DESIGN A VISUAL DOT PROBE TASK FOR OCCUPATIONAL STRESS MEASUREMENT IN MANUFACTURING

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DESIGN A VISUAL DOT PROBE TASK FOR OCCUPATIONAL STRESS MEASUREMENT IN MANUFACTURING

CHONG KAI WEN

A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Mechnical Engineering with Honours

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April 2024

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

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Signature : _________________________

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Date : 20.5.2024

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ABSTRACT

Job-related stress is a crucial but frequently disregarded problem within the manufacturing industry, where it affects individual well-being severely. This study introduces a visual dot probe task prototype developed to assess stress levels by leveraging attentional biases and responses to emotional stimuli. The prototype will be validated using the Perceived Stress Scale (PSS-10) in terms of stress level, while its usefulness and ease of use are evaluated through the Technology Acceptance Model (TAM). The research involved 21 participants from the manufacturing industry who underwent stress testing using the dot probe task prototype and completed two questionnaires, including the PSS-10 and the TAM, to measure stress perception of participants and prototype acceptance, respectively. The visual dot probe task prototype includes 40 trials to assess stress levels using emoji-based stimuli, distinguishing between congruent and incongruent trials, with participants responding to dot locations. High reliability was shown by Cronbach's alpha tests for both PSS-10 (α = 0.866) and TAM (α = 0.976). Descriptive statistics for PSS-10 revealed a moderate stress level (mean range: 1.86 to 2.43) and TAM responses indicated strong acceptance (mean range: 3.43 to 3.91). The visual dot probe task exhibited a congruent trial reaction time of 422.23ms, incongruent trial reaction time of 447.69ms, and an attentional bias score of -25.46ms. Pearson correlations revealed a strong positive correlation between congruent and incongruent reaction times ($r = 0.944$), while attentional bias score showed weaker correlations. A t-test confirmed significant differences between congruent and incongruent reaction times. Comparisons between PSS-10 scores and dot probe task variables demonstrated a moderate negative correlation. T-tests confirmed statistically significant differences between PSS-10 scores and dot probe task variables. Therefore, the visual dot probe task successfully measured attentional biases, demonstrating its usefulness and ease-of-use in the manufacturing industry. This offers a promising alternative for stress assessment and contributes to employee well-being in manufacturing.

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Stress is a complex phenomenon triggered by challenging situations, leading to fear and anxiety, and a fight or flight response (Fink, 2016). Job stress, in particular, can result in behavioral and physical symptoms including difficulty concentrating, tiredness, changes in appetite, and headaches, which can potentially cause ill health outcomes. Prolonged stress without effective coping may lead to various illnesses like depression, anxiety, heart disease, and immune disorders (Dewe et al., 2010). Research has indicated that work stress is caused by several factors, including job requirements, demands, career concerns, workplace relationships, and organizational problem. Furthermore, economic and social changes introduce additional stressors like work-life conflicts, organizational changes, redundancies, and outsourcing, significantly impacting overall well-being and health due to the substantial time spent working (Claridge and Cooper, 2014).

In the manufacturing industry, one of the most apparent indicators of job stress is burnout, which is characterized as a psychological disorder resulting from continual interpersonal stressors at work or as a collection of unfavorable effects stemming from prolonged job-related stress (Shin et al., 2013). This syndrome comprises three key dimensions: a cynical attitude and detachment towards work, overwhelming exhaustion, as well as a sense of ineffectiveness or diminished accomplishment (Edú - valsania et al., 2022). Research results have shown that several factors are linked to burnout. Many hierarchical regressions have revealed a correlation between an increased risk of burnout and factors such as longer weekly work hours, shorter job tenure among employees, and a lower educational level (Wang et al., 2017). Interestingly, older employees are less prone to exhibit signs of emotional fatigue since they have more experience, which enables them to navigate various work situations more effectively. Workers with fewer years in the workforce may have greater expectations when they first start their professions, but a lack of experience and practical skills may lead to a challenging adjustment period (Wu et al., 2014). Furthermore, research indicates that occupational stress leads to 14.7% of manufacturing workers in microscale and small-scale manufacturing companies experiencing occupational injuries (Mulugeta et al., 2020). These injuries often occur in tasks involving machinery and hand tools, resulting in injuries to the common parts of the body, including workers' upper limbs, hands, and fingers (Molla et al., 2015). This can be attributed to workers undergoing work-related stress and not being able to concentrate effectively on their tasks.

Given the substantial effects that job stress has on people, it is crucial for companies to promptly identify and address it. The dot probe task was created to evaluate work-related stress and potential indications of depression in people. The task is based on the principle of attentional biases, where certain stimuli have the ability to automatically draw or repel attention (Cassidy et al., 2023). Such biases towards salient stimuli are observed in humans and are crucial for survival due to evolutionary pressures (Anderson and Britton, 2020). Not only do humans exhibit rapid detection of threats like poisonous animals and predators, but they also respond swiftly to emotionally significant stimuli (Laméris et al., 2022). For more than three decades, the dot probe task has been widely utilized in attentional bias research (Abramowitz and Blakey, 2020).

In the visual dot probe task, two stimuli are concurrently shown on separate sides of the screen, with one of them potentially containing emotional content, like an angry or neutral facial expression (Günther et al., 2021). One cue is selected from a salient category hypothesized to induce an attentional bias, while the other is drawn from a neutral control category. Subsequently, participants are tasked with identifying a probe appearing in the same position as one of the stimuli. Quicker or delayed reaction times to probes shown at the position of salient cues would indicate an attentional inclination toward or away from that specific stimuli, correspondingly (Stojek et al., 2018). A positive attentional bias score suggests a focus on the emotional face, whereas a negative score indicates avoidance of the emotional stimulus (van Rooijen et al., 2017). This behavioral measure of spatial attentional bias has been employed to investigate potential underlying mechanisms of various disorders, including anxiety, obesity, posttraumatic stress disorder, and addiction (Sharpe et al., 2022). By utilizing this task, companies can gain valuable insights into employees' stress levels and proactively address job-related stress to promote overall well-being effectively.

To effectively assess stress, a variety of products have been developed, encompassing both hardware and software solutions. One noticeable hardware product accessible in the market is the stress tracking watch, which employs measures of heat stress and thermal comfort sensations to gauge stress levels (Nazarian et al., 2021). Next, there is another stress tracker available in the market that places emphasis on heart-related metrics. These devices often incorporate heart rate monitors to continuously track beats per minute and provide real-time feedback. (Chalmers et al., 2021). Both of these devices are suitable for tracking changes in daily life stress over time. However, their accuracy can be influenced by individual body conditions and ambient temperature. Furthermore, it's important to note that the stress being tracked may not be specifically focused on job-related stress, as these products are primarily designed for general health tracking purposes. Conversely, the dot probe task comprises both visual and audio versions, both of which exist solely as software products accessible through online websites. These tools are exclusively software-based, and there is a risk of data leakage, which can deter potential users from testing stress online.

Therefore, for the specific measurement of job-related stress, researchers have devised a range of questionnaires. These questionnaires serve as valuable tools for companies to assess individuals' stress levels in the workplace. They are extensively validated by numerous studies to ensure accurate results. Examples of such questionnaires include the Perceived Stress Scale (Yun Chen et al., 2021), Occupational Stress Indicator (Robertson et al., 1990), Ottawa Mood Scales (Wong et al., 2021), Work Stress Questionnaire (Frantz and Holmgren, 2019), NIOSH Generic Job Stress Questionnaire (Kazronian et al., 2013), and the Job Stress Survey (JSS), and more. These questionnaires are designed to cover various aspects of job-related stress, providing insights into an individual's perceived stress levels, specific stressors in work environment, and overall well-being.

In this project, a physical visual dot probe task prototype will be developed in order to measure the accuracy and response time of individuals.

The collected data will be utilized to determine the stress levels among individuals working in the manufacturing industry and undergo comparison using the Perceived Stress Scale (PSS-10), a questionnaire that has been validated by researchers. Furthermore, responses by the individuals will be recorded using the Technology Acceptance Model (TAM) in order to rate the prototype's usability in terms of ease of use and usefulness. The physical dot probe task is planned to examine attention biases and responses to emotional stimuli, which can act as indicators of an individual's stress levels. The development of this prototype has the capacity to have a substantial influence on the stress assessment field and enhance employee well-being in the workplace.

1.2 Importance of the Study

The creation of a dot probe task to assess the reaction time and accuracy of an individual to analyze stress levels is important for several reasons. First, the task is user-friendly, allowing people with language barriers to undergo the dot probe assessment and test their stress levels effectively. As a result, the reliance on job stress questionnaires as the sole medium for stress testing in the workplace may be reduced.

Furthermore, research has consistently shown a strong relationship between occupational stress and poor health. Thus, poor health conditions can drastically reduce human productivity caused by diminished concentration, distractions, and other associated issues. Given that higher stress levels can impact employees' performance, it becomes essential to address stress effectively in the workplace. The development of the dot probe task can be essential in encouraging a stress-free work environment for employees, which will lead to increased productivity (Saradha and Saravanan, 2023).

1.3 Problem Statement

Numerous research investigations have examined the trustworthiness and consistency of the dot probe task in measuring accuracy and response time as indicators of individuals’ stress levels. However, some of these studies have raised concerns about its reliability, suggesting that it may not always provide accurate stress results when compared with job stress questionnaires

(Machulska et al., 2023; Wittekind et al., 2023). Furthermore, existing dot probe tasks predominantly exist in software form, leading to privacy and security apprehensions among users worried about data leaks (Duggineni, 2023). As a result, many people tend to avoid using such software, contributing to a lack of regular stress assessment. The absence of a physical product worsens this issue, as it lacks a tangible reminder for users to monitor their stress levels. Therefore, introducing a physical stress assessment product like the visual dot probe task to the market could offer advantages such as enhanced user experience and privacy assurance. As more data are collected through the development of the visual dot probe task, it becomes possible to verify the reliability of the data obtained through the dot probe task using machine learning techniques.

1.4 Aim and Objectives

Considering the issues stated, the aim of this project is to design a visual dot probe task for occupational stress measurement in manufacturing. In order to achieve this aim, the objectives of this project are:

i) To develop a prototype for the visual dot probe task aimed at assessing occupational stress.
ii) To validate the prototype of the visual dot probe task by measuring the accuracy of individual’s occupational stress levels.
iii) To correlate the parameters of the visual dot probe task with occupational stress.

1.5 Scope and Limitation of the Study

The primary scope of this research will be on designing a visual dot probe task prototype for accessing job stress levels among individuals in the workplace, particularly in the manufacturing industry. This prototype functions to measure individuals' accuracy and response times to probes based on the concept of attention bias. Attentional bias involves emotional or happy faces that have the ability to attract or repel attention, thereby altering reaction times for different stimuli. Thus, the user's reaction time to the probe will be used to calculate the attentional bias score to determine the stress level.

There were a few limitations to this study. Firstly, participants were recruited from a single manufacturing company and were primary from administrative and engineering roles. Future studies should aim to expand the participant pool to include greater diversity in terms of geographic locations, company sizes, and occupational roles within the manufacturing sector. Diversifying the participant pool would improve validity and offer a more comprehensive understanding of stress levels. Another limitation of this study relates to the reliance on self-report measures, including the PSS-10 and TAM. This is because self-report instruments are inherently subjective and may be influenced by various factors, including social desirability and individual interpretation of the questions. Participants may not always provide accurate or unbiased responses, leading to potential measurement errors. Incorporating objective measures or combining self-reported data with physiological indicators of stress, such as heart rate or electroencephalograms, could offer a more comprehensive and reliable assessment of stress levels.

1.6 Contribution of the Study

This study focuses on designing a physical visual dot probe task prototype to measure stress levels within the manufacturing industry. The prototype offers a novel approach to stress measurement, addressing limitations of traditional psychological questionnaires such as language barriers, selection bias based on mood, and inconsistent results. Moreover, the prototype provides a more engaging method of stress testing compared to other measurement techniques, as it is presented as a mini-game application to assess individuals' reaction times.

Furthermore, the study also aims to raise awareness about stress testing within the manufacturing industry. Data collection was conducted to assess job stress levels within the industry, contributing to increased awareness. Participants in the data collection were also informed about their own stress levels. Therefore, the developed prototype represents an effective new technology for stress measurement, contributing to society's understanding of stress measurement.

1.7 Outline of the Report

The overall report involves five chapters, mainly discussing the design of a visual dot probe task for stress measurement in the manufacturing industry. These chapters include an introduction, a literature review, methodology and work plan, results and discussion, and a conclusion.

Chapter 1 provides a general introduction of the project, the importance of the study, the problem statement, the aim and objectives, and delves into the scope and limitations of the research. Chapter 2, the literature review, is a detailed study of relevant topics such as job stress, attention control, physical instruments for attention assessment, the theory behind the dot probe task, and instruments for psychological assessment. Chapter 3, the methodology and work plan, outlines the whole work plan of the project, describes the design and development of the prototype, and elucidates the steps taken during data collection when testing the prototype. Chapter 4 will cover the results obtained from the data collected, including descriptive analysis for the PSS-10 and TAM questionnaires, Pearson correlation tests between congruent and incongruent trial response times, and t-tests of the collected data. Finally, Chapter 5 concludes this study, where all the important findings are summarized and recommendations for the project are provided.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

When designing a visual dot probe task, several parameters must be carefully considered. Firstly, this section will discuss job stress among working individuals and the purpose of utilizing the visual dot probe task to evaluate job stress. After examining the theoretical foundation of the dot probe task, the potential link among sustainable attention and job stress will also be explored. During the design phase, critical factors, such as the time interval between cues and probes, will be taken into account. Additionally, the selection of salient and neutral cues for use in the visual dot probe task will be considered. Furthermore, the response time and accuracy measurements obtained through the visual dot probe task will be addressed, emphasizing their significance in determining the level of job stress. Lastly, this section will delve into the questionnaires employed to assess an individual's stress level, which will be compared with the results obtained from the visual dot probe task. In addition, prototype evaluation questionnaires will be employed to assess the usability of the visual dot probe task under development..

