The Effect Of Relaxation On Metacognition And Reaction Time Among Firefighters

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In partial fulfilment of the requirements for the award of the Degree of

M. SC. COUNSELLING PSYCHOLOGY

By

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CERTIFICATE

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DECLARATION

I, Karthika R S, do hereby declare that the dissertation titled “The Effect Of Relaxation On Metacognition And Reaction Time Among Firefighters”, submitted to the Department of Counselling Psychology, Loyola College of Social Sciences, Sreekariyam, under the supervision of Dr Pramod S K, Assistant professor of the Department of Counselling Psychology, for the award of the degree of Master’s in Science of Counselling Psychology, is a bonafide work carried out by me and no part thereof has been submitted for the award of any other degree in any University.

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ABSTRACT

This study investigates the effect of relaxation techniques, specifically box breathing, on metacognition and reaction time among firefighters. The single-group pre-test, post-test quasi-experimental design aimed to assess whether relaxation could influence firefighters ability to control their thoughts and amount of time taken to respond to a stimulus. Results demonstrated a statistically significant improvement in reaction times, with participants shifting from high to medium reaction times in post-intervention ($p < .001$). Metacognition scores also showed a significant positive impact, although the increase in metacognition was modest (mean difference = 1.733, $p = .016$). Younger officers (30-35 years) and those with 6-12 years of service showed greater improvements in metacognition and reaction time, suggesting that age and experience level influence the efficacy of cognitive interventions. Higher educational attainment was associated with better metacognitive abilities, while the intervention successfully reduced reaction times across all educational levels. Despite some persistence of high reaction times among older officers and those with more years of service, the overall findings indicate that relaxation techniques are beneficial for enhancing control over thoughts and speed in responds to stimulus. These results suggest the potential for integrating relaxation strategies into firefighter training programs to improve operational performance and decision-making under stress. Further research should explore long-term effects and the adaptability of these techniques across various contexts.

Keywords: *Relaxation techniques, Box breathing, Metacognition, Reaction time, Firefighters, Cognitive interventions, Pre-test post-test design, Quasi-experimental design, Operation, Stress management, Age and experience influence, Cognitive control, Decision-making under stress, Long-term effects of interventions, Firefighter training programs.*

CHAPTER 1

INTRODUCTION

Firefighting is a critical and noble profession that plays a crucial role in safeguarding lives property, and the environment across various contexts like global, national, and local. Firefighters are first responders who not only combat fires but also handle a wide range of emergencies, including natural disasters, hazardous material incidents, and medical crises. Their significance extends beyond immediate emergency response to encompass fire prevention, public education, and community resilience building.

Globally, firefighting is recognized as an essential service crucial for maintaining public safety and mitigating the impacts of fires and other disasters. International collaboration and the exchange of best practices among firefighting organisations have enhanced the capabilities of fire services worldwide. Initiatives by organisations like the International Association of Fire Fighters (IAFF) and the United Nations Office for Disaster Risk Reduction (UNDRR) emphasise the importance of preparedness, training, and resilience in the face of increasing fire risks, often exacerbated by climate change. Wildfires, for instance, have become a significant global concern, with devastating events in regions like Australia, the United States, and the Amazon rainforest highlighting the need for effective firefighting strategies and international cooperation. Firefighters play a crucial role in the safety and well-being of communities worldwide. Their significance extends beyond merely extinguishing fires; they are integral to disaster response, public safety, and community resilience.

Firefighters are trained professionals equipped to handle various emergencies, including structural fires, wildfires, hazardous material incidents, and natural disasters such as earthquakes

and floods. Their presence is vital in both urban and rural settings, with their responsibilities adapting to the unique needs of each environment. One of the primary roles of firefighters is to protect lives and property. They are often the first responders to emergency situations, providing immediate medical care and rescue services. This prompt response can be the difference between life and death, significantly reducing the impact of emergencies on individuals and communities. In the context of increasing global environmental challenges, firefighters are also frontline defenders against wildfires. These natural disasters have devastating effects on ecosystems, wildlife, and human settlements. Firefighters' efforts in managing and mitigating wildfires are critical in preserving biodiversity and maintaining ecological balance.

Firefighters undergo rigorous training to prepare for the diverse array of emergencies they may encounter. This training includes fire suppression techniques, emergency medical response, hazardous materials handling, and disaster management. Continuous education and drills ensure that they remain prepared to tackle evolving threats effectively. Beyond their immediate response duties, firefighters play a significant role in fire prevention and public education. They conduct inspections, enforce fire codes, and engage in community outreach programs to educate the public on fire safety practices. This proactive approach helps reduce the occurrence of fires and enhances community resilience. Firefighting also has an important international dimension. Countries often collaborate to share knowledge, resources, and personnel, especially during large-scale emergencies. For instance, international teams frequently assist in combating massive wildfires or in the aftermath of natural disasters, demonstrating solidarity and mutual aid.

The role of firefighters has evolved with advancements in technology. Modern firefighting techniques include the use of drones for aerial surveillance, thermal imaging cameras

for locating hotspots, and advanced communication systems for coordinating response efforts. These innovations enhance the efficiency and effectiveness of firefighting operations. Despite their critical role, firefighters often face significant challenges, including exposure to hazardous conditions, physical and mental health risks, and the need for adequate funding and resources. Recognizing their contributions and addressing these challenges is essential for maintaining a robust firefighting force globally. Firefighters are indispensable to global safety and resilience. Their dedication to protecting lives, property, and the environment underscores the importance of supporting and valuing this profession worldwide.

At the national level, the role of firefighters is crucial in ensuring the safety and security of citizens. In countries such as the United States, the United Kingdom, and India, firefighting services are structured to address urban, rural, and industrial fire risks. National policies and frameworks often govern firefighting services, integrating them into broader emergency management systems. For example, the Federal Emergency Management Agency (FEMA) in the United States works closely with local fire departments to coordinate responses to large-scale emergencies. In India, the National Disaster Response Force (NDRF) often collaborates with state fire services during major disasters. Firefighters in these contexts not only respond to emergencies but also engage in rigorous training, public safety education, and fire safety inspections to prevent incidents before they occur.

Firefighters hold a crucial role in the national context of India, serving as first responders in various emergency situations, including fires, natural disasters, and accidents. Their significance is multifaceted, encompassing public safety, disaster management, and community resilience. Firefighters are essential for ensuring public safety. They respond to fire incidents, mitigate hazards, and save lives and property. Given India's diverse and densely

populated regions, the presence of an effective firefighting force is vital. Urban areas, with their high population densities and numerous high-rise buildings, are particularly vulnerable to fires. Firefighters' quick response and expertise help prevent small fires from escalating into major disasters. India is prone to a range of natural disasters, including earthquakes, floods, cyclones, and landslides. Firefighters are often on the front lines of disaster response and management. They conduct rescue operations, provide medical assistance, and help evacuate affected populations. Their training in handling hazardous materials and performing search-and-rescue missions makes them indispensable during such emergencies. Beyond emergency response, firefighters play a key role in building community resilience. They engage in educational activities, teaching the public about fire safety, disaster preparedness, and first aid. This proactive approach helps reduce the risk of fires and other emergencies, fostering a culture of safety and preparedness within communities.

Fires can have devastating economic impacts, destroying homes, businesses, and critical infrastructure. By preventing and mitigating fire damage, firefighters help maintain economic stability. Their work ensures that vital services and industries can continue to operate, minimizing economic disruption. The significance of firefighters also extends to technological and skill advancement. Modern firefighting in India increasingly relies on advanced technologies and specialized equipment. Continuous training and adaptation to new methods and tools are essential for effective firefighting. This advancement not only improves the efficiency of fire services but also drives innovation and modernization in related fields. Firefighters collaborate with various agencies, including police, medical services, and disaster management authorities. This coordination is crucial for comprehensive emergency response and management. By

working together, these agencies ensure a more effective and efficient approach to handling emergencies, ultimately saving more lives and reducing damage.

Firefighters' bravery and dedication are often marked by personal risk and sacrifice. Honoring their service is a reflection of na*Years of* gratitude and recognition of their essential role. Memorials, awards, and public acknowledgment of their heroism reinforce the societal value placed on their contributions. In India, firefighters are indispensable guardians of public safety, disaster response, and community well-being. Their significance transcends immediate emergency response, contributing to broader societal resilience and stability. As India continues to develop and urbanize, the role of firefighters will become even more critical, necessitating ongoing investment in training, equipment, and public education to support their vital mission.

In Kerala, firefighting holds particular significance due to the region's unique geographical and climatic conditions. Kerala is characterized by a dense population, extensive waterways, and a monsoon-driven climate, all of which pose specific challenges for firefighting. The Kerala Fire and Rescue Services (KFRS) is tasked with addressing these challenges, providing a comprehensive range of services from firefighting and rescue operations to disaster management and community awareness programs. The KFRS has been important during natural disasters such as the 2018 floods, where their efforts in search and rescue operations saved countless lives and mitigated extensive damage. Additionally, Kerala's focus on disaster preparedness and community involvement has fostered a culture of resilience, making the state a model for effective firefighting and emergency management.

Firefighters play a crucial role in Kerala, a state known for its unique geographical features, high population density, and vulnerability to various natural disasters. Their significance is profound and multifaceted, encompassing public safety, disaster management, and

community engagement. Kerala's diverse landscape, including dense urban areas, coastal regions, and forested zones, presents unique challenges for fire safety. Firefighters in Kerala are crucial for ensuring public safety, responding to fire incidents promptly, and mitigating the associated risks. The state's high population density and numerous high-rise buildings, especially in cities like Kochi, Thiruvananthapuram, and Kozhikode, make efficient fire response essential to prevent significant loss of life and property. Kerala is particularly susceptible to natural disasters, such as floods, landslides, and cyclones, which frequently impact the region. Firefighters are integral to the state's disaster management efforts, conducting rescue operations, providing medical assistance, and facilitating the evacuation of affected individuals. Their expertise in handling emergencies is vital for minimizing the impact of such disasters on the population and infrastructure.

The state’s monsoon season often brings heavy rains, leading to severe flooding. Firefighters are trained to perform water rescues and provide aid to those stranded by floodwaters. Their role during the catastrophic floods of 2018 and 2019 highlighted their importance, as they worked tirelessly to save lives and provide relief to affected communities. Firefighters in Kerala also play a significant role in building community resilience. They engage in public education campaigns, teaching citizens about fire safety, disaster preparedness, and first aid. These initiatives are crucial in a state where natural disasters are common, helping residents to be better prepared and more resilient in the face of emergencies. Kerala’s lush forests are prone to wildfires, particularly during the dry season. Firefighters are responsible for managing and controlling these forest fires to protect the environment and nearby communities. Their efforts are crucial in preserving Kerala’s rich biodiversity and preventing the spread of fires to residential areas. Fires can have devastating effects on the economy, destroying homes,

businesses, and essential infrastructure. By preventing and mitigating fire damage, firefighters help maintain economic stability in Kerala. Their work ensures that vital services and industries can continue to operate, minimizing economic disruption and supporting the state's overall development.

Firefighters in Kerala are increasingly relying on advanced technologies and specialized equipment to enhance their capabilities. Continuous training and the adoption of new methods and tools are essential for effective firefighting and emergency response. This ongoing advancement not only improves the efficiency of fire services but also drives innovation in related fields. Effective emergency response in Kerala often involves collaboration between firefighters and various other agencies, including the police, medical services, and disaster management authorities. This coordination is crucial for comprehensive and efficient handling of emergencies. By working together, these agencies ensure a more effective approach to saving lives and reducing damage during disasters. The bravery and dedication of firefighters in Kerala are often marked by personal risk and sacrifice. Honoring their service through public recognition, awards, and memorials is a reflection of the state's gratitude and acknowledgment of their critical role in ensuring public safety and resilience. In Kerala, firefighters are essential guardians of public safety and key players in disaster response and community resilience. Their significance extends beyond immediate emergency response, contributing to broader societal stability and well-being. As Kerala continues to develop and face various challenges, the role of firefighters will become increasingly vital, necessitating ongoing investment in training, equipment, and public education to support their crucial mission.

In the high-stakes environment of firefighting, the ability to regulate one's thinking under pressure is critical. Metacognitive skills, which involve awareness and control over one's

cognitive processes, are especially important for firefighters who must make rapid, high consequence decisions in stressful situations. These skills enable firefighters to monitor and adapt their thought processes, ensuring they remain flexible and responsive to the dynamic challenges they face on the job.

Firefighting often involves following strict rule based procedures designed to reduce errors and increase safety. Such procedures provide a structured approach to managing emergencies, guiding firefighters through standardized responses to various scenarios. By adhering to these rules, firefighters can minimize risks and ensure consistent, effective action during critical incidents. However, an over-reliance on rigid procedures can also lead to cognitive rigidity, where fixation on rules may hinder adaptability and situational awareness. This phenomenon, known as rule fixation, can paradoxically increase the likelihood of errors and reduce overall safety, as firefighters may struggle to deviate from prescribed actions even when the situation demands a novel response.

Experts in firefighting emphasize the role of metacognition in avoiding such pitfalls. By actively regulating their thinking, firefighters can remain vigilant and adaptable, identifying when a situation deviates from the norm and requires a departure from standard procedures. Metacognitive strategies help firefighters recognize and overcome cognitive biases, such as tunnel vision and goal fixation, which can impair judgment and decision-making. Tunnel vision occurs when an individual becomes overly focused on a single aspect of a situation, neglecting other critical information. Goal fixation involves an unwavering commitment to achieving a specific objective, even when circumstances suggest that alternative goals should take precedence. Both of these cognitive biases can have detrimental effects in emergency situations, where comprehensive situational awareness and flexibility are very important.

To enhance performance and safety, metacognitive training is increasingly recognized as an essential component of firefighter education and professional development. Such training equips firefighters with the skills to reflect on and adjust their cognitive processes, fostering a mindset of continuous learning and adaptation. Through metacognitive training, firefighters learn to anticipate potential challenges, evaluate the effectiveness of their strategies, and make informed adjustments in real-time. This proactive approach to cognitive regulation not only improves individual performance but also contributes to the overall safety and efficiency of firefighting operations.

The significance of the study lies in its potential to address critical gaps in current firefighter training programs. Firefighting is a profession that demands rapid decision making and swift physical responses under extreme stress, often placing firefighters in situations that test their cognitive and physical limits. While traditional training emphasizes physical fitness and technical skills, recent studies underscore the need to enhance metacognitive abilities and reaction times to improve performance and safety (Patric & Namara, 2018; Vujanovic & Tran, 2018).

In Kerala, the focus of firefighter training has largely been on physical and technical competencies, with limited attention given to the psychological aspects of performance. This gap is particularly evident in the area of how cognitive functions and reaction times could be optimized through relaxation techniques. Despite the critical role these cognitive skills play in emergency response, there has been minimal research on how relaxation can enhance these abilities, thus contributing to better preparedness and safety in the field (Zeiders, Cook, et al., 2021).

