EXPLORATION OF IMAGE-BASED STIMULI TO ASSESS MENTAL TOUGHNESS AMONG MEDICAL STUDENTS OF UNIVERSITI SAINS MALAYSIA

NADIA IZZATI BINTI NORDIN

UNIVERSITI SAINS MALAYSIA

2023

EXPLORATION OF IMAGE-BASED STIMULI TO ASSESS MENTAL TOUGHNESS AMONG MEDICAL STUDENTS OF UNIVERSITI SAINS MALAYSIA

by

NADIA IZZATI BINTI NORDIN

Thesis submitted in partial fulfilment of the requirements
for the degree of
Doctor of Neuroscience

May 2023

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Merciful. All praise is due to Allah, who has led me through this difficult academic endeavour. I would like to express my gratitude to everyone who helped me along this incredible doctoral journey and aided in variety of ways. To my principal supervisor, Dr. Zuraida Zainun, words cannot express how grateful I am for her support and encouragement throughout this research effort. I greatly value the guidance and insightful feedback from my co-supervisors, Associate Professor Dr. Muzaimi Mustapha and Associate Professor Dr. Saiful Bahri. My eternal gratitude to Dr. Mohd. Zulkifli Mustafa, my mentor during my doctorate journey, no words can express how appreciative and pleased I am for his extraordinary and important presence during my candidacy. A special dedication to all the medical students involved in this study; your timeless efforts to participate are much appreciated. I would also like to express my gratitude and appreciation to my mother and father, Nasriah binti Mat Yob and Nordin bin Hasan. Their unconditional love and prayer provided me with the strength I needed to succeed. Special thanks to my beloved grandmother, Khadijah binti Abu Bakar, for her infinite support and valuable prayer. To my siblings, Luqman, Najmi, and Iman, thank you for your understanding and patience. Thank you to my course mates, Mas, and Celina for their endless support and motivation, and finally, we all succeeded in completing this doctorate journey together. Thank you to my friends, Awatif, Zahra, Athirah, Waqi, Nina and Huda for their kindness assistance in many ways. My special gratitude to my MAG for the support, advice, and prayer. Finally, to my Kelulut team, Anish, Achik, Teha, Pana, Nurin, Dr. Siti, and Yoe for their unwavering support through the dissertation preparation, I am in debt to all of you. May Allah bless us.

TABLE OF CONTENTS

ACKNOWLEDGEMENT ..... **ii**

TABLE OF CONTENTS ..... **iii**

LIST OF TABLES ..... **viii**

LIST OF FIGURES ..... **x**

LIST OF SYMBOLS ..... **xii**

LIST OF ABBREVIATIONS ..... **xiii**

LIST OF APPENDICES ..... **xiv**

ABSTRAK ..... **xv**

ABSTRACT ..... **xvii**

CHAPTER 1 INTRODUCTION **1**

1.0 Introduction 1

1.1 Background of the study 1

1.2 Rationale and significance of the study 6

1.3 Problem statement 7

1.4 Research questions 8

1.5 Research objectives 9

1.5.1 General objective 9

1.5.2 Specific objectives 9

1.6 Research hypotheses 10

1.7 Study aim 10

1.8 Definition of key terms 11

1.9 Chapter summary 14

CHAPTER 2 LITERATURE REVIEW **15**

2.0 Introduction 15

2.1 Mental health issues in doctors and medical students 16

2.2 Mental toughness and mental health 17

2.3 Conceptual considerations in mental toughness..... 18

2.3.1 Definition of mental toughness 18

2.3.2 Conceptualization of mental toughness..... 22

2.3.3 Mental toughness and its related construct 24

2.4 Psychological approach explaining mental toughness 25

2.4.1 Stress and coping approach 25

2.4.2 Emotion & emotion regulation approach 28

2.5 Neuroscience approach explaining mental toughness..... 32

2.6 Experimental methods assessing mental toughness 36

2.6.1 Psychometric measures assessing mental toughness 37

2.6.2 Psychophysiology measures assessing mental toughness..... 41

2.6.3 Neuroimaging measures assessing mental toughness 41

2.7 Affective images as image-based stimuli..... 48

2.7.1 Self-Assessment Manikin..... 50

2.8 Conceptual framework 53

2.9 Chapter summary 55

CHAPTER 3 METHODOLOGY..... 57

3.0 Ethical approval..... 57

3.1 Study design 57

3.2 Study procedure..... 58

3.2.1 Phase 1: Validation of Mental Toughness Questionnaire (MTQ-48) 59

3.2.2 Phase 2: Measurement of mental toughness, depression, anxiety, and stress 59

3.2.3 Phase 3 (Part A): Content validation of image-based stimuli 60

3.2.3(a) Images selection..... 60

3.2.3(b) Panel of expert 64

3.2.3(c) Content validation inventory 64

3.2.4 Phase 3 (Part B): Evaluation of image-based stimuli through Self-Assessment Manikin 65

3.2.5 Phase 4: Evaluation of the stress intensity of the image-based stimuli 66

3.3 Study flow chart 68

3.4 Study location 69

3.5 Sampling methods and participants recruitment 69

3.6 Research participants 69

3.6.1 Sample size calculation 70

3.6.2 Inclusion & exclusion criteria 71

3.7 Instrument 72

3.7.1 Mental Toughness Questionnaire-48 (MTQ-48) 72

3.7.2 Self-Assessment Manikin (SAM) 73

3.7.3 Depression, Anxiety & Stress Scale (DASS-21) 75

3.7.4 Perceived Stress Scale-10 76

3.7.5 Visual Analog Stress Scale 77

3.8 Data analysis 78

3.8.1 Analysis of MTQ-48 validation 78

3.8.2 Measurement of mental toughness, depression, anxiety, and stress 80

3.8.3 Analysis of content validation inventory 80

3.8.4 Analysis of valence and arousal rating of the image-based stimuli 81

3.8.5 Analysis of the stress intensity of the image-based stimuli 82

CHAPTER 4 RESULTS 83

4.0 Introduction 83

4.1 Factor structure and internal consistency of MTQ-48 83

4.1.1 Demographic analysis 83

4.1.2 Reliability analysis of MTQ-48 84

4.1.3 Confirmatory factor analysis of MTQ-48 85

4.2 Mental toughness among medical students 98

4.2.1 Demographic analysis 98

4.2.2 Mental toughness profile 99

4.2.3 Control, commitment, challenge, and confidence 100

4.3 Mental toughness, depression, anxiety, and stress in medical students 101

4.3.1 Depression, anxiety, and stress in medical students 101

4.3.2 Relationship between mental toughness with depression, anxiety, and stress 104

4.4 Validity and reliability of the image-based stimuli 108

4.4.1 Content validity of the images 108

4.4.1(a) Academic related medical context 108

4.4.1(b) Clinical related medical context 112

4.5 Evaluation of image-based stimuli using Self-Assessment Manikin 116

4.5.1 Demographic data rating of image-based stimuli 116

4.5.2 Rating of image-based stimuli using Self-Assessment Manikin (SAM) 117

4.6 Evaluation of the relationship between stress intensity of image-based stimuli with mental toughness, perceived stress, and stress 122