2.2 Occupational Stress

The productivity and efficiency of an organization greatly rely on its human resources, which are indeed a vital asset. Given that individuals spend a substantial amount of time in the workplace, occupational stress significantly influences their productivity and efficiency due to lack of work motivation (Chauhan et al., 2019). Occupational stress, stemming from a variety of stressors, can lead to strain within the workplace. The term "stress" itself signifies pressure and fatigue. Psychological stress deeply affects the autonomic nervous system, arising from the overwhelming demands placed upon individuals. As a result, stress can contribute to a range of issues, including illnesses, depression, and discomfort. This pervasive phenomenon traverses various spheres of individuals' lives (Munjial Singh et al., 2019).

Research findings, derived from collected data, emphasize that job satisfaction significantly and positively impacts the performance of all employees (Soomro and Shah, 2019). This suggests that job satisfaction and its associated indicators offer positive reinforcement for work-related aspects, encompassing elements such as orientation, goals, task completion, benefits, and rewards. This significant contribution to performance is in line with the proposed theory, which highlights the linked nature of satisfaction and performance in determining work outcomes (Mawardi, 2022).

However, certain organizational limitations, encompassing factors like workplace conditions and salary levels, have the potential to hinder optimal employee performance. Notably, lower salaries are found to be linked with reduced job satisfaction (Kollmann et al., 2020). Research also highlights a noteworthy correlation between stress and job satisfaction, particularly among treatment staff. Enhancing crucial aspects such as interpersonal relationships and work conditions emerges as a pivotal strategy for improving overall job satisfaction (Lee et al., 2020).

Hence, it's well-established that occupational stress and dissatisfaction can have detrimental effects on well-being, potentially leading to outcomes like illness (Green and Kinchen, 2021). Research studies have shown a clear interconnection between job stress and job satisfaction, ultimately impacting organizational performance (Hassan et al., 2020). As job satisfaction decreases, job stress increases, leading to increased absenteeism and reduced productivity. This highlights the vital importance of effectively addressing stress for organizations (Dr. Geetha. V, 2017). Successful stress management strategies can help create a positive work environment, ultimately enhancing overall productivity and efficiency.

2.3 Attention Control

Occupational stress remains a significant concern within companies, as it has the potential to adversely affect employee performance and efficiency due to its impact on attention control. Cognitive psychology is the theoretical framework underlying attention control, which is extensively discussed in the literature. However, interpretations of attention control can vary across different sources in the literature. It is proposed that attention control encompasses both competitive planning mechanisms and the supervisory attentional system. The first operation is utilized in decision-making during situations where conflicting behaviors arise, while the second operation is employed when planning and decision-making encounter challenges (Q. Liu et al., 2020). Conversely, others perceive attention control as an individual's capacity to deliberately engage, concentrate, and sustain attention on memory representations despite interference from irrelevant information (Shipstead et al., 2015). Thus, attention control plays a pivotal role within the executive control system, influencing goal setting and closely connected to the processing of emotional data (Angelidis et al., 2018).

Research suggests that chronic stress exerts a substantial burden on the attention system, eventually depleting the available resources for processing less relevant information. Specifically, sustained attention involves the capability to consistently focus on and monitor task-relevant details (Piani et al., 2022). This aspect of attention is commonly evaluated in controlled environments with minimal distractions, such as quiet testing rooms. Impairments in sustained attention due to stress can manifest as challenges in maintaining concentration within work or school settings (Keller et al., 2019).

Furthermore, the research demonstrates that individuals with low trait mindfulness exhibit heightened sensitivity to stress, which in turn is inclined to result in diminished attention and working memory performance (Petranker and Eastwood, 2021). In situations of increased stress, their attention and working memory performance experience further decline, indicating a limited capacity to effectively manage heightened cognitive demands. Low trait mindfulness correlates with a reduced ability to concentrate, focus attention, and sustain stable cognitive engagement during tasks. This highlights that individuals lacking in trait mindfulness might struggle to optimally allocate their cognitive resources, ultimately resulting in lower working memory performance, especially when confronted with demanding or stressful scenarios (Li et al., 2021).

Thus, occupational stress affects employees' attention control and consequently impacts their workplace performance. Chronic stress will diminishes attention resources, especially sustained attention. Moreover, low trait mindfulness increases stress sensitivity. When employees experience high levels of stress, their attention and working memory are compromised.

2.4 Physical Instruments for Attention Assessment

Given the crucial role of evaluating attention to comprehend individuals' stress levels, numerous research has been dedicated to developing tools that can effectively assess attention levels. Multiple paradigms have surfaced as a result, each aimed at evaluating attention levels. Among these paradigms are the Go/No-Go Paradigm, Dot Probe Paradigm, and EEG Paradigm.

2.4.1 EEG-Based Attention Recognition Paradigm

Attention recognition is an emerging research field that offers insights for monitoring and comprehending individuals' attention states. Its applications span various domains such as military operations (Villafaina et al., 2021), medicine (Moghaddari et al., 2020), and driver fatigue prevention (Luo et al., 2019). EEG signals, with their high temporal resolution, hold promise for attention recognition studies (Andrillon et al., 2021). EEG-based paradigms involve cues to induce attention or relaxation states. Attention states are often linked to specific tasks, while relaxation states are task-independent. Tasks like breath counting, reading comprehension, mental arithmetic, imagination, and the Stroop test are used to prompt attention (Kawashima et al., 2023). EEG captures brainwave frequencies like α (alpha), β (beta), δ (delta), θ (theta), and γ (gamma), associated with distinct functions. Research indicates these frequencies reflect attention, emotions, and cognitive processes (Nayak and Anilkumar, 2023).

The EEG paradigm incorporates continuous speaking and unrelated graphic flicker stimuli simultaneously, enabling the concurrent recording of EEG responses in both auditory and visual domains. Moreover, this paradigm introduces a silent video element that captures attention, which is irrelevant to the auditory and visual stimuli, making it adaptable to various population, including young children. This step is crucial for validation to identify which responses can be consistently detected, even in cases where the auditory and visual stimuli are not essentially the primary focus (Backer et al., 2019). The overall process of the EEG-based attention recognition paradigm is depicted in

Figure 2.1. This process encompasses data acquisition through tools like a 32-channel Neuroscan amplifier, subsequent data preprocessing, feature extraction, and concluding with classification (Chen et al., 2023).

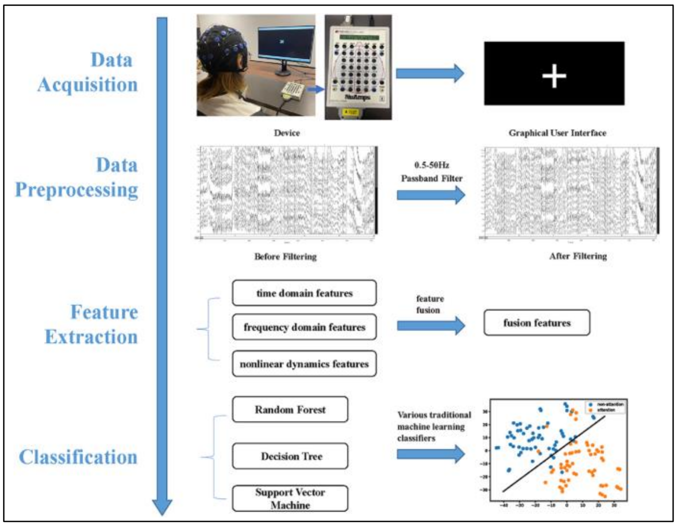

Figure 2.1: Flow of EEG-Based Attention Recognition Paradigm (Chen et al., 2023).

2.4.2 Go/No-Go Paradigm

The clinical setting incorporates numerous experiments rooted in the Go/No-Go paradigm, including the Continuous Performance Task (Lau-Zhu et al., 2019). Within this paradigm, participants are directed to execute a response when a "go" decision is presented and to refrain from taking any action when a "no-go" decision is presented. This approach proves valuable for detecting and dealing with inhibitory control, self-control, as well as impulsive behaviors (Huang-Pollock et al., 2017). However, while the Go/No-Go paradigm is clinically useful, it falls short in offering detailed understanding of the response time distribution for "no-go" decisions (Hadian Rasanan et al., 2021). Consequently, the primary metrics within the Go/No-Go paradigm include accuracy in responding to “go” stimuli, accuracy in withholding responses to “no-go” stimuli, and reaction time to “go” stimuli (Nejati et al., 2020).

The Go/No-Go paradigm is commonly employed in conjunction with EEG/ERP for the assessment of attentional function. Besides, the oddball visual paradigm, along with a cognitive battery psychological test, is integrated into EEG/ERP analysis through a computer interface in this evaluation (Jia et al., 2017). On the other hand, the Go/No-Go test, as depicted in Figure 2.2, was employed to assess working memory capacities, including monitoring, updating, shifting, and inhibiting. In the end, the experimental participants' accuracy and response times was measured, with accuracy presented as a percentage and response times recorded in milliseconds (ms) during the test session (Fukngoen et al., 2022).

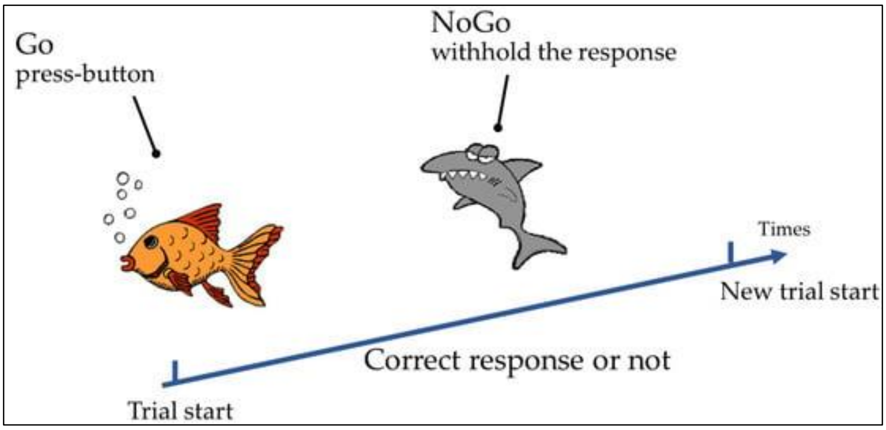

Figure 2.2: Overview of the Go/No-Go Design (Fukngoen et al., 2022).

2.4.3 Dot Probe Paradigm

The dot probe paradigm is extensively employed to examine attentional processes in diverse domains, encompassing issues such as depression, anxiety, obesity, addiction, and problematic eating behavior (Burris et al., 2019). The fundamental trial configuration in the dot probe is quite straightforward, as depicted in Figure 2.3. During each trial, a set of stimuli will be presented simultaneously on the screen, consisting of one emotionally relevant stimulus (an emotional face) and another neutral stimulus (a regular face). The stimulus pair is usually displayed for approximately 500ms to prompt and capture rapid, automatic, or involuntary processes (Vervoort et al., 2021). A probe will immediately appear at one of the two stimulus locations after the pair of stimuli disappears from the screen. Individuals are then required to promptly respond to the position where the probe appears through one of the response buttons (Thigpen et al., 2018).

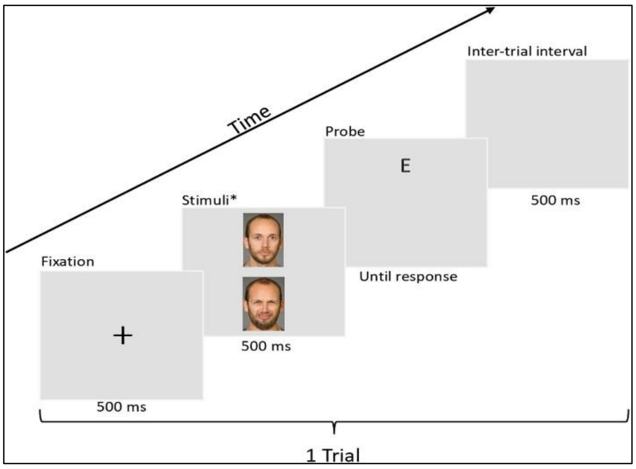

Figure 2.3: Dot Probe Task Design (Ma et al., 2019).

The basic presumption behind the dot probe task suggests that individuals will typically react more rapidly when a stimulus appears in the location they are already paying attention to, as opposed to when a stimulus appears in areas they are not focusing on (Jiang and Vartanian, 2020). As a result, researchers have developed a metric called the attentional bias score, which is calculated as the average disparity in reaction times between congruent and incongruent trials (Carlson et al., 2023). An attentional bias toward emotional faces would manifest as positive attentional bias scores, whereas inclination to avoid emotional faces would be indicated by negative attentional bias scores (Starzomska, 2017).

2.5 Visual Dot Probe Task

The visual dot probe task paradigm involves presenting pairs of stimuli followed by a lateralized target stimulus. These stimuli may vary in emotional content including categories like threat-related versus neutral, or relevance to the disorder, such as social threat or physical threat (Reutter et al., 2019). As depicted in Figure 2.4, the target stimulus may appear either in the similar position as the preceding emotional stimuli, referred to as the congruent condition, or in the opposite position, known as the incongruent condition (White et al., 2017). Then, participants must swiftly and precisely identify the position of the target by pressing buttons.

