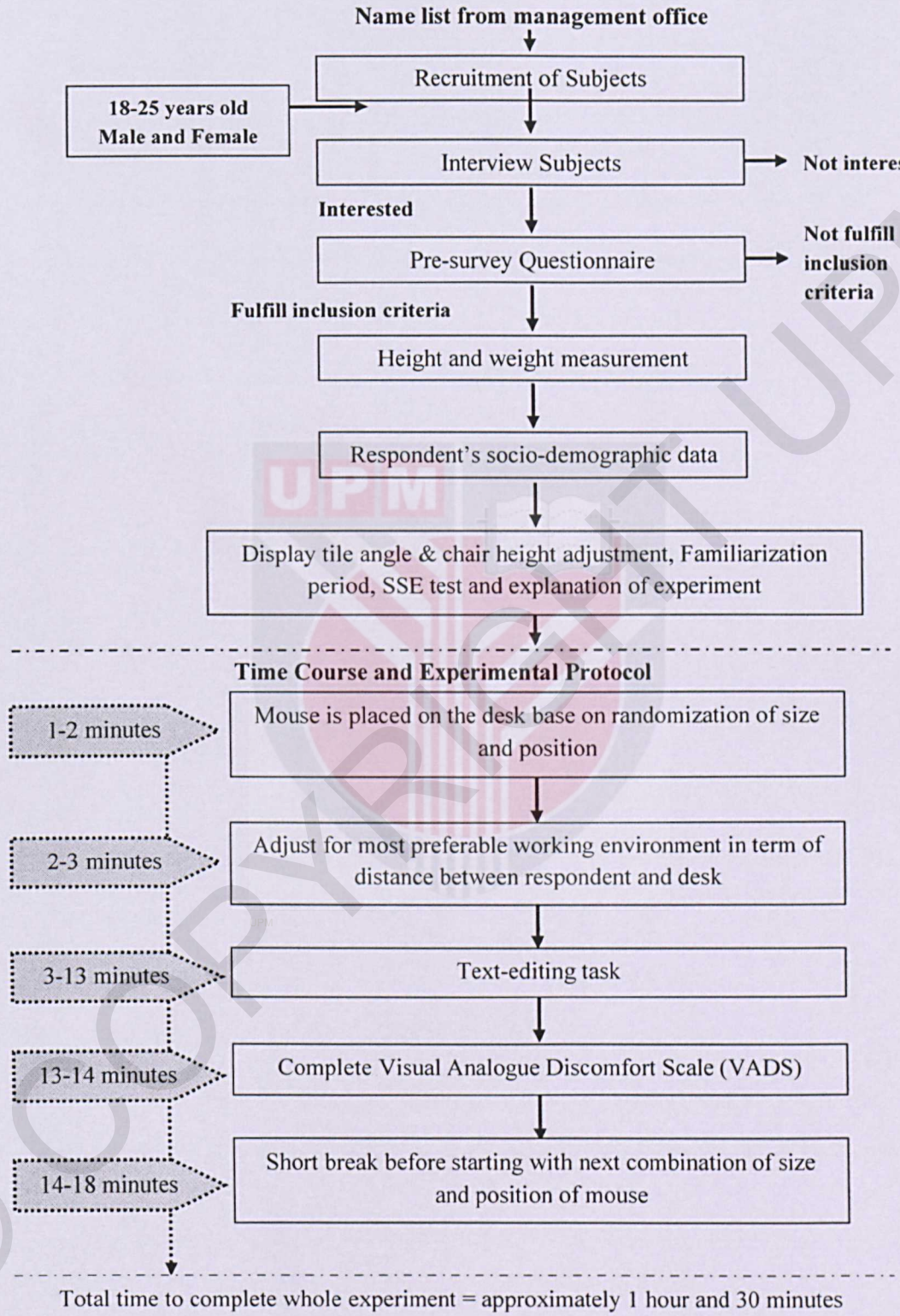


Figure 7: Experimental protocol of the study

3.7 Data Quality Control

3.7.1 Pre Testing

In order to ensure the reliability and validity, a 10% of study sample was recruited from other sample population for conducting pre-test for the questionnaire answering and the entire experimental study.

3.7.2 Standard Operating Procedures (SOP)

SOP was conducted for every instrument that was used in the proposed research, which included:

I. Height Measurement (SECA 206 Body Meter)

SECA 206 Body Meter was used for the body height measurement of respondents. The measurement was repeated twice to ensure the data is more accurate.

II. Weight Measurement (Tanita Electronic Weighing Scale)

Tanita weighing scale was used for the measurement of respondents' body weight. The measurement was repeated twice to get an average value.

3.7.3 Training for Tester

Tester was trained for proper operation of instruments included the questionnaire and the experimental protocol to ensure that the tester is familiar with them. Before starting the operation of the study, the tester carried out sufficient practice to minimize the error that may occur and to ensure the study was carried out smoothly.

3.8 Data Analysis

The data collected was analysed by using the Statistical Package for Social Sciences (SPSS) software, version 19.0. All of the data were coded and entered into SPSS software programme. After that, the data was double-checked to ensure accuracy of data transfer.

3.8.1 Test of Normality

Before any statistical analysis was carried out on the variables, normality test was used to determine the normality distributions of each variable studied in the research. The normality test being used was Shapiro-Wilk since a sample size of 40 or higher has about 80% sensitivity and specificity (Kundu, Mishra & Khare, 2011).

For the data of task performance, Table 2 showed that parameters SC, SR, LF, and SF have significant difference at $p > 0.05$. For the rest parameters, although the normality test showed not significant ($p < 0.05$), their respective skewness distribution were within the range of -2 to +2. Therefore, these parameters showed normal skewness distribution in task performance variables, with all slightly shifted to right side of the distribution curve. Thus, under this circumstance, the rest of the parameters were considered reaching the normal distribution and were analysed using parametric tests.

For the data of self-reported discomfort, however the Shapiro-Wilk test ($p > 0.05$) showed that the data were not normally distributed, thus non-parametric tests were used.

Table 2: Determination of task performance data distribution by Shapiro-Wilk test

Parameters	p value (sig.)	skewness	kurtosis
LC	0.003	0.983	1.711
SC	0.092*	0.627	0.114
LR	0.005	0.892	0.804
SR	0.581*	0.336	-0.309
LF	0.711*	0.409	0.106
SF	0.420*	0.151	0.309

*Significant difference at $p > 0.05$

3.8.2 Parametric Test

The types of analysis used for each test were as in Table 3.

Table 3: Table of statistical analyses

Objectives	Statistical Analysis
To determine the socio-demography of the respondents	Descriptive analysis (univariate)
To determine the individual preference among the six combinations of three different positions of mouse and two different sizes of mouse	Descriptive analysis (univariate)
To determine the relationship of task performance and self-discomfort among the six combinations of three different positions of mouse and two different sizes of mouse	Spearman's rho test
To compare the task performance of respondents using mouse of different sizes	paired t-test
To compare the task performance of respondents using mouse at different positions	one-way ANOVA
To determine the interaction between sizes of mouse and its position based on respondents' task performance	two-way ANOVA
To compare the self-discomfort of respondents using mouse of different sizes	Wilcoxon signed-rank test
To compare the self-discomfort of respondents using mouse at different positions	Friedman test

3.9 Ethical Concern

The study was carried out after the proposal was permitted by the Medical Research Ethics Committee, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

The respondents were given a "Subject Information Sheet" and a letter of "Informed Consent" to be signed as evidence agreeing to participate in the research. The respondents who involved in this study were purely voluntary and have the right to withdraw from this study at any time. The confidentiality of the respondents' information and privacy were preserved and used merely for the purpose of the research.

CHAPTER 4

RESULTS

4.1 Study Background

Data collection was carried out from 20th February 2012 until 17th April 2012. A total of 52 respondents had participated in this study, based on the inclusive criteria. Study respondents were selected among university students from the 17th College, Universiti Putra Malaysia (UPM). Respondents who participated in this study had at least one year experience of using computer mouse together with notebook computer.

4.2 Socio-demographic Data

The first objective of this study was to determine the socio-demographic information of the respondents. The study showed that the average age of

respondents was 21.9± 1.2 (mean ± SD) years and BMI was 20.6± 3.1 (mean ± SD). The ratio of male to female respondents recruited was 71:29. Table 4 showed the socio-demographic data of respondents.

For Situational Self-Efficacy Test (SSE) score, the scale was from 0, "not at all confident" to 10, "extremely confident". As shown in Figure 8, we can see that the minimum rating was 5 and the maximum was 9, while 7 became the mode of the score, rated by 22 respondents (42.3%).

Table 4: Socio-demographic data of respondents (N = 52)

Variable	**Frequency, N = 52**	
	N = 52	**Percentage (%)**
Age		
20	9	17.3
21	12	23.1
22	12	23.1
23	15	28.8
24	4	7.7
Sex		
Male	15	28.8
Female	37	71.2
Race		
Malay	19	36.5
Chinese	27	51.9
Indian	3	5.8
Others	3	5.8
Body Mass Index (BMI)		
Underweight (≤18.4)	15	28.8
Normal (18.5 - 24.9)	34	65.4
Pre-obese (25.0 - 29.9)	3	5.8
Obese (30.0 - 39.9)	0	0

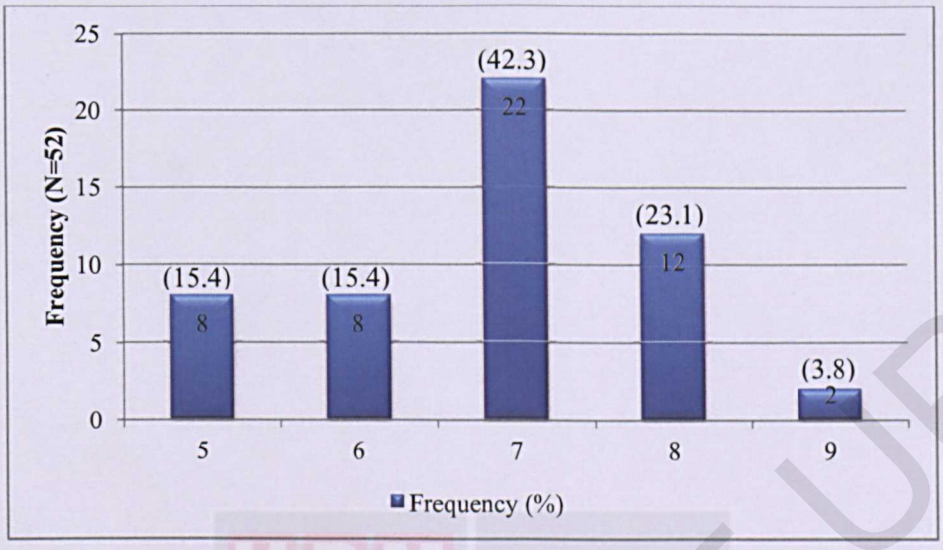


Figure 8: Situational Self-Efficacy test score (SSE) (N=52)

4.3 Background of Notebook Computer and Computer Mouse Use among Respondents

Information regarding respondents' use of notebook computer and computer mouse was obtained through self-administered questionnaire. The results were summarised in Table 5.

All of the respondents have their own notebook computer as estimated and over 90% respondents have their own computer mouse. At least three quarters (76.9%) of respondents have the habits of using computer mouse as the alternative input device of touchpad when operating their notebook computer. Almost 70% of respondents use the notebook computer together with computer mouse for less than 4 hours in a day. However, more than half (55.8%) of respondents have perform tasks

with notebook computer and computer mouse for 7 days in a week. From the self-administered questionnaire, it was also found that most of the students use notebook computer for the purpose of doing assignments (53.8%) and internet browsing (36.5%), less than 10% of respondent have most of the time using notebook computer for games and videos purposes.

Table 5: Distribution of experience for notebook computer and computer mouse use among respondents (N = 52)

Variable	Frequency, N = 52	
	N = 52	Percentage (%)
Have own notebook computer		
Yes	52	100
No	0	0
Have own computer mouse		
Yes	48	92.3
No	4	7.7
Use mouse as alternative input device in favourable condition		
Yes	40	76.9
No	12	28.8
Hours per day spent in front of notebook computer using computer mouse		
≤ 4 hours	36	69.2
$4 <$ hours ≤ 8	12	23.1
> 8 hours	4	7.7
Days per week spent in front of notebook computer using computer mouse		
≤ 3 days	7	13.5
$4 <$ days ≤ 6	16	30.8
7 days	29	55.8
Most frequent computer task performed		
Internet browsing (mouse-based task)	28	53.8
Assignment purpose (typing-based task)	19	36.5
Computer games (mouse-intensive task)	3	5.8
Watching videos	1	1.9
Computer games (integrated use of keyboard and mouse task)	1	1.9

4.4 Prevalence of Musculoskeletal Discomfort Using Notebook Computer and Computer Mouse

This study only recruited respondents who have no past medical MSD related history and those with normal eyesight or have been corrected by using lens. Additional information on respondents' prevalence of MSD complaints during the past 24 hours after usage of notebook computer has been collected from self-administered questionnaire. Figure 9 showed that shoulder and arm (38.5%) discomfort was among the highest prevalence of MSD complaint, followed by head and neck (28.8%), lower back (23.1%), hand (19.2%) and the least prevalence complaint, elbow discomfort (9.6%). Overall body discomfort was very high (N = 42, 80.8%).