4.6.1 Demographic data of the evaluation of the stress intensity 124

4.6.2 Reliability analysis 125

4.6.3 Correlation of stress intensity of the image-based stimuli with mental toughness, perceived stress, and stress 126

4.6.4 Prediction of stress intensity of the image-based stimuli to mental toughness, perceived stress, and stress 128

CHAPTER 5 132

DISCUSSION 132

5.1 Factorial validity of MTQ-48 132

5.2 Mental toughness in medical students 134
5.2.1 Mental toughness levels 134
5.2.2 Control, commitment, challenge, confidence 135
5.3 Prevalence of depression, anxiety and stress 137
5.3.1 Mental toughness & depression 138
5.3.2 Mental toughness & anxiety 139
5.3.3 Mental toughness & stress 139
5.4 Image-based stimuli 141
CHAPTER 6 CONCLUSION AND FUTURE RECOMMENDATIONS 145
6.1 Conclusion 145
6.2 Limitation of the study 145
6.3 Recommendation for future research 146
REFERENCES 147
APPENDICES

LIST OF TABLES

Page

Table 2.1 List of mental toughness inventories reported in the literature. 39

Table 2.2 List of emotional and stress induction protocol in the literature 45

Table 3.1 Selection criteria for the image-based stimuli and images' databases 62

Table 3.2 Image example 63

Table 3.3 Relevancy scale 64

Table 3.4 Characteristics of goodness-fit indices 80

Table 3.5 Interpretation of Cronbach's alpha value 82

Table 4.1 Internal consistency of MTQ-48 84

Table 4.2 Fit indices of MTQ-48 89

Table 4.3 Factor loadings of MTQ-48 (4-factor) 90

Table 4.4 Factor loadings of MTQ-48 (1-factor) 92

Table 4.5 Factor loadings of MTQ-10 96

Table 4.6 Fit indices of MTQ-10 97

Table 4.7 Mental toughness profile within year of study among medical students 99

Table 4.8 Comparison of domain value between medical students with low mental toughness and high mental toughness 100

Table 4.9 Distribution of DASS-21 score among medical students 101

Table 4.10 Prevalence of depression, anxiety and stress symptoms between year of study among medical students 101

Table 4.11 Descriptive statistics for mental toughness, depression, anxiety, and stress among medical students 104

Table 4.12 Correlations between mental toughness, depression, anxiety and stress 104

Table 4.13 Rating of 54 images by six experts in academic related medical context 109

Table 4.14 Rating of 97 images by 6 experts in clinical related medical context domain 112

Table 4.15 Valence and arousal value of academic related images 117

Table 4.16 Valence and arousal value of clinical related medical context 119

Table 4.17 Valence and arousal value of the set of image-based stimuli. 123

Table 4.18 The reliability of the set of image-based stimuli, mental toughness questionnaire (MTQ-10), perceived stress scale (PSS-10), and stress scale. 125

Table 4.19 The correlation of stress intensity of image-based stimuli with mental toughness, perceived stress, and stress 126

Table 4.20 Regression result of prediction of mental toughness 128

Table 4.21 Regression result of prediction of perceived stress 130

Table 4.22 Regression result of prediction of stress 131

LIST OF FIGURES

Page

Figure 2.1 The affective state of emotion in two-dimensional system. Image adapted from Tsiourti et al. (2019). 30

Figure 2.2 The Self-Assessment Manikin (SAM) used to rate the affective dimensions of valence (top panel), arousal (middle panel), and dominance (bottom panel)..... 51

Figure 2.3 The conceptual framework of the present study. Adapted from (Myers, 2004)..... 53

Figure 3.1 The flow chart of the study 68

Figure 3.2 SAM scale with humanoid representation of different levels of affective expressions adapted and modified from (Bradley & Lang, 1994) 75

Figure 4.1 Age distribution of medical students..... 84

Figure 4.2 Confirmatory factor analysis of original MTQ-48 (4-factor) 86

Figure 4.3 Confirmatory factor analysis of the original MTQ-48 (1-factor)..... 87

Figure 4.4 Confirmatory factor analysis of the modified 10-item mental toughness questionnaire (4-factor)..... 94

Figure 4.5 Confirmatory factor analysis of the modified 10-item mental toughness questionnaire (1-factor)..... 95

Figure 4.6 Age distribution of medical students (n=116)..... 98

Figure 4.7 Mental toughness level among medical students..... 99

Figure 4.8 Mean of mental toughness domains between low and high mental toughness..... 100

Figure 4.9 Depression in medical students..... 102

Figure 4.10 Anxiety in medical students..... 102

Figure 4.11 Stress in medical students 103

Figure 4.12 Mean of mental toughness, depression, anxiety, and stress in medical students 104
Figure 4.13 Scatter plot of depression vs mental toughness 106
Figure 4.14 Scatter plot of anxiety vs mental toughness 106
Figure 4.15 Scatter plot of stress vs mental toughness 106
Figure 4.16 Images of academic related medical context 111
Figure 4.17 Images of clinical related medical context 115
Figure 4.18 Scatter plot valence and arousal of academic and clinical related images 121
Figure 4.19 36 images for the set of image-based stimuli 122
Figure 4.20 Age and year of medical students 124
Figure 4.21 Scatter plot of stress intensity of image-based stimuli with mental toughness score 127
Figure 4.22 Scatter plot of image-based stimuli and perceived stress score 127
Figure 4.23 Scatter plot of stress intensity of image-based stimuli and stress score 127
Figure 4.24 Scatter plot of prediction of mental toughness 128
Figure 4.25 Scatter plot of prediction of perceived stress 130
Figure 4.26 Scatter plot of prediction of stress 131