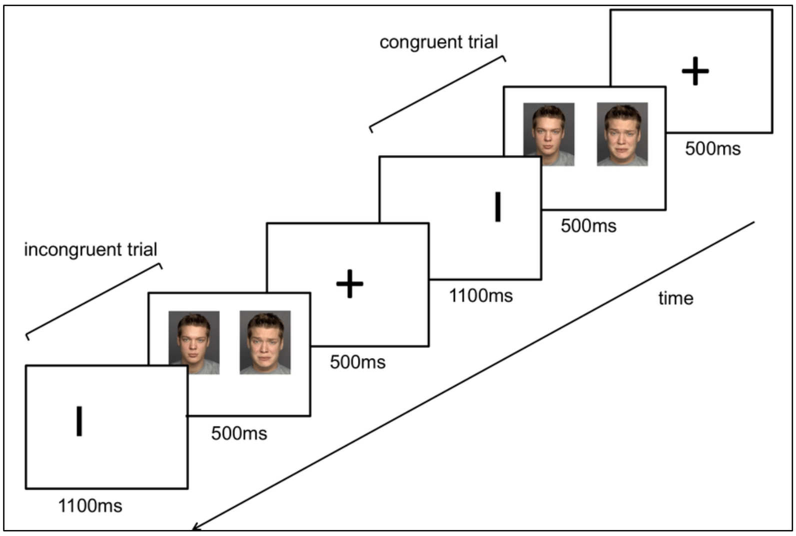

Figure 2.4: Visual Dot Probe Task for Congruent and Incongruent Trials (Kuehl et al., 2021).

Disparities in responses between these conditions signify spatial attention towards the preceding faces. Prior research consistently reveals that targets are detected more rapidly or distinguished with greater accuracy when they follow congruent emotional faces, as opposed to incongruent faces. This trend points towards vigilance directed at the emotional stimulus (Torrence et al., 2017). Conversely, shorter response times in incongruent trials compared to congruent trials suggest avoidance (Wieser and Keil, 2020). Neural imaging studies provide further support for these observations, as enhanced neural activity linked to emotional faces, particularly the N170 component, correlates with reaction time differences (Qiu et al., 2023). Nevertheless, to better comprehend how emotional faces influence the way our brain responds to the subsequent stimuli, it would be beneficial investigate the neural activity patterns indicated by Event-Related Potentials (ERPs) associated with those target (MacNamara et al., 2022).

However, when applying the dot probe task to clinical or sub-clinical populations, for instance individuals with elevated anxiety levels, a number of studies have produced conflicting outcomes, highlighting the inconsistency of the visual dot probe task (Sigurjónsdóttir et al., 2015; Chapman et al., 2019; Puls and Rothermund, 2018). Some studies report faster responses to probes presented at locations linked with threatening cues, while others indicate quicker response times to probes presented at neutral-cue locations. This divergence in results has added complexity to the interpretation of the underlying processes influencing dot probe task performance (Thigpen et al., 2018). Researchers have suggested that the common finding of quicker reactions to probes at threat-cue positions might be attributed to increased attention to threats or difficulties in shifting spatial attention away from a previously focused location, as outlined in the established spatial attention model (Sigurjónsdóttir et al., 2020).

Therefore, the visual dot probe task primarily examines biased attentional processing in social anxiety (Packard et al., 2022). The utilization of facial stimuli holds the potential to provide a more finely tuned gauge of biased processing. Notably, facial expressions assume a heightened significance for individuals grappling with social anxiety, as they offer cues about potential negative evaluations from others (Chen et al., 2020). For instance, an angry facial expression strongly conveys social hostility. Therefore, dot probe investigations frequently include negative facial expressions depicting anger or disgust. In certain cases, supplementary negative facial expressions, including fear and sadness are introduced as control stimuli to represent negative emotional valence (Bantin et al., 2016).

2.6 Theoretical Basis of Visual Dot Probe Task

The visual dot probe task assesses individuals' stress and attention levels. It is rooted in the theoretical framework of attentional processes, specifically targeting attention bias (McNally, 2019) and sustained attention (Gupta et al., 2019). Hence, this section delves deeper into the concepts of attentional bias and sustained attention, exploring the cognitive processes that underlie individuals' responses to emotional stimuli.

2.6.1 Attentional Bias

In the realm of non-verbal affective communication, facial expressions hold particular significance and have proven to be effective attention-capturing stimuli. Previous studies have primarily focused on biases toward negative stimuli, revealing an "anger superiority effect," which suggests a swift identification of angry faces among other stimuli (Ao et al., 2020). However, recent research have also indicated that positive stimuli, such as smiling faces, have the capacity to draw attention more effectively in contrast to neutral stimuli (Pool et al., 2016). Therefore, the dot probe task was developed to investigate such biases, particularly attention biases towards stimuli associated with threats in people with depression or anxiety disorders (Iffland et al., 2019).

Research investigations into attention biases towards facial expressions utilizing the dot probe task have documented such biases for both positive (Wirth and Wentura, 2020) and negative emotional expressions (Carlson and Mujica-Parodi, 2015). However, there is variability in findings when comparing different emotion categories (Valk et al., 2015). Methodological disparities, including stimulus timing and content, have been proposed as explanations for these mixed results (Berlo et al., 2020). Furthermore, individual differences, such as altered processing of emotional stimuli in various mental health conditions, can contribute to inconsistent findings (Kret and Ploeger, 2015).

For example, individuals with Social Anxiety Disorder (SAD), which is indicated by an excessive anxiety of being social scrutinized, exhibit altered attentional allocation towards social information (Folz et al., 2023). Prominent cognitive-behavioral models of SAD emphasize a redirection of attention towards oneself as a social subject during communication, leading to heightened sensitivity to negatively skewed self-perceptions and physiological arousal (García-Blanco et al., 2014). According to the cognitive-behavioral model of anxiety in social phobia, attention is focused on external stimuli, for instance, facial expressions, in order to shape self-representations. Empirical studies have supported this assumption by demonstrating that individuals with social anxiety exhibit altered attention towards threatening facial expressions (Lazarov et al., 2021).

Hence, to gain a deeper understanding of how anxiety influences visual attentional processing, researchers have put forth two main hypotheses (Veerapa et al., 2020). The first theory is known as the "vigilance-avoidance" hypothesis, implies that anxiety is linked to a heightened attention towards stimuli associated with threats. This hypothesis suggests that individuals with anxiety display vigilance responses, wherein their attention is reflexively drawn to negative stimuli. These initial vigilance responses are then followed by a more strategic tendency to avoid such information (Kishimoto et al., 2021). Conversely, according to the "maintenance" hypothesis, individuals, especially those with heightened anxiety, tend to capture and hold attention for a longer duration upon detecting threat-related stimuli compared to neutral stimuli (Fu and Pérez-Edgar, 2019). The sustained attention towards threatening stimuli may arise from a challenge linked to trait anxiety in effectively engaging top-down control systems. When there are competing stimuli present and the requirements of the task do not completely utilize available attentional resources, this challenge becomes more apparent (A Wagemans et al., 2019).

2.6.2 Sustainable Attention

Sustained attention, often referred to as the capacity to sustain focus on a single task over an extended period, which is crucial for various real-world activities, including academics, safety, social interactions, and mental health (Isbell et al., 2018). While transient aspects of attention, such as shifting and selection, have received significant research attention, sustained attention has been comparatively understudied. The part that distinguishes sustained attention is its emphasis on an individual's effectiveness on one task continuously, aiming to explain the differences in an individual's performance and the variability in the capability to sustain consistent task execution (Esterman and Rothlein, 2019). Recent research has highlighted that sustained attention involves fluctuations in performance within individuals, influenced by various factors like mind effort, arousal, wandering, reward, and motivation. Understanding these fluctuations can provide insights into cognitive processes and their neural underpinnings (Fortenbaugh et al., 2017).

Research has revealed a strong connection between sustained attention and conditions like anxiety and depression, which can significantly disrupt sustained attention (Mitsea and Drigas, 2021). This research indicates that adolescents experiencing anxiety and depression tend to encounter difficulties with sustained attention, ultimately leading to academic underachievement. Moreover, a resource allocation model, which explores how depressed mood affects cognition, suggests that students displaying symptoms of anxiety and depression tend to allocate their attention towards interfering and irrelevant thought (Draheim et al., 2022). This cognitive pattern leaves them with limited sustained attention available for cognitive tasks, ultimately resulting in academic failure (Khesht-Masjedi et al., 2019). Therefore, moods characterized by sadness and anger are inversely correlated with sustained attention (Hanif and Fenske, 2020).

Furthermore, studies on boredom proneness characterizes it as a form of attentional disorder. Through meditation, both meditation-induced mindfulness as wll as trait mindfulness can be cultivated. It is seen as the ability to focus one's attention on the current moment (Lee and Zelman, 2019). Moreover, there is an inverse relationship between negative emotions and dispositional mindfulness and boredom proneness (Struk et al., 2017). Boredom proneness is correlated to diminished well-being, anxiety, depression, as well as difficulties in emotional regulation (Isacescu and Danckert, 2018). It has also been linked to deficits in sustained attention. Individuals prone to boredom tend to perform poorly on tasks requiring sustained attention, have difficulty maintaining focus, make more errors in everyday activities, and struggle with their work responsibilities.(Mugon et al., 2020).

2.7 Reaction Time Against Stress Level

The principle underlying the visual dot probe task involves using reaction times during the task to assess the degree of attentional bias. Attentional bias for threat is typically evaluated by examining reaction times to probes in the dot probe task. If someone tends to focus their attention on the position of a threat, they will experience vigilance. It is known as "threat-congruent trials," where they are expected to respond faster to probes appearing in a similar position as the threat stimuli compared to "threat-incongruent trials," where the probes are in a similar position as nonthreat cues (Van Bockstaele et al., 2020). Conversely, individuals who tend to divert attention away from threats, known as avoidance, would typically exhibit slower reaction times when probes replace threat cues compared to non-threat cues (Mogg and Bradley, 2018). Attentional bias scores are determined by deducting reaction times in threat-incongruent trials from those in threat-congruent trials (threat-incongruent minus threat-congruent). Vigilance is indicated by positive scores, reflecting an attentional bias toward threat, whereas avoidance is signified by negative scores, indicating an attentional bias away from threat, and scores close to zero suggest no bias (Morales et al., 2015).

According to research, hypervigilance causes attention bias towards threatening stimuli and increased distractibility, which is a common feature of both generalized anxiety disorder and high trait anxiety (Steinweg et al., 2021). Hypervigilance is considered an underlying vulnerability component of anxiety and becomes noticeable during state anxiety or situations of high stress (Liu et al., 2022). Furthermore, the four-factor theory, which was developed, suggested that anxiety is influenced by four information sources, which include behavioral action tendencies, physiological activity, external stimuli, and cognitive processes such as worry (Franklin et al., 2015). Variations in anxiety levels among individuals are shaped by attention and interpretation biases driven by mental frameworks such as memory representations of potential threats, which are applied to the four information sources (Everaert et al., 2014). Individuals with high trait anxious often exhibit attention and interpretation biases that favor threat-related information. In contrast, individuals characterized as repressors with high social desirability scores and low levels of trait anxiety tend to display opposite biases. People with low social desirability scores and a low level of trait anxiety exhibit no biases (Sedikides et al., 2016; Franklin et al., 2016). Moreover, distinct anxiety disorders exhibit specific predisposing features that emphasize the significance of the four information sources. Attention and interpretation biases for internal body sensations were mainly linked to panic disorder, while biases associated with all four information sources collectively led to the development of generalized anxiety disorder and high trait anxiety (Mogg and Bradley, 2016).

2.8 Instruments for Psychological Measurement

In the contemporary era, stress has become a prevalent issue across various demographic groups. Consequently, numerous psychological measurement instruments have been developed to assess both attention and stress levels in individuals. The primary aim is to identify stress at an early stage, allowing for prompt intervention before it escalates and adversely impacts individuals. Prominent examples of these psychological measurement tools available in the market include the Perceived Stress Scale (PSS), Ottawa Mood Scales, and the Cognitive and Affective Mindfulness Scale - Revised (CAMS-R).

2.8.1 Perceived Stress Scale (PSS)

The Perceived Stress Scale, initially devised by Cohen, Kamarck, and Mermelstein, is a commonly utilized self-report assessment designed to evaluate individuals' stress perceptions in lives (Cohen et al., 1983). This scale assesses the level to which individuals view their life situations as uncontrollable, unpredictable, and overwhlemed over the past month (Costa et al., 2021). Originally consisting of 14 items, the Perceived Stress Scale was subsequently shortened to 10 items because four of the items exhibited weak factor loadings (Huang et al., 2020). The abbreviated 10-item version (PSS-10) demonstrated a slight enhancement in reliability (Cronbach's alpha = .78 compared to Cronbach's alpha = .75), while maintaining comparable validity. Thus, it has led to its endorsement as a suitable choice for both epidemiological and clinical research (Klein et al., 2016). A more concise 4-item version was also created for situations involving time constraints or telephone interviews (Lee, 2012). However, this version did not exhibit the same level of performance as the 10-item and the complete 14-item versions (Ingram et al., 2016).

The PSS-10 has been widely applied to assess occupational stress in various domains. For instance, it was employed during the Covid-19 pandemic to evaluate the stress levels of nurses working in intensive care units, with the aim of supporting their work efficiency (Şanlıtürk, 2021). Moreover, the scale has been employed to examine Generalized Anxiety Disorder (GAD) and the influence of perceived stress on the well-being of medical students, ensuring their overall welfare (Ibrahim et al., 2023). In addition, the PSS-10 has been utilized to gauge the perceived stress levels among restaurant employees, specifically assessing work-related stress (Amran et al., 2018). Hence, these examples highlights the versatility of the PSS-10, rendering it suitable for use across diverse groups, especially for evaluating job-related stress.