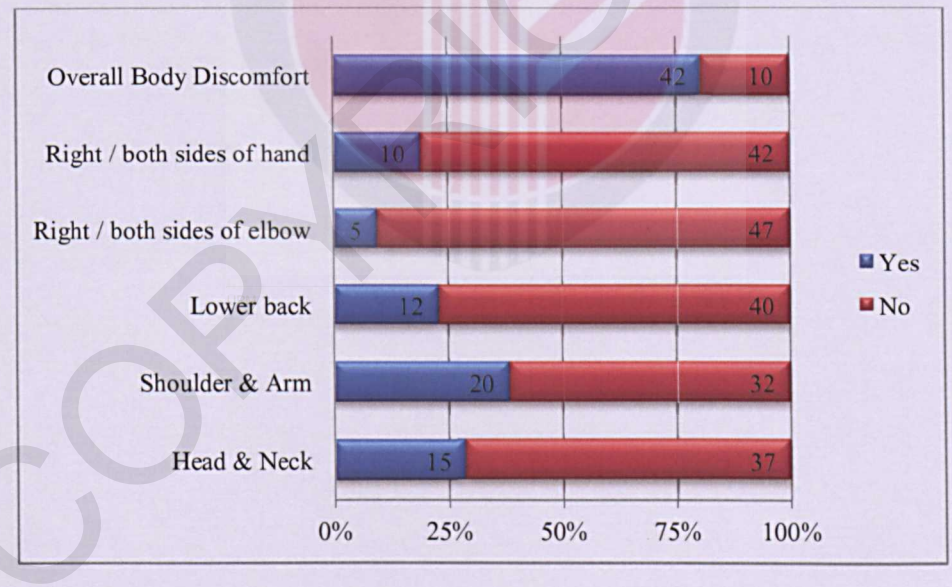


Figure 9: Musculoskeletal discomfort experienced in the past 24 hours (N=52)

4.5 Preferable Size and Position of Computer Mouse among Respondents

After the task had been carried out under all experimental conditions, the respondents were asked to select their preference over the combination of different sizes and positions of computer mouse. The most preferable combination of size and position of computer mouse was the LF (38.5%) condition, followed by SF (21.2%), LR (17.3%), SR (11.5%), SC and LC both at last place (5.8%). Figure 10 showed the individual preference among respondents.

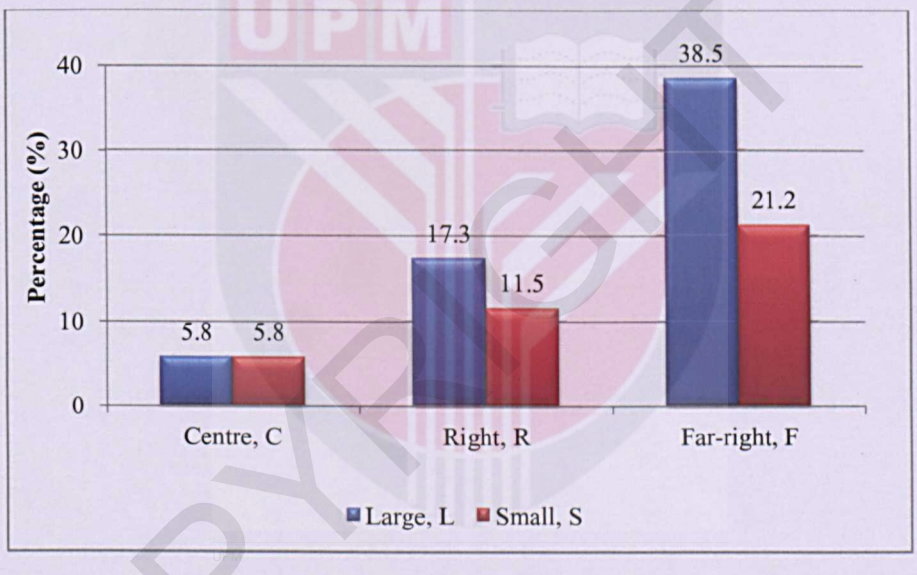


Figure 10: The preferable combination of size and position of computer mouse among respondents (N=52)

4.6 Relationship between Task Performance and Self-discomfort among the Six Combinations of Different Sizes and Positions of Mouse

The third objective was to determine the relationship between task performances and self-discomfort among respondents for all six experimental conditions. Spearman's rho test results in Table 6 showed that there were no significant correlation between task performance and self-discomfort at all conditions except for using Small mouse at Right position (SR). There was a low, negative correlation between task performance and self-discomfort at SR condition which was statistically significant. ($r = -0.330$, $p = 0.017$).

Table 6: Relationship between task performance and self-discomfort (VADS) among the six combinations of different sizes and positions of mouse (N=52)

Variable	Task Performance (r value, p value)					
	Large, L			Small, S		
VADS	**LC**	**LR**	**LF**	**SC**	**SR**	**SF**
Head & Neck	0.039	0.007	0.138	-0.207	-0.102	-0.187
	(0.785)	(0.963)	(0.329)	(0.142)	(0.473)	(0.184)
Right Shoulder	0.064	0.088	0.012	-0.146	-0.330	-0.172
& Arm	(0.654)	(0.535)	(0.933)	(0.301)	(0.017*)	(0.222)
Lower Back	0.121	-0.050	0.150	-0.105	-0.122	-0.074
	(0.394)	(0.727)	(0.289)	(0.459)	(0.387)	(0.602)
Right Elbow &	-0.053	0.110	0.150	-0.099	-0.202	-0.138
Forearm	(0.710)	(0.440)	(0.288)	(0.486)	(0.151)	(0.328)
Right Wrist &	0.074	0.011	0.268	-0.253	-0.170	-0.071
Hand	(0.601)	(0.938)	(0.055)	(0.071)	(0.228)	(0.615)

*Significant p value < 0.05

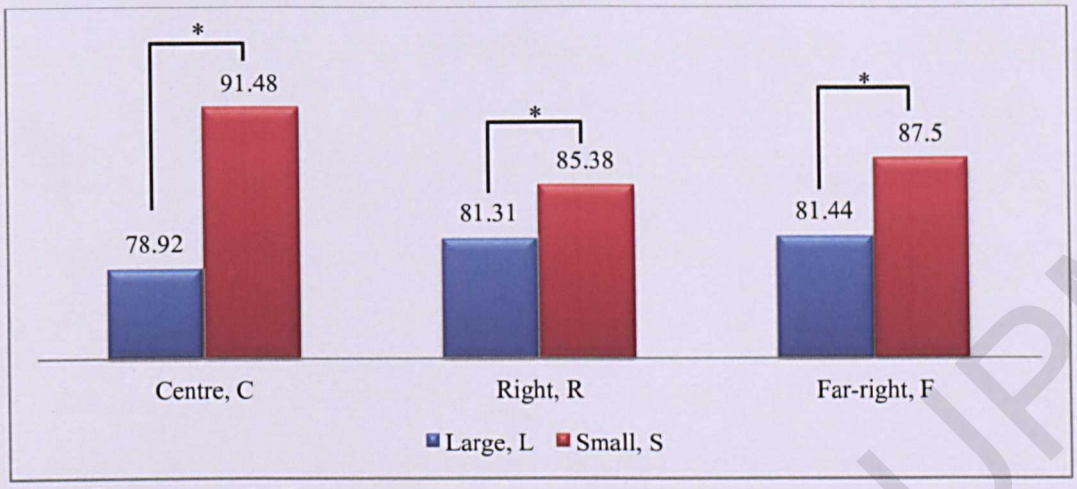
4.7 Comparison of Task Performance using Mouse of Different Sizes

The fourth objective was to compare the task performance when using mouse of different sizes. The comparison was carried out based on each position of mouse, ie. Center, Right and Far-right. Table 7 and Figure 11 showed the results. Paired t-test was used to determine the difference of task performance between LC and SC, LR and SR, as well as LF and SF. All the result of task performance for three mouse positions showed significant differences between Large and Small mice, i.e. LC and SC ($t = -7.738$, $p < 0.0001$), LR and SR ($t = -3.310$, $p = 0.002$) and LF and SF ($t = -4.071$, $p < 0.0001$). Therefore, we can see that the task performance of using Small mouse were significantly higher than the task performance of using Large mouse at all Centre, Right and Far-right positions.

Table 7: Comparison of task performance using mouse of different sizes (N=52)

Variable	Task Performance (Mean (SD))		95% CI	t value	p value
	Large, L	Small, S			
Centre, C	78.92 (15.12)	91.48 (17.20)	-15.82; -9.30	-7.738	<0.0001*
Right, R	81.31 (15.46)	85.38 (13.73)	-6.55; -1.60	-3.310	0.002*
Far-right, F	81.44 (12.62)	87.50 (16.57)	-9.05; -3.07	-4.071	<0.0001*

*Significant at $p < 0.05$



*Significant at $p < 0.05$

Figure 11: Comparison of task performance using mouse of different sizes (N=52)

4.8 Comparison of Task Performance using Mouse at Different Positions

The fifth objective was to compare the task performance at different mouse positions. The comparison was carried out based on each size of mouse, ie. Large and Small. Table 8 and Figure 12 showed the results. One-way repeated measures ANOVA was used to determine the difference of task performance between LC, LR and LF as well as between SC, SR and SF. We witnessed that there was no significant difference in task performance when using Large mouse regardless of placement of the computer mouse [$F(2, 102) = 2.260$, $p = 0.110$]. Therefore, no post-hoc analysis was required.

However, there was significant difference of using Small mouse at different positions [$F(2, 102) = 11.913$, $p < 0.0001$]. Three paired samples t-tests were used to

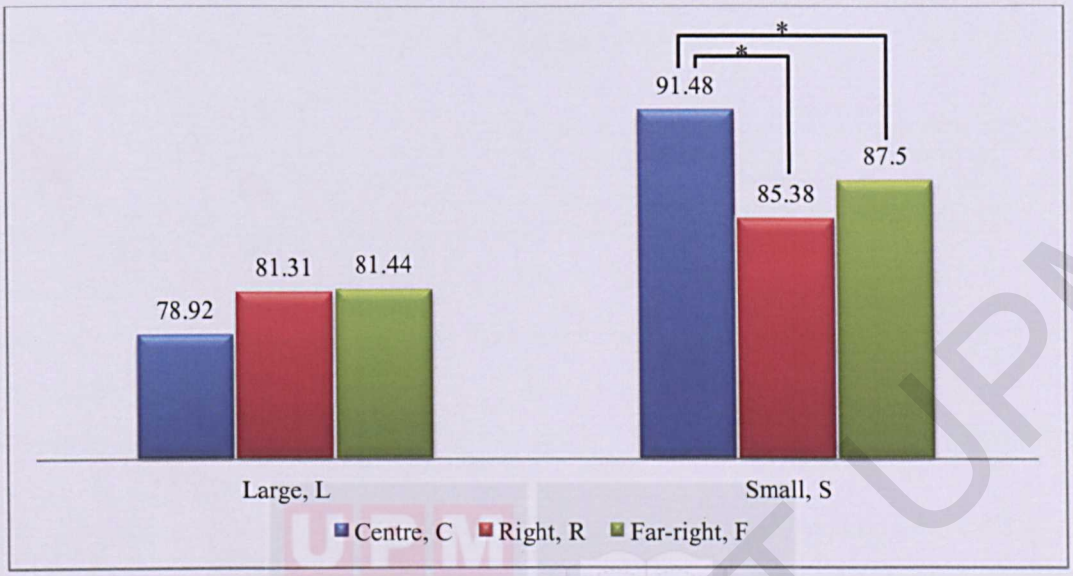
make post-hoc comparisons between positions. A first paired samples t-test indicated there was a significant difference in the task performance for SC (91.48±17.20) and SR (85.38±13.73) conditions; $t = 4.542$, $p < 0.0001$. A second paired samples t-test indicated that there was a significant difference in the task performance for SC (91.48±17.20) and SF (87.50±16.57) conditions; $t = 3.244$, $p = 0.002$. A third paired samples t-test indicated that there was no significant difference in the task performance for SR (85.38±13.73) and SF (87.50±16.57) conditions; $t = -1.717$, $t = 0.092$. These results suggested that mouse positions really have an effect on task performance when using Small mouse. Specifically, the results suggested that when in SC condition, the respondents performed the text-editing task significantly better than in SR and SF conditions. However, there was no real difference in task performance when comparing SR and SF conditions.

Table 8: Comparison of task performance at different mouse positions (N=52)

Variable	Task Performance (Mean (SD))			F value	p value
	Centre, C	Right, R	Far-right, F		
Large, L	78.92	81.31	81.44	2.260	0.110
	(15.12)	(15.46)	(12.62)		
Small, S	$91.48^{a,b}$	85.38^{a}	87.50^{b}	11.913	<0.0001*
	(17.20)	(13.73)	(16.57)		

*Significant at $p < 0.05$

$^{a, b}$ means with different superscripts differ significantly at $p < 0.017$ (pairwise comparison using paired samples t-test)



*Significant at $p < 0.017$

Figure 12: Comparison of task performance using mouse at different positions (N=52)

4.9 Interaction between Size and Position of Mouse towards Task Performance

The sixth objective of the study was to determine the interaction between size and position of mouse based on respondents' task performance. Two-way within subject ANOVA was carried out and the results were shown in Table 9. It showed that there was a significant main effect of mouse sizes [$F(1, 51) = 67.722$, $p < 0.0001$] and significant interaction existed in between size and position of mouse [$F(2, 102) = 10.278$, $p < 0.0001$] towards task performance. However, position of mouse did not have significant main effect on task performance [$F(2, 102) = 2.377$, $p = 0.098$].