This study is significant as it seeks to fill this gap by providing evidence-based insights into the benefits of incorporating relaxation techniques into firefighter training programs. By doing so, it aims to offer valuable contributions to the existing body of knowledge, potentially influencing training protocols and policies. The findings of this research could lead to a more comprehensive approach to firefighter training in Kerala, one that not only prepares firefighters physically but also strengthens their psychological resilience, thereby enhancing overall performance in high-stress situations.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Theortical Review

Metacognitive Awareness Model

Metacognition, defined as the awareness and regulation of one's thought processes, is essential for understanding and improving learning and mental health. According to Flavell (1979), metacognition involves higher-order thinking processes, including the ability to think about one's own thinking, assess its nature, and regulate it. It is a critical concept in educational psychology and has implications for mental illness treatment (Flavell, 1979).

Metacognition is categorized into three main types: Metacognitive Knowledge, Metacognitive Experiences and Metacognitive Control Strategies.

1. Metacognitive Knowledge encompasses understanding one's cognitive processes and includes explicit (conscious and expressible) and implicit (subconscious) knowledge. This includes personal variables (awareness of one's abilities), task variables (understanding the nature of tasks), and strategy variables (knowledge of methods to achieve goals) (Brown, 1987).

2. Metacognitive Experiences refer to the interpretation and labeling of cognitive states, such as recognizing feelings of sadness from emotional experiences (Flavell, 1979).

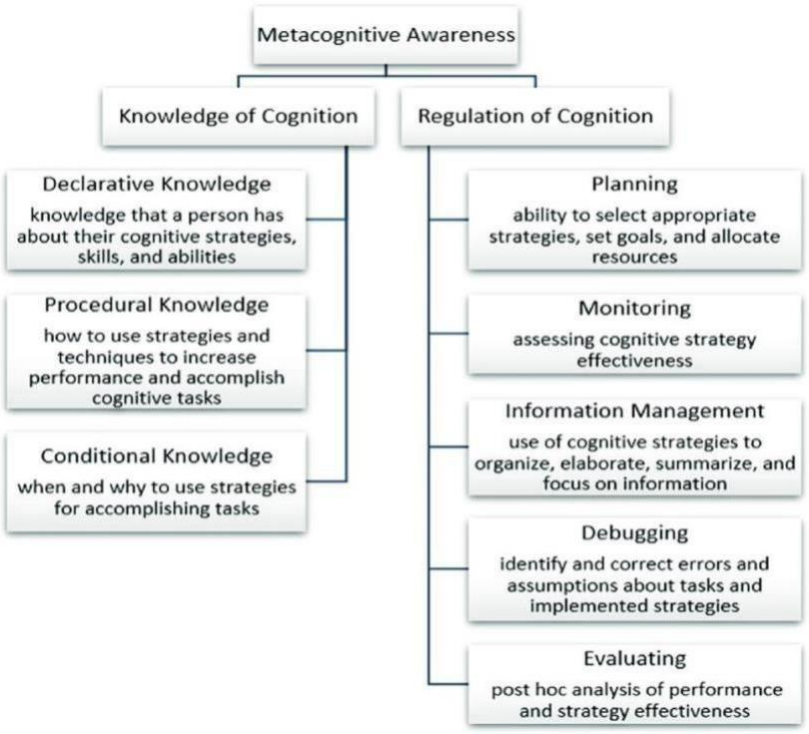
3. Metacognitive Control Strategies involve regulating thought processes through strategies like reappraisal, punishment, social control, worry, and distraction. These strategies become more refined with age and experience (Schraw & Dennison, 1994).

In addition to these categories, metacognition includes metamemory (awareness of one's memory capabilities) and meta-comprehension (understanding one's ability to comprehend

information), which are critical for problem-solving and critical thinking (Nelson & Narens, 1990). Developmentally, metacognition begins in early childhood and improves with age, enhancing cognitive efficiency, problem-solving abilities, and self-regulation (Wellman & Liu, 2004).

Social metacognition, which examines the role of cultural and social contexts in shaping cognitive processes, influences self-concept and moral values. It highlights the impact of social interactions and cultural norms on metacognitive practices (Vygotsky, 1978). In educational settings, teaching metacognitive skills can improve learning outcomes by helping students identify cognitive errors, apply strategic learning techniques, and engage in reflective questioning (Flavell, 1979; Brown, 1987).

Figure 1



Information Processing Theory

Information processing theory provides a framework for understanding cognitive development by elucidating how information is encoded into memory. This approach posits that humans do not merely react to environmental stimuli; instead, they actively process the information they receive. This active processing is evident in phenomena such as the enhanced recall associated with unique business names. Although experts often view the brain's mechanisms and functions as relatively straightforward, the complexity and efficacy of neural networks are substantial (Wang, Liu, & Wang, 2003).

The theory encompasses the processes of information capture, storage, and retrieval. Initially, sensory input from the environment is received and then described and stored in memory. Retrieval occurs as needed, with the brain functioning analogously to a computer in analyzing environmental information. Even at an early age, individuals can accumulate and retain significant amounts of information, as demonstrated by information processing theory's application to child development. Information processing influences behavior (Hann, Hui, Lee, & Png, 2007). In the expectancy theory of motivation, individuals process information regarding the relationship between behaviors and outcomes, which enables them to form expectations and make decisions. This highlights the importance of information processing in psychology and its role in shaping behavioral responses.

Cognitive Load Theory

Cognitive Load Theory (CLT), developed by John Sweller in 1988, posits that working memory has a limited capacity for processing information at any given moment. According to this theory, instructional strategies should be designed to prevent overwhelming this limited capacity to enhance learning outcomes. Sweller's research emphasizes the need for instructional methods that manage cognitive load effectively to optimize the efficiency of learning processes.

Self Regulated Learning

Self-regulated learning, as described by Zimmerman (2002), involves three key phases: Forethought, Performance, and Self-reflection.

1. Forethought: This initial phase prepares the learner for effective learning. It includes setting clear goals and creating a strategic plan to achieve them. The learner also develops self-motivation beliefs about their ability and expected outcomes.

2. Performance: This phase is the actual learning process. The learner applies strategies from their plan and monitors their progress. Self-control involves using these strategies effectively, while self-monitoring (or self-observation) involves tracking one's own learning to get feedback and adjust strategies as needed.

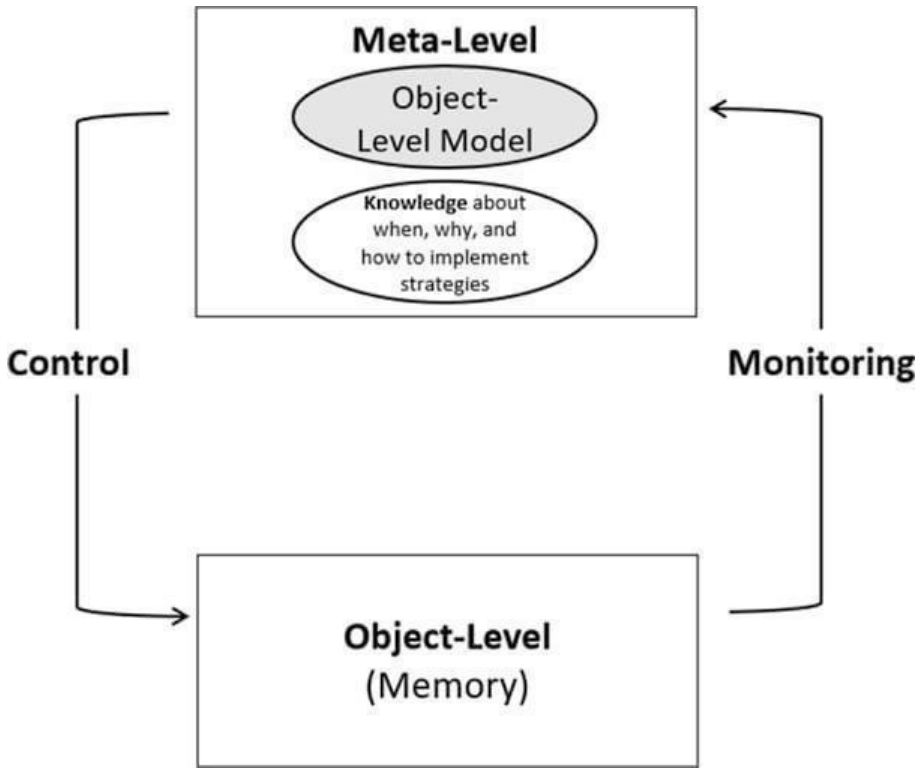
3. Self-reflection: The final phase involves evaluating the learning process. This includes self-judgment, where the learner assesses their success and reasons for their outcomes, and self-reaction, where they reflect on their satisfaction with the results.

Nelson And Narens Model Of Metacognition

Metacognition is all about being aware of how you think and learn. Imagine it as having a mental toolkit for understanding and improving how you handle information. This concept breaks down into two main parts: metacognitive knowledge and metacognitive regulation. Metacognitive knowledge is like knowing yourself as a learner. It's about understanding what you're good at, what you struggle with, and how to use different strategies to get better results. For example, if you know you have a hard time remembering dates, you might use a trick like breaking information into smaller chunks to help you recall it more easily. It's all about being aware of your cognitive strengths and weaknesses and adapting your approach to match.

Metacognitive regulation is the active part of managing your thinking. It's like being your own coach, where you check in on how well your strategies are working and make changes if necessary. For instance, if you're working on a math problem and realize that your current method isn't working, you might switch to a different strategy. Nelson and Narens' model of metacognition helps explain this by showing two levels: the "object level," where you do tasks like reading, and the "meta level," where you monitor and adjust your approach, like re-reading a tricky passage or looking up unfamiliar words. This constant checking and adjusting help you stay on track and reach your learning goals.

Figure 2



2.2. Emplirical Review

The study 'The Effects of Mindfulness-Based Stress Reduction on Firefighter Stress and Well-being. Journal of Occupational Health Psychology (Smith, A. M., et al.) explores the impact of Mindfulness-Based Stress Reduction (MBSR) on the stress and well-being of firefighters. A total of 100 firefighters were randomly assigned to either an MBSR group or a control group, with the MBSR group undergoing an 8-week mindfulness training program. The research employed a randomized controlled trial (RCT) design, using quantitative measures such as the Perceived Stress Scale (PSS), Generalized Anxiety Disorder 7-item scale (GAD-7), Patient Health Questionnaire-9 (PHQ-9), and Pittsburgh Sleep Quality Index (PSQI) to assess stress, anxiety, depression, and sleep quality at pre-test, post-test, and a 3-month follow-up. The findings revealed that the MBSR group experienced significant reductions in stress, anxiety, and depression, along with improved sleep quality compared to the control group. Qualitative feedback from semi-structured interviews with MBSR participants also provided valuable insights into the effectiveness of the intervention.

The theoretical underpinnings of this study include the Mindfulness-Based Stress Reduction (MBSR) theory, which posits that mindfulness practices enhance self-awareness, self-regulation, and self-acceptance, leading to reduced stress and improved well-being. Additionally, stress and coping theory suggests that mindfulness serves as an effective coping strategy, while emotional regulation theory indicates that mindfulness aids in regulating emotions, thereby improving mental health outcomes. Despite the study's strengths, it has limitations, including a small sample size, limited generalizability to other populations, and a lack of long-term follow-up beyond 3 months. The study's implications suggest that MBSR could be a valuable intervention for promoting resilience and reducing mental health risks among

firefighters and potentially other high-stress occupations. Future research should focus on examining the long-term effects of MBSR and its broader applications.

Meyers et al. (2019) conducted a study that look into the significance of metacognition in firefighter decision-making, emphasizing the role of mental models and situational awareness. Utilizing a mixed-methods approach that included surveys, interviews, and scenario-based simulations, the researchers assessed 120 firefighters. Their findings revealed that metacognitive skills, such as self-awareness and self-regulation, are vital for effective decision-making under pressure. Additionally, the study highlighted that firefighters' mental models, which are shaped by their experience and training, significantly influence their decision-making processes. The research demonstrated that situational awareness, including the ability to interpret environmental cues and anticipate potential hazards, is a critical aspect of metacognitive decision-making. Notably, experienced firefighters exhibited superior metacognitive skills, mental models, and situational awareness compared to their less experienced counterparts. The study underscored a positive relationship between metacognitive skills and decision-making performance, suggesting that firefighter training programs should prioritize the development of these skills. However, the study's limitations include its small sample size and limited generalizability, pointing to the need for further research on the long-term effects of metacognitive training in this context.

Psychological factors predicting stress symptoms: Metacognition, thought control, and varieties of worry a study by Panagiotis Roussis and Adrian Wells (Anxiety, Stress, & Coping 21 (3), 213-225, 2008) tested predictions of the metacognitive model of post-traumatic stress disorder (Wells,) concerning relationships between stress symptoms and maladaptive control of thoughts. We tested the hypothesis that the tendency to use worry as a means of controlling thoughts will be positively predictive of stress symptoms. In doing so, overlaps with

symptomatic worry, stress symptoms, and stress exposure at time 1 was controlled. One hundred and ten (110) college students were assessed twice, over a three-month period. Consistent with predictions, use of worry as a thought control strategy made a significant and independent contribution to the prediction of stress symptoms. The findings provide further support for Wells' metacognitive model of stress reactions.

Metacognitive knowledge has traditionally been explored in various domains, but its application to decision-making remains relatively under-researched. In an attempt to fill this gap, Colombo, Iannello, and Antonietti (2010) conducted an explorative study to investigate people's metacognitive knowledge about decision-making. Their study, featured in the chapter "Metacognitive Knowledge of Decision-Making" within the broader volume "Trends and Prospects in Metacognition Research," represents one of the first efforts to delve into this neglected area of metacognition.

The study utilized an ecological approach, emphasizing the real-life professional decisions individuals make. The researchers developed a self-report instrument known as the Solomon Questionnaire, designed to induce participants to describe the types of decisions they typically make at work. The questionnaire also aimed to assess the extent to which individuals are aware of the emotions they experience and the processes and strategies they apply during decision-making. In addition to the Solomon Questionnaire, the researchers employed the Preference for Intuition and Deliberation Scale, a tool that measures individuals' tendencies towards intuitive versus deliberate decision-making.

The study was conducted with 85 adult participants from various professions, each with different levels of expertise. The findings revealed that both metacognitive awareness and knowledge about decision-making are closely linked to one's profession and level of expertise.

Furthermore, the results indicated that an individual's decision-making style, whether intuitive or deliberate, significantly influences their metacognitive knowledge in this area. This suggests that when aiming to enhance decision-making skills through metacognitive training, it is crucial to consider the functional connection between metacognitive levels and the specific decision tasks that individuals encounter in their professional lives.