Therefore, the 10-item version of the scale has consistently demonstrated its utility in stress research, exhibiting strong test-retest reliability over different timeframes, maintaining satisfactory Cronbach's alpha values, as well as displaying robust factorial validity for measuring perceived stress in a wide range of populations. Moreover, the PSS-10 has undergone validation in numerous languages, such as Mandarin (Sun et al., 2018), Malay (Sandhu et al., 2015), Spanish (Baik et al., 2017), Swedish (Rozental et al., 2023), German (Bastianon et al., 2020) and others. While the PSS-10 has been utilized by various demographic, including minority groups, some psychometric investigations on the PSS-10 suggest the importance of further validation in even more diverse samples.

2.8.2 Ottawa Mood Scales

The Ottawa Mood Scales, also recognized as the Ottawa-Georgia Mood Scales, were created by Dr. Michael Cheng, CA, with the principal objective of assessing a wide range of mood experiences in individuals of various ages, including children, youth, and adults. This questionnaire consists of five items that explore concepts related to self-regulation, including under- and overstimulation, along with emotions such as stress, worry, anger, sadness, and happiness. Each item features a query, prompting participants to evaluate their present emotional state using an 11-point numeric scale (Cheng, 2011). An innovative aspect of the questionnaire is the incorporation of visual representations illustrating pertinent emotional states at the scale's endpoints, depicted through schematic facial expressions.

The Ottawa Mood Scales received its first validation in 2021, following its previous utilization in various situations (Wong et al., 2021). It has found significant application in research, particularly within two key demographic groups: children and older individuals. For instance, it has been utilized to assess the impact of music that matches a person's emotional state on cognitive performance in both adults as well as young children, encompassing both positive and negative emotions (Franco et al., 2014). Furthermore, the mood scale has been utilized in the exploration of mood regulation among young adults in natural settings as part of Cognitive Behavioral Eco-Art Therapy research (Saraceno, 2017). Its effectiveness has been leveraged in investigating the impact of psychological preparation on the mood, stress, and anxiety of children undertaking cardiac surgery in the perioperative period (Kumar et al., 2019). On the other hand, it has been instrumental in investigating the correlation between mood, happiness levels, and engagement in art among older adults aged 65 and above (Hillary, 2018). In addition, the questionnaire has proven beneficial in aiding older adults with learning disabilities and mild cognitive impairment in overcoming depression (Green, 2017). Moreover, the questionnaire's adaptability is showcased through its application for accessing mood and anxiety levels among adults experiencing stuttering symptoms. The questionnaire's ease of use and simplicity were pivotal factors influencing its selection for this purpose (Hum et al., 2017).

Utilizing pictorial scales offers the advantage of circumventing challenges associated with translation and ensuring the reliability of cross-cultural application (Soucek and Voss, 2022). Furthermore, the endorsement of an existing questionnaire that addresses a broader population simplifies the allocation of time and resources, obviating the need for the creation of validated translations (Baumgartner et al., 2023). The Ottawa Mood Scales, designed for assessing emotional states, employs uncomplicated questions and consistent emotional terminology in its scale labels, thereby enhancing the effectiveness of information conveyance (Baumgartner et al., 2019). Moreover, the integration of schematic imagery alongside these labels augments clarity and accessibility (Sauer et al., 2021).

2.8.3 Cognitive and Affective Mindfulness Scale – Revised (CAMS-R)

The Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) serves as a 12-item assessment tool utilized to gauge participants' mindfulness levels. It is an adaptation of the original 18-item CAMS, this scale was developed to evaluate various aspects of mindfulness, including present-focused attention, awareness of the present moment, and the approach of accepting and non-judgmental attitudes towards one’s thoughts and emotions (Feldman et al., 2022). These dimensions collectively contribute to a comprehensive mindfulness score (Bergomi et al., 2013). Notably, trait mindfulness signifies a stable disposition wherein an individual consistently exhibits an anticipated level of mindfulness over time. Conversely, state mindfulness refers to a transient mental state that can undergo significant fluctuations from one instance to another (Dorais and Gutierrez, 2021).

The concept of mindfulness has undergone ongoing refinement as it continues to be applied within the context of contemporary psychotherapy. A two-component model has been proposed to offer a modern framework for defining and measuring mindfulness in clinical as well as therapeutic contexts (Chan et al., 2016). The initial component involves self-regulation of attention, encompassing attention switching, sustained attention, and the inhibition of in-depth processing that could divert from one's present moment experience (Wimmer et al., 2016). This facet aligns with the principle of maintaining a present-centered attentional focus on here and now. The following component pertains to the therapeutic aspect of the mindfulness concept and it involves an attitudinal orientation characterized by openness, acceptance, and curiosity (Hofmann and Gómez, 2017).

Due to its effectiveness in assessing individual mindfulness levels, the CAMS-R finds widespread application in diverse research contexts. For instance, it has been employed to investigate the interplay between mindfulness and sleep quality, with a focus on the mediation of emotion regulation (Talley and Shelley-Tremblay, 2020). Moreover, researchers have utilized it to explore the mindfulness levels of distinct age groups during the Covid-19 lockdown that was implemented in response to the second wave of the pandemic (Kumar et al., 2021). Furthermore, the assessment tool has been adapted and validated in numerous languages, including the Indonesian version for Muslims (Sutarto et al., 2022), Turkish version (Catak, 2012), Chinese version, and others.

2.9 Instruments for Prototype Evaluation

In this assignment, the focus will be on designing a prototype and evaluating its usefulness in the manufacturing industry. Therefore, a study on instruments for evaluating prototypes has been conducted to assess usability. Various types of prototype evaluation questionnaires are available in the market, including the System Usability Scale (SUS), Post-Study System Usability Questionnaire (PSSUQ), and Technology Acceptance Model (TAM).

2.9.1 System Usability Scale (SUS)

The System Usability Scale (SUS) is a straightforward, ten-item Likert scale that offers a broad overview of subjective assessments of usability. It employs a Likert scale ranging from 1, which implies strong disagreement, to 5, which denotes strong agreement for each statement (Peres et al., 2013).

It was developed through a methodical process involving the compilation of 50 potential questionnaire items, evaluation of two software systems representing extremes of usability, and selection of items based on their ability to elicit extreme responses. The selected items were intended to cover a range of usability aspects, such as the need for support, training, and system complexity, ensuring comprehensive usability evaluation. The SUS's alternating positive and negative statements prevent response biases and promote active engagement from respondents. The resulting System Usability Scale covers various aspects of system usability, demonstrating high face validity in usability measurement (Brooke, 1996).

The SUS is widely employed across various fields to evaluate the perceived usability of an object. For instance, it has been utilized in studies to assess the perceived usability of well-known mobile applications such as Facebook, WhatsApp, Mail, and YouTube, with 222 participants in the dataset(Kaya et al., 2019). The research on utilizing the SUS to measure the perceived usability of mobile applications has undergone further review by other researchers (Vlachogianni and Tselios, 2021). This indicates the widespread adoption of the SUS in research settings. Additionally, a simplified version of the SUS has been developed and validated. Numerous investigations involving older adults, both with and without cognitive impairment have made use of the simplified SUS (Cornet et al., 2019). Its general score distribution characteristics of this measure is similar to that of the original SUS, highlighting its widespread usage and ongoing refinement by researchers (Holden, 2020).

2.9.2 Post-Study System Usability Questionnaire (PSSUQ)

The Post-Study System Usability Questionnaire (PSSUQ) is a questionnaire employed to evaluate perceived usability, and no license is required to utilize it. The original version comprises 19 items, while a shortened version comprises 16 items. Both versions employ a 7-point Likert scale, with lower scores indicating higher levels of perceived usability, reflecting greater satisfaction among users (Lewis, 1992). In various research, factor analysis constantly reveals three unique factors termed System Usefulness, Information Quality, and Interface Quality. Its Cronbach's alpha ranges from 0.83 to 0.96, suggesting its high level of reliability (Lewis, 2002). It encompasses all attributes of usability, including efficiency, effectiveness, learnability, and satisfaction (Hodrien and Fernando, 2021). They have been referred to as tools employed in a variety of applications, including educational technology systems, and provide good validation for assessing them (Schnall et al., 2018).

The PSSUQ has been extensively used in research. For instance, it has been employed to assess educational technology and reviewed to evaluate perceived usability. In a study assessing educational technology systems with 58 participants, the perceived usability was found to be reasonably satisfactory, with mean scores and standard deviations (Vlachogianni and Tselios, 2023) aligning with earlier research suggesting an average PSSUQ score (Sauro and Lewis, 2016). Moreover, perceived usability has been interpreted through analyzing the PSSUQ score by researchers and experts in Human-Computer Interaction (HCI) alongside established benchmarks from prior research. Given its high correlation with SUS scores, it can aid in establishing the original standards for SUS when converted to a 0–100-point scale (García-Peñalvo et al., 2019).

2.9.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) extends the Theory of Reasoned Action (TRA), initially proposed by Davis in 1980 (Davis, 1989). It was developed to address the issue of employees not utilizing available Information Technologies (IT) despite their accessibility. The primary objective of TAM is to increase IT usage by first increasing acceptance of the technology among users. This acceptance is typically assessed by questioning individuals about their future intentions to use the technology. TAM substitutes several attitude measures from TRA with technology-specific acceptance measures, including perceived ease of use and perceived usefulness.

Both TAM and TRA assume that individuals, once they have the intention to act, will freely carry out that action without constraints (Malatji et al., 2020).

The TAM questionnaire contains 12-items rated on a Likert scale, ranging from 1 (extremely likely) to 7 (extremely unlikely), with responses closer to 1 indicating a positive perception of the prototype’s usefulness and ease of use, while responses closer to 7 suggest a more negative perception. The scale comprises two main factors: perceived usefulness, consisting of items 1 to 6, and perceived ease of use, consisting of items 7 to 12.

The TAM questionnaire is extensively employed to assess both perceived usefulness and perceived ease of use. For instance, it has been utilized in acceptance analyses of and mobile learning technologies (Gitumu Mugo et al., 2017), telemedicine services (Kamal et al., 2020), mobile library applications (Rafique et al., 2020), and e-learning platforms (Natasia et al., 2022). All these applications demonstrate the diverse ways in which TAM is utilized to test the usability of prototypes.

2.10 Summary

In this section, occupational stress and its connection to an individual's attention control is discussed. Given the significance of occupational stress and attention control, various physical instruments for attention assessment, including EEG-based attention recognition paradigms, the Go/No-Go Paradigm, and the dot probe paradigm.

The main focus of the project is on the visual dot probe task, for which a detailed explanation along with its theoretical foundations, namely attentional bias and sustained attention. Subsequently, the reaction time in the visual dot probe task in relation to the stress levels of individuals is analyzed. Then, three psychological measurement instruments to assess the stress levels of individuals are being discussed, including the Perceived Stress Scale, Ottawa Mood Scales, and Cognitive and Affective Mindfulness Scale-Revised. Finally, instruments to evaluate prototypes to measure their usability were also discussed, including the System Usability Scale (SUS), Post-Study System Usability Questionnaire (PSSUQ), and the Technology Acceptance Model (TAM).

Generally, there are multiple tools to measure occupational stress levels in individuals working in the manufacturing industry. Although past works demonstrate significant success in evaluating attention levels, a physical prototype of the dot probe task is still absent. To address this research gap, this project focuses on designing a physical prototype using attentional bias and sustained attention, reminding users to test their stress levels often, and preventing data leakage.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

The purpose of this project is to create a visual dot probe task for measuring occupational stress in the manufacturing sector. As outlined in Figure 3.1, the methodology and work plan section follows the literature review process, and it involves conceptual design. This section applies the knowledge acquired in the previous phase to the development of a prototype for the visual dot probe task. After development of the prototype, the prototype will be used for data collection in terms of congruent trial reaction time, incongruent trial reaction time in manufacturing industry. During data collection, the participants are also required to response to PSS-10 and TAM questionnaires. Lastly, the results obtained are analysed and discussed. Here, a comprehensive discussion of the prototype's design to guide its construction is provided.

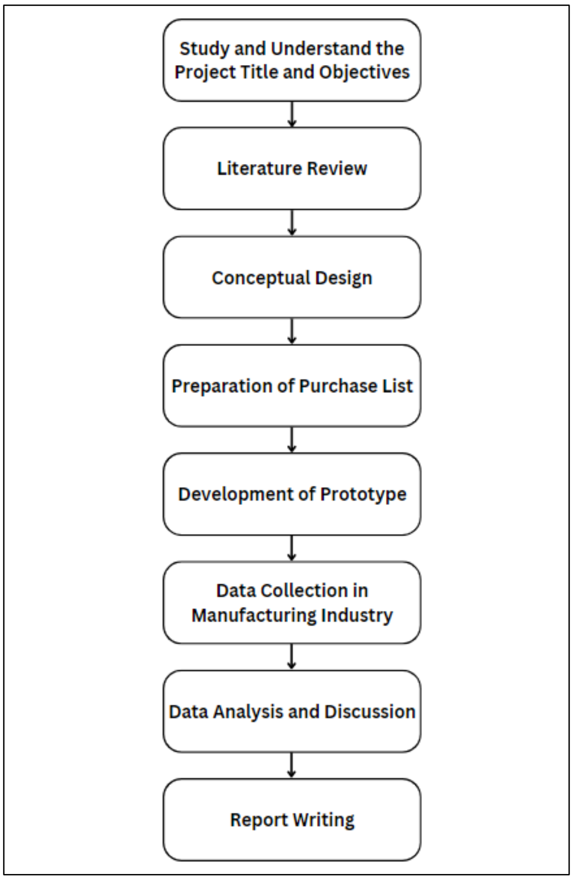

Figure 3.1: Flowchart of the Project.