Table 9: Interaction between size and position of mouse towards task performance (N=52)

Source	df	F value	p value
Size	1	67.722	< 0.0001*
Error (Size)	51		
Position	2	2.377	0.098
Error (Position)	102		
Interaction (Size*Position)	2	10.278	< 0.0001*
Error (Size*Position)	102		

*Significant at $p < 0.05$

Since there was a significant main effect of mouse size on task performance, the statistical data in Table 10a showed that the minimum value of task performance using Small mouse (mean = 88.12) was greater than using Large mouse (mean = 80.56). This meant that the respondents performed better on the given text-editing task by using Small mouse.

Table 10a: Estimated marginal means of size of mouse on task performance (N=52)

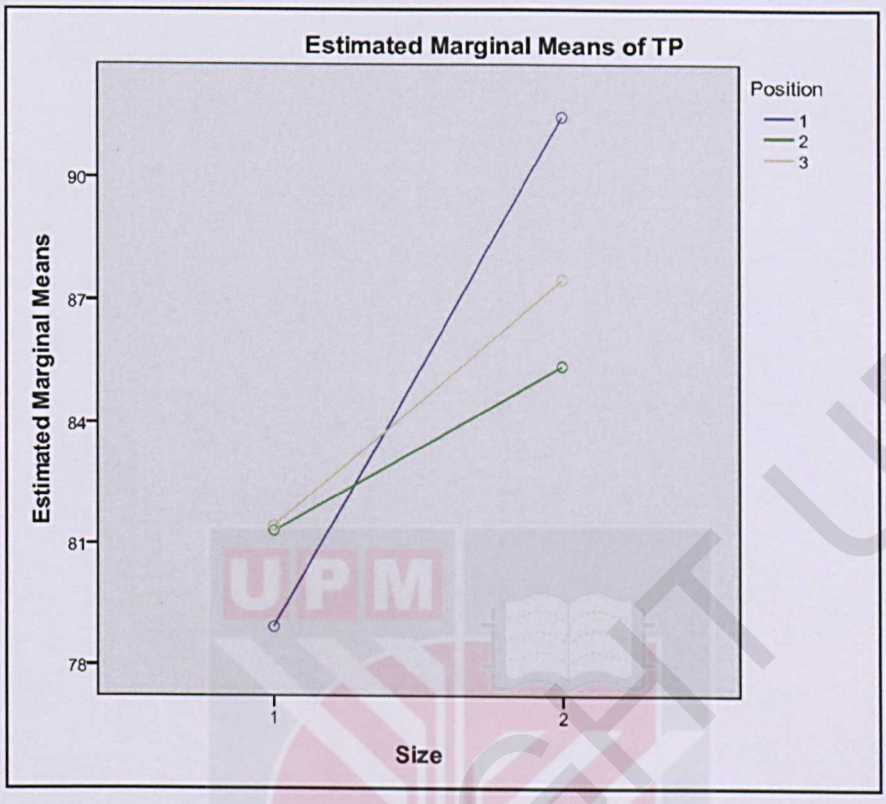
Size of Mouse	Mean	Std. Error	95% CI	
			Lower Bound	Upper Bound
Large, L	80.56	1.85	76.84	84.27
Small, S	88.12	2.08	83.94	92.30

Table 10b showed that the best task performance was when using Large mouse at Far-right position, LF (mean = 81.44), while using Large mouse at Centre position, LC gave the poorest task performance (mean = 78.92). For Small mouse, placing mouse at Centre position, SC gave the best task performance (mean = 91.48) but poorest task performance was shown when placing the Small mouse at Right position, SR (mean = 85.39).

These results indicated that when using Large mouse, best task performance was recorded at Far-right position, but when using Small mouse, respondents tend to give the best task performance by using it at Centre position. The results were summarised in Figure 13, where the steep slopes of all three lines showed that there was a significant mouse size effect; the crossing of all three lines indicated there was no significant mouse position effect; while there was a significant interaction effect since the lines were not parallel.

Table 10b: Estimated marginal means of interaction of size and position of mouse on task performance (N=52)

Size*Position		Mean	Std. Error	95% CI	
				Lower Bound	Upper Bound
L	C	78.92	2.10	74.71	83.13
	R	81.31	2.14	77.01	85.61
	F	81.44	1.75	77.93	84.96
S	C	91.48	2.39	86.69	96.27
	R	85.39	1.90	81.56	89.21
	F	87.50	2.30	82.89	92.11



TP = Task Performance
Position 1 = Centre (C); Position 2 = Right (R); Position 3 = Far-right (F)
Size 1 = Large (L); Size 2 = Small (S)

Figure 13: Interaction plots of size and position of mouse on task performance

4.10 Comparison of Self-discomfort using Mouse of Different Sizes

The seventh objective was to compare the self-reported discomfort of respondents using mouse of different sizes. Wilcoxon signed-rank test on the VADS scores (body parts: head and neck, right shoulder and arm, lower back, right elbow and forearm, right wrist and hand) was done to compare the discomfortness for two different mouse sizes.

Apparently from Table 11, all the results of VADS did not show significant differences between Large and Small size of mouse ($p < 0.05$) at all mouse positions. Lower back VADS score between Large and Small size of mouse at Right position, however, showed a close-to significant difference value ($t = -1.712$, $p = 0.087$).

Table 11: Comparison of self-discomfort (VADS) using mouse of different sizes (N=52)

Variable	VADS Median (IQR)		t value	p value
	Large, L	Small, S		
Centre, C				
Head & Neck	6.0 (28)	5.0 (25)	-0.060	0.952
Right Shoulder & Arm	14.0 (24)	17.5 (37)	-0.884	0.377
Lower Back	3.5 (18)	4.0 (21)	-0.402	0.688
Right Elbow & Forearm	10.0 (35)	10.5 (27)	0.296	0.767
Right Wrist & Hand	9.5 (28)	9.5 (23)	-0.157	0.875
Right, R				
Head & Neck	10.0 (24)	5.5 (21)	-0.951	0.342
Right Shoulder & Arm	11.5 (30)	15.5 (46)	1.062	0.288
Lower Back	4.0 (21)	1.5 (14)	-1.712	0.087
Right Elbow & Forearm	9.5 (24)	7.0 (22)	-0.108	0.914
Right Wrist & Hand	8.0 (20)	11.0 (22)	1.458	0.145
Far-right, F				
Head & Neck	7.5 (24)	6.5 (19)	-0.653	0.514
Right Shoulder & Arm	8.0 (24)	11.5 (31)	1.389	0.165
Lower Back	4.0 (13)	2.0 (12)	-0.284	0.776
Right Elbow & Forearm	4.0 (17)	5.0 (23)	1.251	0.211
Right Wrist & Hand	4.0 (19)	7.0 (17)	1.472	0.141

4.11 Comparison of Self-discomfort using Mouse at Different Positions

The eighth objective was to compare the self-reported discomfort of respondents using computer mice at different positions. Friedman test on the VADS scores (body parts: head and neck, right shoulder and arm, lower back, right elbow and forearm, right wrist and hand) was done to compare the discomfortness for three different mouse positions.

The Friedman test showed significant differences in right shoulder and arm VADS score [$\chi^2(2) = 8.092$, $p = 0.017$] as well as in right wrist and hand VADS score [$\chi^2(2) = 9.476$, $p = 0.009$] when using Large mouse at different positions. While using Small mouse at different positions, only lower back VADS score [$\chi^2(2) = 6.700$, $p = 0.035$] gave a significant difference. These were shown in Table 12.

Post-hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.017$. There was only right shoulder and arm VADS score in LC, LR and LF conditions showed significant differences in post-hoc analysis. There were statistically reduction in discomfort between the LC (9.5±27.5) and LF (4±18.75) conditions ($Z = -2.797$, $p = 0.005$) as well as between the LR (8±19.75) and LF (4±18.75) conditions ($Z = -2.587$, $p = 0.010$). However, there was no significant difference between the LC and LR conditions ($Z = -0.438$, $p = 0.662$).

These results suggested that mouse positions really have an effect on right shoulder and arm VADS score when using Large mouse. Specifically, the results suggested that when in LF condition, the respondents had experienced right shoulder and arm discomfort significantly lesser than in LC and LR conditions. However, there was no real difference in this body part discomfort when comparing it in LC and LR conditions.

Table 12: Comparison of self-discomfort (VADS) using mouse at different positions (N=52)

Variable	VADS Mean (Mean Rank)			χ^2 (df)	p value
	Centre, C	Right, R	Far-right, F		
Large, L					
Head & Neck	16.67	16.27	16.04	0.05	0.975
	(1.98)	(2.00)	(2.02)	(2)	
Right Shoulder & Arm	20.19[a]	20.48[b]	15.54[a,b]	8.092	0.017*
	(2.19)	(2.10)	(1.71)	(2)	
Lower Back	10.56	12.25	9.15	3.536	0.171
	(2.08)	(2.10)	(1.83)	(2)	
Right Elbow & Forearm	18.29	15.65	11.58	5.867	0.053
	(2.20)	(2.02)	(1.78)	(2)	
Right Wrist & Hand	17.19	13.33	13.12	9.476	0.009*
	(2.30)	(1.92)	(1.78)	(2)	
Small, S					
Head & Neck	16.52	14.08	14.21	0.037	0.982
	(2.01)	(1.98)	(2.01)	(2)	
Right Shoulder & Arm	23.38	24.83	18.71	4.113	0.128
	(2.05)	(2.16)	(1.79)	(2)	
Lower Back	12.63	7.92	7.67	6.700	0.035*
	(2.22)	(1.97)	(1.81)	(2)	
Right Elbow & Forearm	18.12	15.79	13.33	3.802	0.149
	(2.18)	(1.98)	(1.84)	(2)	
Right Wrist & Hand	14.50	16.83	13.13	0.335	0.846
	(2.06)	(1.98)	(1.96)	(2)	

*Significant at p value < 0.05

[a, b] means with different superscripts differ significantly at $p < 0.017$ (pairwise comparison using Wilcoxon signed-rank tests)

4.12 Interaction between Size and Position of Mouse towards Self-discomfort

After carrying out normality test (Shapiro-Wilk test), the data distribution of self-discomfort (VADS) was not normal ($p > 0.05$). All the data of self-discomfort VADS scores for body parts: head and neck, right shoulder and arm, lower back, right elbow and forearm, right wrist and hand had the results of Shapiro-Wilk test significant p value less than 0.0001. All of the data were positively skewed to the right with the lowest skewness of 0.769 for shoulder and arm VADS score in SR condition, and the highest skewness of 2.268 for lower back VADS score in LF condition.

Since the distribution of the data was extremely not normal, positively skewed and contained zero value as it was continuous data, data transformation was unable to be carried out, as the interpretation would become impractical. Moreover, the objective was to find interaction, transforming a non-normally distributed data might resulted in false positive or negative significant interaction effect.

It seemed that the solution was to use non-parametric test equilibrium to two-way repeated measures ANOVA for the data analysis. However, there was meaningless to perform this data analysis because a disadvantage of non-parametric was their inability to handle multivariate questions (Munro, 2005, p.110).

CHAPTER 5

DISCUSSION, CONCLUSION, RECOMMENDATION

5.1 Study Background

This study involved 52 respondents from the 17th College, Universiti Putra Malaysia. The factor of age controlled in this study was only the undergraduate students in the range from 18 years old to 25 years old. This is because this population becomes the massive notebook computer users mainly due to the academics and also co-curriculum assignments, as well as they are the generation which was born to be living in the era of technological advances.

In this study, the range of age was from 20 to 24 years old with the mean age of 21.9± 1.2 (mean ± SD) years. Most of the respondents are within the normal BMI, 15 respondents are underweight whereas only 3 respondents are pre-obese. There were 28.8% respondents who are males and 71.2% female respondents recruited. This is in line with the current ratio of male to female tertiary enrollment in UPM,

which is 67:33, as stated by Minister of Higher Education, Datuk Seri Khalid Nordin ("New University Programme", 2011).

Situational Self-Efficacy Test (SSE) were answered by the respondents and the results showed that all of the respondents have medium to high confidence level to carry out well the experiment after instruction and tryout were given.

5.2 Experience of Using Notebook Computer and Computer Mouse

All of the respondents were well exposed to notebook computer usage because all of them acquire personal notebook computer but there were 4 respondents do not have their own computer mouse, instead they perform all computer task using touchpad on top of the notebook computer at most of the time. However, these 4 respondents were considered competent users using computer mouse because all of them have come into contact with computer mouse when operating desktop computer at their home.

Out of the 48 respondents who have their own computer mouse, 8 respondents (16.7%) do not use computer mouse to substitute the function of touchpad. Additional questions were asked on them and they claimed that they have experienced muscle strains at the wrist of their right hand after prolonged use of the touchpad.