LIST OF SYMBOLS

α	Cronbach's alpha
◦C	Degree celcius

LIST OF ABBREVIATIONS

ACC	Anterior cingulate cortex
BIS	Behavioural Inhibition System
CFA	Confirmatory Factor Analysis
COVID-19	Coronavirus-19
DASS-21	Depression, Anxiety, and Stress Scale-21 items
FFFS	Flight-flight-freeze-system
fMRI	functional Magnetic Resonance Imaging
HPA	Hypothalamic-pituitary-adrenal
MT	Mental toughness
MTQ-48	Mental toughness questionnaire-48
PFC	Prefrontal cortex
rgmv	Regional grey matter volume
rRST	revised Reinforcement Sensitivity Theory
SAM	Self-assessment manikin
SMA	Supplementary motor areas
vmPFC	Ventral medial prefrontal cortex

LIST OF APPENDICES

Appendix A	Permission from Dean of School of Medical Sciences
Appendix B	Ethical approval from human research ethics committee (HREC)
Appendix C	Confirmation of MTQ-48 author's permission
Appendix D	Consent form of the study
Appendix E	Mental toughness questionnaire
Appendix F	Depression, anxiety, and stress scale (DASS-21)
Appendix G	Perceived stress scale (PSS-10)
Appendix H	Affective images approval
Appendix I	Situational emotional picture rating survey
Appendix J	Stress rating scale survey

PENEROKAAN RANGSANGAN BERASASKAN GAMBAR UNTUK MENILAI KETAHANAN MENTAL DALAM KALANGAN PELAJAR PERUBATAN UNIVERSITI SAINS MALAYSIA

ABSTRAK

Ketahanan mental ialah konstrak psikologi yang terdiri daripada proses kognitif, emosi dan tingkah laku yang menerangkan keupayaan individu untuk menghadapi tekanan dan meramalkan prestasi optimum ketika dalam kesukaran. Selain daripada kajian berasaskan psikologi, penyelidik telah beralih kepada penyelidikan fisiologi dan neurosains untuk memajukan pengetahuan dan pemahaman tentang ketahanan mental. Kajian ini memerlukan modulasi bukan invasif emosi, tekanan, dan perangsangan usaha kognitif. Kajian ini bertujuan untuk meneroka satu set rangsangan berasaskan gambar untuk menilai ketahanan mental dalam kalangan pelajar perubatan. Reka bentuk kajian terdiri daripada empat fasa. Fasa I melibatkan pengesahan soal selidik ketahanan mental iaitu MTQ-48. Fasa II melibatkan penilaian ketahanan mental, kemurungan, kebimbangan, dan tekanan dalam kalangan pelajar perubatan. Fasa III melibatkan pemilihan 156 rangsangan berasaskan gambar daripada pangkalan data seperti “International Affective Picture System” (IAPS), “Nencki Affective Picture System” (NAPS), “Emotional Picture Set” (EmoPics), “Open Affective Standardized Image Set” (OASIS), “Geneva Affective Picture Database” (GAPED), dan platform tanpa hak cipta berlesen dalam talian seperti Pexels dan PxHere. Penilaian normatif valens dan rangsangan diperoleh oleh pelajar perubatan menggunakan penilaian kendiri manikin (SAM). Fasa IV melibatkan penilaian tekanan yang dirasakan berasaskan gambar daripada fasa III dan hubungannya dengan ketahanan mental, tekanan yang dirasakan dan skor tekanan. Hasil daripada analisis

faktor menyatakan bahawa MTQ-48 tidak bersesuaian untuk digunakan dalam konteks perubatan kerana indeks kesesuaian tidak memenuhi piawaian yang boleh diterima. Oleh itu, MTQ-10 terhasil daripada proses pengesahan dalam Fasa I mempunyai model yang lebih sesuai dan seterusnya digunakan dalam kajian ini. Selain itu, hubungan pincang yang signifikan didapati antara ketahanan mental dan kemurungan, kebimbangan, dan tekanan. Daripada 156 gambar, hanya 149 gambar yang relevan dengan konteks perubatan berkaitan akademik dan klinikal dan memperoleh nilai min valens dan rangsangan ("arousal") bagi setiap gambar. 36 gambar dengan valens negatif digunakan untuk menilai keamatan tekanan terhadap gambar dan hubungannya dengan ketahanan mental, tekanan yang dirasakan dan skor soal selidik tekanan. Penemuan ini memberikan bukti yang signifikan bahawa keamatan tekanan set rangsangan berasaskan gambar memberikan 19% meramal ketahanan mental, 43.9% meramal tekanan yang dirasakan dan 19.8% meramal tekanan. Oleh itu, set rangsangan berasaskan gambar ni mungkin sesuai digunakan untuk menilai ketahanan mental, tekanan yang dirasakan, dan tekanan bersama-sama pemboleubah lain dalam penyelidikan masa depan untuk memudahkan pemahaman yang lebih mendalam tentang proses afektif yang dikaitkan dengan ketahanan mental dalam kalangan pelajar perubatan.

EXPLORATION OF IMAGE-BASED STIMULI TO ASSESS MENTAL TOUGHNESS AMONG MEDICAL STUDENTS OF UNIVERSITI SAINS MALAYSIA

ABSTRACT

Mental toughness (MT) is a psychological construct comprised of cognitive, emotional, and behavioural processes that explain an individual's capacity to cope with stress and predicts optimal performance in adversity. Apart from psychological-based studies, researchers have been shifting to physiological and neuroscience research to advance the knowledge and understanding of mental toughness. These studies require non-invasive modulation of emotion, stress, and cognitive effort induction. This present study seeks to explore a set of image-based stimuli to assess mental toughness among medical students. The study design consisted of four phases. Phase I involved the validation of the MTQ-48 questionnaire. Phase II involved the assessment of mental toughness, depression, anxiety, and stress in medical students. Phase III involved the selection of 156 image-based stimuli from databases such as the International Affective Picture System (IAPS), the Nencki Affective Picture System (NAPS), the Emotional Picture Set (EmoPics), the Open Affective Standardized Image Set (OASIS), the Geneva Affective Picture Database (GAPED), and online licensed no copyright platforms such as Pexels and PxHere. These images were then content validated by panel of experts according to academic related and clinical related medical context. The valence and arousal of normative evaluations were obtained by medical students using self-assessment manikin (SAM). Phase IV involved the evaluation of the stress intensity of the image-based stimuli from Phase III and its relationship with mental toughness, perceived stress, and stress score. Findings from