3.2 Development of Visual Dot Probe Task

The visual dot probe task is intended to include a total of 40 trials, which are split into 20 congruent trials and 20 incongruent trials. Each trial begins with the display of a fixation cross in the middle of the screen, serving as an inter-trial interval, lasting for 500 milliseconds. Following this, a pair of stimuli, comprising a happy face and a sad face, is displayed on opposite sides of the screen for an additional 500 milliseconds. The faces serve as stimuli that either attract or repel the attention of individuals before respond to the dots (Zhang et al., 2019). Subsequently, either a left dot will appear to the left of the preceding image (a happy face) or a right dot will appear to the right of the previous image (a sad face) and remain visible for 1100 milliseconds (Kuehl et al., 2021). If participants fail to respond within the 1100-millisecond timeframe, it will be counted as an inaccurate response, and the task proceeds to the next trial. The trials are categorized as incongruent when the dot appears on the side of the happy face and as congruent when it appears on the side of the sad face. Participants were instructed to push the buttons on the controller corresponding to the location of the dot they observed, and the reaction time for each trial was recorded. The "A" button is for the dot appearing on the right side, and the "B" button is for the dot appearing on the left side. Figure 3.2 provides an illustrative instance of both a congruent and an incongruent trial sequence.

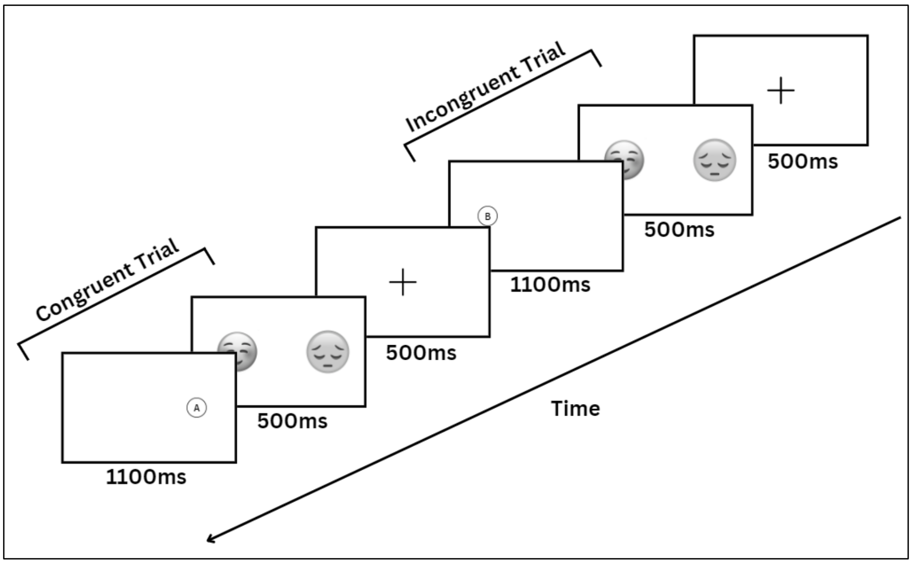

Figure 3.2: Developed Visual Dot Probe Task (Kuehl et al., 2021).

3.3 Emoji-Based Stimuli

The visual dot probe task for the prototype utilized emoji-based stimuli, as proposed by Wong, Croarkin, and Lee (Wong et al., 2022). Their research suggested that happy and sad emoji faces could effectively differentiate between individuals with depression and those without, and this method demonstrated comparability to the traditional face-based dot probe task. The findings demonstrated a significant disparity in positive bias scores between the two groups, highlighting the equivalence of the emoji-based task with the standard face-based task. It was found that individuals experiencing depression displayed a reduced attention bias toward happy emojis when contrasted with their non-depressive counterparts (Wong et al., 2022).

Furthermore, recent research has demonstrated that the impact of incongruent versus congruent emojis illustrates that emojis effectively elicit emotional responses, leading to an increase in individuals' reaction times (Chatzichristos et al., 2020). Therefore, the visual dot probe task integrated this concept, using happy emoji faces as neutral stimuli and sad emoji faces as emotional stimuli, as illustrated in Figure 3.3.

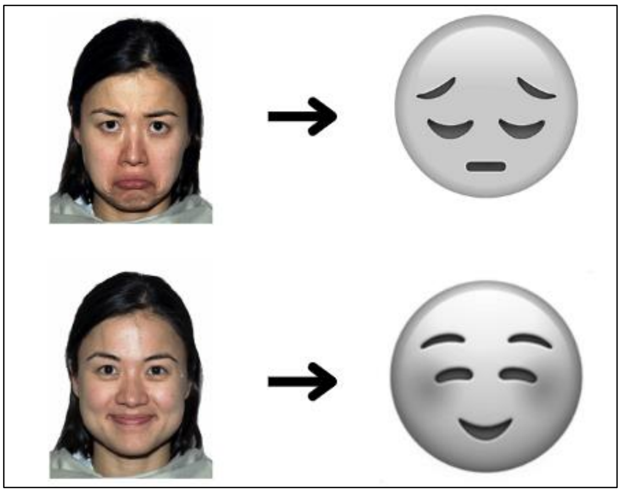

Figure 3.3: Sad Emoji Face as Emotional Stimuli and Happy Emoji as Neutral Stimuli (Huynh and Balas, 2014).

3.4 Effect of Colors on Mood Change

During the design of the visual dot probe task, a white color background is employed. In addition, the stimuli used consist of black and white images. This choice is informed by the understanding that different colors can have varying effects on human mood. Studies have consistently shown that white color serves as a neutral control, exerting minimal influence on human mood. For instance, according to the Depression, Anxiety, and Stress Scale (DASS), the score for white is the lowest, at 9.5, in comparison to green (11.1) and red (11.9) (Guo, 2022).

Furthermore, the emojis utilized in this task are typically presented in yellow color, which is associated with fostering positive mood, as indicated by research. Numerous studies have established a strong connection between the color yellow and happiness. It's worth noting that some research has also suggested that mood differences can be linked to color temperature. In other words, higher color temperatures are associated with heightened mental activity and agitation, while lower temperatures have the opposite effect. These discoveries can offer supplementary evidence supporting the link between colors such as yellow and red with positive emotions, including excitement and happiness, particularly in the context of higher color temperatures (Luo, 2022). Hence, white is the most suitable color for the dot probe task to maintain a neutral mood and ensure accurate results.

3.5 Development of Physical Visual Dot Probe Task

Figure 3.4 illustrates the prototype of the visual dot probe task, with dimensions of 18cm in length, 12.5cm in width, and 1.4cm in thickness. It comprises several components, including seven buttons, one LCD screen, one ESP 32 microcontroller, an on-off switch, and a battery holder. The design features "A" and "B" buttons, which enable users to respond to the cue's location during the task. Moreover, there are up and down buttons for menu navigation and left and right buttons for navigation across the virtual keyboard for the input of the users' name. The LCD screen displays the dot probe task as programmed. Finally, a battery holder will be employed to accommodate the battery, powering the entire prototype and eliminating the need for external power banks, thereby enhancing mobility. All the components are connected and soldered onto the donut board.

Figure 3.4: Final Design of the Physical Dot Probe Task.

3.5.1 System Design

The system design primarily centers around the ESP32 microcontroller, as illustrated in Figure 3.5. This microcontroller enables the LCD screen to display the dot probe task, ensuring that users can see and respond to the task as required. Users are guided to provide responses using the buttons, and the microcontroller records the performance, including response times for congruent and incongruent trials, as well as task accuracy. Therefore, the press button serves as an input from the user, the LCD screen displays the output, and the microcontroller processes the data based on the response time and task accuracy.

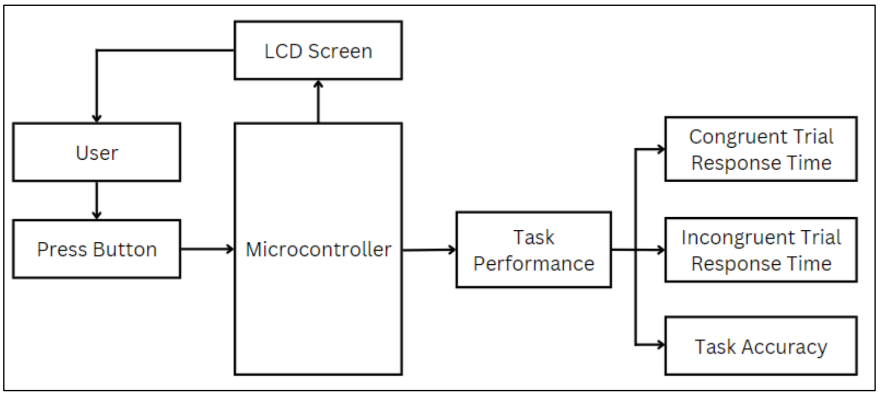

Figure 3.5: Block Diagram of the Visual Dot Probe Task Prototype.

When the visual dot probe task is switched on, it immediately begins the process of connecting to WiFi, as shown in Figure 3.6 (a). The WiFi connection is preset in the Arduino code, allowing it to automatically detect available networks. The prototype attempts to connect to WiFi for a period of 10 seconds. If the connection is successful, Figure 3.6 (b) is displayed, indicating to the user that WiFi is connected. However, if the prototype fails to connect, Figure 3.6 (c) is shown, informing the user of the failure. Regardless of the outcome, the process leads to the home screen displayed in Figure 3.6 (d). The key difference in WiFi connection status is that when connected successfully, the collected data, including congruent and incongruent trial results, as well as the attentional bias score, are sent to a preset Google Sheet to streamline the data collection process. However, if WiFi connection fails, no data is sent.

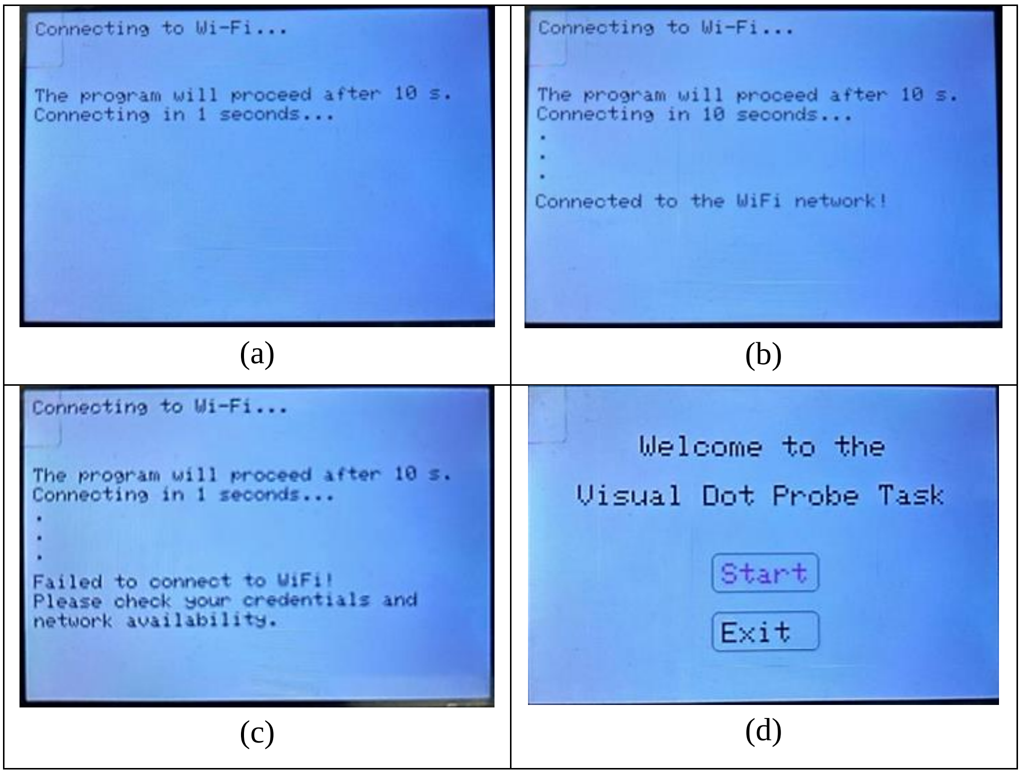

Figure 3.6: (a) The User Interface When The ESP32 is Connecting to Wi-Fi. (b) The User Interface When The ESP32 is Connected to Wi-Fi. (c) The User Interface When The ESP32 is Fails to Connect to Wi-Fi. (d) Home Ccreen After Connected to Wi-Fi.

At the home screen, users are presented with two options: start or exit. Choosing the exit option will terminate the program and close the application. Opting to start will navigate users to a name input page, as depicted in Figure 3.7. Here, a virtual keyboard is displayed on the screen, and users are prompted to input their name. Navigation across the screen is facilitated by the up, down, left, and right buttons to select alphabets, with the "A" button used for selection and the "B" button for backspacing. Once the name is entered, users must select "#" to proceed to the dot probe task application, as illustrated in Figure 3.2.

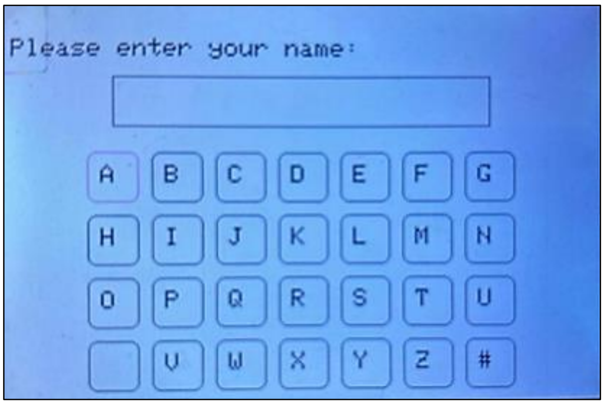

Figure 3.7: Name Input Page of the Visual Dot Probe Task.

After completing the entire dot probe task, the program will calculate the average congruent and incongruent trial times, as well as the attentional bias score. These calculated scores will be displayed on the screen, as illustrated in Figure 3.8. Users can proceed by pressing any button, and the program will return to the home page, as shown in Figure 3.6 (d).

Figure 3.8: Scoreboard of the Visual Dot Probe Task Prototype.