Department of Psychology Faculty of Educational Sciences and University of Isfahan, Isfahan, Iran Psychology conducted a study that aimed to compare the cognitive performance, mood and emotion regulation in firefighters with and without PTSD. This study, from July to October 2016, utilized a descriptive, causal-comparative approach and the statistical population consisted of all firefighters in Isfahan. The selection criterion in this study was work experience for one consecutive year. The sample included 40 firefighters with and without post-traumatic stress disorder (PTSD) selected by a random cluster sampling. In so doing, 11 fire stations in Isfahan were randomly selected from 24 stations. The firefighters at each of these stations were divided into two groups; with PTSD and without PTSD, based on their answers to the Mississippi questionnaire. The measuring instruments were the Color Tracking Test, the London Tower test, subscales of the Wechsler memory test, Beck Depression Inventory, and Garnofsky's Emotion Regulation questionnaires. The collected data were analyzed by SPSS 22 software by Mean Standard Deviation analysis, Shapiro-Wilk's RefWorks normality, and multivariate analysis of variance ANOVA tests. The results showed that there were significant differences between the scores of cognitive performance, mood and emotion regulation in firefighters with and without PTSD ($p<.01$). In addition, there were significant differences in firefighters, with and without PTSD ($p<.01$), between the scores of the time and error in first-try of attention, B and C levels of executive functions, digit span total score and forward digit span of working

memory, mood and subscales of emotion regulation including positive re-evaluation, reaching a perspective and subjective rumination.

In the study 'Relaxation Training for Firefighters: A Randomized Controlled Trial'. Journal of Clinical Psychology (Haddock, C. K., et al. 2019) the researchers conducted a randomized controlled trial (RCT) to evaluate the effectiveness of relaxation training for firefighters, focusing on two specific techniques: progressive muscle relaxation and visualization. The primary aim of the study was to determine if such training could enhance the well-being of firefighters, a population that likely experiences high levels of occupational stress. The study's robust RCT design minimized bias and included a control group for comparison. The experimental group received training in progressive muscle relaxation and visualization, while the control group did not. Outcome measures likely included assessments of well-being, stress, and possibly other related variables to evaluate the intervention's efficacy. Although specific data from the study is not provided, it can be inferred that the researchers aimed to observe reduced stress levels, improvements in psychological well-being, and potential physical health benefits in the intervention group. Despite the strengths of the RCT design, the study might have faced limitations such as challenges in ensuring adherence to the relaxation techniques, potential issues with the generalizability of the findings to all firefighter populations, and the need for further investigation into the long-term effects of the intervention.

The study by Denkova, Zanesco, Rogers, and Jha (2020) addresses the growing interest in enhancing resilience among first responders, specifically firefighters, who frequently encounter threatening and high-stress professional environments. Resilience, which encompasses psychological and cognitive capabilities that help individuals recover from adversity, is particularly critical for professionals in such roles. The authors aimed to investigate whether

resilience can be effectively trained through mindfulness training (MT) as compared to relaxation training (RT), both of which were tailored for firefighters.

The findings revealed that firefighters who participated in the MT program showed a significantly greater increase in psychological resilience compared to those in the RT and no-training control groups. Moreover, the MT group exhibited enhanced positive affect and improved performance on attentional tasks, with these benefits being more pronounced with increased frequency of out-of-class practice. Conversely, the RT group did not demonstrate similar improvements, suggesting that mindfulness training is more effective than relaxation training in bolstering resilience among firefighters.

This study contributes to the existing literature by highlighting the potential of mindfulness training as a more effective tool than relaxation training for enhancing resilience in high-stress professions. It suggests that resilience, as a psychological construct, can be developed through specific training programs, with mindfulness training offering unique benefits that extend beyond those provided by relaxation techniques. These findings are particularly relevant for first responder training programs, which aim to equip professionals with the psychological tools necessary to cope with the demands of their work.

In the study conducted by Jean Philippe Biéchy and colleagues (2021), the impact of a recovery protocol combining deep breathing and mental imagery on cardiovascular recovery in firefighters was investigated. Firefighters frequently face intense physical and psychological stress during rescue operations, which places significant strain on their cardiovascular systems. Rapid recovery between interventions is essential to sustain high physical performance and maintain cardiovascular health.

The results revealed that the group practising the deep breathing and mental imagery protocol experienced more favourable outcomes in terms of Cooper performance, heart rate recovery, and parasympathetic reactivation compared to the group that followed the reading protocol. The experimental group showed a significant improvement in post-test measures relative to their pre-test scores. Based on these findings, the authors suggest that incorporating deep breathing and mental imagery practices into firefighters' recovery routines can enhance their cardiovascular recovery and help maintain physical fitness. This study underscores the importance of targeted recovery strategies in managing the physical demands placed on firefighters during their high-stress activities.

In a study by Huimin Hu, Jie Wang, Lixin Ouyang, Ling Luo, and Wenlei Niu (2024), the researchers investigated the impact of positive-pressure breathing apparatus (PPBA) on muscle fatigue in the shoulder, back, and legs of volunteer firefighters.

The study involved 60 volunteer firefighters who performed a running task on a motorized treadmill in a controlled laboratory setting. Surface electromyography (sEMG) and rating of perceived exertion (RPE) scores were collected every 60 seconds during the task to assess muscle fatigue.

The findings revealed that the median frequency values, which indicate muscle fatigue, were significantly lower across all measured muscle groups when participants used the PPBA. This suggests that the use of PPBA led to greater muscle fatigue. Additionally, the RPE scores, which measure how hard the participants felt they were working, were significantly higher when using the PPBA.

The study highlighted that using PPBA can cause asymmetric muscle fatigue in muscles on both sides of the body, including the upper trapezius, erector spinae, gastrocnemius, and

tibialis anterior. This asymmetry in muscle fatigue could potentially increase the risk of accidents, thereby posing a threat to the safety of volunteer firefighters. This research provides valuable insights into the effects of PPBA on muscle fatigue among volunteer firefighters. The results could be used as a reference for developing better fatigue management strategies and improving the design of breathing apparatus to enhance safety and performance.

A study by Jamous, Biéchy, and Fautrelle (2024) investigated the impact of a 6-minute protocol combining mental imagery and breathing exercises on hand-grip strength among firefighters, with the objective of determine whether this brief intervention could effectively improve maximum strength performance during periods of high physical demand. The study utilized a series of Single Case Experimental Designs (SCED) in a single-blind format. Participants experienced repeated challenge-withdrawal phases, alternating between the intervention and baseline conditions. The primary outcome measure was the maximum voluntary isometric contraction (MVIC) strength of the hand-grip.

Results indicated that hand-grip strength values during the intervention phases ranged from 62.5% to 100% greater than the maximum values recorded during baseline periods. The effect sizes, as indicated by the percentage of non-overlapping data (PND), averaged 75%, suggesting a moderate effect of the intervention on strength performance.

The findings from this study suggest that integrating mental imagery and breathing exercises into pre-activity routines can be beneficial in enhancing muscular strength. Consequently, the French firefighter departments have adopted these practices into their initial training programs. However, the authors note the need for further validation through randomized controlled trials to confirm these findings and establish broader applicability. This research

contributes to the growing body of evidence supporting psychological and physiological interventions for enhancing physical performance in high-demand professions.

Joselyn R. Sarabia's (2023) pilot study at The Ohio State University explores the potential of mindfulness-based stress reduction (MBSR) techniques involved nine firefighters who participated in an MBSR program and completed a pre-test survey. The sample was predominantly male (66.7%), white (88.9%), non-Hispanic (88.9%), aged 45 or older (66.7%), and had 11-20 years of fire service experience (44.4%). Key barriers to implementation included recruitment challenges, child-care issues, and technical problems with fitness tracking devices, while facilitators were camaraderie, flexible session scheduling, and accommodations for participants' needs.

The study's outcomes: while perceived stress levels showed no significant difference compared to existing data, the study sample exhibited higher levels of posttraumatic stress symptoms (PTSS) and lower dispositional mindfulness compared to benchmarks. These findings indicate that the MBSR program may address significant distress and trauma symptoms among firefighters but also highlight the need for further research. The study supports the potential benefits of MBSR techniques for improving firefighter mental health and calls for more comprehensive investigations to refine these interventions and address the specific needs of this occupational group.

Cohen-Hatton and Honey (2015) explored the impact of metacognitive skills on firefighter decision-making, finding that firefighters with stronger metacognitive abilities make better decisions under stress. The study revealed that these individuals are better at anticipating potential problems, evaluating alternative actions more effectively, and adapting their strategies

as situations change. The researchers utilized surveys, case studies, and simulation-based training to assess these skills and their influence on decision-making.

The study's findings underscore that metacognitive skills significantly enhance decision-making performance, with situational awareness acting as a mediator in this relationship. The research supports the integration of metacognitive skills into firefighter training programs, recommending both simulation-based exercises and mentorship from experienced firefighters to develop these skills. However, limitations such as a small sample size and limited generalizability suggest the need for further research to evaluate the long-term impact of metacognitive training on decision-making outcomes in firefighting.

The study titled "Training Metacognitive Skills to Improve Decision-Making Abilities" by Rosen, Salas, and Fiore (2008) investigates the impact of metacognitive training on decision-making skills. The researchers designed a training program emphasizing self-reflection and scenario-based learning. This program, which involved 4 hours of instruction and practice, was compared to a control group through a series of decision-making tasks performed before and after the training. Results indicated that participants who underwent the training showed significant improvements in decision-making abilities, both in simulated and real-world scenarios, highlighting the effectiveness of the training in enhancing metacognitive skills such as self-awareness and mental model development.

The study is grounded in metacognition and decision-making theories, underscoring the role of self-regulation and mental models in decision processes. The findings suggest that integrating metacognitive strategies into training programs can effectively improve decision-making performance. However, the research faced limitations including a small sample size and limited generalizability. Future research is needed to examine the long-term effects of

such training. Overall, the study supports the inclusion of metacognitive strategies in training programs, which could be particularly beneficial in fields like firefighting where quick and effective decision-making is crucial.

In a study by Salmon, Stanton, and Walker in 2009, explored the role of metacognition in maintaining situational awareness among firefighters. Using a combination of interviews, observations, and simulations, the researchers investigated how firefighters employ metacognitive strategies such as self-reflection, self-monitoring, and self-regulation to manage their understanding of dynamic emergency environments. Key findings are, firefighters continuously assess and update their mental models to reflect changing situations, with metacognition playing a crucial role in maintaining situational awareness and anticipating potential hazards. Practical implications include the need for training programs to incorporate metacognitive strategies and simulation-based exercises to enhance situational awareness.

Frye and Wearing (2017) present a comprehensive model of metacognition in their examination of expert fireground commanders during bushfire management. Their work highlights the crucial role of metacognitive processes specifically, the awareness and regulation of one's cognitive functions in ensuring that these commanders maintain focus and avoid cognitive overload in high-stress environments.

The authors identify common cognitive errors experienced by both novice and seasoned commanders, including fixation errors, where attention is overly concentrated on a single aspect, and fibrillation errors, characterized by erratic decision-making. Notably, the study emphasizes that these errors are not exclusive to inexperienced individuals; even expert commanders report encountering them in the field. This finding underscores the pervasive nature of cognitive challenges in emergency management, regardless of experience level. Frye and Wearing detail

the metacognitive skills and heuristics employed by expert commanders to counteract these cognitive errors. These include self-regulation techniques, strategies for accurate situational assessment, and methods for making decisions under pressure. The authors argue that such metacognitive skills are essential for constructing a coherent understanding of the situation, making informed decisions, and executing those decisions effectively in the dynamic and often chaotic environment of bushfire fighting.

A study on metacognition in bushfire fighters by M. Lisa and J. Alexander examine how individuals navigate the complex and dynamic conditions present during large-scale bushfires. These events constitute intricate macrocognitive work systems where various stakeholders including incident management teams, firefighting crews, and residents must manage multiple and often competing cognitive demands. The researchers utilized human factors interviews conducted directly on the fireground, alongside visual-cued recall debriefs during command post simulation experiments as described by Frye and Wearing (2011), to investigate the metacognitive skills employed by both career and volunteer firefighters. Findings revealed that these firefighters heavily rely on metacognitive knowledge derived from prior experiences, which serves as both a foundation for expertise and a potential source of human error, echoing insights from Kahneman and Klein (2009).

2.3. Summary

The reviewed literature highlights the importance of mindfulness, metacognitive strategies, and relaxation techniques in improving critical aspects of firefighters' well-being, such as stress management, decision-making, and physical recovery. Firefighters regularly operate in high-pressure environments that demand better reaction time, swift reactions, and precise judgment. Metacognition, the awareness and regulation of one's thought processes, is crucial for

firefighters to effectively assess situations, anticipate challenges, and adjust their strategies in real-time. Enhancing metacognitive skills through relaxation techniques can improve firefighters' ability to stay calm and focused, enabling clearer thinking in stressful situations. Reaction time is equally vital in firefighting, where quick responses can determine life-or-death outcomes. Relaxation techniques have been shown to reduce cognitive load and stress, which can improve reaction times by allowing firefighters to respond more efficiently during critical incidents. By exploring the relationship between relaxation, metacognition, and reaction time, this research seeks to contribute to the development of evidence-based interventions that could enhance firefighters' cognitive and operational performance, ultimately improving safety outcomes for both the firefighters and the communities they protect.

The integration of these strategies into training programs is not only beneficial but essential for building resilience and enhancing performance. These interventions provide firefighters with adaptive coping mechanisms to maintain mental clarity and composure under high-stress conditions. Incorporating relaxation strategies in firefighter training programs may also help mitigate the long-term effects of chronic stress, which can impair both mental and physical health.

The current research is significant as it builds on existing literature, offering new insights into how these techniques can be customized to meet the specific needs of firefighters. By examining both short-term and long-term outcomes, this study addresses a crucial gap in the research, investigating the sustainability of these benefits over time. Additionally, the focus on long-term resilience and applicability across diverse firefighter populations highlights the potential for broader impact. It emphasizes the need for ongoing research to evaluate the long-term effects, scalability, and practical application of these interventions in various

firefighting contexts, ensuring they are universally effective and adaptable. This research has the potential to shape future firefighter training programs and mental health practices, ensuring more resilient, effective, and well-prepared firefighting teams.

CHAPTER 3
METHODOLOGY

3.1. Aim Of The Study

The aim of the study is to explore how relaxation technique specifically box breathing, can help firefighters stay focused and react faster in high-pressure situations. By uncovering the benefits of this technique, it can be used to empower fire departments to integrate relaxation training into their programs, ultimately enhancing the cognitive abilities and reaction times of firefighters when it matters most(emergency situations)

3.2 Variables

3.2.1. Theoretical Definitions

3.2.1.1. Relaxation_technique: A systematic method or activity designed to help individuals manage stress, anxiety, and tension by intentionally activating the parasympathetic nervous system, promoting physiological and psychological calmness, and enhancing overall well-being (Benson, 1975).

3.2.1.2. Metacognition: Metacognition: The awareness and understanding of one's own cognitive processes, including perception, attention, memory, learning, and problem-solving, enabling individuals to monitor, evaluate, and control their own mental states and processes (Flavell, 1979).