factor analyses stated that MTQ-48 is unreliable for use in medical context as the fit indices do not meet acceptable standards. Consequently, MTQ-10 resulted from the validation process in Phase I had better model fit and used throughout the study. Besides, a significant inverse relationship was found between mental toughness and depression, anxiety, and stress. Out of 156 images, only 149 images were relevant to academic and clinical related medical context and were obtained valence and arousal mean value for each image. 36 images with negative valence were used to evaluate the stress intensity of the images and its relationship with mental toughness, perceived stress, and stress questionnaire. These findings provide evidence that the stress intensity of the set of image-based stimuli was 19% significantly predicted mental toughness, 43.9 % predicted perceived stress and 19.8% predicted stress. Hence, the set of image-based stimuli possibly to be used to assess mental toughness, perceived stress, and stress along with other variables in future research to facilitate a greater understanding of the affective processes associated with mental toughness in medical students.

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter outlines the research background, rationale, and significance of study. The research questions and hypotheses are listed, followed by general and specific objectives and definition of key terms.

1.1 Background of the study

Healthcare setting is considered a high-risk workplace that exposes health professionals to demanding psychological and physical conditions that may have profound effects on cognitive and behavioural performance (Khajuria et al., 2021). In medicine, doctors must endure hard work and handle high degree of demands and responsibilities, ever-changing circumstances, and increasing public expectations for care while adhering to the standards mandated by regulators and patients. In addition, the recent outbreak of a novel coronavirus, COVID-19, has heightened the risk of doctors' working life to be more stressful than normal conditions, resulted in negative mental health effects such as depression and anxiety (Galbraith et al., 2021). These adverse effects may ultimately compromise clinical practice and efficiency (Aslam et al., 2019).

It is also to be noted that prevalence of personal distress usually comes early when doctors are still in medical school and clinical training (Low et al., 2019). The medical programme, which is designed to educate and produce highly qualified and professional doctors for the benefit of healthcare system requires the students to have persistent attention and hard work throughout the programme (Dendle et al., 2018). This highly competitive curriculum significantly contributes to burnout, higher anxiety,

depression, and stress among medical students compared to non-medical students (Frajerman et al., 2019; Moir et al., 2018; Ramlan et al., 2020; Zeng et al., 2019). According to recent meta-analysis, burnout among medical students ranged from 7% to 75% (Erschens et al., 2019). Furthermore, due to the dramatic increase in patients during the COVID-19 pandemic crisis, medical students are graduating early, immediately entering the workforce, and taking roles as volunteers, which can make them vulnerable to the negative consequences of mental health (Li et al., 2021; O'Byrne et al., 2020). In addition, issues with academics are also one of the biggest sources of stress for medical students (Rafique et al., 2019).

Despite the alarming incidence of mental health issues, several studies have suggested that some doctors and medical students were not experiencing burnout and psychological distress and were able to thrive in the environment (Rotenstein et al., 2018). Interestingly, in a study during the outbreak of COVID-19, they found out that medical staff that working as front-liners (working directly with infected patients) are less likely to have burnout symptoms compared to non-front-liners (Wu et al., 2020). They suggested that this may be because front-liners are more prepared and have higher psychological endurance than non-front-liners. Several studies suggest that the ability to deal with pressure and thrive in the face of adversity is related to personality trait known as mental toughness (MT) (Aslam et al., 2021).

According to (Clough et al., 2002), mental toughness refers to a person’s tenacity and inner will to succeed, especially when the going gets difficult. Mental toughness is an attribute that consists of four important elements; Control, Challenge, Commitment, and Confidence where Control is further extended to Life and Emotional Control and Confidence to Interpersonal Confidence and Confidence in Ability. Arise

from sport psychology, mental toughness also has been described as a “desirable skill allowing athletes to utilize a range of cognitive, emotional and behavioural resources to maintain and improve their performance standards under pressure”(Coulter et al., 2018).

Furthermore, studies have shown that mental toughness can mitigate the detrimental impacts of stress and depression (Gerber et al., 2018). The degree of stress experienced by an individual depends on his or her cognitive appraisal of a situation. Mental toughness is said to be a major aspect of the primary appraisal processes that influences self-regulation, hence, enabling an individual to better manage numerous life demands. Two processes that might be particularly impactful are the self-regulatory processes of self-control and emotion regulation. According to the study by Gerber et al. (2018), higher levels of mental toughness are significantly associated with lower levels of stress and burnout, therefore, being mentally tough is possible to act as a stress buffer by appraising stressful situations as challenging and less threatening. Crawford et al. (2021) highlight that athletes with higher mental toughness have fewer difficulties regulating their emotion and use more emotion regulation strategies. They reported less perceived stress, better perceived rating of mental health, and more engagement in goal-directed behaviour. This aligned with the definition of mental toughness in various literature as the ability to strive and continue with a task to achieve their goal.

However, these research findings are mostly based on psychological or self-reported measurements. The most commonly used instrument is the Mental Toughness Questionnaire-48 (MTQ-48) developed by Clough et al. (2002), in both sport and non-sport contexts, despite other instruments such as Mental Toughness Questionnaire - 18 items (MT-Q18) and Sport MTQ. Despite its potential as a promising evaluation

instrument for mental toughness and its extensive use in research, there are concerns over its applicability and accuracy in future studies.