3.5.2 Circuit Design

The proposed circuit of the system was built on an ESP32 microcontroller. The ESP32 is a powerful System on Chip (SoC) device that comes with built-in Wi-Fi 802.11 b/g/n and dual-mode Bluetooth version 4.2 (Babiuch et al., 2019). The components connected to the ESP32 microcontroller include an LCD screen, six buttons, an on/off button, and a battery holder.

Firstly, the LCD screen used is a 4-inch TFT LCD color display screen module, specifically the ST7796S SPI Interface with 480x320 pixels. The overall dimensions of the LCD screen are 108.04mm in length and 61.74mm in height, and it is connected to the ESP32 using wires. The connections from the LCD screen to the ESP32 enable the screen to display tasks, which are summarized in Table 3.1 below. Next, the six buttons, each with dimensions of 12mm in length and 12mm in width, will be connected to the input channels of the ESP32 microcontroller, as illustrated in Table 3.2. This allows the buttons to be used for collecting response time data and selecting menu options. Finally, the battery holder is linked to the ESP32 microcontroller, with the positive side connected to the VIN and the negative side connected to the GND. The overall connections of the components are shown in Figure 3.9.

Table 3.1: Connection of TFT LCD Screen with ESP32 Microcontroller.

TFT LCD Screen	**ESP32**
VCC	3V3
GND	GND
CS (Chip Select)	D5
RESET (Screen Reset)	D4
DC/RS (Register Select)	D2
SDI (MOSI)	D23
SCK	D18
LED	3V3

Table 3.2: Connection of the Buttons with ESP32 Microcontroller.

Buttons	ESP32
Up Button	D26
Down Button	D27
Left Button	D12
Right Button	D14
A Button	D33
B Button	D25

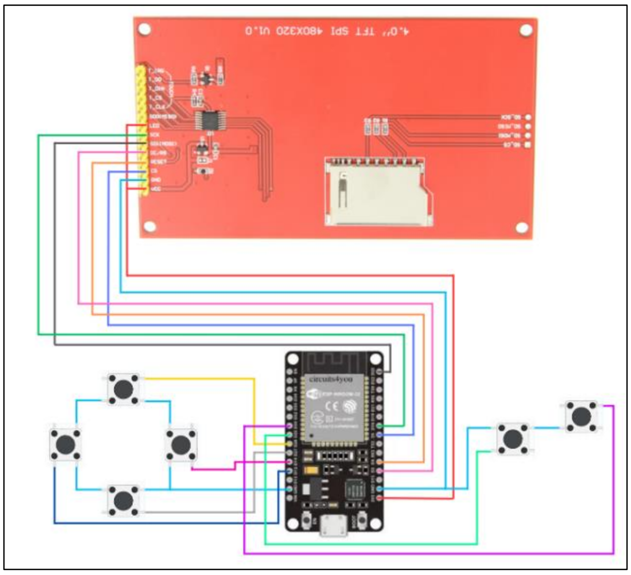

Figure 3.9: Circuit Connection of the Prototype.

3.6 Instruments for Psychological Measurement

In the present study, two distinct questionnaires were employed during the data collection phase. The questionnaires include the Perceived Stress Scale (PSS-10) for evaluating individuals' perceived stress and the Technology Acceptance Model (TAM) to assess the usability of the prototype.

3.6.1 Perceived Stress Scale (PSS-10)

The PSS-10 serves as a psychological tool for assessing an individual's perception of stress. It comprises ten items and employs a five-point Likert-type format, spanning from 0 (never) to 4 (very often) (Cohen et al., 1983). Respondents are requested to rate their thoughts and emotions regarding specific statements. The maximum total score on this scale is 40, with higher scores indicating a heightened perception of stress (Lee and Jeong, 2019).

3.6.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) serves as a tool utilized for evaluating users' acceptance and adoption of emerging technologies. It is among the most impactful models in technology acceptance, featuring two main components that influence people’s inclination to adopt emerging technology: perceived usefulness and perceived ease of use (Charness & Boot, 2016). This scale ranges from 1 (Extremely Likely) to 7 (Extremely Unlikely).

3.7 Participants

The research procedures have received approval by the Scientific and Ethical Review Committee of the university. A total of twenty-one participants (9 males and 12 females) employed in the manufacturing industry, were recruited to undergo a stress test utilizing the visual dot probe task prototype. All participants were from different departments within the manufacturing company, including human resources (n=2), administration (n=4), engineering (n=12), and technicians (n=3). All these occupations were considered important roles within the manufacturing company. Additional eligibility requirements comprised being over the age of 18 and having at least one year of working experience in a position.

3.8 Procedures

During the stress measurement utilizing the prototype, it is ensured that the experiment is conducted in an environment with adequate lighting, whether in a room or an open area. Furthermore, it is ensured that the environment is quiet and comfortable to ensure that individuals won’t be distracted by their surroundings and can focus on the task.

The procedure begins with a simple briefing about the objective of the project, overall procedure that will take place, the steps of using the prototype, and the questionnaires that will be used during the data collection phase. Next, participants will start by taking a 5-minute break, during which they remain seated upright in their chairs to relax both their psychological and physiological states, as illustrated in Figure 3.10. Following the break, participants are instructed to use Google Form to complete the Perceived Stress Scale (PSS-10). Subsequently, participants receive further explanation on how to operate the controls of the visual dot probe task prototype. After the instructional session, participants engage in 40 trials of the visual dot probe task, containing 20 congruent trials and 20 incongruent trials. Following the dot probe task test, participants are requested to take another 5-minute break before filling in the Technology Acceptance Model (TAM) through Google Form to provide feedback regarding the prototype. The overall procedure of the data collection phase has been summarized in Figure 3.11 below.

Figure 3.10: Participants Resting Upright for 5 Minutes During Data Collection.

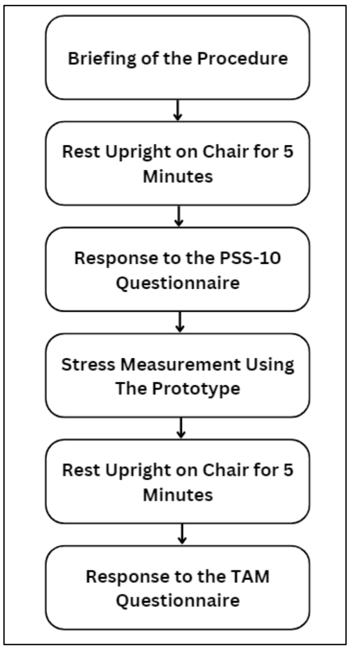

Figure 3.11: Overall Procedure of the Data Collection Phase.

3.9 Statistical Analysis

The data obtained underwent analysis through IBM SPSS (Statistical Package for the Social Sciences), version 29. Initially, descriptive statistics were computed for PSS-10, which included mean, standard deviation, skewness, and kurtosis, alongside the mean and standard deviation for TAM responses. To verify the reliability of the collected responses for both PSS-10 and TAM, Cronbach's alpha was calculated.

Moving forward, the visual dot probe task prototype data was examined. Average congruent and incongruent trial reaction times, along with the average attentional bias score, were computed. Then, the Pearson correlation test were then used to investigate the relationship between congruent and incongruent trials, followed by t-tests to understand significant differences between these parameters.

Finally, Pearson correlation tests and t-tests were utilized to investigate correlations and significant differences between the visual dot probe task prototype parameters, including congruent and incongruent trial reaction times and attentional bias score and responses from PSS-10.

3.10 Work Plan

The overall timeline of the work plan for Part 2 of the final year project is summarized. Firstly, it begins with the development of the overall prototype during the short semester, which is split into several parts: the main menu page, name input page, the dot probe task application, the scoreboard for the task, Wi-Fi connection features, and, lastly, linking the program to Google Sheets for data processing.

This is followed by initiating the search for manufacturing companies for data collection by connecting with companies through emails, LinkedIn, and the companies' websites. Once confirmation is received from one of the companies, Cheng Hua Sdn Bhd, a meeting is held with the HR department to schedule the data collection, and the data collection is set for 20 February 2024. During this phase, preparations are made, including the creation of questionnaires such as the PSS-10, Ottawa Mood Scale, CAMS-R, and TAM, which are then transformed into QR codes for streamlined participant responses.

After the completion of data collection, data analysis is conducted using IBM SPSS. The analyzed data is then discussed with the supervisor to determine its acceptability. Subsequently, a manuscript in brief report and article format is prepared for publication. Finally, the FYP poster and thesis are prepared for submission.

3.11 Summary

Therefore, to conclude this section, the design of the visual dot probe task has been discussed, encompassing both the system design and the circuit design. Additionally, the overall application of the visual dot probe task has been discussed, comprising 20 congruent trial reaction times and 20 incongruent trial reaction times, totaling 40 trials. These trials appear randomly to test individuals' response times. Furthermore, participants are required to respond to two questionnaires, including the PSS-10 and TAM. Lastly, data analysis has been conducted to determine correlations between the parameters.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Twenty-one consented participants from the manufacturing industry have completed the test, which includes the PSS-10, dot probe task test, and TAM. In this section, the responses obtained from the PSS-10 and TAM will be analyzed through descriptive analysis and undergo Cronbach's alpha test to verify the internal consistency reliability of the data obtained. Next, the parameters of the visual dot probe task, including the congruent and incongruent trial reaction times, as well as the attention bias time, will be analyzed and discussed. Various analysis, such as Pearson correlation analysis and t-tests, will also be performed to analyze the obtained parameters. Lastly, the responses from the PSS-10 will be tested with the parameters of the visual dot probe task using Pearson correlation tests and t-tests to understand the relationship between them.

4.2 Analysis of Responses from PSS-10

The PSS-10 will measures two aspects including positive phrased item labelled as "Perceived Self-Efficacy" and negative phrased items labelled as "Perceived Helplessness", each with distinct implications for stress assessment (Bastianon et al., 2020). Perceived helplessness is linked with negative factors and includes items 1, 2, 3, 6, 9, and 10. A higher score in this factor indicates greater perceived stress or a heightened sense of helplessness. Conversely, perceived self-efficacy, encompassing positive factors, is composed of items 4, 5, 7, and 8, reflecting a lesser degree of stress. The scoring process involves reverse-scoring, where the values are assigned inversely. Specifically, a response of 0 is scored as 4, 1 as 3, 2 as 2, 3 as 1, and 4 as 0. This scoring method is applied to capture the subtle nuances of stress perception (Liu et al., 2020). The sum of both perceived helplessness and perceived self-efficacy scores yields the final stress level of an individual. Figure 4.1 displays the responses collected through the Google Form, focusing on the Perceived Stress Scale (PSS-10) questions.

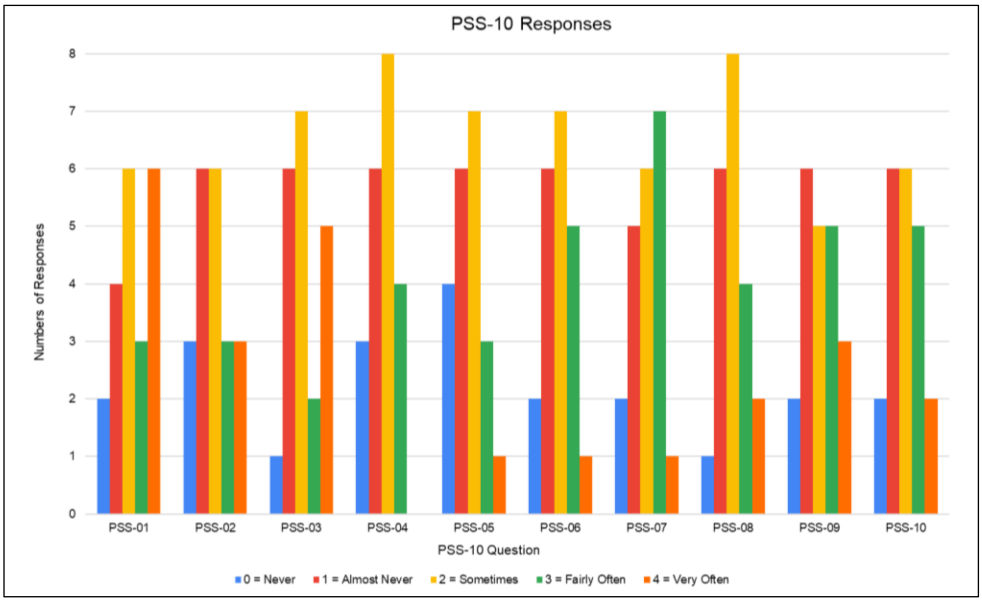

Figure 4.1: Bar Chart for PSS-10 Responses.

The data obtained from the PSS-10 questionnaire are then summed together according to perceived self-efficacy and perceived helplessness to determine the stress level of the participants. The PSS-10 score is categorized into three categories: scores ranging from 0 to 13 represent low stress, while scores between 14 and 26 signify moderate stress, and scores from 27 to 40 indicate high stress. Table 4.1 summarizes the stress level categories along with the total participant number in each category. From the table, it was found that 3 out of 21 participants (14.29%) exhibited low stress levels, 16 (76.19%) exhibited moderate stress levels, and only 2 (9.52%) exhibited high stress levels. This shows that the majority of participants within the manufacturing company are experiencing moderate stress levels, with only a small portion experiencing low or high stress levels.

Table 4.1: Stress Level Category for Responses of PSS-10.

Stress Level	**PSS-10 Score**	**Number of Participants**
Low Stress	0 – 13	3
Moderate Stress	14 – 26	16
High Stress	27 – 40	2

The results obtained align with research on occupational stress from other industries. For instance, a study on restaurant workers involving 528 respondents found that 9.19% of respondents experienced low stress, while 85.16% experienced moderate stress, and a minority of 5.65% experienced high stress (Amran et al., 2018). This data indicates that the majority of respondents had moderate stress levels, with a minority experiencing high stress levels, and low stress falling in between. Furthermore, another study investigated the occupational stress of academic staff. It found that 76% of the staff experienced moderate to high stress, while 24% experienced low to no stress (Amirul Arbae et al., 2019) This suggests that a majority of people working in various fields tend to experience stress.