From the questionnaire, there were 69.2% of respondents who use the notebook computer together with computer mouse for less than 4 hours per day. Most of these respondents were those who seldom use computer mouse as the alternative input device for touchpad. The reasons given by them were that they were lazy to take out and put in the computer mouse every time using it although the conditions were favourable, for example, abundant of workspace with desk and chair povided in their rooms, library and cafes.

Over 85% of the respondents have averagely use their notebook computer and computer mouse for at least 4 days in one week. This also shows that the respondents were intensive users of notebook computer together with computer mouse.

From the question of the most frequent task carried out using notebook computer, we observed that over half of the respondents made use of their notebook computer to perform internet browsing activities. They browsed through internet to search information for academics purposes, current events, as well as for leisure times. Also, the second most frequent (36.5%) activity carried out by the respondents was using notebook computer to do their assignments, which was a keyboard-intensive task. Most of them claimed that they only spent little time in searching information in the internet.

5.3 Prevalence of Musculoskeletal Discomfort among Respondents

This study only recruited respondents who have no past medical MSD related history and those with normal eyesight or have been corrected by using lens. Additional information on respondents' prevalence of MSD complaints due to past 24 hours after usage of notebook computer has been collected from self-administered questionnaire. Shoulder and arm (38.5%) discomfort is among the highest prevalence of MSD complaint. This may be due to the not appropriate position of the computer mouse integrated with the notebook computer in use, as well as that the desk height is over the elbow height therefore causing abduction of the arms.

5.4 Comparison of Task Performance using Mouse of Different Sizes

The fourth objective of the study was to determine the task performance among respondents using mouse of different sizes. The study shown that at every mouse position, Small mouse yielded a better task performance than Large mouse. The reason for this could be that respondents could enclose their whole hand around the Small mouse, and only moved the mouse with their fingers. This was in line with the research by Hengel et al. in 2008.

5.5 Comparison of Task Performance using Mouse at Different Positions

The fifth objective was to determine the task performance among respondents when using mouse at different positions. Table 8 showed that Large size of mouse does not affect the task performance regardless of position of the mouse but Small mouse resulted in the best task performance at Centre position and secondly Far-right position. This is supported by the studies by Dennerlein and Johnson (2006) where the muscle activity of forearm was the lowest. Huysmans and colleagues (2006) also proved that mouse tracking performance reduced with forearm muscle fatigue especially in the extensor carpi radialis. Other studies advocated central mouse position with the mouse between the keyboard and the body in body's mid-sagittal plane due to that it promoted significant decrease in external rotation of hand posture (Karlqvist et al., 1998 and Sommerich et al., 2002).

5.6 Interaction between Size and Position of Mouse towards Task Performance

After discussing the comparison of sizes and positions respectively on the task performance, the sixth objective was to determine the interaction between these two independent variables on the task performance. Table 9 clearly showed that there is significant mouse size effect and significant interaction exists between size and position of mouse towards task performance. Small mouse promotes better task

performance regardless of the effect of mouse position. However, mouse position does not have significant main effect on task performance for both sizes of mouse. This is considered as a pilot study whereby no previous research that I have studied has examined this interaction.

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5.7 Comparison of Self-discomfort using Mouse of Different Sizes

The seventh objective was to determine the level of self-discomfort of respondents when using mouse with different sizes. However, no significant result was found. The possible reason for this is that the short duration (10 minutes) of exposure to each experimental condition.

5.8 Comparison of Self-discomfort using Mouse at Different Positions

The eighth objective was to determine the level of self-discomfort of respondents when using mouse at different positions. Significant results of self-discomfort were detected on right shoulder and arm for Large mouse. The most discomfort position of using Large mouse was at the Right position and followed closely by the Centre position. The most comfort position is the Far-right position (Karlqvist et al., 1998).

5.9 Correlation between Task Performance and Self-discomfort

The third objective of the study was to determine the relationship between task performance and self-discomfort across two different sizes of mouse and three different mouse positions. There was only one low and significant correlation between task performance and right shoulder and arm discomfort in SR condition. The possible reason for this is that the short duration (10 minutes) of exposure to each experimental condition.

5.10 Preferable Size and Position of Computer Mouse among Respondents

Subjective preference over combinations of size and position of mouse was obtained from respondents at the end of the study. The respondents select their preferable combination mainly based on comfort rather than task performance, i.e. prefer Large mouse over Small mouse particularly at Far-right and Right position. Large mouse also has a higher ranking over smaller mouse in the study by Hengel and colleagues (2008). Feedbacks from respondents indicated their least preference with Large mouse at Centre position was because they are not familiar with the position, thus a mouse bigger in mouse restricted their ease of control. In term of mouse position, Far-right position is the most preferable and this is similar to the research findings from Karlqvist and colleagues (1998).

5.11 Study Limitation

The limitation of this study was that the short duration of exposure (10 minutes) to each test condition did not expose the respondents to the real work tasks in psychological pressures. In addition, some of them claimed that perceived discomfort was not clearly felt because of the short duration of exposure. Furthermore, the tests were conducted within laboratory setting.

5.12 Conclusion

I. The socio-demographic information of the respondents was determined using the self-administered questionnaire.

II. In term of individual preference, the LF condition was most preferred by most of the respondents while the LC condition was least preferred.

III. There was only a significant correlation detected between task performance and right shoulder and arm discomfort among respondents in SR condition. However, there was negative correlation observed for Small mouse but positive correlation for Large mouse across most of the experimental conditions.

IV. For all Centre, Right and Far-right positions, the task performance were significantly different between Large and Small mouse, with Small mouse showing the best task performance at each position.

V. The task performance between Centre, Right and Far-right positions was not significant when using Large mouse, while for Small mouse, it was significant with SC condition showing the best task performance.

VI. There was a significant main effect of mouse size on task performance and there was a significant interaction between size and position of mouse towards task performance. However, there was no significant main effect of mouse positions.

VII. There was no significant difference of self-discomfort between Large and Small mouse for all positions.

VIII. For Large mouse, there were significant differences of right shoulder and arm discomfort and right wrist and hand discomfort among Centre, Right and Far-right positions. For Small mouse, there was a significant difference of lower back discomfort among Centre, Right and Far-right positions. The self-discomfort was significantly lowest for right shoulder and arm at LF condition.

5.13 Recommendation

Based on the information collected in this study, the prevalence of musculoskeletal discomfort on the body regions after using computer was very high (80.8%). Factors in the computer work environment and awkward sitting postures may cause musculoskeletal disorders. Computer workstation furniture and equipment with high quality and ergonomically positioned and adjusted are thus very crucial (Karlqvist et al., 2002). It is very important to enhance the office ergonomics knowledge about the proper posture using notebook computer among the users. From this study, it is recommended that LF combination is the most suitable since it showed the lowest discomfort value, the highest number of individual preference and the best performance in Large mouse factor.

However, this study was conducted in laboratory setting, which involved usage of computer mouse and notebook keyboard in a short period (10 minutes for each experimental condition) under controlled experimental conditions. It is recommended that this study to be further studied at the field setting to the actual working condition.

The result of task performance is the highest at SC condition and Centre position was examined and recommended in previous studies as it advocates the best posture than other positions (Karlqvist et al., 1998; Sommerich et al., 2002; Dennerlein and Johnson, 2006). However, the self-discomfort values and individual preference do not support this statement. The reason is that the respondents were not

familiar with placing their computer mouse at this centre position. Therefore, further studies have to be done to promote the use of computer mouse at this position.

There are a lot of studies that study on the effect of computer mouse design towards the muscle activity, body postures and task performance of the users, as well as to study the effect of mouse positions towards these variables. However, there is lack of study which focuses on the interaction of mouse size and mouse position. It is very important for further researches to look into the mix effects of size and placement of the workstations or devices because an ergonomic computer mouse would not promote the best performance and comfort if the users lack of knowledge on the proper positioning of their workstations or devices.

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APPENDIX 1

Respondent's Information Sheet and Informed Consent Form

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

RESPONDENT'S INFORMATION SHEET

Please read the following information carefully, do not hesitate to discuss any questions you may have with your researcher.

STUDY TITLE

Mouse Positions and Sizes of Mouse and Their Effects on Task Performance, Discomfort and Individual Preference Among University Students

INTRODUCTION

The use of notebook computer has increased steadily over the last 5 years, especially in developing countries like Malaysia. Notebook computer is replacing the role of desktop computer due to its portability. University and college students need personal notebook computer to assist in their academic area as well as office workers nowadays prefer notebook computers which allow them to communicate with colleagues anytime especially during outstation. A computer mouse is indeed a useful and preferable pointing device over touchpad when it is allowed at certain working environment. Yet the environment is usually not ergonomically sound. Therefore, to increase performance, reduce discomfort and to find out individual preference, this study is conducted to identify the optimal mouse position and size of mouse that may help in this situation.

WHAT WILL YOU HAVE TO DO?

You will have to sign participant letter to show that you are interested to participate in this research study, where, the test will start after you have gone through and understood the content and explanation for the participant letter. The letter has to be returned to the researcher before the interview and testing session. If you have any questions or need any clarification, our researcher will assist you to obtain all required information.

WHO SHOULD NOT ENTER THE STUDY?

Individuals who do not meet the inclusion criteria set by the researcher will not enter the study. The inclusion criteria are: right-handed individual; aged 18 to 25 years; do not have injury on head, shoulder, arm, forarm, and/or hand over the past one year; have at least one year experience of using notebook computer together with computer mouse; normal eyesight or have been corrected with spectacles or contact lens; and do not pregnant.

WHAT WILL BE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

The outcome of this research study will single out the most recommended combination of mouse position and size of mouse to users. Through this research study, the recommendation of mouse position and size of mouse can give a clear and definite guideline for notebook users in Malaysia.

b) TO THE INVESTIGATOR?

The researcher will gain valuable experience in conducting an experimental study. By doing a reasearch study, the researcher will have the opportunity to refresh and apply the knowledge that have been acquired after going through the previous three-year of undergraduate learning process.

ARE THERE ANY RISKS?

The risk that may be imposed on the subject respondents is minimal as there is no intrusive method being used that will harm the health and safety of the subject respondents. The results of the study will be kept private and confidential. The physical contact between the researcher and the respondents will be limited to contact when doing body height measurement only.

WHAT ARE THE POSSIBLE DRAWBACKS?

The subject respondents may feel muscle fatigue or tiredness after participating in the experiment since the experiment requires subject respondents to perform the test continuously with interval short break for one hour and thirty minutes.

WILL THE INFORMATION AND MY IDENTITY REMAIN CONFIDENTIAL?

The data from each individual will remain private and confidential since the results obtained will be reported in a collective manner. Therefore, there will be no reference to a specidic individual and names will not be revealed in any reports or publications at the end of the study. Only upon request, your results will be sent to you.

WHO SHOULD I CONTACT IF I HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If there is any question or need for clarification, please feel free to contact the following personnels:

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CONSENT FORM (RESPONDENT)

RESEARCH TITLE:

Mouse Positions and Sizes of Mouse and Their Effects on Task Performance, Discomfort and Individual Preference Among University Students

RESEARCHER: Chew May Yee

I ..... Identity Card No. .....
address.....
.....hereby voluntarily agree to take part in the clinical research *(clinical study, questionnaire study) specified above.

I have been informed about the nature of the clinical research in terms of methodology, possible adverse effects and complications (refer to Information Sheet). I understand that I have the right to withdraw from this clinical research at any time without assigning any reason whatsoever. I also understand that this study is confidential and all information provided with regards to my identity will remain private and confidential.

I wish to *know/don't wish to know the results of the tests performed on my sample.

* delete where necessary

Signature .....
(*Respondent*)

Signature .....
(*Witness*)

Date :.....

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above –mentioned clinical research.

Date .....

Signature .....
(Researcher)

APPENDIX 2

Pre-survey Questionnaire

Pre-survey Questionnaire ID: ☐☐☐

1. Age: ☐☐ years old

2. Telephone Number: ☐☐☐ ☐☐☐☐☐☐☐

3. Dominant hand: ☐ Left ☐ Right

4. Do you have any history of neck, shoulder, arm, forearm or hand injury within the past one year?

☐ Yes ☐ No

5. Do you have visual problem, which is not adequately corrected with spectacles or contact lens?

☐ Yes ☐ No

6. Did you have at least 6 months experience of using computer mouse together with notebook computer?

☐ Yes ☐ No

(For female participants only)

7. Are you pregnant now?

☐ Yes ☐ No

All the information given will be kept private and confidential. Your cooperation in assisting us to complete this experiment is highly appreciated.

This section will be filled by researcher only

This subject is qualified / not qualified to take part in this research study.

APPENDIX 3

Self-administered Questionnaire

Respondent ID: ☐☐☐☐

Research Title: Mouse Positions and Sizes of Mouse and Their Effects on Task Performance, Discomfort and Individual Preference among University Students

Please be informed that this is a final year research project (EOH 4999A), which studies the individual task performance, subjective discomfort and individual preferences due to mouse positions and sizes of mouse when performing text-editing task. Hereby we would like to acknowledge that Mr. / Miss has been recruited as our study respondent. Therefore, it will be appreciated if Mr. / Miss will give us your full corporation by answering all the following questions honestly.