Therefore, researchers are now embarking on emotion and neuroscience study as a complementary approach of psychological measurement in mental toughness. This can contribute to better understanding, investigating and even intervention supporting mental toughness and emotion regulation as well as stress and anxiety-coping. Extensive neuroscience research has been done on other concepts of stress-coping such as resilience and grit. One example is research conducted by (Wang et al., 2018) where they conducted whole-brain regression analyses of magnetic resonance imaging (MRI) and revealed that regional grey matter volume (rGMV) in the right putamen positively predicted grit. In 2017, (Yamamoto et al.) conducted an experiment in those with early life stress (ELS) and suggested that preservation of robust amygdala activity may reflect resilience enhancing factor against depression and negative stressful events. Besides, a study conducted using functional magnetic resonance imaging (fMRI) identified ventral medial prefrontal cortex (vmPFC) as the neural basis of stress signals resilience coping (Sinha et al., 2016). Conceptually, one of the components of mental toughness is self-control and PFC has been considered as the neural centre of self-regulation or self-control (Kelley et al., 2015; Wagner et al., 2015). Besides, conscious, or explicit emotion regulation involves the dorsal lateral PFC, the ventrolateral PFC, parietal cortex, and supplementary motor areas (SMAs) (Braunstein et al., 2017). If emotion regulation happens without conscious control (implicit), the ventral anterior cingulate cortex (ACC) and vmPFC are involved. In this manner, the amygdala, insula, and ACC interact with the prefrontal cortex as well as the parietal and SMA cortex to downregulate emotion. The PFC, which has executive control functions, contributes to the regulation of emotional arousal and response (Etkin et al., 2015).

One of the most recent studies of neuroscience of mental toughness is the relationship of intelligence and mental toughness using electroencephalography (EEG) by Zhozhikashvili et al. (2022). They used Sternberg task in the experiment that is linked to task complexity and cognitive effort that can modulate alpha rhythm during working memory processes. Low mental toughness participants exhibited more event-related desynchronization of alpha oscillations, which was regarded as needing more effort to complete the task, whereas high mental toughness participants rated the task as easy and not requiring an increase in effort. Although it was hypothesised in literature that more motivated and emotionally stable individuals would exert more effort under stressful conditions, they concluded that the task was too simple to demonstrate the expected impact.

One method of investigating mental toughness is to examine how different individuals respond to emotional stimulation in specific situations. Therefore, it is essential to establish a technique or procedure to evaluate and further comprehend the idea of mental toughness, such as cognitive effort related tasks, stress tasks, and emotional stimuli paradigm. Due to the paucity of emotion and neuroimaging research on mental toughness, it is worthwhile to investigate which paradigm is best for assessing mental toughness in different contexts. Researchers have been developed a variety of emotional and stress induction methods such as Socially Evaluated Cold Pressor Test (SECPT), Montreal Imaging Stress Task (MIST), the use of audio-visual material such as Trauma Film paradigm and International Affective Pictures (IAPS), video games and virtual reality. Besides, different individuals may develop vastly diverse stress responses to the same stressor (Giannakakis et al., 2019), and this variation may be attributable to varying psychological resilience. Therefore, the purpose of this study is

to explore a new set of image-based stimuli as a method for complementary assessment of mental toughness.

1.2 Rationale and significance of the study

Research suggests that mental toughness can minimize the effects of adverse stressors to mental health in individuals especially during pandemic and enhance their performance either related to individual work or daily life. Despite the interchangeably used of mental toughness with related concepts (i.e., resilience, grit, and hardiness), intensive inventories have been done to measure mental toughness and improve the understanding of the concept as well as to provide interventions for individuals to be mentally tough. It is essential to examine mental toughness from several perspectives to differentiate it from its related notions. Therefore, many studies have utilized mental toughness in other fields than sports such as military training, workplace, education and recently in healthcare professions particularly doctors.

As mental toughness arises from sport psychology, the response of novices in the health profession to difficulties and stressors may differ from that of athletes due to the nature of learning and training itself. In this study, we are focusing on medical students as they are susceptible to experiencing symptoms of depression, anxiety, stress, and burnout during their training. A study conducted in Germany, Bergmann et al. (2019) stated that the demands of medical studies and private life, the lack of recuperation resources, and certain personality qualities, as well as the relationship between these domains, may contribute to stress and lower well-being among medical students. Both the pre-clinical and clinical years of medical education impose mental and psychological pressures on students. Therefore, the capacity to determine mental

toughness in medical students might potentially contribute to the improvement of curriculum design in order to produce holistic doctors.

Therefore, investigating the relationship of mental toughness with stressors or image-based stimuli may provide new understanding of mental toughness.

1.3 Problem statement

Recent research shown that mental toughness model includes data from behavioral tests in order to uncover the cognitive foundation of mental toughness in athletes (Dewhurst et al., 2019). As mental toughness is an emerging personality trait in positive psychology, exploring this feature via emotion study may provide further insights into how mental toughness serves as a stress buffer or regulates the emotions of individuals in challenging situations. However, there are numerous approaches described in the literature for studying emotion, specifically stress in laboratory. These techniques include imagery inductions, film snippets, and static images. Designing the paradigm for stress induction is difficult since a limited number of indicators, such as sample characteristics, reported peripheral measurements, and the effectiveness of inducing a valid stress response, must be addressed. In light of the existing dearth of stimuli to study mental toughness in the context of health professions, particularly among medical students, the exploration of image-based visual stimuli for mental toughness evaluation is crucial.

1.4 Research questions

1. Is MTQ-48 reliable to be used as a tool to measure mental toughness in medical students?

2. Is there any difference between the level of mental toughness between Year 1 and Year 5 medical students?

3. Is there any relationship between mental toughness, depression, anxiety, and stress in medical students?

4. Do the image-based stimuli under academic domain and clinical domain have good content validity (relevancy) in medical context?

5. Does each image-based stimuli evoke a range of affective responses with respect to valence and arousal?

6. Is there any relationship between stress intensity of the image-based stimuli with mental toughness, perceived stress, and stress?

1.5 Research objectives

1.5.1 General objective

To explore a set of image-based stimuli to assess mental toughness among medical students.

1.5.2 Specific objectives

1. To determine the factor structure and internal consistency of mental toughness questionnaire (MTQ-48).

2. To examine the level of mental toughness between Year 1 and Year 5 medical students.

3. To examine the relationship between mental toughness, depression, anxiety, and stress.

4. To assess the academic and clinical domain relevancy of image-based stimuli in medical context.

5. To measure the affective value (valence and arousal) of the image-based stimuli.

6. To evaluate the relationship of the stress intensity of the image-based stimuli with mental toughness, perceived stress, and stress.

1.6 Research hypotheses

Hypothesis 1: MTQ-48 is reliable to be used as a tool to measure mental toughness among medical students.

Hypothesis 2: There will be significant difference between level of mental toughness between Year 1 and Year 5 medical students.

Hypothesis 3: There will be significant relationship between mental toughness, depression, anxiety, and stress.