Therefore, it can be concluded that the trend in job stress observed in the manufacturing industry, as indicated by the stress levels obtained through the PSS-10 questionnaire, is similar to that found in other working environments.

4.2.1 Cronbach’s alpha test of Responses from PSS-10

In addition, the collected data was utilized to conduct a Cronbach's alpha test, measuring the internal consistency reliability. The total Cronbach’s alpha values for the PSS-10 are 0.866, with values for perceived helplessness and perceived self-efficacy at 0.906 and 0.805, respectively. With the total Cronbach’s alpha exceeding 0.7, this indicates that the PSS-10 demonstrates reliability in measuring stress perception among participants.

According to research, the Cronbach’s alpha coefficient for PSS-10 should range from 0.75 to 0.91 (Cohen et al., 1983). Hence, the total Cronbach’s alpha value obtained from the data collected falls within the range proposed by the researchers, indicating that it achieves internal consistency reliability. Additionally, in a study on the perceived stress scale among healthy university students, the Cronbach’s alpha coefficients were reported as 0.78 and 0.71 for perceived self-efficacy and perceived helplessness, respectively (Anwer et al., 2020). Although these coefficients are lower than the one obtained, the coefficients still fall within the proposed range, further validating the reliability of PSS-10 obtained from the data obtained. Furthermore, in a study comparing perceived stress scale scores between migrants and native

Germans, the Cronbach's alpha coefficients for perceived helplessness were 0.85 for natives and 0.83 for migrants, while for perceived self-efficacy, they were also 0.85 for natives and 0.83 for migrants (Bastianon et al., 2020). These coefficients closely align with those obtained from the data collected.

Therefore, by comparing the Cronbach alpha value obtained from the PSS-10 responses with coefficients from other research, it can be concluded that the obtained coefficient is consistent and falls within the proposed range, indicating the internal consistency reliability of the data collected for the PSS-10.

4.2.2 Descriptive Analysis of Responses from PSS-10

Table 4.2 presents the descriptive statistics for the items of PSS-10. The means for each item spanned from 1.86 to 2.43, indicating a moderate level of stress reported by participants. This aligns perfectly with the stress level category mentioned earlier, where the majority of participants within the manufacturing industry exhibit moderate stress. The standard deviations ranged from 0.973 to 1.354, suggesting variability in responses across the items, indicating a wide range of perceived stress levels among the participants.

Next, the skewness and kurtosis values are generally smaller than 1, exhibit mild asymmetry in the scores, indicating a relatively balanced distribution. This observation aligns with research on the psychometric testing of the PSS-10 for Chinese nurses, where similarly small skewness and kurtosis values were reported, indicating that the items are normally distributed (Du et al., 2023). Furthermore, another research study was conducted on Chinese adolescents. It also shows that the skewness and kurtosis indicate that the items are normally distributed (Liu et al., 2020). However, deviations from normal distributions are observed in some cases from the obtained data, such as with PSS-01 and PSS-03, where the kurtosis value is larger than 1. This suggests that the scores for these items are more extreme compared to a normal distribution. Therefore, these statistics provide insights into the distributional characteristics of the PSS-10 item scores, revealing asymmetry in the score distribution.

Table 4.2: Mean, Standard Deviation, Skewness and Kurtosis for PSS-10 Responses.

PSS-10 Questions	Mean	Standard Deviation	Skewness	Kurtosis
PSS-01	2.33	1.354	-0.143	-1.120
PSS-02	1.86	1.276	0.293	-0.776
PSS-03	2.19	1.250	0.283	-1.029
PSS-04	1.62	0.973	-0.190	-0.785
PSS-05	1.57	1.121	0.274	-0.408
PSS-06	1.86	1.062	0.034	-0.505
PSS-07	2.00	1.095	-0.252	-0.694
PSS-08	2.00	1.049	0.287	-0.271
PSS-09	2.05	1.244	0.074	-0.968
PSS-10	1.95	1.161	0.101	-0.713

4.3 Analysis of Responses from TAM

The Technological Acceptance Model (TAM) comprises two factors: perceived usefulness and perceived ease-of-use (Cheah et al., 2022). Perceived usefulness assesses the utility of the visual dot probe task prototype and includes items 1, 2, 3, 4, 5, and 6. Conversely, perceived ease-of-use, which determines whether the prototype is easy to use and learn, is composed of items 7, 8, 9, 10, 11, and 12. A lower score in perceived usefulness indicates greater perceived usefulness, whereas a lower score in perceived ease-of-use indicates that the prototype is considered easy to use and learn (Lewis, 2023). Figure 4.2 presents the responses obtained through the Google Form, specifically focusing on the questions related to the Technological Acceptance Model (TAM) after the completion of stress measurement using the visual dot probe task prototype.

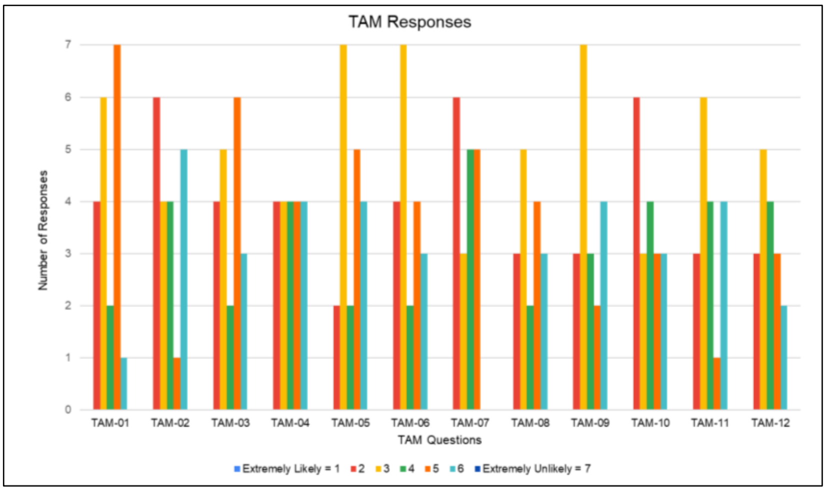

Figure 4.2: Bar Chart for TAM Responses.

4.3.1 Cronbach's alpha test of Responses from TAM

Moreover, the internal consistency reliability of the collected data was assessed through Cronbach's alpha test. The total Cronbach's alpha score for TAM is 0.976, with values for perceived usefulness and perceived ease-of-use at 0.964 and 0.960, respectively. With the total Cronbach's alpha surpassing 0.7, this indicates that the TAM demonstrates strong reliability in measuring the acceptance of technology.

According to Davis, the researcher who proposed TAM, it is found that from his research, the Cronbach's alpha coefficient for perceived usefulness is 0.97, and for perceived ease of use is 0.91 (Davis, 1989). The coefficients are approximately similar to the data obtained from the TAM responses. In addition, research investigating the acceptance of a mobile library application showed that the Cronbach's alpha coefficient for perceived usefulness is 0.93, and for perceived ease of use is 0.97 (Rafique et al., 2020). The coefficients for both factors are very close to each other when compared with the Cronbach's alpha coefficient obtained, demonstrating that the Technology Acceptance Model (TAM) achieves internal consistency reliability.

Thus, by comparing both of the Cronbach's alpha coefficients obtained from the data collected through the responses of the TAM questionnaire, it is validated that the data achieve internal consistency reliability as they are approximately similar to the coefficients found in previous research done by other researchers.

4.3.2 Descriptive Analysis of Responses from TAM

Table 4.3 illustrates the descriptive analysis for TAM, including the mean and standard deviation. The average score obtained for perceived usefulness is 3.7255, indicating an average score below 4. This suggests that individuals believe that using the prototype would enhance their task of measuring stress, as it would make the process easier to accomplish, thus indicating its utility. Similarly, the average score for perceived ease-of-use is 3.593, also below 4 on average. This indicates that individuals perceive the prototype as easy to use and learn. Both scores suggest that the prototype's usefulness and ease-of-use lean towards the positive side of the scale. Therefore, the results imply that participants find the technology acceptable for assessing their stress levels, as they consider it as both useful and easy to use.

Table 4.3: Mean and Standard Deviationfor TAM Responses.

TAM Questions	Mean	Standard Deviation
TAM-01	3.609	1.4961
TAM-02	3.609	1.7128
TAM-03	3.784	1.6140
TAM-04	3.827	1.6326
TAM-05	3.915	1.5856
TAM-06	3.609	1.5808
TAM-07	3.563	1.6636
TAM-08	3.694	1.9209
TAM-09	3.565	1.6636
TAM-10	3.435	1.6895
TAM-11	3.738	1.8467
TAM-12	3.563	1.8375

4.4 Analysis of Parameters of the Visual Dot Probe Task

The visual dot probe task revealed that the total average congruent trial reaction time was calculated as 422.23 ms, and the total average incongruent trial reaction time was 447.69 ms. Consequently, the average attentional bias score was determined to be -25.46 ms. The negative attentional bias score indicates longer average reaction times during incongruent trials and faster reactions during congruent trials.

Moreover, analysis of the data revealed that 17 out of 21 participants exhibited a negative attentional bias score, indicating longer average reaction times during incongruent trials and faster reactions during congruent trials. This suggests that the participants' bias towards threat is vigilant. Conversely, only 4 participants had a positive attentional bias score, suggesting a greater attraction to the happy emoji stimuli and longer reaction times to the emotional emoji stimuli. This indicates that the participants' bias away from threat is avoidance (Evans and Britton, 2018).

Both results discussed align with the hypothesis that participants would retain their attention on the emotional face and react faster to it. Thus, sustained attention to the emotional face was observed to impact the reaction time to the neutral face, with reaction times towards the emotional emoji stimuli being shorter compared to the neutral emoji stimuli. This result aligns with previous research, where individuals experiencing stress tend to retain their attention longer towards the emotional face, leading to faster reactions to the dot after the emotional face and slower reactions to the dot after the happy face (Wong et al., 2022). Furthermore, in research on moderators of age effects on attention bias toward threat and its association with anxiety, it is shown that negative stimuli tend to retain attention, resulting in faster reaction times towards negative stimuli. The research indicates that both young adults and older adults, who are typically within the age range of working individuals, will react faster to negative stimuli, particularly in congruent trials (Namaky et al., 2017). Therefore, the research supports the finding that congruent reaction time is shorter than incongruent reaction time due to sustained attention towards threat stimuli, which in turn leads to a slower reaction towards neutral stimuli. The comparison between the average congruent reaction time and average incongruent reaction time is shown in Figure 4.3.

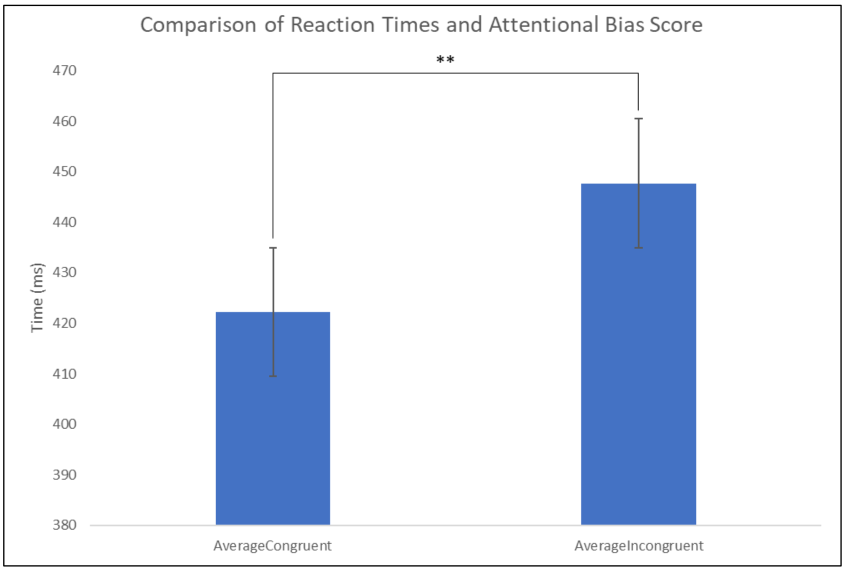

Figure 4.3: Comparison of Congruent and Incongruent Reaction Time.

In order to further analyze the relationship between the congruent and incongruent trial reaction time, as well as the attentional bias score, two different tests were conducted on the obtained data. These tests included the Pearson correlation test to evaluate the correlation between the parameters, and the t-test to find out if there are any significant differences among the parameters.

4.4.1 Pearson Correlation Test for Dot Probe Task Parameters

A Pearson correlation test was performed between the average congruent and incongruent trial reaction time, as well as the attentional bias score. Firstly, the findings show that the average congruent and incongruent reaction times have a strong positive correlation with an r-value of 0.944. This suggests a robust positive relationship, meaning that as one variable increases, the other tends to increase as well. Congruent and incongruent trial reaction times are highly correlated, which can be attributed to variations in participants' reaction times. This can be supported by research on reaction times, which indicates that individuals who exercise regularly tend to have faster reaction times, while those with a sedentary lifestyle typically exhibit slower reaction times (Jain et al., 2015). Furthermore, another research study has shown that playing games can have an effect on reaction time. Specifically, esport players exhibited faster response times after completing gaming sessions (Sousa et al., 2020).

Thus, both congruent and incongruent reaction times are likely influenced by individuals' varying lifestyles, contributing to their high correlation.