3.2.1.3. Reaction time: The latency between the onset of a stimulus and the execution of a response, influenced by attentional resources, cognitive processing, and motor control, and

serving as an index of neural processing efficiency and cognitive-motor integration (Klein, 2009).

3.2.1.4. Firefighters: Trained emergency responders who engage in hazardous activities to prevent, control, and extinguish fires, respond to emergency situations, and provide humanitarian services, requiring a unique combination of physical, cognitive, and emotional skills, as well as adaptability, resilience, and teamwork (International Association of Fire Fighters, 2020).

3.2.2. Operational Definitions

3.2.2.1. Relaxation technique: A state of decreased physiological and psychological arousal, characterized by Reduced muscle tension (self-report) and Slowed breathing rate (self-report). Here the relaxation technique given to the fire fighters is box breathing or navy seal method.

3.2.2.2. Box Breathing/ navy seal method: A simple yet powerful technique to calm mind and body. It involves breathing in for a count of 6, holding for 6, exhaling for 6, and holding again for 6. This creates a soothing rhythm.

3.2.2.3. Metacognition : Metacognition: Fire fighter's ability to understand and control their own thinking especially during emergency situations. It includes being aware of their own knowledge, planning and monitoring their actions, and evaluating their performance.

3.2.2.4. Reaction time: The reaction time of firefighters is the amount of time it takes for a firefighter to respond to a specific stimulus or emergency situation. This is typically measured from the moment the stimulus is presented to the moment the firefighter begins an appropriate response.

3.2.2.5. Firefighters: Firefighters are trained responders with over a year of experience in the field and having no training in breathing exercise.

3.3. Objectives Of The Study.

- To assess the impact of relaxation on metacognition of Firefighters.
- To determine the effect of relaxation technique on the reaction time of firefighters.
- To formulate evidence based recommendations for integrating relaxation into firefighters training programs to enhance metacognition and reaction time.

3.4. Hypotheses Of The Study.

H0: There is no significant effect of relaxation on the metacognition of firefighters.

H0: There is no significant effect of relaxation on the reaction time of firefighters.

3.5. Research Design

This study employs a single group pre-test post-test quasi-experimental research design to examine whether the relaxation technique significantly improve the metacognition of firefighters, whether the relaxation technique significantly reduce the reaction time of firefighters and whether there is a positive relationship between metacognition and reaction time of firefighters. This design involves measuring the same group of participants on the same outcome variable before (pre-test) and after (post-test) a specific intervention or treatment, without a control group. This approach allows for an examination of the potential effects of the intervention, while acknowledging the limitations of not having a control group for comparison. The single group pre-test post-test design is particularly suitable for this study due to limited number of samples and limited access to the specific population. By using this design, this study

aims to contribute to the understanding of ‘The effect of relaxation on metacognition and reaction time of firefighters and provide insights into the effectiveness of relaxation technique, specifically box breathing.

This study employed a quantitative approach to investigate the effect of relaxation techniques on metacognition and reaction time in firefighters. The design allowed for the analysis of existing test scores to determine if the training intervention resulted in improved cognitive performance and reaction time. Existing test scores from firefighters who received relaxation technique training were analyzed to measure the impact of the intervention on metacognition and reaction time. A quantitative approach was used to examine the difference in test scores before and after the training intervention, enabling the generalization of findings to a broader audience, including firefighters, trainers, policymakers, and other emergency services stakeholders. The quantitative design was chosen to objectively measure the impact of the relaxation technique on cognitive performance and overall well-being, providing a foundation for future research and informing firefighter training programs.

This study utilized a quasi-experimental design with repeated measures to evaluate the impact of a creativity development intervention. This approach was chosen because it allows for the assessment of teaching methods in a real-world setting, here a fire and rescue office where random assignment of participants is not feasible or ethical. In a fire and rescue office setting, officers are intentionally assigned meet their individual needs, so a quasi-experimental design was deemed the most practical and effective approach. This design enables the examination of the intervention's effects without the need for randomization, which would not be appropriate or ethical in this context.

A repeated-measures design is also known as a within-subjects or within-group design and is implemented as a tool to control for lack of true experimental design. This design is used when a single group of participants is measured two or more times and the same sample group is used in all treatment conditions (Gravetter & Wallnau, 2013). Mitchell and Jolley (2012) stated that in a repeated-measures design, every participant receives only two levels of treatment: treatment and no treatment. This study used a repeated-measures design because, although between-subject factors were examined, the same group of officers was measured under both the treatment and control (no treatment) condition. Paired sample t test is used to determine whether test scores differed between pretest and post-test.

An advantage of a repeated-measures design is that it has a greater statistical power by controlling for difference between subjects (Gravetter & Wallnau, 2013). This design eliminates problems due to individual differences in that the participants are being compared to themselves and not to other participants (Gravetter & Wallnau, 2013). Due to the increased statistical power, fewer people are needed in the sample and still the effect exists (Mitchell & Jolley, 2012). Data are collected at multiple points using metacognition questionnaire and reaction time ruler for each subject and can assess effects over time, which is suited well for studying learning and development or other changes that can take place over time (Gravetter & Wallnau, 2013).

3.6. Participants

The participants in this study consisted of 15 fire and rescue officers from the Kadakkal Fire and Rescue office in Kollam district. All participants had more than one year of experience in the field, ensuring a certain level of familiarity with the physical and mental demands of their job. Notably, none of the participants had prior experience with breathing exercises, making them a suitable group for examining the effects of the relaxation technique intervention. This

sample of experienced firefighters provided a unique opportunity to explore the potential benefits of breathing exercises in reducing stress and improving performance in a high-pressure occupation.

Table 1 *Frequency distribution of Age*

Age	Frequency (N= 15)	Percentage
30 to 35 Years	7	46.7%
36 to40 Years	7	46.7%
41 to 45 Years	1	6.7%
Total	15	100%

Table 2 *Frequency distribution of Year'of services*

Years of Service	Frequency (N= 15)	Percentage
6 to 12 years of experiences	14	93.3%
13 to 19 years of experiences	1	6.7%
Total	15	100%

Table no 3 *Frequency distribution of Education qualification*

Age	Frequency (N= 15)	Percentage
UP to Plustwo	3	20%
Undergraduate	10	86.7%
Postgraduate	2	13.3%
Total	15	100%

Among the participants 46.7% of officers are between the age of 30 to 35 and 36 to 40 equally and 6.7 % are between the age of 41 to 45.(table 1). 93.3% of officers having 6 to 12 years of experience and only 6.7 % of officers have 13 to 19 years of service experience. (table 2). When considering the education qualification 20% of officers are with qualification upto plustwo, 66.7% are degree qualified and 13.3% of officers are cleared post graduation. (table 3)

3.7.Tools Used For The Data Collection

Tools used for data collection are Metacognition – 30 and Reaction time measurement scale. For personal information collection and consent taking, self prepared concent letter and personal information questionnnaires are used.

The metacognition questionnaire is concerned with the beliefs people have about their thinking. The Metacognition questionnaire-30 is a concise version of the original Metacognitions Questionnaire, designed to evaluate individual differences in five key factors linked to mental health issues. Specifically, unhelpful thinking patterns, as measured by the MCQ-30, may exacerbate symptoms of obsessive-compulsive disorder, pathological worry, and trait anxiety. The questionnaire comprises five subscales, which assess:

1. Confidence in one's cognitive abilities

2. Positive attitudes towards one's own thought processes

3. Tendency to worry

4. Negative self-perceptions about the uncontrollability of thoughts and perceived danger

5. Beliefs about the need to control one's thoughts

These subscales provide insight into metacognitive processes that may contribute to various psychological disorders.

The Metacognitions Questionnaire-30 (MCQ-30) has been shown to be a reliable and valid measure of metacognitive processes. Research by Wells and Cartwright-Hatton (2004) found that the scale and its five subscales have high internal consistency, indicating that the items within each subscale are related and measure the same construct. Additionally, the MCQ-30 demonstrated convergent validity by showing significant positive correlations with measures of obsessive-compulsive symptoms, pathological worry, and trait anxiety in a sample of 182 adults. Furthermore, four out of the five subscales showed good test-retest reliability, meaning that the scores were consistent over time, with the exception of the subscale measuring negative beliefs about the uncontrollability of thoughts and danger.

The Metacognitions Questionnaire-30 (MCQ-30) yields subscale scores ranging from 6 to 24 and total scores ranging from 30 to 120. Higher scores indicate more maladaptive metacognitive processes. For instance, high scores on the "Cognitive Confidence" subscale suggest greater distrust in one's memory and other unhelpful cognitive beliefs. To facilitate interpretation, results can also be expressed as percentiles based on a normative community sample (Wells & Cartwright-Hatton, 2004). The subscales are calculated by summing specific item scores:

1. Lack of Cognitive Confidence: items 8, 14, 17, 24, 26, and 29
2. Positive Beliefs about Worry: items 1, 7, 10, 19, 23, and 28
3. Cognitive Self-Consciousness: items 3, 5, 12, 16, 18, and 30
4. Negative Beliefs about Uncontrollability and Danger: 2, 4, 9, 11, 15 and 21
5. Need to Control Thoughts: 6, 13, 20, 22, 25 and 27

The reaction time is measured using reaction time ruler developed by Science World Society. The distance the reaction timer travels before you catch it has been converted to time using the equation $\boldsymbol{d}=1/2\boldsymbol{a}t^2$ where $\boldsymbol{a}$ is the acceleration due to gravity.

3.8. Procedure For Data Collection.

The study comprised 15 Fire and Rescue officers from the Kadakkal Fire and Rescue office in Kollam district. The officers were assembled in a gathering area, where the study's theme was introduced. As an initial step, informed consent was obtained through a consent letter, which explained the study's background and purpose.

3.8.1 Pretest

The pretest consisted of two primary components: the Metacognition Questionnaire and the Reaction Time Measurement. Initially, participants completed the Metacognition Questionnaire, a comprehensive tool designed to assess the metacognition of firefighters. This questionnaire served as a baseline measure of participants' metacognitive state. Upon completion of the questionnaire, participants' reaction times were measured using a reaction time ruler, a device specifically designed to assess reaction time under standardized conditions. To ensure consistency, the reaction time test was conducted in a controlled environment, adhering to strict protocol guidelines such as, same individual (the researcher) dropped the ruler, avoided the environmental distractions and maintain uniform environment for all participants as possible and uniform and constant instructions are given for each participant. Participants were instructed to catch the ruler as fast as they can when the researcher dropped it. This two stage procedure enabled the collection of robust data, facilitating a comprehensive examination of metacognition and reaction time.

3.8.2 Intervention

Box Breathing Exercise: Participants were then introduced to the Box Breathing Exercise, also known as Square Breathing or Tactical Breathing (Kabat-Zinn, 2003). This mindfulness-based intervention involved a specific breathing pattern where participants inhaled for a count of 4, held their breath for a count of 4, exhaled for a count of 4, and held their breath again for a count of 4 (McGonigal, 2012). This technique had been used by Navy SEALs and other high-performance individuals to reduce stress and improve focus (Willink & Babin, 2017). Participants were trained in this technique and asked to practice it daily for two weeks. The participants successfully completed the two-week practice period, and their outcomes were measured to assess the effectiveness of the Box Breathing Exercise.

3.8.3 Post-test

After two weeks of regular practice of box breathing, participants will undergo the post-test assessments. After completing two weeks of regular practice of box breathing, participants underwent post-test assessments to evaluate the effectiveness of the intervention. They completed the same Metacognition Questionnaire as before, allowing researchers to assess any changes in their metacognition following the box breathing practice. Additionally, their reaction times were measured again using the reaction time ruler under the same conditions as the pre-test, enabling a comparison of their reaction times before and after the intervention.

3.8.4 Data Collection Schedule

Day 1: Administer the pre-test (Metacognition Questionnaire and Reaction Time Measurement).

Day 1 to Day 14: Participants practice box breathing daily.

Day 15: Administer the post-test (Metacognition Questionnaire and Reaction Time Measurement).

3.8.5 Data Recording

The data from the questionnaires and reaction time tests had been recorded and stored securely, and was subsequently analyzed to determine the impact of the box breathing exercise on the participants' metacognition and reaction times.

3.8.6 Ethical Considerations

Informed consent was obtained from all participants prior to the study. Participants were assured of the confidentiality of their responses and data. The study was conducted in accordance with ethical guidelines, ensuring the well-being and rights of the participants. This procedure ensured that data collection was systematic, consistent, and aligned with the objectives of the study.

3.9. Statistical Technique Used For Data Analysis

The data collected in this study were analyzed using a combination of descriptive and inferential statistical methods by various statistical techniques through SPSS-22 (Statistical Package for the Social Sciences) software. These techniques were employed to ensure a rigorous examination of the data, enabling accurate interpretation of the results (IBM Corp., 2013), to assess the impact of a relaxation technique, specifically box breathing, on the metacognition and reaction time of firefighters. The research employed a single group pre-test post-test quasi experimental design, which allowed for the measurement of changes within the same group of participants over time.

Descriptive statistics, including frequency distribution, means, and standard deviations, were calculated to provide a comprehensive summary of the data. The use of descriptive statistics offered several benefits, such as enabling a clear understanding of the central tendencies and the dispersion of scores before and after the intervention. This foundational analysis was crucial for identifying patterns in the data, which informed subsequent inferential tests.

To test the normality of the data, the Shapiro-Wilk test was employed. The Shapiro-Wilk test is particularly effective for small sample sizes, as it assesses whether the data are normally distributed, which is a key assumption for conducting parametric tests like the paired sample t-test. The results of the Shapiro-Wilk test guided the decision to proceed with the paired sample t-test or consider alternative non-parametric tests if the normality assumption was violated.

For inferential analysis, a paired sample t-test was conducted using SPSS. The paired sample t-test was chosen for its advantages in comparing two related samples in this case, the pre- and post-intervention scores of the same participants. This test is particularly advantageous because it controls for individual variability, making it more sensitive to detecting differences due to the intervention. The paired sample t-test allowed for a rigorous examination of whether the changes observed in metacognition and reaction time following the box breathing intervention were statistically significant.

The integration of these statistical techniques provided a strong framework for analyzing the data, ensuring that the conclusions drawn were both accurate and reliable. The results of these analyses were then used to formulate evidence-based recommendations for integrating relaxation techniques into firefighter training programs, with the aim of enhancing cognitive function and operational efficiency.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to explore how relaxation technique specifically box breathing, can help firefighters to enhance metacognition and react faster in high-pressure situations. By uncovering the benefits of this technique, it can be used to empower fire departments to integrate relaxation training into their programs, ultimately enhancing the cognitive abilities and reaction times of firefighters when it matters most(emergency situations). Metacognition was assessed using the Metacognition Questionnaire -30 and reaction time was measured using reaction time ruler. These scores were examined using a quantitative approach comparing pretest scores of Fire and rescue officers with posttest scores of the same where the relaxation technique specifically the box breathing technique had been implemented. A single group pre- test post – test quasi-experimental, design was used to determine whether the relaxation technique would significantly increase influence the metacognition and reaction time of firefighter's.