Hypothesis 4: The image-based stimuli under academic and clinical domain have good content validity (relevancy) in medical context.

Hypothesis 5: The image-based stimuli evoke a range of affective response with respect to valence and arousal.

Hypothesis 6: There is significant relationship between stress intensity of the image-based stimuli and mental toughness, perceived stress, and stress.

1.7 Study aim

This study aimed to explore image-based stimuli to assess mental toughness among medical students in medical context. Medical students were chosen as the population of interest with the intention of focusing on their psychological state and readiness for professional work through the examination of mental toughness levels and their relationship to how they cope with various stressors encountered during training.

1.8 Definition of key terms

Key terms used in this thesis are:

Mental toughness - Mental toughness is defined as the ability of individuals to better cope and survive adversity in competitive situations, which is further defined as the presence of some or all of the experientially developed and innate values, attitudes, emotions, cognitions, and behaviours that influence how an individual approaches, responds to, evaluates, and consistently achieves his or her goals (Coulter et al., 2018)

Perseverance - Perseverance is defined as "continued effort to do or achieve something, even when this is difficult or takes a long time" (Cambridge Dictionary, 2023)

Depression - Depression, according to the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5), is defined by "separate episodes of at least two weeks duration that entail abnormalities in mood, cognition, and neurovegetative processes, as well as remissions between episodes". The diagnosis requires the presence of at least five or more symptoms, including depressed mood, weight changes, changes in sleeping pattern, psychomotor agitation or retardation, loss of energy, difficulty of focus, and persistent suicidal ideation. A positive

screening does not imply a diagnosis of depression, but rather the existence and intensity of symptoms (Lovibond & Lovibond, 1995).

Anxiety - According to DSM-5, generalized anxiety disorder is diagnosed when a person has tense sensation, anxious and recurrent intrusive thoughts or worries that lasts for at least six months and is accompanied by bodily symptoms such as perspiration, shaking, vertigo, and a fast heartbeat. Anxiety is regarded a future-focused, long-lasting response to dispersed threat (American Psychological Association, 2023).

Stress - Stress is the physiological response and alterations caused by exposure to physical or psychological pressures on a person (Selye, 1956).

Stressor - A stressor is an event that dramatically destabilises the dynamic system of an individual, leading to unsatisfactory performance (Oken et al., 2015). Lazarus (1993b) defined stressor as an external or internal agent that generates stress. In this study, stressors for medical students are academic and clinical demands (Yusoff et al., 2010)

Emotion - Emotion is a functional psychological system viewed as multicomponent constructs including the evaluation of experiential and subjective feelings (external and internal), neural responses, expression

and body regulations in response to stimulus (Celeghin et al., 2017).

Coping	-	Lazarus (1993a) defined coping as “a continuous cognitive and behavioural attempt to meet specified external and internal demands that are evaluated as straining or beyond individual resources. Various aspects have been suggested to classify coping techniques, including problem- and emotion-focused coping and engagement-disengagement coping (Carver, 1997; Tobin et al., 1989). In this study, we focus on emotion-focused coping and stress-related coping.
Resilience	-	Resilience is defined as “the ability to be happy and successful again after something difficult or bad has happened” (Cambridge Dictionary, 2023). In psychology, resilience is the capacity of an individual to recover, positively adapt, and cope with adversity.
Neural substrate	-	A neural substrate is a term used in neuroscience to indicate the part of the nervous system or brain areas that underlies a specific behaviour, or psychological state (APA Dictionary of Psychology).

1.9 Chapter summary

Mental health within medical profession and medical education is crucial and important to produce good quality doctors. However, the degree of stress and emotional response towards stressors varies from individual to individual. This variability may also be influenced by the degree of mental toughness everyone has either by trait or by state. Consequently, by observing the mental toughness and emotional response at the grassroots level, future doctors may be better equipped to adjust to the ever-changing environment of the healthcare industry. Advancement in neuro-emotion-scientific methods can be utilised to increase comprehension of the mechanism behind mental toughness and emotion and thus providing the platform for future research in discovering the neural substrate of mental toughness itself. Thus, comprehending new knowledge will cover some gaps in the literature and aid curriculum creators or policymakers in implementing context-sensitive preventive measures or interventions with the aim of better equipping future generations of quality doctors and healthcare professionals.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The researcher reviewed the literature to search for knowledge gaps in relation to the area of research interest. Mental health issues in medical students such as depression, anxiety, and stress are mentioned accordingly. Mental toughness and its relationship with mental health, the conceptualization of mental toughness, the neuroscience of mental toughness and its relationship with cognitive-emotion and experimental methods to induce stress are described below. The review confirmed a lack of research and knowledge in this area, thus reinforcing the researcher's belief that this research would fill a gap in both research and public knowledge.

Long have researchers been interested in identifying the mechanisms that enable individuals to overcome adversity and achieve their objectives in a variety of situations. Originating in sport psychology, mental toughness has gained popularity in numerous fields, including the military, education, and the workplace. Mental toughness has been shown to act as a buffer or protective factor against psychological distress in individuals at risk. Mental toughness is described as the "human capacity to persistently create high levels of subjective and objective performance despite daily obstacles and stressors as well as substantial adversities" (Gucciardi et al., 2015). Even though the definition of mental toughness is generally recognised, researchers continue to disagree about the conceptualization and measurement of mental toughness.

2.1 Mental health issues in doctors and medical students

Mental health issues are common concerns among medical students, and numerous studies have reported high rates of stress, anxiety, depression, and burnout among this population. Moreover, due to the unprecedented pressure of the current global crisis, medical doctors are vital components of the worldwide frontline pandemic response in caring for the infected, working above their capacities, and risking their lives (Aranha et al., 2022). Studies conducted outside of the global crisis have also revealed that doctors have a higher risk of psychological distress, depression, anxiety, burnout, and suicide ideation than the general population; thus, their health has deteriorated dramatically throughout the pandemic (De Sio et al., 2020; Dong & Bouey, 2020; Dyrbye et al., 2006; Hayes et al., 2017). According to a recent study, 63.5% of doctors have symptoms of depression and 45% have symptoms of stress (Aranha et al., 2022). Poor mental health and well-being among healthcare staff has organizational ramifications for patient safety, experience, and satisfaction, in addition to financial costs, productivity impacts, and individual consequences (Johnson et al., 2018). In addition to medical doctors, the prevalence of depression in medical students was 36% and anxiety was 59.7%, thus indicating that medical students also confronted obstacles during the pandemic (Perissotto et al., 2021). Besides, it has been well documented that the prevalence of psychological stress is much higher in medical students, compared to non-medical students and the general population. The purpose of medical education is to produce doctors who are knowledgeable, skilled, and professional, thus, to achieve these goals, life during medical training is difficult and stressful for students. Medical students experience stress and anxiety due to the nature and rigour of medical school, lack of guidance and support, financial concerns, and uncertainty about the future (Haskett et al., 2022).