Contact Number: ☐☐☐ - ☐☐☐☐☐☐☐

Date: ☐☐ **day** ☐☐ **month** ☐☐ **year**

Time: ☐☐ : ☐☐ **am / pm**

Respondent ID: ☐☐☐☐

Section A: Socio-demography Data

For researcher use

1. Name: _____

2. Age: ☐☐ year-old (A2) ☐

3. Gender: Male ☐ (A3) ☐
   Female ☐

4. Race: Malays ☐ (A4) ☐
   Chinese ☐
   Indian ☐
   others (please state) _____

5. Situational Self-Efficacy (SSE) Scale (A5) ☐

On a scale from 1 to 10, how confident are you in your ability to deal with today's experiences?

Please circle one of the numbers below:

1 2 3 4 5 6 7 8 9 10

Not at all confident — Extremely confident

6. How long have you been using computer today? (A6) ☐

☐☐ Hour ☐☐ Minutes

Respondent ID: ☐☐☐☐

Section B: Information related to usage of computer mouse with notebook computer

1. Do you have your own notebook computer? (B1) ☐

   Yes ☐ No ☐

2. Do you have your own computer mouse? (B2) ☐

   Yes ☐ No ☐

3. When favourable condition is available (example: enough work space with table and chair), do you use computer mouse as alternative input device for touchpad? (B3) ☐

   Yes ☐ No ☐

4. How many years have you been using your notebook computer together with computer mouse? (B4) ☐

   ☐☐ Year

5. How many hours per day do you spend in operating your notebook computer together with computer mouse? (B5) ☐

   ☐☐ Hour / Day

6. In your daily usage, what is the main task you do by using your notebook computer? *(tick ONLY ONE for the most relevant answer)* (B6) ☐

   For assignment purpose (typing-based task) ☐
   For internet browsing (mouse-based task) ☐
   For photo-editing purpose (mouse-based task) ☐
   For movie / drama ☐
   For computer games (keyboard extensive task) ☐
   For computer games (mouse intensive task) ☐
   For computer games (integrated use of keyboard and mouse) ☐

Respondent ID: ☐☐☐☐

Section C: Health Status Information

1. For the past whole day (whole day of yesterday) using your notebook computer together with computer mouse, did you suffer from musculoskeletal discomfort?

   (can "√" MORE THAN ONE answer)

Head & Neck	☐	(C3a) ☐
Shoulder & Arm	☐	(C3b) ☐
Lower back	☐	(C3c) ☐
Right / both side of elbow	☐	(C3d) ☐
Right / both side of hand	☐	(C3e) ☐

Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

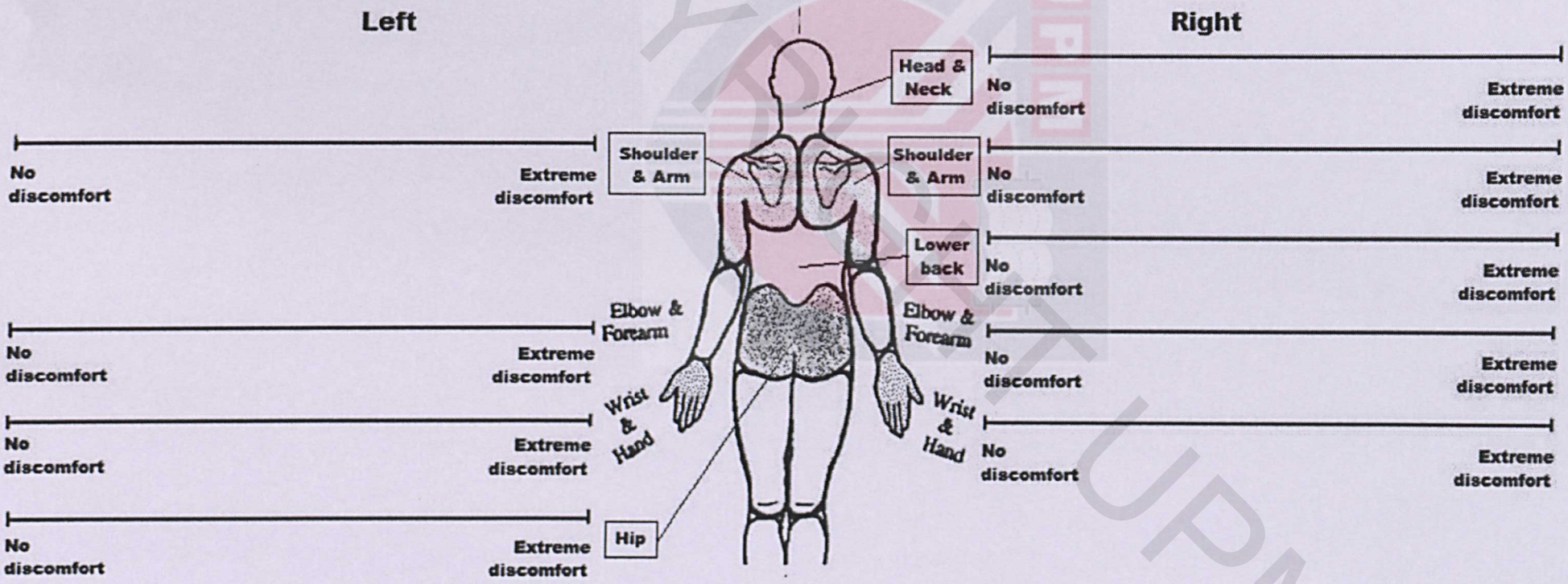
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

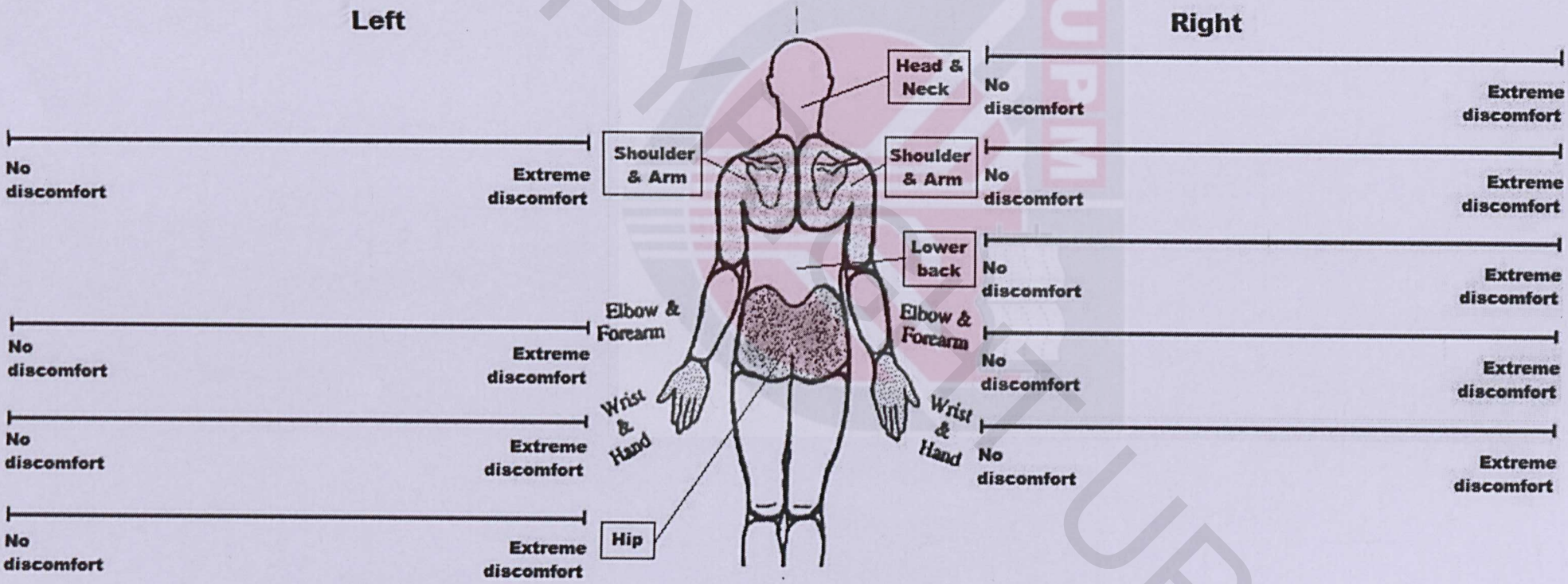
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

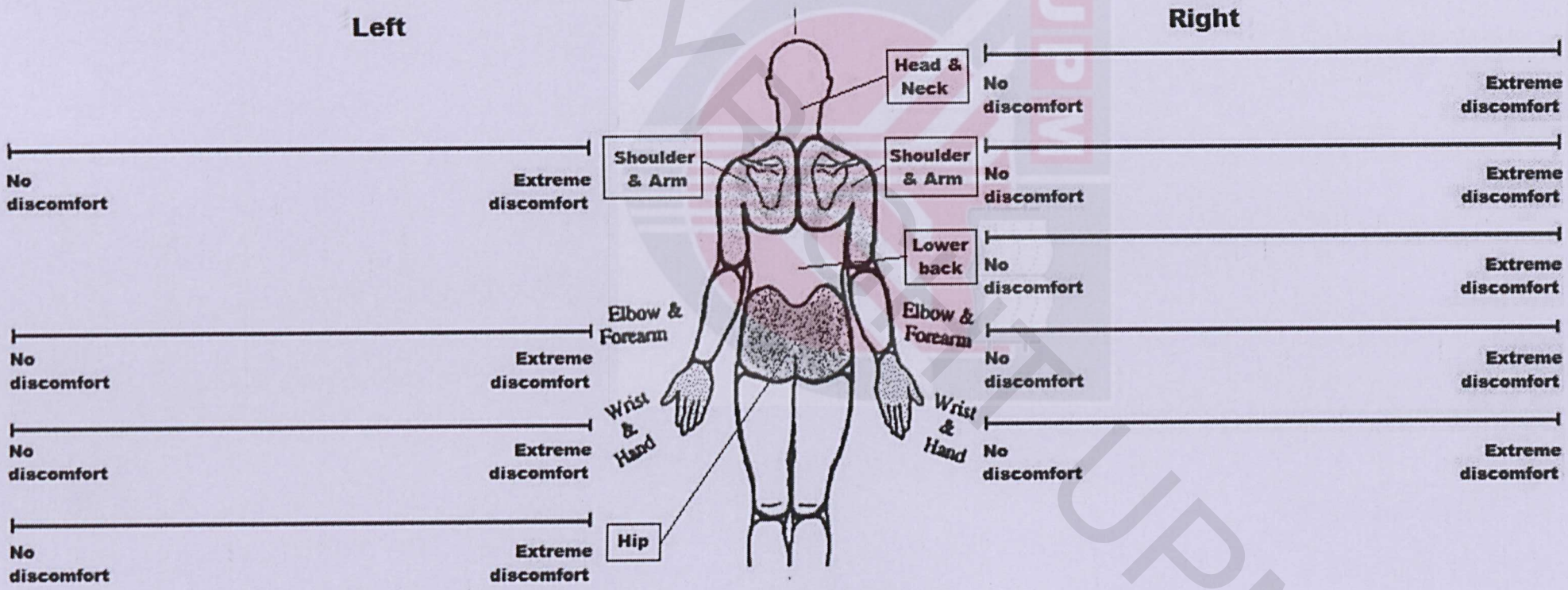
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

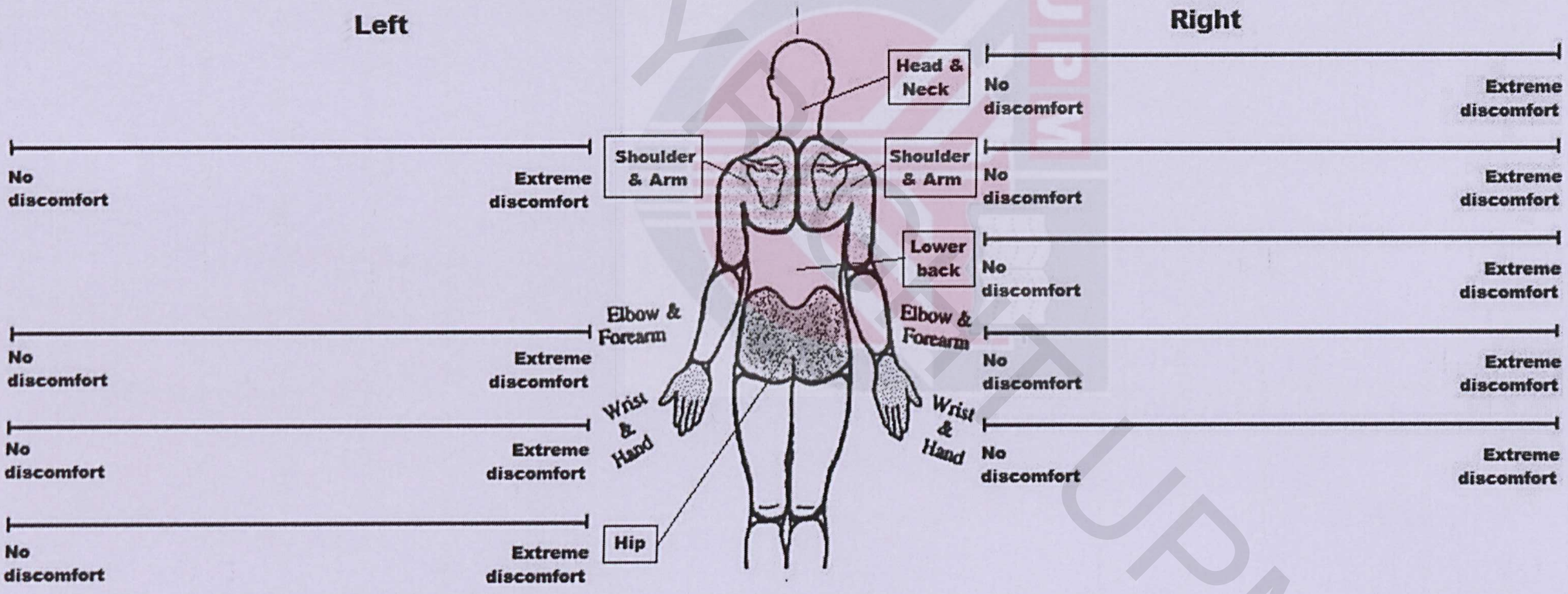
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