In this chapter the results of the analyses are given. First the normality test is given, following the participant information is given then the descriptive statistics were presented. Following the results of objectives and the chapter concludes with a summary of the statistical findings.

4.1 Normality of distribution

Table 4 *The statistic, df, and significance of the data*

Shapiro-Wilk		
Statistic	df	Significance
0.930	15	0.273
0.771	15	0.243
0.940	15	0.377
0.841	15	0.128

The Shapiro-Wilk test is used to test the normality of data. Results indicate that the pre-test metacognition scores, with a statistic of 0.930 and a p-value of 0.273, follow a normal distribution as the p-value is greater than 0.05. Similarly, the pre-test reaction time scores also follow a normal distribution with a statistic of 0.771 and a p-value of 0.243, both of which exceed the 0.05 threshold for significance. These results suggest that the pre-test data for both variables do not significantly deviate from normality. For the post-test data, the metacognition scores have a statistic of 0.940 and a p-value of 0.377, indicating that they adhere to a normal distribution. Likewise, the post-test reaction time scores, with a statistic of 0.841 and a p-value of 0.128, also do not show significant deviation from normality. Overall, the p-values for all tests are greater than the 0.05 significance level, supporting the use of parametric statistical methods for analyzing these data as they conform to the assumption of normality(table 4).

This section explains the sample that was selected for the experiment. To collect data sufficient for the quasi-experimental study, the researcher relied on a sample of 15 Fire and Rescue officers from Kadakkal Fire and Rescue Office in Kollam district. In the pre- test, 21 total officers were scheduled for the intervention; however, due to transfer and new joinings, only 15 officers had complete attending the intervention and the post-test. Only the officers with a score for all three stages were utilized. Among the participants 46.7% of officers are between the age of 30 to 35 and 36 to 40 respectively and 6.7 % are between the age of 41 to 45(table 1). 93.3% of officers having 6 to 12 years of experience and only 6.7 % of officers have 13 to 19 years of service experience. (table 2). When considering the education qualification 20% of officers are with qualification upto plus two, 66.7% are degree qualified and 13.3% of officers are cleared post graduation (table 3).

When considering the extend of variables Metacognition and Reaction time,the results are as follows:

4.2 Pretest and Poatest levels of Metacognition

Table 5 *Frequency distribution of Pre- test Metacognition levels*

Variable	Pretest Levels	Frequency	Percentage
Metacognition	High	1	6.7%
	Medium	9	60%
	Low	5	33.3%

Table 6 *Frequency distribution of Post- test Metacognition levels*

Variable	Post-test Levels	Frequency	Percentage
Metacognition	High	0	0
	Medium	10	66.7%
	Low	5	33.3%

The pre-test metacognition scores revealed that 33.3% of officers had low metacognition, 60% had medium metacognition, and 6.7% had high metacognition scores(table 5). The post-test metacognition scores revealed that 33.3% of officers still had low metacognition scores, indicating no change from the pre-test. 66.7% of officers had medium metacognition scores, showing a slight increase compared to the pre-test. Notably, no officers achieved high metacognition scores in the post-test(table 6).

The analysis of the metacognition scores before and after the intervention reveals several important insights into the cognitive patterns of the officers involved. Initially, the pre-test results indicated that a significant portion of the officers (60%) possessed medium levels of metacognition, while a smaller group exhibited either low (33.3%) or high (6.7%) levels. These findings suggest that while the majority of officers had an average awareness and regulation of their cognitive processes, there were notable variances within the group. Upon examining the post-test scores, it is evident that the distribution of metacognition levels remained relatively stable, with 33.3% of officers continuing to exhibit low metacognition, and 66.7% maintaining medium metacognition. However, a notable decline occurred in the percentage of officers who previously exhibited high metacognition; none of the officers achieved high metacognition scores in the post-test.

One plausible explanation for this lack of significant change in metacognition scores could be the tendency of some officers to provide socially acceptable responses on the questionnaires. This phenomenon, often referred to as social desirability bias, can result in responses that do not accurately reflect the officers' true metacognitive abilities. Consequently, these responses may remain consistent between the pre-test and post-test, thereby limiting the observable impact of the intervention. Moreover, the relatively short time interval between the pre-test and post-test might have constrained the potential for measurable improvements in metacognition. Cognitive and behavioral changes, particularly in areas such as metacognition, often require extended periods of practice and reflection to manifest. A longer follow-up period, such as 2 to 3 months, may have allowed for a more substantial development of metacognitive skills, yielding more pronounced differences between the pre-test and post-test scores.

While the intervention did result in a slight improvement in the medium metacognition category, the overall stability in scores suggests that both the timing of the assessment and the nature of the responses may have influenced the outcomes. Future studies should consider extending the duration between assessments and addressing potential response biases to better capture the true impact of metacognitive training on cognitive performance.

4.3. Pretest and Posttest levels of Reaction time

Table 7 *Frequency distribution of Pre- test Reaction time*

Variable	Pretest Levels	Frequency	Percentage
Reaction time	High	13	86.7%
	Medium	2	13.3%
	Low	0	0

Table 8 *Frequency distribution of Post- test Reaction time*

Variable	Pretest Levels	Frequency	Percentage
Reaction time	High	1	6.7%
	Medium	9	60%
	Low	5	33.3%

The pre-test reaction time results showed that 13.3% of the officers had a medium reaction time, while 86.7% had high metacognition scores, and none had a low reaction time(table 7). In the post-test, 93.3% of officers exhibited a medium reaction time, indicating a significant increase in the number of officers with medium reaction times compared to the pre-test. Additionally, 6.7% of officers had a high reaction time in the post-test, demonstrating a substantial decrease in the number of officers with high reaction times compared to the pre-test and no officers had low reaction time(table 8).

The results of the reaction time assessment reveal significant changes between the pre-test and post-test, indicating the impact of the intervention or time between measurements. In

pre – test majority of officers (86.7%) had a high reaction time, with only 13.3% showing a medium reaction time, and no officers falling into the low reaction time category. This suggests that before the intervention, most officers were slower in their response times, which could indicate higher levels of stress, fatigue, or a lack of optimal cognitive functioning. In the post – test there was a substantial shift in reaction times post-intervention, with 93.3% of officers now exhibiting medium reaction times and only 6.7% retaining a high reaction time. This shift suggests a considerable improvement in reaction times, possibly due to the effects of relaxation techniques, since they were not given or taken other exercises or practices during the period. No officers were recorded with low reaction times, maintaining consistency in the absence of extremely fast responses, which might be unrealistic given the baseline cognitive demands.

The movement from predominantly high reaction times to a majority with medium reaction times in the post-test implies that the intervention likely helped reduce the stress levels and increase the focus among the officers, leading to quicker, more consistent reaction times. This change could be attributed to improved metacognitive awareness or better management of stress, which often affects cognitive functions. The decrease in the percentage of officers with high reaction times from 86.7% to 6.7% is particularly notable. It suggests that the intervention had a significant impact on most participants, enhancing their ability to respond more swiftly. This outcome may reflect an improvement in cognitive processing speed and overall mental alertness, critical factors in the high-stakes environment in which officers operate.

The increase in officers with medium reaction times to 93.3% post-test could also indicate a normalization of response times, where officers are no longer experiencing the extremes of reaction times (either too slow or unrealistically fast). This balanced improvement aligns with the goals of the intervention, aiming for consistent, reliable performance rather than

erratic or suboptimal response times. The findings suggest that the intervention may be beneficial for improving cognitive functioning, as evidenced by quicker reaction times. This could have practical implications for enhancing on the job performance, particularly in high-pressure situations where swift and accurate responses are crucial. The results also highlight the potential for metacognitive interventions to influence reaction times, as changes in how officers perceive and manage their cognitive processes may directly impact their performance in tasks requiring rapid responses. Overall, the results indicate a positive shift towards more optimal reaction times following the intervention, with potential benefits for operational efficiency and effectiveness in real-world settings. Future studies could explore the long-term sustainability of these improvements and whether similar results can be replicated in different contexts or with different interventions.

When considering the influence of descriptive variables over the variables, the results are as follows:

4.4 Age and Metacognition

Table 9 *Age wise variation in metacognition in Pre- test*

Variable	Pretest extend of metacognition		
Age	High	Medium	Low
30-35	57.1%	42.9%	0%
36-40	14.3%	71.4%	14.3%
41-50	0%	100%	0%

Table 10 *Age wise variation in metacognition in post test*

Variable	Postest extend of metacognition		
Age	High	Medium	Low
30-35	57.1%	42.9%	100%
36-40	14.3%	85.7%	100%
41-50	33.3	100%	100%

The crosstabulation of age and pretest metacognition extent provides a detailed comparison across different age groups. Among the officers aged 30 to 35 years, 57.1% exhibited a high level of metacognition, while 42.9% demonstrated a medium level. Notably, none of the officers in this age group had a low metacognition score. In the 36 to 40 years age group, the distribution was somewhat different. Only 14.3% of the officers showed high metacognition, while a significant majority, 71.4%, had a medium level of metacognition. Additionally, 14.3% of the officers in this group had low metacognition scores. For the officers aged 41 to 45 years, 100% of them fell into the medium metacognition category, with no representation in either the high or low categories. The combined data shows that 33.3% of the total officers scored high in metacognition during the pretest, while 60% fell into the medium category, and 6.7% had low metacognition scores. This indicates a greater prevalence of medium metacognition levels across the different age groups during the pretest(table 9).

A crosstabulation analysis was conducted to explore the relationship between age and post-test metacognition extent among the participants. The results reveal that in the age group of 30 to 35 years, 57.1% (4 out of 7) of the participants achieved a high level of post-test metacognition, while the remaining 42.9% (3 out of 7) showed a medium level. This suggests

that a significant proportion of younger participants are more likely to attain higher levels of metacognitive awareness following the intervention. In contrast, the age group of 36 to 40 years showed a different trend. Among these participants, only 14.3% (1 out of 7) reached a high level of post-test metacognition, whereas a substantial majority of 85.7% (6 out of 7) exhibited a medium level. This indicates that as age increases, there may be a decrease in the likelihood of achieving high metacognitive levels post-intervention, as observed in this group. For the age group of 41 to 45 years, there was only one participant, who displayed a medium level of post-test metacognition(table 10). When considering the overall distribution across all age groups, 33.3% of participants reached a high level of post-test metacognition, while 66.7% achieved a medium level. These findings suggest that younger participants (aged 30 to 35 years) are more likely to benefit from the intervention in terms of enhancing metacognition compared to their older counterparts.

The crosstabulation analysis of age and metacognition, both pre- and post-test, offers valuable insights into the relationship between age and the extent of metacognitive awareness among the officers. The pretest results indicate that metacognitive awareness varied significantly across different age groups. Officers aged 30 to 35 years demonstrated the highest level of metacognition, with 57.1% scoring high, while the remaining 42.9% showed a medium level. Notably, none of the participants in this age group had low metacognition scores. This suggests that younger officers might inherently possess or have developed stronger metacognitive skills compared to their older counterparts. In contrast, the 36 to 40 years age group had a more dispersed distribution, with only 14.3% scoring high, a significant majority (71.4%) falling into the medium category, and 14.3% scoring low. This indicates a possible decline in metacognitive awareness as age increases within this group. The 41 to 45 years age group presented a

homogenous distribution, with all officers falling into the medium metacognition category. The absence of high and low scores within this group could indicate a plateau in metacognitive development or a consistent level of metacognitive skills that are neither exceptional nor deficient.

The post-test results reveal interesting trends that align with, but also diverge from, the pretest findings. The 30 to 35 years age group maintained a similar distribution as in the pretest, with 57.1% achieving high metacognition and 42.9% remaining in the medium category. This consistency suggests that the intervention had a reinforcing effect on those who were already at a higher level of metacognitive awareness. For the 36 to 40 years age group, the post-test results showed a shift towards medium metacognition, with 85.7% scoring in this range and only 14.3% reaching a high level. This indicates that while the intervention was somewhat effective in maintaining or slightly enhancing metacognition, it was less impactful in raising metacognitive awareness to a high level in older participants. The single participant in the 41 to 45 years age group remained at a medium level post-intervention, consistent with their pretest performance. This could imply that the intervention had limited impact on enhancing metacognitive awareness in older participants, possibly due to factors such as cognitive rigidity or lower adaptability to new learning methods.

The overall analysis across age groups reveals that while the intervention was effective in enhancing or maintaining metacognitive awareness, the degree of improvement varied by age. Younger officers (aged 30 to 35 years) were more likely to achieve high levels of metacognitive awareness post-intervention, suggesting that they may be more receptive to interventions aimed at enhancing metacognition. On the other hand, older officers, particularly those in the 36 to 45

years range, exhibited a tendency to plateau at medium metacognition levels, indicating that age may be a factor in the extent to which metacognitive awareness can be improved.

These findings suggest that age-specific strategies might be necessary to maximize the effectiveness of interventions aimed at improving metacognition. Younger participants may benefit from more challenging tasks that push their metacognitive boundaries, while older participants might require interventions that address potential cognitive barriers or leverage their existing experience in a manner that fosters deeper metacognitive reflection. In conclusion, while metacognition can be enhanced across all age groups, the degree of improvement and the effectiveness of interventions may vary significantly with age, highlighting the importance of tailored approaches in metacognitive training programs.

4.5. Age and Reaction time

Table 11 *Age wise variation in Reaction time in pre-test*

Variable	Pretest exten of reaction time	
Age	Medium	High
30-35	28.6%	71.4%
36-40	0	100%
41-50	0	100%

Table 12 *Age wise variation in Reaction time in post- test*

Variable	Pretest exten of reaction time	
Age	Medium	High
30-35	100%	0
36-40	85.7%	14.3%
41-50	100%	0

In the cross-tabulation analysis of pretest reaction time extent by age group, participants aged 30 to 35 years showed varied results. Of the 7 participants in this group, 28.6% (n=2) exhibited a medium level of reaction time, while the remaining 71.4% (n=5) demonstrated a high level of reaction time. This indicates a significant portion of younger participants falling into the high reaction time category. For the age group 36 to 40 years, all participants (100%, n=7) exhibited a high level of reaction time. This uniformity suggests that individuals in this age range tend to have consistently higher reaction times during the pretest phase. Similarly, the single participant in the age group 41 to 45 years also demonstrated a high level of reaction time, indicating a possible trend of increased reaction time with age. The majority of participants across all age groups (86.7%, n=13) exhibited a high level of reaction time, while a smaller portion (13.3%, n=2) fell into the medium reaction time category. These findings suggest that reaction time tends to be higher among older participants, particularly those aged 36 and above, with a clear trend toward higher reaction times in these groups during the pretest(table 11).