However, the attentional bias score showed weaker correlations: a positive correlation of 0.057 with average congruent reaction time and a negative correlation of -0.274 with average incongruent reaction time. These values indicate that both average congruent and incongruent reaction times have a weak linear correlation with the attentional bias score. The attentional bias score shows a weaker correlation for both congruent and incongruent trial reaction times, where the difference between the reaction times will remain the same and will not affect the attentional bias score.

4.4.2 T-Test for Dot Probe Task Parameters

Furthermore, a t-test was conducted for the average congruent and incongruent reaction times. The obtained t-value is 3.312 with a p-value of 0.003. These results indicate a significant difference between the average congruent trial reaction time and average incongruent trial reaction time. With a p-value lower than 0.05, the difference between congruent reaction time and incongruent reaction time is not likely due to random chance. Thus, the t-test supports the conclusion that average congruent and incongruent reaction times are significantly different from each other.

This aligns with previous research on dot probe tasks, which has also shown a significant difference between congruent and incongruent reaction times (Mahr and Wentura, 2014). Moreover, the t-test results indicate that participants do not react the same way for two different trials, as they tend to retain their attention on one of the stimuli and react faster and more accurately to it (Xu et al., 2022). Significant differences occur between the reaction times in congruent and incongruent trials, indicating that users exhibit attentional bias towards or away from fear stimuli and experience difficulty in disengagement or facilitated engagement. This aligns with research indicating that attentional bias towards and away from fearful faces is modulated by developmental amygdala damage (Pishnamazi et al., 2016).

Therefore, the t-test results obtained align with research conducted by other researchers, indicating that the significant differences are due to attention bias towards or away from the stimuli. Consequently, the reaction time for congruent and incongruent trials will differ.

4.5 Correlation Between Responses from PSS-10 with Parameters of Visual Dot Probe Task

For the final analysis, responses to the PSS-10 questionnaire were compared with variables from the dot probe task, including average congruent and incongruent reaction time, as well as the attentional bias score. Pearson correlation coefficients were computed in order to assess the correlations between the dot probe task variables and PSS-10 scores. The results revealed moderate negative correlations: -0.245 with average congruent reaction time, -0.166 with average incongruent reaction time, and -0.213 with the attentional bias score. These findings suggest that all dot probe task variables exhibit a moderate negative correlation with the mean PSS-10 score.

From the Pearson correlation analysis, it is observed that the attentional bias score is moderately negatively correlated with PSS-10 scores. This suggests that when the attentional bias score is low, the PSS-10 score tends to be higher, indicating higher stress levels. However, this finding is inaccurate as it deviates from previous research that linked attention bias to threat. In previous studies, attention bias was significantly positively associated with anxiety levels, meaning that as attention bias increased, stress levels also tended to increase (Çek et al., 2016). Therefore, the obtained correlation appears to be inaccurate compared to previous research findings, which may be attributed to insufficient data collected.

On the other hand, the Pearson correlation coefficient is quite accurate. For the average congruent reaction time, there is a moderate negative correlation, indicating that people with higher stress will react faster towards emotional stimuli. Conversely, the Pearson correlation coefficient for average incongruent reaction time shows a positive correlation, indicating that users with higher stress will react slower towards neutral stimuli. This explanation aligns with Section 4.4.2 above, where users tend to retain their attention towards emotional stimuli, leading to faster reactions to them and slower reaction times towards neutral stimuli. Therefore, the correlation aligns with the theory of sustained attention as explained by other researchers.

Next, t-tests were done to conclude whether the mean PSS-10 score and the dot probe task variables differed significantly. The null hypothesis proposed no significant difference, while the alternative hypothesis suggested otherwise. The obtained t-values for PSS-10 with average congruent and incongruent reaction times were -17.519 and 18.062, respectively, both yielding p-values of less than 0.001. Similarly, the t-value for PSS-10 with the attentional bias score was -5.5, also with a p-value below 0.001. These findings indicate a statistically significant difference between the PSS-10 score and the measured dot probe task variables.

4.6 Summary

In summary, the analysis of PSS-10 responses indicates that the majority of individuals working within the manufacturing industry experience moderate stress levels, with only a small portion experiencing low or high stress. Conversely, responses to TAM suggest that participants perceive the prototype as useful for measuring stress levels, as well as easy to use and learn, as indicated by scores above the average.

Furthermore, the dot probe task revealed that the average congruent reaction time was 422.23 ms, and the average incongruent reaction time was 447.69 ms, resulting in an average attentional bias score of -25.46 ms. This negative attentional bias score suggests longer reaction times during incongruent trials and faster reactions during congruent trials, consistent with previous research findings. Moreover, Pearson correlation analysis showed a high correlation between congruent and incongruent reaction times, while t-tests proven a significant difference between these reaction times. Lastly, Pearson correlation tests conducted between the parameters of the dot probe task and PSS-10 responses showed moderate negative correlations, with t-tests indicating significant differences.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In conclusion, job stress can lead to severe health consequences if left unaddressed, making it crucial to develop effective tools for its assessment and management. Hence, this project aims to design a visual dot probe task for measuring occupational stress in the manufacturing industry. The objectives include validating the prototype by measuring occupational stress levels and correlating its parameters with occupational stress.

Before developing the visual dot probe task, an in-depth study was conducted, examining occupational stress and its connection to an individual's attention control. Various physical instruments for attention assessment were explored, including the dot probe paradigm, the Go/No-Go Paradigm, and the EEG-based attention recognition paradigm. The main focus of the project is on the visual dot probe task, for which a detailed explanation, along with its theoretical foundations, namely attentional bias and sustained attention, was studied. Before commencing the design process, an analysis of parameters for the visual dot probe task in relation to individuals' stress levels was conducted to further understand the task. Three psychological measurement instruments to assess individuals' stress levels were discussed, including the Perceived Stress Scale, the Ottawa Mood Scales, as well as the Cognitive and Affective Mindfulness Scale-Revised. Lastly, instruments used for prototype evaluation are also discussed, including the Technology Acceptance Model, the Post-Study System Usability Questionnaire, and the System Usability Scale.

During the fabrication process, the ESP32 and a TFT LCD screen were selected due to the ESP32's ability to connect to Wi-Fi and the LCD screen's wide and clear display. The overall program consists of 20 congruent trial reaction times and 20 incongruent trial reaction times, totaling 40 trials, which appear randomly to test individuals' response times. When measuring stress using the prototype, users will also be asked to fill in the PSS-10 and TAM questionnaires to provide additional information for data analysis.

The analysis of PSS-10 responses indicates that the majority of individuals working within the manufacturing industry experience moderate stress levels. Conversely, responses to TAM suggest that participants perceive the prototype as useful for measuring stress levels, as well as easy to use and learn, as indicated by scores above the average. Furthermore, the dot probe task revealed that the average congruent reaction time was 422.23 ms, and the average incongruent reaction time was 447.69 ms, resulting in an average attentional bias score of -25.46 ms. This negative attentional bias score suggests longer reaction times during incongruent trials and faster reactions during congruent trials, consistent with previous research findings. Moreover, Pearson correlation test demonstrated a high correlation between congruent and incongruent reaction times, while t-tests revealed a significant difference between these reaction times. Lastly, Pearson correlation tests conducted between the parameters of the dot probe task and PSS-10 responses showed moderate negative correlations, with t-tests indicating significant differences.

Therefore. the visual dot probe task successfully measured attentional biases, demonstrating its usefulness and ease-of-use in the manufacturing industry. This offers a promising alternative for stress assessment and contributes to employee well-being in manufacturing.

5.2 Recommendations for Future Work

In future work, it is recommended to collect more data to expand the dataset size. With a larger dataset, machine learning techniques can be applied to categorize stress levels more effectively. By incorporating AI into data analysis, more accurate results can be obtained, allowing for the immediate classification of stress level categories without the need for manual comparison with questionnaires. This advancement could greatly enhance the usability and efficiency of stress assessment tools in various settings.

Furthermore, it is recommended to incorporate the prototype with either a headset port or a speaker. This feature could provide additional functionality to the prototype, such as offering sound instructions for the dot probe task. These instructions could assist users in understanding the steps for using the prototype effectively. Additionally, the added instructions could be provided in multiple languages to accommodate users from diverse backgrounds. Moreover, if the sound function is available, an audio dot probe task could also be included. While the current dot probe task addresses the language barrier, these additional features would enable individuals with visual impairments to also utilize the dot probe task prototype for stress testing.

Lastly, to further enhance the current prototype, it is recommended to utilize better components. The current components, being cheaper, come with several limitations. For instance, the ESP32 microcontroller has limited memory capacity, potentially leading to issues such as memory depletion for the current prototype. Therefore, it would be beneficial to utilize an external memory source, such as a micro SD card, or to opt for a more advanced microcontroller. Additionally, it is feasible to replace physical buttons with a touchscreen interface, allowing users to interact directly with the screen for all functions. This change would not only reduce the size and compactness of the prototype but also enhance user experience.

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APPENDICES

Appendix A: PSS-10 Questionnaire

Table A-1: PSS-10 Questionniare.

	PSS-10 Questions
PSS-01	In the last month, how often have you been upset because of something that happened unexpectedly?
PSS-02	In the last month, how often have you felt that you were unable to control the important things in your life?
PSS-03	In the last month, how often have you felt nervous and stressed?
PSS-04	In the last month, how often have you felt confident about your ability to handle your personal problems?
PSS-05	In the last month, how often have you felt that things were going your way?
PSS-06	In the last month, how often have you found that you could not cope with all the things that you had to do?
PSS-07	In the last month, how often have you been able to control irritations in your life?
PSS-08	In the last month, how often have you felt that you were on top of things?
PSS-09	In the last month, how often have you been angered because of things that happened that were outside of your control?
PSS-10	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Appendix B: TAM Questionnaire

Table B-1: TAM Questionniare.

	TAM Questions
TAM-01	Using [this product] in my job would enable me to accomplish tasks more quickly.
TAM-02	Using [this product] would improve my job performance.
TAM-03	Using [this product] in my job would increase my productivity.
TAM-04	Using [this product] would enhance my effectiveness on the job.
TAM-05	Using [this product] would make it easier to do my job.
TAM-06	I would find [this product] useful in my job.
TAM-07	Learning to operate [this product] would be easy for me.
TAM-08	I would find it easy to get [this product] to do what I want it to do.
TAM-09	My interaction with [this product] would be clear and understandable.
TAM-10	I would find [this product] would be clear and understandable.
TAM-11	It would be easy for me to become skillful at using [this product].
TAM-12	I would find [this product] easy to use.

Appendix C: Overall Responses by Participants.

Table C-1: Table of Overall Responses of PSS-10.

No.	How many hours of sleep do you get daily?	Do you play games frequently?	PSS10										
			PSS-1	PSS-2	PSS-3	PSS-4	PSS-5	PSS-6	PSS-7	PSS-8	PSS-9	PSS-10	TOTAL
1	8	No	0	0	0	1	0	0	1	2	0	0	4
2	5	No	1	0	1	0	0	1	0	0	1	1	5
3	5	Yes	1	1	2	1	1	1	1	2	1	1	12
4	6	No	2	1	1	1	1	3	0	1	1	2	13
5	7.5	No	0	1	1	2	1	2	3	2	1	1	14
6	7	No	4	2	1	0	0	1	3	1	2	0	14
7	7	No	2	0	1	2	1	2	3	3	0	3	17
8	5	No	2	1	2	3	0	2	2	2	1	2	17
9	5	No	1	1	1	1	1	0	1	1	2	1	18
10	6	No	1	1	2	1	3	2	2	3	2	2	19
11	6	No	2	2	2	2	2	3	2	1	2	2	20
12	4.5	No	4	2	4	2	2	1	1	2	3	1	22
13	6	Yes	2	2	2	3	2	2	2	2	3	3	23
14	5	No	2	2	4	2	1	3	2	3	3	2	24
15	5	No	4	4	2	2	2	2	2	2	2	2	24
16	9	Yes	3	2	2	3	4	1	4	4	1	1	25
17	7	No	4	3	3	0	2	3	3	1	3	3	25
18	6	No	3	3	3	2	2	1	1	2	3	4	26
19	6	No	3	3	4	1	2	2	3	1	4	3	26
20	6	No	4	4	4	2	3	3	3	3	4	3	33
21	6	Yes	4	4	4	3	3	4	3	4	4	4	37

Table C-2: Table of Overall Responses of TAM.

No.	TAM											
	TAM-01	TAM-02	TAM-03	TAM-04	TAM-05	TAM-06	TAM-07	TAM-08	TAM-09	TAM-10	TAM-11	TAM-12
1	3	3	3	3	3	3	4	3	4	4	3	4
2	4	4	5	5	4	4	4	4	4	4	4	4
3	5	5	5	5	5	5	5	5	5	5	5	5
4	5	6	6	4	6	4	5	6	5	6	7	7
5	2	3	5	3	3	5	2	1	1	1	1	1
6	3	2	2	2	3	3	3	3	3	2	2	1
7	5	6	5	6	6	6	5	5	6	5	6	6
8	3	2	3	4	5	2	2	5	3	4	4	4
9	1	1	1	1	1	1	1	1	1	1	1	1
10	3	6	6	6	6	5	4	6	6	5	6	5
11	3	2	3	3	3	3	3	3	3	3	3	3
12	6	6	6	6	6	6	7	7	6	6	6	6
13	5	4	4	5	5	5	5	5	4	4	4	4
14	2	2	3	3	3	2	4	1	3	3	3	2
15	5	6	5	6	5	6	5	3	6	6	4	5
16	5	4	5	5	5	3	4	6	2	2	6	3
17	2	2	2	2	2	2	2	2	2	2	3	2
18	5	4	4	4	4	3	2	3	3	2	3	3
19	2	2	2	2	2	2	2	2	2	2	2	2
20	3	3	2	4	3	3	2	4	3	2	3	3
21	4	3	3	2	3	3	3	2	3	3	2	3