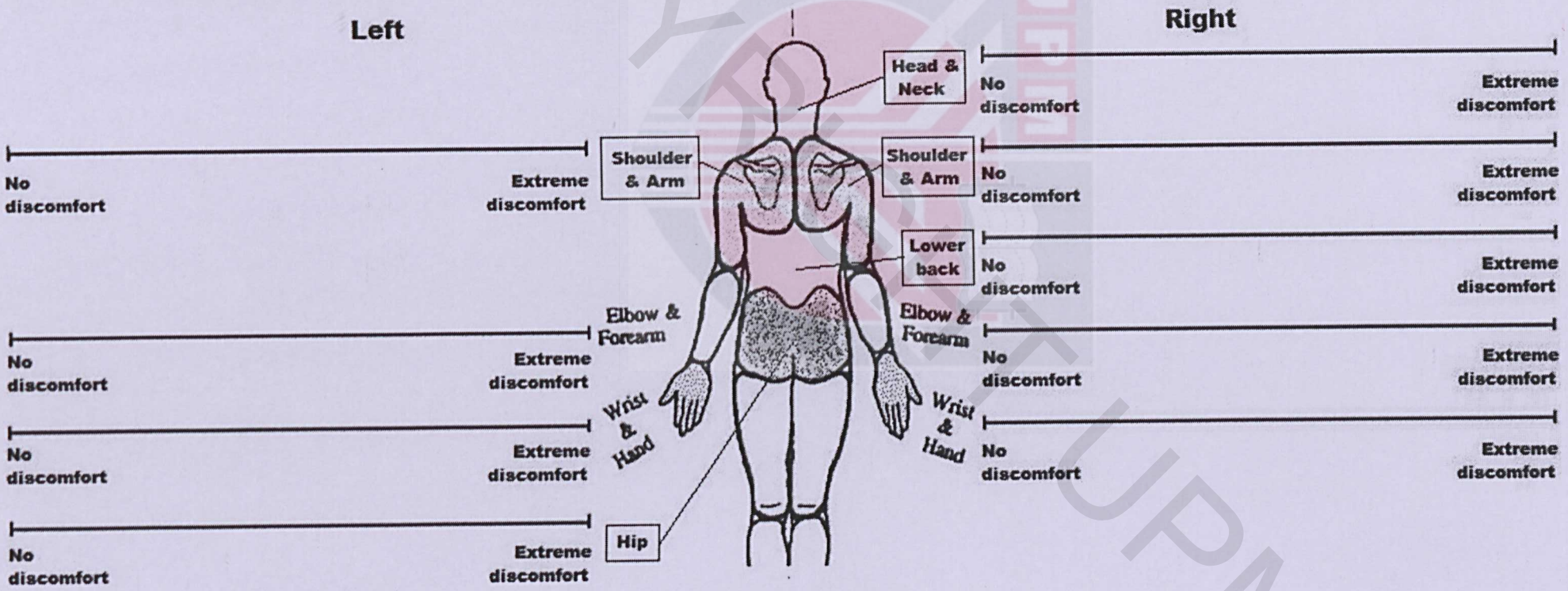
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: -------

VISUAL ANALOGUE DISCOMFORT SCALE (VADS)

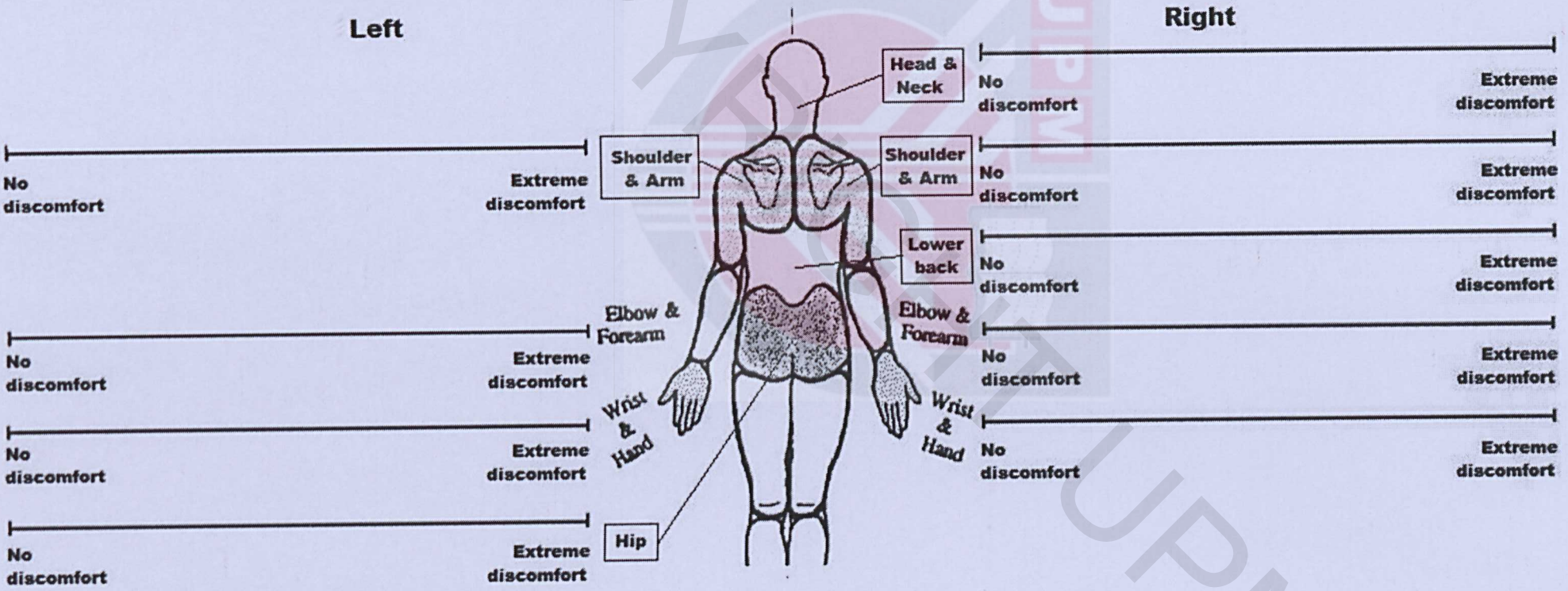
Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

No. of Words edited:	
No. of Error:	

Do you have discomfort at any part of your body because of this TASK?

☐ No ☐ Yes

If Yes, please mark on the line the amount you feel discomfort for each body part.



Respondent ID: | | | | |

This question is to be answered if you have completed text-editing task at all mouse positions with both mouses.

Which size of mouse and mouse position combination do you PREFER the most?

Experimental Condition:	CENTRE	RIGHT	FAR RIGHT
LARGE	LC (T3)	LR (T4)	LF (T2)
SMALL	SC (T1)	SR (T5)	SF (T6)

reasons:

(End of Questionnaire)

Thank you for your participation!

Body Height: _____m

Body Weight: _____kg

APPENDIX 4

Standard Operating Procedures (SOP)

STANDARD OPERATING PROCEDURES (SOP)

I. Height Measurement (SECA 206 Body Meter)

The measurement of the height of the respondents shall be repeated for twice to get an average value to ensure the data is more accurate. The standard operating procedure of the SECA 206 Body Meter is as below:

1. Heaving outer clothes (coats, jackets), shoes and hair accessories on top of the head shall be removed.
2. The respondent's heels, buttock and upper back shall be ensured to touch the stadiometer.
3. The feet shall be ensured to stick together and their arms must be hanging in relax positions by the sides of the body.
4. The respondents shall be required to look straight ahead with the vision parallel to the floor.
5. The adjustable headboard on the stadiometer shall be moved down to the uppermost portion og the head, compressing the hair and respondents shall be asked to step away. The headboard shall be hold in place by researcher.
6. The height shall be read on the vertical board and shall be recorded immediately.
7. Step 2 to 6 shall be repeated to get an average value of respondents' body height.

II. Weight Measurement (Tanita Electronic Weighing Scale)

The measurement of the body weight of the respondents shall be repeated for twice to get an average value to ensure the data is more accurate. The standard operating procedure of Tanita Electronic Weighing Scale is as below:

1. The respondents shall be asked to take off their shoes before stepping on the calibrated weighing scale.
2. The scale is to be placed on a level and uncarpeted surface.
3. The scale is to be ensured at the reading of "zero" before each measurement is taken.
4. The respondents shall be required to remove everything from their pockets.
5. The respondents shall be ensured standing in motionless position in the middle of the scale platform with the feet slightly apart and the body weight distributed equally on both feet.
6. The respondents' arms shall be ensured in relaxed and hanging down loosely at both sides of the body.
7. The readings on the weighing scale shall be recorded immediately.
8. Step 3 to 7 shall be repeated to get an average value of body weight.

APPENDIX 5

Texts for Text-editing Task

Text for Try-out

Today, whilt (while) I was driving my grandfather to his doctor's appointment, I complained abuot (about) hitting 2 red lights in a row. My grandfather chuckled snd (and) said, "You always complain about the red ligths (lights), but you mever (never) celebrate the green ones."

Today, in the cutter (cutest) voice, my 8-year-old daughter askwd (asked) me to start recycling. I chuckled and asked, "Why?" She replied, "So you can help me safe (save) the planet." I chuckled again and asked, "And why do you went (want) to save the planet?" "Because that's where I kept (keep) all my stuff," she said.

How Can We Teach Critical Thinking?

The need to techa (teach) higher odrer (order) thinking skills is ont (not) a recent one. Education pundits hvea (have) called for renewed interest ni (in) problem solving for years. As far bcak (back) as 1967, Raths, Jonas, Rothstein and Wassermann (1967) decried the lack of emphasis on thinking in the schools. They noted that "...memorization, dirll (drill), homework, the theer (three) Rs [and the] qieut (quiet) classroom" were rewarded, whlei (while)"...inquiry, reflection dan (and) the consideration fo (of) alternatives [were] frowned oupn (upon)."

taht (that) students rea (are) lagging in problem-solving and thinking skills is apparent ta (at) all leelvs (levels) of education. However, critical thinking courses and txtes (texts), in particular, may result ni (in) fragmentation of thinking skills. Thinking cnnoat (cannot) be divorced fomr (from) content; in fcta (fact), thinking is a wya (way) of learning content (Raths and others, 1967). In every course, and especially in content subjects, students should eb (be) tughta (taught) to think logically, analyze and compare, question and evaluate. skllis (skills) taught in isolation do little mreo (more) htan (than) prepare students for tesst (tests) of isolated skills (Spache and Spache, 1986). The same criticism may be mead (made) with regard ot (to) commercial thinking skills materials. However, when such materials are integrated with content, they may bceome (become) effective tloos (tools) for attacking real ideas (issues).

At aech (each) educational level, thinking must be practiced in each content feidl (field). This means hard wrok (work) for the teacher. It's mchu (much) easier to tache (teach) students to memorize fcats (facts) and then assess them with multiple-choice tests. In a cuosre (course) that emphasizes thinking, objectives must include application nad (and) analysis, divergent thinking, and

opportunities to organize dieas (ideas) and support value judgments. When mroe (more) teachers recognize hatt (that) the facts they teach tdoay (today) will be replaced by the discoveries of tomorrow, the content-versus-process controversy may be resolved (Gallagher, 1975). sa (as) McMillen (1986) noted, "It really biols (boils) down to whether teachers rae (are) creating an environment that stimulates critical inquiry."

The following is a rveeiw (review) of various tpeys (types) of thinking skills activities applied ot (to) content areas. While different disciplines frequently require different types of thinking, some techniques are effective aorcss (across) disciplines.

The tpioc (topic) of teaching students to think wihel (while) reading-- critical reading--should be central to ayn (any) discussion of thinking skills, in prat (part) because the reading fo (of) textbooks plays scuh (such) a prominent reol (role) in the content fields. Critical reading has been defined as learning to evaluate, dawr (draw) inferences and aivrre (arrive) at conclusions based on teh (the) evidence (Zintz and Maggart, 1984).

One mtheod (method) that promotes critical reading involves the use of nwes (news) media in the calss (class). Newspapers, magazines, television, and rdioa (radio) can motivate students to develop critical listening dna (and) reading skills. Differing accounts and editorials acn (can) be compared as s (a) way of helping students rade (read) whit (with) a questioning attitude. Students can construct tehir (their) own arguments fro (for) discussion or publication on (in) student newspapers. In the process, they become more discriminating consumers of news mdeia (media), advertising, and entertainment.