The results of the post-test reaction time extent across different age groups are presented in the crosstabulation. Among the participants aged 30 to 35 years, all individuals (100%) had a medium reaction time extent, with none showing a high reaction time extent. Similarly, in the

age group 41 to 45 years, 100% of participants had a medium reaction time extent. However, in the age group 36 to 40 years, while the majority (85.7%) also demonstrated a medium reaction time extent, one participant (14.3%) exhibited a high reaction time extent. Overall, 93.3% of all participants had a medium reaction time extent, and 6.7% had a high reaction time extent. This suggests that age may have a slight influence on the variability of post-test reaction time, particularly in the 36 to 40-year-old group (Table 12).

The analysis of reaction time across different age groups in both pre-test and post-test phases provides valuable insights into the relationship between age and cognitive processing speed among the participants. In the pre-test phase, the data revealed a clear trend of higher reaction times associated with older age groups. Among participants aged 30 to 35 years, a significant portion (71.4%) exhibited high reaction times, with only 28.6% demonstrating medium reaction times. This suggests that even within younger cohorts, a considerable number of individuals have slower cognitive processing speeds. For participants aged 36 to 40 years, all individuals exhibited high reaction times, indicating a uniformity in slower cognitive processing speeds within this age range. The single participant in the 41 to 45-year-old group also displayed a high reaction time, reinforcing the observation that older age groups tend to have slower reaction times. Overall, 86.7% of participants across all age groups had high reaction times, with only 13.3% showing medium reaction times. This suggests that as age increases, there is a general trend towards slower cognitive processing speeds, with the most pronounced effects observed in participants aged 36 years and above.

The post-test results, however, show a significant shift in reaction times across age groups, with the majority of participants exhibiting medium reaction times. In the 30 to 35-year-old group, all participants had medium reaction times, indicating an improvement or

normalization of reaction time in this cohort. This trend was also observed in the 41 to 45-year-old group, where 100% of participants exhibited medium reaction times. While most participants in the 36 to 40-year-old group also showed medium reaction times in the post-test, one participant (14.3%) still demonstrated a high reaction time. This suggests that although there is a general improvement in reaction times post-intervention, age-related variability persists, particularly within the 36 to 40-year-old group. Overall, 93.3% of participants exhibited medium reaction times in the post-test, with only 6.7% demonstrating high reaction times. This significant improvement compared to the pre-test results indicates that the intervention was effective in enhancing cognitive processing speeds across age groups. However, the slight persistence of high reaction times in the 36 to 40-year-old group suggests that age may continue to influence reaction time variability, even after intervention.

The findings from both the pre-test and post-test analyses suggest that reaction time is generally higher among older participants, particularly those aged 36 years and above. This trend is consistent with existing research that suggests cognitive processing speeds tend to slow with age. However, the post-test results indicate that the intervention had a positive effect on reducing reaction times across all age groups, with a particularly marked improvement in the younger cohort (30 to 35 years). The overall reduction in reaction times post-intervention suggests that targeted cognitive interventions can be effective in mitigating age-related declines in processing speed. However, the slight age-related variability observed in the post-test results underscores the importance of considering individual differences when designing and implementing cognitive training programs. Tailoring interventions to account for these differences may enhance their effectiveness, particularly in older population.

4.6. Years of service and Metacognition

Table 13 *Years of service wise variation in metacognition in pretest*

Variable-	Pretest extend of metacognition		
Years of service	High	Medium	Low
6 to 12	35.7	57.1%	100%
13 to 19	33.3%	100%	100%

Table 14 *Years of service wise difference in metacognition in post- test*

Variable-	Post-test extend of metacognition		
Years of service	High	Medium	Low
6 to 12	35.7%	64.3%	100%
13 to 19	33.3%	100%	100%

The crosstabulation analysis of pretest metacognition extent based on years of service reveals that officers with 6 to 12 years of experience show a varied distribution of metacognition levels. Specifically, 35.7% of these officers exhibited a high level of metacognition, 57.1% showed a medium level, and 7.1% demonstrated a low level. This indicates a predominant concentration of medium metacognition levels among officers within this experience range. In contrast, officers with 13 to 19 years of experience exclusively displayed a medium level of metacognition, with no individuals categorized in the high or low levels. This finding suggests that officers with more extended service tend to maintain a consistent medium level of metacognition, with a lack of variability in their scores. Across all participants, 33.3% exhibited

a high level of metacognition, 60.0% were at a medium level, and 6.7% were categorized at a low level during the pretest(table 13).

In the analysis of post-test metacognition extent across different years of service, the results are as for individuals with 6 to 12 years of experience, 35.7% had a high extent of metacognition, while 64.3% had a medium extent. This indicates a higher proportion of medium metacognition levels among this group. For those with 13 to 19 years of experience, 100% were classified under the medium extent of metacognition, with none achieving a high extent. Among all participants, 33.3% demonstrated a high extent of metacognition, and 66.7% exhibited a medium extent(table 14).

The crosstabulation analysis of metacognition levels based on years of service presents an insightful overview of how experience influences cognitive self-awareness and regulation among officers. The data suggests a nuanced relationship between the years of service and metacognitive abilities, highlighting variations in cognitive self-assessment and regulation across different experience groups. In the pre-test, officers with 6 to 12 years of experience exhibited a diverse range of metacognition levels. Specifically, 35.7% demonstrated high metacognition, indicating a strong ability to reflect on and regulate their cognitive processes. However, the majority (57.1%) displayed medium metacognition, suggesting that while they possess some metacognitive skills, there is room for improvement in fully optimizing their cognitive strategies. A small percentage (7.1%) exhibited low metacognition, which could indicate challenges in self-regulation or awareness. Officers with 13 to 19 years of experience, on the other hand, all fell into the medium metacognition category. This lack of variation could imply a plateau in cognitive self-awareness, where long-term service leads to a stabilization of metacognitive abilities at a medium level. The absence of both high and low metacognition levels within this

group suggests that extended experience does not necessarily equate to enhanced cognitive self-regulation, but rather to a consistent, moderate level of metacognitive ability.

The post-test results reveal a slight shift in metacognition levels across the different experience groups. Among officers with 6 to 12 years of service, the distribution remained similar to the pre-test, with 35.7% maintaining a high level of metacognition and 64.3% at a medium level. This consistency indicates that the intervention or time lapse between tests did not significantly alter the metacognitive abilities of this group, reinforcing the idea that mid-career officers may already possess relatively stable metacognitive skills. For officers with 13 to 19 years of experience, the trend of medium metacognition continued in the post-test, with 100% of these individuals remaining at a medium level. This further confirms the earlier observation that extended years of service might lead to a consistent, moderate level of metacognitive ability, without significant fluctuations over time or due to interventions.

The findings suggest that years of service are correlated with distinct patterns in metacognitive abilities. Officers with 6 to 12 years of experience show a broader range of metacognition levels, which could be attributed to the developmental stage of their careers, where cognitive skills are still maturing and adapting to various challenges. The presence of high metacognition within this group indicates potential for further cognitive development and refinement. In contrast, the uniform medium metacognition observed among officers with 13 to 19 years of service could indicate a ceiling effect, where metacognitive abilities have reached a stable but moderate level that does not significantly change over time. This stability might be reflective of the entrenched routines and cognitive strategies that develop over long-term service, which can be both a strength and a limitation. While consistency in cognitive regulation is

beneficial, the lack of high metacognition in this group suggests that there may be untapped potential for further enhancing cognitive self-regulation among more experienced officers.

These findings highlight the importance of targeted interventions that consider the varying needs of officers at different stages of their careers. For mid-career officers, fostering higher levels of metacognition could lead to improved decision-making and adaptability, while for more experienced officers, strategies to break through the ceiling effect and elevate metacognitive skills to a higher level could be beneficial. The data underscores the complex relationship between experience and metacognitive development, suggesting that continuous cognitive training and development are essential throughout an officer's career to optimize performance and decision-making capabilities.

4.7.Years of service and Reaction time

Table 15 *Years of service wise variation in Reaction time in pretest*

Variable-	Pretest extend o reaction time	
Years of service	Medium	High
6 to 12	14.3%	85.5%
13 to 19	0	100%

Table 16 *Years of service wise variation in Reaction time in post- test*

Variable- Years of service	Post-test extend of reaction time Medium	High
6 to 12	92.9%	7.1%
13 to 19	100%	0

In examining the relationship between years of service and pre-test reaction time, the results indicated distinct patterns across different experience groups. Officers with 6 to 12 years of experience were more likely to have higher pre-test reaction times, with 85.7% falling into the high reaction time category, while only 14.3% exhibited medium reaction times. For officers with 13 to 19 years of experience, the data showed an a concentration in the and the reaction times were uniformly high. Specifically, 100% of the participants in this group demonstrated high pre-test reaction times, with none falling into the medium reaction time category. When considering the total sample, 13.3% of all participants had medium reaction times, while a significant majority of 86.7% had high reaction times. This distribution highlights a prevalent trend of higher reaction times among officers, particularly as their years of service increase (table15).

The crosstabulation of years of service and post-test reaction time extent shows that the majority of participants with 6 to 12 years of experience had a medium post-test reaction time (92.9%), while a small proportion had a high reaction time (7.1%). Participants with 13 to 19 years of experience all exhibited a medium post-test reaction time (100.0%). Overall, 93.3% of

the participants across both experience groups had a medium post-test reaction time, and only 6.7% had a high reaction time(table 16).

The analysis of the relationship between years of service and reaction time among officers provides insightful findings, particularly when comparing pre-test and post-test reaction times across different experience levels. The pre-test results reveal a notable trend wherein officers with more years of service tend to have higher reaction times. Specifically, Officers with 6 to 12 Years of Experience. The majority of this group, 85.7%, exhibited high reaction times, with only 14.3% falling into the medium reaction time category. Officers with 13 to 19 Years of experience group uniformly demonstrated high reaction times, with 100% of the participants falling into the high reaction time category. These findings suggest that as officers accumulate more years of service, their reaction times tend to increase. This could be indicative of the impact of prolonged exposure to the demands of the job, which might contribute to slower cognitive and motor responses. The trend of higher reaction times among more experienced officers might be explained by factors such as occupational stress, physical fatigue, or cognitive wear over time. These factors could potentially impair the quick decision-making and reflexive responses that are critical in high-pressure situations.

The post-test results, on the other hand, present a significant shift in reaction times across both experience groups: Officers with 6 to 12 Years of experience an overwhelming majority as 92.9%, had medium reaction times, while only 7.1% exhibited high reaction times. Officers with 13 to 19 Years of experience group showed uniformity in their post-test results, with 100% of the participants falling into the medium reaction time category. These post-test results highlight the effectiveness of the intervention or training applied during the study, leading to a noticeable improvement in reaction times among officers across both experience levels. The

shift from predominantly high reaction times in the pre-test to mostly medium reaction times in the post-test suggests that the intervention was successful in enhancing cognitive and motor functions, thereby reducing reaction times.

When considering the total sample, the pre-test data showed that 86.7% of all participants had high reaction times, and only 13.3% had medium reaction times. This underscores the prevalence of slower reaction times among the officers before the intervention, particularly among those with more years of service. However, the post-test data revealed a reversal of this pattern, with 93.3% of participants achieving medium reaction times and only 6.7% maintaining high reaction times. This shift further validates the positive impact of the intervention. The observed trends have important implications for the management and training of officers, particularly those with more years of service. The initial findings of high reaction times among experienced officers suggest that continuous exposure to the demands of their role may lead to cognitive and physical decline, impacting their ability to respond swiftly in critical situations. The success of the intervention in improving reaction times across all experience levels also suggests that similar programs should be integrated into regular training regimens, not only to maintain but to enhance the cognitive and motor capabilities of officers as they progress in their careers. The study's findings highlight a clear relationship between years of service and reaction time, with more experienced officers initially exhibiting higher reaction times. However, the significant improvement observed in the post-test results indicates that targeted interventions can effectively enhance reaction times, counteracting the negative impact of prolonged service. These results underscore the importance of ongoing training and assessment to ensure that officers maintain optimal performance levels throughout their careers.

4.8. Education Qualification and Metacognition

Table 17 *Education qualification wise variation in metacognition in pre- test*

Variable- Education	Pretest extend of metacognition		
	High	Medium	Low
Upto plustwo	33.3%	66.7%	0
UG	30%	60.5%	10%
PG	50%	50%	0

Table 18 *Education qualification wise variation in metacognition in post- test*

Variable- Education	Post- test extend of metacognition	
	High	Medium
Upto plustwo	33.3%	66.7%
UG	30%	70%
PG	50%	50%

The crosstabulation analysis of educational qualifications and pretest metacognition extent reveals distinct patterns across different education levels. Among participants with education up to Plus Two, 33.3% demonstrated high metacognition extent, while the majority (66.7%) exhibited medium metacognition extent. Notably, none of the participants in this group displayed low metacognition extent. For those with Undergraduate (UG) qualifications, a similar trend was observed, with 30.0% of participants showing high metacognition extent and 60.0%

showing medium metacognition extent. However, unlike the Plus Two group, 10.0% of participants with a UG qualification exhibited low metacognition extent. Participants with Postgraduate (PG) qualifications showed a relatively balanced distribution, with 50.0% demonstrating high metacognition extent and the remaining 50.0% displaying medium metacognition extent. Across all educational levels, the majority of participants exhibited medium metacognition extent, with higher education levels generally associated with a greater proportion of participants in the high metacognition category. Only a small percentage (6.7%) of the total participants fell into the low metacognition category, predominantly within the UG group(table 17).

The cross-tabulation analysis between Educational Qualification and Post-Test Metacognition Extent reveals the distribution of metacognition levels across different educational backgrounds. The table shows that among participants with educational qualifications up to Plus Two, 33.3% exhibited high post-test metacognition, while 66.7% showed medium levels. For participants with an undergraduate degree (UG), 30% displayed high metacognition, and 70% had medium levels. Among those with a postgraduate degree (PG), 50% demonstrated high metacognition, and the other 50% showed medium levels. Overall, out of the 15 participants, 33.3% had high post-test metacognition, and 66.7% had medium levels, with the highest concentration of medium level metacognition observed in the ug group (table18).

The crosstabulation analysis of educational qualifications and metacognition extent provides significant insights into how educational background may influence metacognitive abilities. The analysis covers both pre-test and post-test scenarios, highlighting key trends and shifts across different education levels. The pre-test results indicate that educational attainment is associated with varying levels of metacognition. Participants with educational qualifications up to Plus Two

predominantly exhibited medium metacognition (66.7%), with a notable 33.3% displaying high metacognition. This trend is similarly reflected in the UG group, where 60.0% of participants demonstrated medium metacognition and 30.0% exhibited high metacognition. However, a small percentage (10.0%) of UG participants fell into the low metacognition category, a distinction not observed in the Plus Two group. For participants with PG qualifications, there was a more balanced distribution between high and medium metacognition, with 50.0% in each category. These findings suggest that higher educational levels are generally associated with an increased likelihood of higher metacognition, although medium metacognition remains the most prevalent across all groups. The presence of low metacognition extent exclusively within the UG group is noteworthy and may indicate a gap in metacognitive development during this educational stage.