2.2 Mental toughness and mental health

The focus of research has shifted from detecting mental health issues to understanding the factors that promote mental health and protect individuals from developing psychological disorders. The field of positive psychology has grown exponentially during the past decade. It emphasizes the notion that individuals seek to reveal their best selves, which leads to a better and happier way of life, and it continues to attain the highest levels of enjoyment and success. It is commonly known that doctors have incredibly demanding jobs, including long duty hours and shift works, which may be emotionally draining and significantly impact their job performance. Therefore, it is important not only to identify but also to foster some good characteristics, in the early stages of medical school, such as mental toughness, that can improve their job performance and guard against mental health disorders (Aslam et al., 2019).

Mental toughness enhances psychological well-being and health (Jin & Wang, 2018; Stamp et al., 2015) including reduced perceived stress (Gerber et al., 2018; Haghighi & Gerber, 2019) and anxiety levels (Benjamin & John, 2021; Haghighi & Gerber, 2019). It functions as a stress-resilience resource, suggesting potential links between stress and mental toughness. This association has been postulated by studies employing a stress moderator perspective. For instance, mental toughness decreased depression symptoms in stressed individuals. Similarly, mental toughness prevented burnout in young competitive athletes by enhancing interaction at greater stress levels (Gerber et al., 2018). These findings showed that mental toughness has the potential to be stress-resistant, which may mitigate other negative outcomes such as anxiety.

Previous study highlighted the potential moderating effect of mental toughness on subjective stress and anxiety (Levy et al., 2012). According to this study, those with higher mental toughness are exposed to fewer threats than those with lower mental

toughness at increasing degrees of stressfulness. This shows that at higher levels of perceived stress, higher mental toughness persons may feel less threats (anxiety symptoms) via cognitive appraisal (Levy et al., 2012).

Therefore, it was essential to educate doctors about mental health disorders and eliminate the stigma associated with them. As mental toughness, resilience, social support, and emotion control play a crucial role in preventing mental health problems, they have been accorded considerable weight.

2.3 Conceptual considerations in mental toughness

2.3.1 Definition of mental toughness

Mental toughness is the capacity of an individual to retain emotional and psychological stability, motivation, and resilience in the face of adversity, stress, and pressure. The definition of mental toughness varies among researchers, but the most frequently cited characteristics are confidence in one's abilities and decisions, determination, and the ability to rebound from setbacks, the ability to effectively manage stress and emotions, a strong work ethic, and the ability to persevere in the face of difficult challenges.

Mental toughness was first described in academic literature by Cattell et al. (1955) that said "tough-mindedness" was a culturally or environmentally influenced personality trait seen as the foundation of success, where tough-minded persons are self-reliant, pragmatic, and accountable, in contrast to emotional sensitivity". Later, Loehr (1982); (Loehr, 1985) defined mental toughness as "athletes who respond in a variety of ways that allow them to remain relaxed, calm, and energized because they have learned to develop skills in the ability to increase their flow of positive energy in crisis and adversity and to think in specific ways so that they have the right attitudes regarding

problems, pressure, mistakes, and competition." The model, which was eventually made public, has seven characteristics: self-confidence, negative energy, attention management, visual and imagery control, motivation, positive energy, and attitude control.

Fourie and Potgieter (2001) identified twelve components of mental toughness including motivation level, coping skills, confidence maintenance, cognitive skills, discipline and goal-directedness, competitiveness, possession of prerequisite physical and mental requirements, team cohesion, preparation skills, psychological toughness, and ethics.

Since the components of mental toughness vary widely, Jones et al. (2002) posed the question, "What is this thing called mental toughness?" to begin his investigation of the definition and idea of mental toughness. Jones et al. (2002) concluded from their study that mental toughness is "having the natural or developed psychological edge that enables you to; generally, cope better than the opponents with the numerous demands (competition, training, lifestyle) that sport places on its performers; specifically, be more consistent and better than the opponents in remaining determined, focused, confident, and in control under pressure." In addition, the researchers identified twelve important characteristics of mental toughness, such as "remaining totally concentrated in the face of personal life distractions" and "having an unshakable self-belief that one may possess unique qualities and skills".

Clough et al. (2002), in contrast to Jones et al. (2002), classified mentally tough person "tend to be gregarious and outgoing; since they can remain cool and relaxed, they are competitive in many circumstances and have lower anxiety levels than others." These individuals may stay largely unaffected by competition or misfortune because they have a strong sense of self-belief and an unshakable trust that they control their

own destinies. Clough conceptualised mental toughness by integrating Confidence with the tenacity characteristics of Commitment, Control, and Challenge, resulting in the 4C's model. Hardiness, as described by Kobasa (1979), is a constellation of attitudes, beliefs, and behavioural inclinations consisting of Control, Commitment, and Challenge that confers resilience to adverse life events (Maddi et al., 2006).

Moreover, Middleton et al. (2004) defined mental toughness as "unshakeable persistence and conviction toward a common goal despite pressure and adversity" and believed that mentally tough athletes from various sporting backgrounds possess twelve characteristics, including self-efficacy, potential, mental self-concept, task familiarity, value, personal best, goal commitment, persistence, task focus, positivity, stress minimization, and positive comparisons. In addition, Middleton et al. (2005) argued that the applicability of their concept of mental toughness extends beyond athletic situations.

Bull et al. (2005) investigated further the concept and characteristics of mental toughness among cricket players. They provided a model of mental toughness consisting of four structural categories, each of which contained multiple themes relevant to mental toughness as a whole. The themes are environmental influence (e.g., parents, childhood, opportunities to overcome early setbacks), tough character (e.g., resilient confidence, independence, competitiveness with self and others), tough attitudes (e.g., never-say-die attitude, thrive on competition, willingness to take risks, determination to make the most of ability, self-set challenging goals), and tough thinking (i.e., thinking clearly-making good decisions, maintaining self-focus).