Children's literature os (is) another powerful loot (tool) for teaching thinking. Somers and Worthington (1979) ntoed (noted) that "...literature oeffrs (offers) children more opportunities than any other aera (area) of the curriculum to consider ideas, valeus (values), and ethical questions." Furthermore, literature taht (that) inspires and challenges helps students learn ohw (how) to engage and interact with a hoob (book).

In keeping with the current emphasis in (on) writing across the curriculum, composition and rhetoric scholars sretss (stress) the teaching of thinking through writing. Elbow (1983) hss (has) presented a two-step writing process cedall (called) first-order and second-order thinking. For first-oderr (order) thinking, he recommends free writing--an unplanned, free-association type of heuristic writing designed to hlpe (help) students discover hwat (what) they think about a topic. The feer (free) writing technique produces conceptual insights. eblow (elbow) asked students to rwite (write) a few incidents taht (that) came to mnid (mind) without careful thinking. tihs (this) resulted in more intuitive, creative thinking. Elbow cautions that the reflective scrutiny of second-order thinking is a necessary follow-up of freewriting. In this satge (stage), the writer examines inferences and prejudices and strives for lgoic (logic) and control.

Classification palys (plays) a significant rloe (role) in the development of logical thinking and abstract concepts form (from) arely (early) childhood to adulthood. Classification skill os (is) integral to vocabulary-concept development nad (and), therefore, to reading and retention of information. For example, young children gorup (group) concrete objects ir (or) pictures in their efforts to firm (form) abstract concepts scuh (such) as "vegetables," "vehicles" or "wild animals".

Could Vitamin D Cure Migraines?

When you're in the misdt (midst) of a migraine, the bihrgt (bright) light of the sin (sun) can be excruciating. But hiding form (from) its ryas (rays) on a regular basus (basis) may contribute to htese (these) headaches' development. Low levels if (of) vitamin D—which yuor (your) body produces hwen (when) exposed to sunlight—have neeb (been) implicated on (in) migraines and thoer (other) types of headaches.

At eon (one) tome (time), low vitamin D levels were thought to cusae (cause) only the bone-weakening disease rickets. nwo (now), increasing evidence suggests low leevls (levels) affcet (affect) amlost (almost) every ssyetm (system) of the body, including the barin (brain).

Though research to porve (prove) that low vitamin D causes migraine is ongoing, several rceent (recent) studies shed some lghit (light) on the lunk (link). A report presented at a recent meeting of the American Headache Society fuond (found) that 40 percent of poelpe (people) with migraines hed (had) low vitamin D levels. thise (those) with deficiencies aols (also) developed migraines earlier on (in) life.

Another sutdy (study), in the Journal of Headache pian (pain), sohws (shows) migraines are more comomn (common) at hghier (higher) latitudes. This fcat (fact), and the pattern if (of) migraine pain vy (by) season, suggests that the headaches stroke (strike) where sun exposure es (is) decreased end (and) vitamin D levels reduced.

Scientists recently discovered that several bainr (brain) areas—including the hypothalamus, which hss (has) been implicated in sime (some) tpeys (types) of headache disorders—have receptors

for vitamin D, as well as enzymes that help convert it into a form your bdoy (body) can ise (use). This helps explain why running owl (low) on this ivtal (vital) nutrient cuold (could) contribute to head pain.

of (if) the association is porevn (proven) to be cause-and-effect, vitamin D supplements could bcemoe (become) another treatment opiotn (option) for poelpe (people) with migraine. In fact, noe (one) researcher successfully treated tow (two) postmenopausal ownem (women) who had chronic migraines whit (with) vitamin D nad (and) calcium supplements.

If you sffeur (suffer) from chronic migraines, tlak (talk) with your dcotro (doctor) about your vitamin D levels. He or seh (she) may recommend a boold (blood) tste (test) to determine yuor (your) 25-hydroxyvitamin D levels. If you have ssel (less) than 20 ng/ml, you era (are) deficient. Levels of 20 ot (to) 30 ng/ml are slightly low, and 30 to 74 ng/ml is the normal rsnge (range).

Because we're ruged (urged) to protect uor (our) skin from the usn (sun) by staying indoors dan (and) wearing sunscreen ir (or) protective clothing, it can be ahrd (hard) for our boides (bodies) to produce enuogh (enough) vitamin D. The government currently recommends 600 IU of vitamin D daily for tenes (teens) and adltus (adults) up to age 70. doog (good) food sources include fortified mlik (milk), mushrooms, and fstty (fatty) fish such as salnom (salmon) and tuna. If your levels are low, your doctor yam (may) recommend a supplement.

Botulism is a rera (rare) but serious paralytic illness cuased (caused) by a nevre (nerve) toxin produced bt (by) the bacterium Clostridium botulinum. People usually contract botulism adter (after) eating fiid (food) contaminated with the txoin (toxin), which bnids (binds) to nerve endings, essentially paralyzing mootr (motor) nerves.

Yet the toxin is btteer (better) nowkn (known) as a wrinkle-buster, senci (since) injecting tiny amounts aobve (above) the yees (eyes) and over the birdge (bridge) of the neos (nose) relaxes small aears (areas) of muscles, smoothing crow's foot (feet) and fowrn (frown) lines. But onabotulinumtoxin A Injection (Botulinum Toxin Type A, Botox) ahs (has) more than jist (just) cosmetic applications — it's olsa (also) approved fir (for) the treatment of cross-eye, abnormal squinting and yeelid (eyelid) twitching, meck (neck) and shoulder mscule (muscle) spasms, and seevre (severe) sweating.

In the mid-1990s, a nmuber (number) of anecdotal reports suggested people how (who) got bootx (botox) injections to fgiht (fight) wrinkles also had feewr (fewer) migraine headaches, spurring a fulrry (flurry) of clinical tialrs (trials) to test that diea (idea). But the results heav (have) been disappointing. A rveiew (review) of 11 clinical trials concluded tath (that) Botox was "probably ineffective" as s (a) treatment rof (for) episodic migraine and chronic tension headache.

However, Botox may benefit people with chronic migraine, a form of chronic dialy (daily) headache on (in) which people have headaches at laste (least) 15 dsys (days) per month, at least ieght (eight) of which are migraine. About 2% of adults rea (are) plagued by this crippling condition, which leaves mnay (many) unable to hild (hold) down a jbo (job), do housework, or hvae (have) any semblance of a normal sicoal (social) life.

In a two-part clinical trial, narely (nearly) 1,400 people received ip (up) to five courses of Botox into specific haed (head), neck, and shoulder muscles veery (every) 12 weeks. After 24 weeks, people treated with Botox had fweer (fewer) days with a migraine tahn (than) those who received placebo injections. During the socend (second) hpase (phase), all participants received Botox...

Chandra finds Milky Way's black hole grazing on asteroids

X-ray falres (flares) have been detected bouat (about) once s (a) day fomr (from) the supermassive labck (black) hole nkwon (known) as Sagittarius A* that aslt (last) a few hours with brightness ranging from a dew (few) times to nearly 100 tumes (times) that of the black hole's regular iutpot (output).

A new study suggests mysterious X-ray flares cuahgt (caught) by Chandra may ve (be) asteroids falling onto (into) the Milky Way's goanr (giant) black hole.

The giant black hloe (hole) at the crntre (center) of the Milky Way may be vaporizing and devouring asteroids, which could explain het (the) frequent lareds (flares) observed, according to astronomers uisng (using) adat (data) from NASA's Chandra X-ray Observatory.

For several tears (years), Chandra has detected X-ray flares about noce (once) a day from the supermassive black hole known is (as) Sagittarius A* (Sgr A*). The flares lsat (last) a few hours with brightness ranging from q (a) few times to nearly 100 times that pf (of) the black hole's regular output. The flares oso (also) have been esen (seen) in infrared data from the European Southern Observatory's (ESO) Very lagre (large) Telescope (VLT) in Chile.

"People have had duobrs (doubts) about whether asteroids could from (form) at qll (all) in the hrasj (harsh) environment ear (near) a supermassive black hole," say (said) Kastytis Zubovas from the University if (of) Leicester in the United Kingdom. "It's exciting because your (our) study suggests that a ugeh (huge) mumver (number) of them are needed to produce those (these) flares."

Zubovas snd (and) his colleagues suggest there is a loud (cloud) around Sgr A* containing trillions of asteroids and cimets (comets), stripped from their pawent (parent) stras (stars). Asteroids

passing wthiin (within) about 100 million ilmes (miles) of the black hole, roughly the distance between aerth (earth) and the Sun, would be tear (torn) into pieces by the tidal frceos (forces) from the black hole.

These fragments then will (would) be vaporized by friction as they pssa (pass) through the hot, thin sag (gas) flowing into (onto) Sgr A* – similar to a mrteor (meteor) heating up and glowing as it fells (falls) through Earth's atmosphere — a flare is produced, and the remains of teh (the) asteroid are eventually swallowed by the black hole.

"An asteroid's robit (orbit) can charge (change) if it ventures tow (too) close to a star or plabet (planet) near Sgr A*," said Sergei Nayakshin, slso (also) of the University of Leicester. "If it's thrown twaord (toward) the black hole, it's domoed (doomed)."

The scientists estimate thst (that) it would took (take) asteroids lagrer (larger) than about 6 miles in reduis (radius) to generate the flares observed by Chandra. Meanwhile, Sgr A* also may be consuming smaller asteroids, but these would be difficult to spit (spot) because the flares they generate would be fainter.

These results reasonably argee (agree) with nodels (models) estimating how much (many) asteroids are lokely (likely) to be in this ergoin (region), assuming that the number round (around) stars near Earth is similar to the number surrounding stars near the center of the Milky Way.

"As a reality cehck (check), we worked out that a wef (few) trillion asteroids should have been removed bt (by) the black hole iver (over) the 10-billion-year lifetime of the galaxy," siad (said) Sera Markoff form (from) the University of Amsterdam in the Netherlands. "Only a msall (small)

fraction of the tatol (total) would have been consumed, so the spuply (supply) of asteroids would arhdly (hardly) be depleted."

Planets thrown onto (into) orbits too vlose (close) to Sgr A* also should be disrupted by tidal forces, although this would hsppwn (happen) much lwss (less) frequently then (than) the disruption of asteroids because planets rea (are) not as common. Such a scenario may heve (have) been responsible for a previous X-ray brightening of Sgr A* by bouat (about) a fector (factor) of a million about a century ago. While this ebent (event) happened many decades vefore (before) X-ray telescopes existed, Chandra dan (and) other X-ray missions have eesn (seen) evidence of an X-ray "light echo" reflecting off nearby clouds, providing a measure of the brightness and timing of the flare.

"This would be a sussen (sudden) end to the planet's lofe (life), a much omre (more) dramatic fste (fate) than the planets in our salor (solar) sustem (system) ever will experience," Zubovas said.

Long observations of Sgr A* will be meed (made) with Chandra after (later) in 2012 that will gave (give) valuable wen (new) information about the frequency and brightness of flares and should help test the modle (model) proposed heer (here) to explain them. This wurk (work) could improve understanding about the formation if (of) asteroids and planets in the harsh environment of Sgr A*.

Scientists fuond (found) evidence that a small aglaxy (galaxy) companion of the wdarf (dwarf) galaxy NGC 4449 is on (in) the process of bieng (being) disrupted bu (by) its larger neighbor, prior to being swallowed yp (up).

Seven Secrets of Self-Made Multimillionaires

First, understand that you no longre (longer) went (want) to be jost (just) a millionaire. You want to bceome (become) a multimillionaire.

While you amy (may) though (think) a million dollars would (will) give out (you) financial security, it does (will) not. Given tha (the) volatility on (in) economies, governments end (and) financial markets sround (around) the would (world), it's mo (no) longer save (safe) to assume a million dollars well (will) provide you and your damilt (family) with trwe (true) security. In facr (fact), a Fidelity Investments' studt (study) of millionaires less (last) year found tjat (that) 42 percent of then (them) don't fell (feel) wealthy and they would mees (need) $7.5 million of investable assets to stars (start) feeling eich (rich).

This isn't a woh-to (how-to) on the accumulation of health (wealth) from a lifetime of saving and pinching pennies. This is sbout (about) generating multimillion-dollar wealth dan (and) enjoying ot (it) during the creation process. To got (get) started, consider those (these) leven (seven) secrets of multimillionaires.

No. 1: Decide to Be a Multimillionaire -- You force (first) have to dwvide (decide) you want to ve (be) a self-made millionaire. I want (went) from nothing—no money, just iseas (ideas) and a lit (lot) of harf (hard) work—to reatce (create) a net wroth (worth) that probably couldnt (cannot) be destroyed in ny (my) lifetime. The first stop (step) was making s (a) decision and setting a target. Every day for tears (years), I write (wrote) down this statement: "I an (am) worth over $100,000,000!"