In the post-test results, the distribution of metacognition levels remains largely consistent with the pre-test findings. Participants with Plus Two qualifications still show 33.3% high and 66.7% medium metacognition. Among UG participants, the proportion of those with high metacognition remains at 30%, but there is a slight increase in medium metacognition (70%). The PG group continues to exhibit a 50-50 split between high and medium metacognition. The absence of low metacognition in the post-test suggests an overall improvement in metacognitive abilities, likely due to the intervention or training provided between the pre-test and post-test phases. The persistence of medium metacognition as the dominant level across all educational groups highlights that while education contributes to higher metacognitive abilities, there is still room for growth even among those with higher educational attainment.

The cross-tabulation of educational qualifications with metacognition extent, both pre-test and post-test, reveals that higher education levels tend to correlate with higher metacognitive abilities. However, medium metacognition remains the most common outcome,

regardless of educational background. The pre-test data shows a small percentage of participants with low metacognition, mainly within the UG group, which raises questions about the effectiveness of undergraduate education in fostering metacognitive skills. The post-test results indicate some improvement, particularly in the reduction of low metacognition cases, suggesting that targeted interventions can enhance metacognitive abilities across educational levels.

4.9 Education Qualification and Reaction time

Table 19 *Education qualification wise variation in Reaction time in pre- test*

Variable- Education	Pre-test extend of Reaction time	
	High	Medium
Upto plustwo	100%	0%
UG	80%	20%
PG	100%	0

Table 20 *Education wise variation in Reaction time in Post- test*

Variable- Education	Post- test extend of reaction time	
	High	Medium
Upto plustwo	0	100%
UG	10%	90%
PG	0	100%

The crosstabulation analysis of educational qualification and pretest reaction time extent reveals some interesting patterns. Among participants with an education level up to Plus Two, all

(100%) exhibited a high pretest reaction time, with none falling into the medium category. This suggests a strong association between lower educational attainment and higher reaction time in this group. For those with an undergraduate (UG) degree, the distribution of reaction times is more varied. While the majority (80%) of participants in this group displayed a high pretest reaction time, a notable 20% exhibited medium reaction times. This indicates that within the UG category, there is a slight presence of individuals with a relatively better pretest reaction time compared to the Plus Two group. Participants with a postgraduate (PG) degree showed a similar pattern to the Plus Two group, with all (100%) of them displaying high pretest reaction times. This suggests that both the highest and lowest levels of educational attainment in this study are associated with higher pretest reaction times. Overall, the analysis shows that a majority of participants, regardless of educational qualification, tend to have a high pretest reaction time (table 19).

The crosstabulation between educational qualifications and post-test reaction time extent reveals that participants with different educational backgrounds exhibited varying levels of reaction time. Among those with educational qualifications up to Plus Two, all three participants (100%) demonstrated a medium extent of post-test reaction time, with none falling into the high extent category. For participants with undergraduate (UG) qualifications, there was a slight variation. Out of 10 participants, 9 (90%) displayed a medium extent of post-test reaction time, while 1 participant (10%) showed a high extent. This indicates that a small proportion of those with a UG qualification might experience a higher extent of reaction time following the intervention. Participants with postgraduate (PG) qualifications all exhibited a medium extent of post-test reaction time, similar to those with only up to Plus Two education. None of the PG-qualified participants fell into the high extent category(table 20).

The analysis of the relationship between educational qualifications and reaction time in both pre-test and post-test conditions offers intriguing insights into how education might influence cognitive performance, specifically reaction time. The pre-test data reveal a distinct pattern concerning educational attainment. Participants with educational qualifications up to Plus Two exhibited uniformly high reaction times, suggesting a potential association between lower education levels and higher reaction times. This finding implies that individuals with less formal education may have slower cognitive processing or less effective attention mechanisms, which could contribute to delayed reaction times. In contrast, participants with undergraduate (UG) degrees showed some variability in their pre-test reaction times. While 80% still demonstrated high reaction times, 20% of this group displayed medium reaction times. This variation suggests that undergraduate education might offer some cognitive benefits compared to lower educational levels, potentially leading to a modest improvement in reaction times. Participants with postgraduate (PG) degrees mirrored the Plus Two group in displaying high pre-test reaction times. This pattern suggests that the educational benefits that might improve reaction times at the undergraduate level do not appear to persist at the postgraduate level. This could indicate that the cognitive challenges or demands associated with postgraduate education might not directly translate to improvements in reaction time, or that other factors may be at play. Overall, the pre-test analysis suggests that higher educational attainment does not necessarily correlate with better reaction times. Instead, high reaction times are prevalent across different educational levels, with the most pronounced impact observed at the Plus Two and PG levels.

The post-test data show a shift in reaction time patterns across educational qualifications. Participants with educational qualifications up to Plus Two transitioned from high to medium reaction times, indicating a positive impact of the intervention. This improvement suggests that

the intervention was effective in reducing reaction time for individuals with lower educational backgrounds, potentially highlighting a beneficial effect of targeted cognitive training or other interventions. For UG-qualified participants, the majority (90%) maintained a medium extent of reaction time, with a small proportion (10%) still exhibiting high reaction times. This suggests that while the UG group showed overall improvement, a small segment continued to experience higher reaction times, possibly indicating variability in individual responses to the intervention. Participants with PG qualifications also showed a medium extent of post-test reaction times, similar to those with Plus Two education. The absence of participants in the high reaction time category post-test further supports the effectiveness of the intervention across different educational backgrounds.

In summary, the analysis underscores the complexity of the relationship between educational attainment and reaction time. While educational qualifications alone do not seem to be a definitive predictor of reaction time, the intervention appears to have a positive impact on reducing reaction times for participants across educational levels. The findings suggest that educational background might influence initial reaction times, but effective interventions can lead to improvements regardless of educational qualifications.

4.10. Pre and post test of Metacognition

Table 21 *Mean,standard deviation, n value, t value and significant level of pre and post test metacognition*

Variable	Pre/Post-test	n	Mean	Std. Deviation	t	Sig. (2-tailed)
Metacognition	Pre-test	15	68.8000	11.17523	2.726	0.016
	Post-test	15	67.0667	9.75754		

Considering the inferential statistics the results are as follows:

A paired samples t-test was conducted to compare metacognition scores before and after the intervention. The mean score for metacognition before the intervention (M = 68.80, SD = 11.18) was slightly higher than the mean score after the intervention (M = 67.07, SD = 9.76). The standard error of the mean was 2.89 for the pre-test and 2.52 for the post-test.

In the paired samples t-test conducted to compare pre-test and post-test metacognition scores, a statistically significant increase was found in the post-test scores compared to the pre-test scores. Specifically, the mean difference was 1.733 (SD = 2.463), with a standard error of the mean (SEM) of 0.636. The 95% confidence interval for the mean difference ranged from 0.369 to 3.097, indicating a reliable improvement in metacognition. The t-value was 2.726, with 14 degrees of freedom (df), and the result was statistically significant (p = .016). This suggests that the intervention had a positive effect on metacognition among the participants.

The results of the paired samples t-test provide valuable insights into the impact of the intervention on metacognition scores among the officers. Initially, the mean metacognition score before the intervention was 68.80 (SD = 11.18), slightly higher than the mean score of 67.07 (SD = 9.76) observed after the intervention. Despite the pre-test scores being marginally higher, the paired samples t-test revealed a statistically significant increase in metacognition scores post-intervention. Specifically, the mean difference between pre-test and post-test scores was 1.733 (SD = 2.463), with a standard error of 0.636. The 95% confidence interval for this mean difference ranged from 0.369 to 3.097, which does not include zero, indicating a reliable and positive change in metacognition as a result of the intervention. The t-value of 2.726 with 14 degrees of freedom and a p-value of .016 further confirms that this improvement is statistically significant.

The statistically significant improvement in metacognition suggests that the intervention effectively enhanced participants' self-awareness and cognitive regulation. Metacognition, encompassing awareness and control over one's cognitive processes, is crucial for effective problem-solving and decision-making. The positive effect observed indicates that the intervention likely facilitated a better understanding of their cognitive strategies and improved their ability to monitor and control their thinking processes.

4.11. Pre and post test of Reaction time

Table 22 *Mean, n value, standard deviation, t value and significant level of pre post test Reaction time*

Variable	Pre/Post-test	n	Mean	Std. Deviation	t	Sig. (2-tailed)
Reaction time	Pre-test	15	0.1760	0.02772		
					7.834	0.000
	Post-test	15	0.1227	0.01033		

The paired samples statistics for reaction time before and after the intervention is given.The mean pre-test reaction time was 0.176 seconds (SD = 0.02772), while the mean post-test reaction time was 0.1227 seconds (SD = 0.01033). The standard error of the mean was 0.00716 for the pre-test and 0.00267 for the post-test, based on a sample size of 15 participants. Based on the paired samples t-test conducted to compare pre-test and post-test reaction times, the results indicate a statistically significant difference between the two conditions. The mean difference between the pre-test and post-test reaction times was 0.05333 seconds, with a standard deviation of 0.02637 seconds and a standard error mean of 0.00681 seconds. The 95% confidence interval for the difference in means ranged from 0.03873 to 0.06794 seconds. The t-value was 7.834 with 14 degrees of freedom, and the p-value was less than 0.001, indicating a highly significant result ($p < .001$). It can be conclude that there was a significant improvement in reaction times following the intervention, as evidenced by the reduction in reaction time from pre-test to post-test.

The results of the paired samples t-test reveal a significant improvement in reaction times following the intervention. The mean pre-test reaction time was 0.176 seconds with a standard deviation of 0.02772, whereas the post-test mean reaction time was 0.1227 seconds with a standard deviation of 0.01033. This reduction in mean reaction time of 0.05333 seconds, from pre-test to post-test, demonstrates a notable enhancement in response speed among participants. The standard error of the mean was smaller in the post-test (0.00267) compared to the pre-test (0.00716), indicating greater precision in the post-test measurements. The calculated 95% confidence interval for the difference in means, ranging from 0.03873 to 0.06794 seconds, further supports the statistical significance of the improvement observed. The t-value of 7.834 with 14 degrees of freedom and a p-value less than 0.001 indicate that the observed difference in reaction times is highly significant. This strong statistical result underscores the effectiveness of the intervention in reducing reaction times.

The analysis of paired samples t-test results highlights a significant improvement in reaction times following the intervention. The data shows a mean reduction in reaction time from 0.176 seconds to 0.1227 seconds, a difference of 0.05333 seconds. The reduction is statistically significant, as evidenced by a t-value of 7.834 and a p-value of less than 0.001. The 95% confidence interval for the mean difference (0.03873 to 0.06794 seconds) confirms that the observed effect is both reliable and meaningful. These findings suggest that the intervention successfully enhanced reaction time among participants, reflecting improved reaction time. This outcome aligns with the objective of the intervention, which aimed to positively impact reaction time. Future research could explore the long-term effects of such interventions and whether these improvements are sustained over extended periods.

The analysis of metacognition scores before and after the intervention shows that while the majority of officers had medium metacognition levels both pre- and post-intervention, there was a significant decrease in the number of officers with high metacognition scores post-intervention. Despite an overall stable distribution, the slight improvement in medium metacognition and the statistically significant increase in metacognition scores suggest that the intervention had a positive impact. However, social desirability bias and the short time frame may have limited the observable changes. Age and years of service influenced metacognitive levels, with younger officers showing higher levels and those with 13 to 19 years of experience plateauing at a medium level.

In terms of reaction time, there was a notable improvement from predominantly high reaction times pre-intervention to medium reaction times post-intervention. This shift suggests that the intervention effectively reduced reaction times, likely enhancing cognitive processing speed and overall mental alertness. The improvement was consistent across age groups and years of service, although older officers and those with more experience exhibited slight persistence of high reaction times. Educational qualifications did not significantly affect the change in reaction times, with all educational groups showing improvement post-intervention. The paired samples t-test confirmed a statistically significant reduction in reaction times, highlighting the effectiveness of the intervention.

In the insight of the above mentioned results and discussions dome evidence based recommendations are formulated as follows: This study recommends integrating relaxation techniques like box breathing and mindfulness into firefighter training to enhance cognitive performance and reaction time. Key points include:

- Structured Training: Regularly practice relaxation techniques to improve resilience and reaction time.

- Tailored Approaches: Adapt training to firefighters' age and experience for optimal impact.
- Evaluation: Regularly assess the effectiveness of these techniques and adjust based on feedback.
- Holistic Integration: Combine relaxation with stress management and cognitive strategies for comprehensive support.
- Continuous Learning: Include relaxation in ongoing professional development to maintain mental health throughout firefighters' careers.

The elaborated version of evidence based recommendations are provided in the fifth chapter.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1. Summary of the study

The study titled "The Effect of Relaxation on Metacognition and Reaction Time among Firefighters" investigated how a relaxation intervention influenced the metacognition and reaction times of firefighters. At the onset of the study, the majority of participants demonstrated medium levels of metacognition, with smaller groups displaying low and high levels. Following the intervention, there was a slight increase in the proportion of firefighters with medium metacognition, although none reached high levels of metacognition. This outcome may be attributed to response biases or the short interval between the pre-test and post-test assessments.

Younger firefighters were more likely to achieve higher metacognition scores, while older participants tended to plateau at medium levels. Firefighters with moderate years of service exhibited a broader range of metacognitive abilities compared to those with longer service, who consistently remained at medium levels. Additionally, higher educational attainment was generally associated with better metacognition, although medium levels were the most common across all education groups. A paired samples t-test revealed a significant improvement in metacognition after the relaxation intervention, indicating that it effectively enhanced cognitive awareness and self-regulation. However, the study found that the intervention's impact varied by age, experience, and education, highlighting the need for tailored approaches to optimize cognitive performance in firefighters.

The findings also revealed a substantial improvement in reaction times following the intervention. Initially, most officers exhibited slower reaction times, likely due to factors such as

stress and fatigue. However, post-intervention results showed a significant shift, with nearly all officers demonstrating quicker and more consistent reaction times. This improvement was observed across different age groups, years of service, and educational levels, although older and more experienced officers exhibited a slight persistence of slower reaction times. The overall reduction in reaction times suggests that the relaxation intervention was effective in enhancing cognitive processing speed and mental alertness, which are critical for optimal performance in high-pressure environments. The statistical analysis confirmed the significance of these improvements, underscoring the value of targeted cognitive training programs in supporting the operational efficiency of firefighters.

5.2. Major findings

- The post-test results demonstrated stability in metacognition levels, with 66.7% of officers maintaining medium metacognition and 33.3% remaining at low levels. No officers achieved high metacognition in the post-test, indicating that the intervention's impact may have been limited by factors such as social desirability bias and the brief interval between tests.
- Younger officers (aged 30-35 years) consistently exhibited higher levels of metacognition. In contrast, officers aged 36-40 years primarily maintained medium levels of metacognition and showed a decrease in high metacognition post-intervention. Officers aged 41-45 years remained in the medium category, suggesting possible cognitive rigidity or reduced adaptability to the intervention.
- Officers with 6-12 years of service demonstrated a diverse range of metacognitive abilities, including a notable proportion with high levels. Conversely, those with 13-19

years of service consistently scored at medium levels, indicating a potential plateau in cognitive self-awareness and regulation over time.