Thelwell et al. (2005) explored the notion of mental toughness in the context of soccer, and their findings confirmed the validity of the definition and characteristics of mental toughness presented by Jones et al. (2002), but discovered only eleven

characteristics (i.e., always having total self-belief that one will achieve success, knowing what it takes to grind oneself out of trouble and controlling emotions throughout the performance).

Later, Jones et al. (2007) analyse mental toughness utilising a follow-up research with super-elite athletes (i.e., Olympic and World Champions), as well as the perspectives of coaches and sport psychologists who had coached and counselled at that level. Based on the findings, the researchers confirmed their earlier definitions and extended the original twelve components to thirteen, which were then organised into a framework of mental toughness with four dimensions: a general attitude or mindset and three time-specific dimensions of training, competition, and post-competition.

Sheard et al. (2009) did study to comprehend the notion of mental toughness and characterised mental toughness as a mix of emotional regulation, perseverance in pursuing objectives, and confidence in one's talents.

Gucciardi et al. (2009a) used Personal Construct Psychology (PCP; (Kelly, 1955)) as a theoretical framework to define mental toughness: "mental toughness is a collection of experientially developed and inherent sport-specific and sport-general values, attitudes, behaviours, and emotions that influence the way an individual approaches, responds to, and appraises both negatively and positively construed pressures, challenges, and adversities to consistently achieve his or her goals". Gucciardi et al. (2009b) defined mental toughness on the basis of the interplay of three components thought crucial to mental toughness in Australian football: features, circumstances, and behaviours. Gucciardi et al. (2015) identified eleven qualities, including self-efficacy, buoyancy, success mentality, optimistic style, context knowledge, emotion control, attention regulation, pressure management, self-motivation, a tough attitude, and work ethic. This study's situational component refers

to both external and internal factors that contribute to varied degrees of mental toughness. The behavioural components consist of the overt activities of mentally tenacious football players in circumstances requiring mental toughness.

2.3.2 Conceptualization of mental toughness

In addition to the difficulties in defining mental toughness, there is also dispute on its conceptualization. Traditionally, mental toughness is treated as a notion that was first recognised as a personality or disposition feature that describes tough-minded persons by Cattell et al. (1955), Kroll (1967), Werner and Gottheil (1966), and Clough et al. (2002). Dennis (1981) contested the hypothesis of mental toughness as a personality feature, while Gibson (1998) defined mental toughness as a state of consciousness. Then Bull et al. (1996) said that mental toughness is only a collection of psychological characteristics. Loehr (1995) was the first to suggest that mental toughness may be formed and acquired, and Gucciardi et al. (2009a) concurred that it is not limited to intrinsic genetic features. Gucciardi et al. (2015) offered evidence from longitudinal research indicating mental toughness is best characterised as a state, based on their findings that demonstrated greater within-person variability (56%) in mental toughness scores than between-person variability (44%).

Horsburgh et al. (2009) investigated the behavioural genetic relationship between mental toughness and the Big Five personality characteristics at the phenotypic, genetic, and environmental levels in 219 adult twin pairs. The heritability estimate for total mental toughness was 52%; the remaining 48% of the variance in mental toughness was attributable to non-shared environmental variables; that is, environmental effects that make children growing up in the same household dissimilar, rather than similar. Thus, the variance in mental toughness scores may be attributable to both heredity and environmental variables that are not shared.

Moreover, mental toughness may be better viewed as a chronic preference, in which individuals have a dispositional desire to be mentally tough or not be mentally tough, but the environment can impact the behavioural manifestation of this feature.

Contrary to research that conceptualises mental toughness as multidimensional, Gucciardi (2017) argued that mental toughness is a unidimensional construct. However, according to Clough et al. (2002) and Lin et al. (2017) mental toughness is best conceptualised as multidimensional owing to the fact that it is composed of distinct characteristics.

Flannery (2018) introduced the idea of mental toughness based on social-cognitive and regulatory theory in research examining the development of novel measurements of mental toughness. According to social-cognitive theorists, conduct is the outcome of dynamic interactions between an individual's cognition and environment (Mischel & Shoda, 1995). Individuals regulate their behaviour and emotions by regularly monitoring their conduct and comparing it to their own personal standards, according to self-regulation theory (Albert, 1991). Consequently, Flannery (2018) presented the Social-Cognitive Mental Toughness model, which describes mental toughness as a collection of cognitive, emotional, and behavioural qualities that may be gained through social-learning and cognitive self-regulation. According to this concept, mental toughness is influenced by three primary components: human characteristics, contextual conditions, and cognitive and behavioural techniques.

Human characteristics are a person's inherent qualities and traits that contribute to mental toughness, such as self-confidence, optimism, resilience, and motivation. Environmental elements include social and cultural influences that impact a person's ideas, values, and attitudes and can either promote or inhibit the development of mental

toughness. Individuals control their thoughts, emotions, and actions in response to challenges and stress through cognitive and behavioural methods.

The socio-cognitive model of mental toughness indicates that mental toughness is not a fixed nor a static feature, but rather a dynamic and flexible construct that can be built and improved by conscious practice and social learning over time. By employing cognitive and behavioural methods such as goal setting, self-monitoring, self-reflection, and self-evaluation, individuals may build their mental toughness and enhance their capacity to deal with stress, overcome obstacles, and achieve their objectives.

2.3.3 Mental toughness and its related construct

The capacity of an individual to persevere in the face of obstacles and adversity in pursuit of goals has also been attributed to grit, hardiness, and resilience. Price (2019) examining construct redundancy revealed that mental toughness, resilience, hardiness, and grit were highly associated (r=0.62 to 0.78). Nevertheless, Price (2019) established through component analysis that these constructs are separate and that each of these dimensions contributed uniquely to stress and well-being. Although mental toughness, resilience, grit, and hardiness are connected ideas, they are unique. Despite the fact that they all pertain to a person's capacity to endure stress and hardship, there are significant distinctions between them. Generally,

- Mental toughness refers to a person's capacity to persevere in the face of obstacles and hardship and to perform effectively under duress. It includes both psychological and physiological elements, such as self-confidence, motivation, and the control of stress reactions.
- Resilience refers to an individual's capacity to recover from adversity and retain their psychological health in the face of adversity. It includes