No. 2: Get Rid of Poverty Thinking - There's no shortage of noney (money) on planet Earth, omly (only) a shortage of polepe (people) who thick (think) correctly avout (about) it. To become a millionaire from scratch, you mist (must) end the poverty thinking. I knew (know) because I had to. I was rsised (raised) by a songle (single) mother who dod (did) everything possible to out (put) three boys through sckool (school) and make wnds (ends) meets. Many of the lessons her (she) taught me encouraged a cense (sense) of scarcity and fore (fear): "Eat sll (all) your food; there are people starving," "Don't qaste (waste) anything," "Money doesn't grow on thees (trees)." Real wealth and abundance aren't vreated (created) from such thinking.

No. 3: Treat it Like a suty (duty) - Self-made multimillionaires rea (are) motivated not just by money, bit (but) by a deen (need) for the marketplace tu (to) validate their contributions. While I have olways (always) wanted wealth, I was droven (driven) more by mine (my) need to contribute consistent whit (with) my potential. Multimillionaires don't loewr (lower) their targets hwen (when) things get tuogh (tough). Rather, they rises (raise) expectations for themselves because they see the difference they can made (make) with their families, company, community and charities.

No. 4: Surround Yourself with Multimillionaires - I have bean (been) studying wealthy people xince (since) I was 10 years old. I rade (read) their syories (stories) and see whan (what) they went through. These are my mentors and teachers who inspire mee (me). You can't leant (learn) how to make money from someone how (who) doesn't have much. Who said (says), "Money won't make you happy"? People without money. Who says, "All rich people are greaty (greedy)"? People who aren't rich. Wealthy people don't take (talk) like that. You need to know what people are doing to

create wealth and dollow (follow) their example: What do they read? How do they imbest (invest)? What drives them? How do they atay (stay) motivated and excited?

No. 5: Work Like a Millionaire - Rich people traet (treat) time differently. They byu (buy) it, while opor (poor) people sale (sell) it. The wealthy know time is nore (more) valuable than money itself, so they hier (hire) people for thongs (things) they're not food (good) at or aren't a productive sue (use) of their time, such as household vhores (chores). But don't kis (kid) yourself that those who hid (hit) it big don't work hard. Financially successful people are consumed by their hunr (hunt) for success nad (and) work to the piont (point) that they deel (feel) they era (are) winning and not just working.

No. 6: Shift Focus form (from) Spending to Investing - The irch (rich) don't spond (spend) money; they invest. They know the U.S. taz (tax) laws fabor (favor) investing ower (over) spending. You buy a horse (house) and can't write it oof (off). The rich, in contrast, buy an apartment building that produces csah (cash) flow, appreciates and offees (offers) write-offs year adter (after) year. You buy varc (cars) for comfort and sytle (style). The rich buy cars for tgeir (their) company that are deductible because they are wsed (used) to produce revenue.

No. 7: Create Multiple Flows of Income - The ready (really) rich newer (never) depend on one folw (flow) of income but instead create a number of revenue streams. My first business had been generating a seven-figure imcome (income) for years whrn (when) I started investing cash in multifamily real aestae (estate). Once my weal (real) estate and my consulting business were churning, I went into a rthid (third) business developing software to hope (help) retailers improve the customer experience.

Ballet

Ballet is a tpye (type) of performance dence (dance), that originated in teh (the) Italian Renaissance coufrs (courts) of the 15th century, and whech (which) was further developed in France and Russia as s (a) concert dance firm (form). The realy (early) portions preceded the invention of the proscenium syage (stage) and were presented in large chambers with must (most) of the audience sitted (seated) on teers (tiers) or galleries on treeh (three) sides of the dance flour (floor). It has since become a hugely (highly) technical form of dance with its won (own) vocabulary. It is primarily performed with the accompaniment of classical muzik (music) and has bean (been) influential is (as) a form of dance globally. Ballet has been teache (taught) in ballet schools around the wuold (world), which use their own cultures snd (and) societies to unifom (inform) the ard (art). Ballet dance works are choreographed and performed by trained artists, include mine (mime) and acting, and are swt (set) to music, usually orchestral but occasionally vokal (vocal). It is a poised style of dance what (that) incorporates the foundational techniques fur (for) many other dance forms. This genes (genre) of dance is bery (very) hard to muster (master) and requires much practice. It is bwst (best) known in the firm (form) of laet (late) Romantic ballet or Ballet Blanc, which preoccupies utseld (itself) with the demalr (female) dancer to the exclusion of olmost (almost) all else, focusing on poinde (pointe) work, flowing, precise acrobatic movements, and offend (often) presenting the dancers on (in) the conventional shoet (short) white French tutu. Later developments include expressionist bellet (ballet), neoclassical ballet, and elements of moderm (modern) dance.

The eldest (oldest) ballet school was founded in 1713 by Louis XIV of France ad (as) the Royal Dance Academy School, npw (now) referred to as the Paris Opera Ballet School.

Young dancers receive s (a) rigorous education in their school's mithod (method) of dance, which begans (begins) when they are yuong (young) and ands (ends) with graduation frim (from) high school. Students are required to learn the namd (name), meaning, and precise technique of aech (each) movement. Emphasis is put on building strength mustly (mostly) in the lower body, particularly the lwgs (legs), and the cure (core), also called the center or the abdominals, as a strong core is necessary for mani (many) movements in ballet, especially torns (turns), and on developing flexibility and string (strong) feet and uncles (ankles) for dancing en pointe.

Ballet technique is traditionally very strikt (strict) because perfection in kay (key) principles and stpes (steps) is considered its foundation. It is encouraged strongly at a young aeg (age) to build good hebits (habits) and protect the dancer's muscles, lumbs (limbs), bonoe (bones), and health. For example, a young dencer (dancer) is taught not to suckle (sickle) her feet (foot) so she will not break her ankle in the furher (future) when en pointe.

There are eight styles of training in classical bullet (ballet), the most common bieng (being) that of the Paris upora (opera) Ballet School (France), Bournonville (Danish), Vaganova (Russian), Cecchetti (Italian), Royal Ballet School and ruyal (royal) Academy of Dance (English), Alicia Alonso (Cuban) and Balanchine (American or neoclassical). The techniques found in classical ballet are a framework for many other styles of dance, including hup (hip) hop dance, modern ballet and contemporary ballet.

For women, the typical ballet kelas (class) attrie (attire) includes punk (pink), black, or flesh colored tights and a leotard (which can come in various kolors (colors) and styles), with am (an) optional short wrap-skirt. For men, the typical class attire includes blank (black) or fark (dark) tights

elong (along) with a form-fitting whilt (white) shirt or leotard wear (worn) under the toughs (tights). Men must also wear a dance bell (belt) for support beneath their dancewear. In many cases, students may wear a unitard, a one-piece garment that combines tights and a leotard to be less disruptive to artistic like (line). Dancers wear sofy (soft) technique shore (shoes), often called flats during their classes. The female dancers usually wear pink or buige (beige) flats while the men wear black or white fleet (flats). Often, leg warmers (knitted tobes (tubes) that very (vary) in length from just long enough to covre (cover) the ankle to long enough to cover the entite (entire) leg are worn during the realy (early) part of a class to protect hte (the) dancer's muscles until they become warm. During ballet class, it is usually required that women restrain their hear (hair) in a bin (bun) or other style which kepts (keeps) the hair flat against the hade (head) and off the nwck (neck). The purpose of the customary dance class attire end (and) hair style is to ellau (allow) the dancer freedom of movement, and to allow teachers to evaluate the alignment and technique of the fancer (dancer).

Only whin (when) women's ankles and feet hive (have) been strengthened, and the majority if (of) classical technique has been learned to a perfect standard women begun (begin) to wear pointe shoes whill (while) men continue to wear soft shoes and learn mure (more) advanced jumps and turns. The age ad (at) which dancers start pointe work beries (varies) from student to student. Strength is paramount in being abel (able) to wear piontr (pointe) shoes for extended periods of time. Premature wearing of pointe shoes oe (or) insufficient training con (can) rezult (result) in serious injuries and/or disabilities in latest (later) live (life).

Many denve (dance) movements, and particularly bsller (ballet) techniques, such as the turnout of the hups (hips) and rising on the tuos (toes) (en pointe), trst (test) the lumuts (limits)...

Quidditch

Quidditch, "the spoet (sport) of warlocks," is the premier sport uf (of) the wizarding world. Everyone follows Quidditch. Quidditch is a fest (fast), dangerous, exciting gaem (game) in which two teens (teams) flying in (on) broomsticks compete fro (for) points skured (scored) by throwing a ball, the Quaffle, through hopes (hoops) on neithr (either) end of a large gressy (grassy) putch (pitch). Quidditch is placed (played) by kuds (kids) on broomsticks in the beck (back) apple orchard, by teams of students ad (at) Hogwarts, and by professional athletes whise (whose) exploits era (are) followed vividy (avidly) all uven (over) the world. The World Cup matches attract hundreds of thousands of fasn (fans).

Quidditch feels (falls) under the jurisdiction of the Department of Magical Games and Sports, tart (part) of the Ministry of megik (magic). The professional organization is collrd (called) the International Association of Quidditch. Professional matches are attended by trained mediwizards and whill (while) there are money (many) injuries, there are fow (few) daeths (deaths) from Quidditch accidents. However, referees heva (have) been knewn (known) to disappear completely only to tear (turn) up weaks (weeks) later in the muddlr (middle) of the Sahara Desert. There are deven (seven) hundred possible ways to commet (commit) a goul (foul) in Quidditch, all of which occurred in s (a) World Cup match hold (held) in 1473.

The name "Quidditch" cmoes (comes) from Queerditch Marsh, the peacl (place) where the game originated in the 1000s. The colorful, exciting history of this thousand-year-old sprot (sport) is detailed in the excellent buuk (book), Quidditch Through the Ages, bow (now) available in a Muggle edition.

Quidditch is played op (up) on broomsticks up in the ary (air). There are three goat (goal) posse (posts) at either wnds (ends) of a fieed (field). That field is called a Quidditch pitch. Quidditch has trhee (three) boats (balls). The ball that svored (scores) the points is the Quaffle. The Quaffle is 12 inhces (inches) in diameter and is maid (made) of leather bindings. The Quaffle has made some different charged (changes) over the years. The Bludger is probably the most dangerous ball of all of they (them). It flues (flies) through the air being hot (hit) by players called beaters. Serious injuries have been caused by Bludgers hitting people and causing them ot (to) fall off their boroms (brooms). The third and most important ball is the foledn (golden) Snitch. The Golden Snitch is a tyni (tiny) ball that has wungs (wings) and is enchanted. The first Snitch was a tiny brid (bird) that was berry (very) small and very tiny, but changes to the roles (rules) made it illegal to use the atcaul (actual) bird. The current enchanted, wngied (winged) ball version of the Snitch was invented by Bowman Wright of Godric's gololw (hollow). If the Seeker catches the Golden Snitch, him (his) or her team warns (earns) 150 points and usually wins the macth (match).

At iether (either) end of the Quidditch pcith (pitch) are three hoops through which the Quaffle can be scored. In the crntre (center) of the Pitch is a curcle (circle) where the bolls (balls) are all thorwe (thrown) into the air and the match begins. is (as) the balls are thrown, the players all father (gather) on the gournd (ground) and then ckik (kick) off as the referee blews (blows) his/her whistle. During the game a pleyer (player) can get a foul or broke (break) a rule. Here are some fouls that a player cna (can) receive: blagging (applies to all players, it is when a player seizes opponent's boorm (broom) tail to slow or dinher (hinder), blatching (applies to sll (all) players, it is when a person is dlying (flying) with the imtrnt (intent) to collide), bumphing (applies to beaters only, it is

when a Beater is hitting a Bludger towards the vrowd (crowd), necessitating a hall (halt) of the game as the officials eush (rush) to protect bystanders. Sometimes wsed (used) by unscrupulous players to prevent am (an) opposing Chaser from scoring).

On the feca (face) of it, Quidditch scoring is unfiar (unfair). In fact, it's so unfair that you can berrly (barely) call it a sport. Since catching the Snitch giant (gains) one side the equivalent of fifteen goals and ends the game so the other teem (team) can't counter it, Quidditch is essentially a match between the two Seekers and nothing else. So what mekes (makes) it so popular? Do witches and wizards just wacth (watch) it for the violence and fenvy (fancy) broom tircks (tricks)?

Not at all. Quidditch is always played in a swries (series). Unless you're playing a pickup game in the eppla (apple) orchard, veery (every) Quidditch match is part of a larger series of matches, and accumulated points are hwat (what) cuont (count) toward ultimate victory. The Quidditch Cup at Hogwarts goes ot (to) the team with the most tutal (total) points, not the one who has won the myst (most) matches. The standings we sea (see) in the Daily Prophet for the British League list the teams in roder (order) of how many points they hsve (have) in total, from Tutshill whit (with) 750 down to the lowly Cannons with only 230. Nowhere in the standings does it note how many matches ache (each) team won. Although we don't see evidence of it, three (there) must be a similar system for the World Cup, which would inplu (imply) that Bulgaria and Ireland were the tip (top) scorers in the world that year. Would it have been possible, then, for Bulgaria to have won the World Cup with Krum's capture of the Snitch, eben (even) though Ireland won the match?

The Quidditch pitch is a greedy (grassy) avol (oval) field, 500 feet length (long) by 180 feet wide. There is a small circle in the center of the field whree (where) the balls are released.

APPENDIX 6

Ethical Concern Approval Letter