- Higher educational attainment was generally associated with higher levels of metacognition. However, medium metacognition remained the most common outcome across all educational levels. The intervention led to a slight improvement in metacognition scores, notably reducing instances of low metacognition among undergraduates.
- The paired samples t-test indicated a statistically significant improvement in metacognition following the intervention, with a mean difference of 1.733 ($p = .016$). This result confirms that the intervention had a positive effect on enhancing cognitive self-awareness and regulation among the officers.
- The intervention led to a significant reduction in reaction times, with a notable decrease observed from pre-test to post-test. This change was statistically significant, demonstrating the intervention's effectiveness in enhancing response speed among participants.
- Prior to the intervention, the majority of participants exhibited high reaction times. Post-intervention, there was a substantial shift towards medium reaction times, indicating that the intervention markedly improved cognitive processing speed.
- Initial results revealed that older participants, particularly those aged thirty-six years and above, had slower reaction times. However, following the intervention, a marked improvement was observed across all age groups, with most participants achieving medium reaction times. Despite this, some persistence of high reaction times was noted among participants aged thirty-six to forty years, suggesting age-related variability.

- Officers with more years of service initially demonstrated higher reaction times. Post-intervention, there was a significant improvement across experience levels, with all officers showing medium reaction times. This finding suggests that the intervention effectively countered cognitive decline associated with prolonged service.
- Analysis revealed that educational qualifications did not strongly correlate with reaction times in the pre-test, as high reaction times were prevalent across all educational levels. Post-intervention, improvement was observed across all educational groups, with a shift from high to medium reaction times.
- Metacognition scores showed that while the majority of officers had medium levels both before and after the intervention, there was a slight increase in medium metacognition scores and a decrease in high metacognition scores post-intervention. This indicates a positive impact on metacognitive awareness, though changes were influenced by potential social desirability bias and the short duration of the intervention.
- The statistical analysis confirmed a significant reduction in reaction times, affirming the intervention's effectiveness in improving response speed.
- The intervention significantly enhanced cognitive processing speed and mental alertness, with implications for operational performance. The results suggest that targeted cognitive interventions are effective in addressing reaction time issues and may be beneficial for maintaining optimal performance in high-pressure environments. Future research should investigate the long-term sustainability of these improvements and the applicability of similar interventions in different contexts.

5.3. Implications

The significant improvement in metacognition post-intervention suggests that targeted cognitive training programs can effectively enhance self-awareness and cognitive regulation among officers. This enhancement has the potential to improve decision-making, problem-solving, and overall job performance, particularly in high-stress environments. Additionally, the findings indicate that younger officers (aged 30-35) are more receptive to metacognitive interventions, highlighting the potential for age-specific training approaches. Tailoring these interventions to different age groups could maximize cognitive benefits, with younger officers possibly benefiting from more challenging tasks and older officers requiring strategies that address cognitive rigidity.

The analysis reveals that officers with 6-12 years of experience display a broader range of metacognitive abilities, suggesting that mid-career officers may be at a crucial stage for cognitive development. This insight could inform the design of professional development programs, emphasizing the importance of continuous cognitive training throughout an officer's career. The correlation between higher education levels and metacognitive abilities also underscores the role of formal education in cognitive development. Integrating educational programs that emphasize metacognitive skills into officer training curricula could foster higher levels of cognitive self-regulation.

The significant reduction in reaction times post-intervention suggests that the applied techniques, such as relaxation or metacognitive strategies, were effective in enhancing cognitive processing speed. This improvement is crucial, as it could translate into better decision-making and response accuracy in high-pressure situations, which are critical for officers in operational settings. The shift from predominantly high reaction times to medium reaction times indicates

that the intervention likely contributed to reducing cognitive fatigue and stress levels among officers. This has direct implications for improving on-the-job performance, where quicker reaction times are essential for effective and timely responses in critical scenarios.

The observed differences in reaction times across age groups and years of service highlight the need for tailored interventions. Younger officers and those with fewer years of experience showed more significant improvements, suggesting that cognitive training may need to be adapted to better suit older, more experienced officers. Given the intervention's effectiveness across various educational levels, it implies that similar cognitive enhancement programs could be applied broadly across different officer demographics, potentially leading to widespread improvements in reaction time and overall cognitive functioning. Although the increase in metacognition was subtle, the intervention still positively impacted officers' self-awareness and cognitive control, which could indirectly contribute to sustained improvements in reaction times.

5.4. Limitations

- Officers may have provided responses they believed to be socially acceptable, potentially skewing the accuracy of self-reported metacognition scores.
- The brief time between pre-test and post-test assessments may have limited the observable effects of the intervention, particularly in cognitive areas that require more time to change.
- The small, specific sample size limits the generalizability of the findings. A larger, more diverse group would provide broader insights.
- Without long-term follow-up, it's unclear whether improvements in metacognition and reaction time are sustained over time.

- Differences in age affected the intervention's effectiveness, indicating that it may not be equally effective across all age groups.
- The study did not thoroughly explore how varying educational backgrounds influenced baseline cognitive performance or response to the intervention.
- The study's findings are specific to the officer cohort and may not apply to other populations or occupational groups.
- The intensity and duration of the intervention may not have been sufficient to produce more substantial changes, particularly in metacognition.
- The tools used for measuring metacognition and reaction time may have inherent limitations, such as sensitivity to external factors or participant fatigue, affecting the reliability of the results.
- External environmental factors, such as workplace stress or distractions during testing, may have influenced the outcomes, potentially confounding the results.

5.5. Suggestions

- Implement follow-up periods of 2-3 months or more to assess the long-term sustainability of cognitive improvements.
- Use anonymous surveys and objective measures of cognitive performance to reduce social desirability bias.
- Develop cognitive training programs customized for different age groups and experience levels to address specific needs effectively.
- Incorporate metacognitive strategies into regular professional development and educational curricula to foster ongoing cognitive growth.

- Expand research to include larger and more diverse samples to enhance generalizability and validate findings across various contexts.
- Explore the effects of combining metacognitive training with other cognitive or behavioral interventions for a comprehensive approach.
- Include a more diverse population, such as officers from different regions or sectors, to improve the applicability of the results.
- Study how different educational backgrounds affect cognitive training outcomes to tailor interventions more effectively.
- Emphasize metacognitive strategies in future training to improve cognitive awareness and control alongside reaction time.
- Extend the duration of follow-up studies to better understand the long-term effects of cognitive interventions on both reaction times and metacognition.

5.6.Evidence Based Recommendations

Objective: To enhance reaction time and metacognition among firefighters through the systematic integration of relaxation techniques into training programs, thereby addressing the critical need for mental health support and improving overall operational effectiveness.

1. Development and Integration of Relaxation Techniques.

Develop a structured training curriculum that incorporates a range of relaxation techniques, including deep breathing exercises, progressive muscle relaxation, mindfulness, and guided imagery. These techniques should be systematically introduced as core components of firefighter training to improve mental resilience and cognitive functioning.

Schedule regular training sessions that emphasize the practice and application of these relaxation techniques. Ensure that these sessions are conducted in various training contexts to facilitate practical application and effectiveness under realistic conditions.

2. Customization Based on Demographic and Experience Factors.Customize relaxation training to address the unique needs of different age groups. For younger firefighters, incorporate more intensive and varied relaxation exercises to leverage their higher adaptability to new techniques. For older firefighters, provide tailored approaches that address potential cognitive rigidity and facilitate integration of relaxation techniques.

Adapt relaxation techniques based on years of service. Mid-career firefighters (6-12 years) may benefit from advanced relaxation practices that build on their existing skills. For those with extensive experience, offer specialized interventions aimed at overcoming cognitive plateauing and maintaining cognitive agility.

3. Extension of Training Duration and Frequency.

Increase the duration and frequency of relaxation practice sessions to ensure comprehensive and sustained benefits. Extended practice will help improve reaction times, reduce stress, and address the mental health challenges faced by firefighters.

Encourage firefighters to integrate relaxation techniques into their daily routines, both during and outside of training. This practice will help reinforce the benefits and contribute to ongoing mental well-being and cognitive enhancement.

4. Implementation of Robust Monitoring and Evaluation Processes.

Establish a structured evaluation framework to assess the impact of relaxation techniques on reaction times and metacognition. Regularly conduct performance assessments and analyze data to determine the effectiveness of the techniques and identify areas for improvement.

Implement a systematic approach for collecting feedback from participants regarding the efficacy of the relaxation techniques. Use this feedback to make informed adjustments to the training program and address any issues or challenges encountered by the firefighters.

5. Integration with Other Cognitive Enhancement Strategies.

Combine relaxation techniques with additional cognitive enhancement strategies, such as stress management programs and cognitive-behavioral interventions. This integrated approach will create a holistic training program that addresses both mental health and cognitive performance needs.Utilize a multi-faceted approach to improve both cognitive processing and physical performance, ensuring that firefighters are well-prepared to respond effectively in high-pressure situations.

6. Incorporation into Professional Development and Continuous Learning.

Embed relaxation techniques and other mental health support strategies into professional development and career advancement programs. This will address the significant gap in mental health support currently observed in firefighter training.

Include relaxation techniques in both initial training programs and refresher courses. This ensures continuous support for mental health and cognitive development throughout a firefighter’s career, enhancing overall effectiveness and resilience.

By systematically integrating relaxation techniques into firefighter training programs and addressing the critical need for mental health support, these recommendations aim to enhance reaction time, metacognition, and overall performance. This comprehensive approach will contribute to improved operational efficiency and resilience in high-pressure environments, ultimately benefiting both the firefighters and the communities they serve.

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APPENDICES

Consent letter

Study tittle: The Effect of Relaxation on Metacognition and Reaction time among Firefighters

Principal investigator: Karthika R S under the supervision of Dr. Pramod S K assistant professor of department of Counselling Psychology, Loyola College of Social Sciences Sreekariyam

institution: Loyola College of Social Sciences Sreekariyam

Contact Information:

Email: karthikars2016@gmail.com

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Introduction:

You are invited to participate in a research study conducted by Karthika RS, under the supervision of Dr. Pramod S K, assistant professor of department of Counselling Psychology, Loyola College of Social Sciences Sreekariyam

This study aims to investigate the 'Effect of relaxation on metacognition and reaction time among fire fighters'. Before you agree to participate, it is important that you understand the purpose of the study, what your participation will involve, and the potential risks and benefits.

Purpose of the study

The purpose of this study is to find out the effect of relaxation on metacogtion and reaction time among firefighters.

Procedures

If you agree to participate in this study, you will be asked to complete the following:

1. A demographic and background questionnaire.

2. An activity to measure reaction time.

3. Metacognitive assessment, including self-report questionnaire.

Duration

The total duration of participation is approximately 60 minutes.

Risks and discomforts:

There are minimal risks associated with this study. You may experience mild fatigue or stress from completing the tasks. If you feel uncomfortable at any time, you may take a break or discontinue participation without penalty.

Benefits

Participating in the study offers several benefits as Firefighters may experience improved self-awareness and cognitive skills, which are crucial for effective decision-making under stress. The relaxation technique involved in the study could lead to faster reaction times, and enhanced overall mental well-being. Participants will also have the opportunity to gain personal insights into their metacognitive abilities and reaction times, which can contribute to personal growth and improved job performance.

Also by taking part in this research, firefighters will be contributing to valuable scientific knowledge that could shape future training programs aimed at enhancing cognitive and reaction time abilities among their peers. Participants will also benefit from free access to relaxation intervention specifically box breathing that can be applied in both their professional and personal lives.

Confidentiality

All information collected in this study will be kept confidential. Results will be reported in aggregate form, without identifying any individual participants.

Voluntary participation

Your participation in this study is entirely voluntary. You may choose to withdraw at any time without any penalty or loss of benefits to which you are otherwise entitled.

If you have any questions about the study, please feel free to contact the principal investigator at the contact information provided above.

Consent

By signing below, you indicate that you have read and understood the information provided above, and you voluntarily agree to participate in this study.

Participant's Name :

Participant's Signature :

Date:

Researcher's Signature:

Date:

Personal Data Sheet

1. Full Name:

2. Age:

3. Gender:

4. Phone number:

5. Years of Service as a Firefighter:

6. Current Rank/Position:

7. Station/Department:

8. Education Level:

- ☐ High School
- ☐ Higher Secondary
- ☐ Bachelor's Degree
- ☐ Master's Degree

9. Have you participated in similar studies before?

- ☐ Yes
- ☐ No

10. Do you have any medical conditions that might affect your reaction time?

- ☐ Yes (please specify):
- ☐ No

11. How often do you engage in physical training?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Rarely

12. Do you use any substances that might affect your cognitive or physical performance? (e.g., caffeine, nicotine, medications)

- Yes (please specify):

- No

13. Have you participated in any skill development programs?

- Yes

- No

14. Do you have practice in any kind of relaxation techniques?

- Yes(please specify):

- No

15. Do you have adavanced firefighting equipments in your station?

- Yes(please specify):

- No

Thank you for your participation!

Participant's Signature:

Date:

Metacognition Questionnaire – 30

Some questions are given below. As a firefighter based on your thoughts and experience read and mark response to each item provided.

		Don't agree	Agree slightly	Agree moderately	Agree very much
1	Worrying helps me to avoid problems in the future.				
2	My worrying is dangerous for me.				
3	I think a lot about my thoughts.				
4	I could make myself sick with worrying.				
5	I am aware of the way my mind works when I am thinking through a problem.				
6	If I did not control a worrying thought and then it happened, it would be my fault.				
7	I need to worry in order to remain organised.				
8	I have little confidence in my memory for words and names.				
9	My worrying thoughts persist, no matter how I try to stop them.				
10	Worrying helps me to get things sorted out in my mind.				
11	I cannot ignore my worrying thoughts.				
12	I monitor my thoughts.				
13	I should be in control of my thoughts all of the time.				
14	My memory can mislead me at times.				
15	My worrying could make me go mad.				
16	I am constantly aware of my thinking.				
17	I have a poor memory.				
18	I pay close attention to the way my mind works.				
19	Worrying helps me cope.				
20	Not being able to control my thoughts is a sign of weakness.				
21	When I start worrying, I cannot stop.				
22	I will be punished for not controlling certain thoughts.				
23	Worrying help me to solve problems.				

24	I have little confidence in my memory for places.				
25	It is bad to think certain thoughts.				
26	I do not trust my memory.				
27	If I could not control my thoughts, I would not be able to function.				
28	I need to worry, in order to work well.				
29	I have little confidence in my memory for action.				
30	I constantly examine my thoughts.				

REACTION TIME:

METACOGNITION :

Reaction time ruler