2024

Human Performance in Context: Exploring the Effect of Social Support on Vigilance

Allison E. Garibaldi
University of Central Florida

HUMAN PERFORMANCE IN CONTEXT: EXPLORING THE EFFECT OF SOCIAL SUPPORT ON VIGILANCE

by

ALLISON E. GARIBALDI
B.S., University of Florida, 2017

M.A., University of Central Florida, 2021

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Psychology
in the College of Sciences
at the University of Central Florida
Orlando, Florida

Spring Term
2024

Major Professor: James Szalma

ABSTRACT

Over many decades, vigilance research has consistently found that performance on vigilance tasks decline over time (i.e., the vigilance decrement; Davies & Parasuraman, 1982), and that performing a vigilance task is both mentally demanding and stressful (Warm et al., 2008). Researchers have subsequently implemented a wide range of interventions to both understand and attempt to attenuate the vigilance decrement and its associated affective effects. Among these efforts, little attention has been devoted to understanding the effects of the social environment on vigilance. Nonetheless, a handful of studies have indeed suggested that the presence of others can affect performance, workload, and stress in vigilance. The present dissertation sought to extend these findings by examining the effect of social support on vigilance, a novel form of social presence in vigilance research, based on findings that the provision of social support may improve performance on cognitive tasks.

236 participants were randomly assigned to complete a cognitive vigilance task either alone or in one of seven social presence conditions: supportive or non-supportive observer, supportive or non-supportive co-actor, independent co-actor, evaluative observer, or merely present observer. Regarding the novel supportive and non-supportive manipulations, results indicated that receiving non-supportive statements resulted in a more conservative response bias than supportive statements, but that receiving supportive statements resulted in higher perceived effort. Additionally, receiving statements from a co-actor, regardless of the type of statement, resulted in higher median response times. In comparing the novel manipulations to existing manipulations of social presence in vigilance, participants in the non-supportive observer condition outperformed those in the independent co-actor and mere presence conditions. The results of this dissertation thus imply that verbal interactions during vigilance tasks – and the

supportive or non-supportive nature of those interactions – can affect performance and workload differently than non-verbal forms of social presence.

This dissertation is dedicated to my mother, my father, my sibling, and my partner. While there are many wonderful hands who have helped build me, these four individuals are the pillars that hold me up. I am nothing without them.

ACKNOWLEDGMENTS

This dissertation would not have been possible without the guidance and support of my adviser, Dr. James Szalma. It has been a privilege to be trained by a scientist as talented as he is, but it is the dark humor, witty insults, and genuine words of encouragement when I needed them most that got me through this journey. I would also like to thank my dissertation committee, Drs. Valerie Sims, Mustapha Mouloua, and Gerald Matthews for overseeing this dissertation. Each of you have contributed to my career in ways I am eternally grateful for. A huge thank you my research assistants, Amy Abdelmasih, Brooke Ibarra, Hailey Rodriguez, and Yazmin Hernandez as well for their dedication to this project, as it would have been impossible to complete without them.

To the friends I made along the way, especially Grace Waldfogle, Steve and Sara Ford (and Charlotte and Amelia), Briana Sobel, Jazmyn Donovan, Gabby Flores-Cruz, and all the members of the STRIKE Lab at NAWCTSD, both present and former: getting through this would surely have been impossible without your support. I am immensely privileged to call you my friends. To the friends and non-genetic family who have been with me since before this journey began, especially the Powers family, Amy Dunlap, Tiffany Petkov, and Annabel Dinh: your words of encouragement and steadfast belief in me have gotten me through this more than I can say. To the family who I am privileged enough to share DNA with, especially my mom, dad, siblings, Walker family, Flores family, Tia Joyce, Mama Cora, and Abuelo: there are simply no words to express how thankful I am to have you all. Everything I am and could ever hope to be, I owe to you. Lastly, to my partner in love and life, the father to my cats, and my best friend, Matthew Powers: just thank you. After this is all said and done, let's sit on the couch with the cats and watch movies for about a week or so, shall we?

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

The interactions of humans with other humans are a fundamental topic of psychological research. The innate human "need to belong" (Baumeister & Leary, 1995) appears to influence cognition (Sedikides et al., 1993), psychological well-being (Cobb, 1976), and even physical health outcomes (Lynch, 1979). However, the effect of this need and other social factors on human performance is, as yet, poorly understood. Considering that the tasks that many human factors researchers are interested in are likely performed in the presence of others in operational settings, the lack of research in this area is particularly concerning. For example, performance in high-stakes settings, like military surveillance and homeland security, is often done in the presence of others. Such tasks often depend on the individual's ability to monitor for infrequently occurring signals over an extended period of time (i.e., vigilance; Davies & Parasuraman, 1982). It is thus important to understand how the presence of other people while performing monitoring tasks affects performance, although this topic has received surprisingly little attention in vigilance literature.

Vigilance: A Brief Overview

Vigilance has been at the forefront of research in human performance since World War II (Mackworth, 1948). The prominence of vigilance research is tied to its applicability to a variety of operational tasks, such as military surveillance, air-traffic control, and long-distance driving (Parasuraman et al., 1987). As the role of automation in the workplace continues to grow, monitoring displays for critical signals will likely become an increasingly important skill (Parasuraman, 1996; Sheridan, 2002; 2021). Thus, despite its long history within human factors

research, vigilance will remain crucial to the study of human performance in the decades to come.

Performance on vigilance tasks tends to decrease over time, an effect referred to as the vigilance decrement (Davies & Parasuraman, 1982). As one might imagine, the decrement poses considerable problems for vigilance in high stakes, operational settings (e.g., baggage screening, threat detection). Hence, vigilance researchers have devoted considerable attention toward attenuating the vigilance decrement through a variety of psychological factors (e.g., rest breaks; Helton & Russell, 2017, monetary rewards; Esterman et al., 2016; knowledge of results; Colquhoun, 1966; Szalma et al., 2006). However, the potential effect of the social environment on vigilance has been rather under-researched by comparison. Nonetheless, the limited research that has been conducted on this topic has yielded interesting results with potential implications for vigilance in the real-world.

Social Presence in Vigilance: A Brief Overview

Although the presence of others during vigilance tasks has received relatively little empirical examination, interest in the effect dates back quite far in the trajectory of vigilance research. In 1963, Bergum & Lehr observed that the presence of an authoritative figure improved overall performance on a vigilance task, a finding that was later corroborated experimentally by Ware et al (1964) and Putz (1975). However, interest in the role of social presence in vigilance waned after these early studies and has only recently received renewed attention. For example, a study by Yu & Wu (2015) revealed faster response times when a simple baggage screening task was performed in the presence of an audience. Moreover, a recent series of studies by Claypoole & Szalma (2018a, 2018b) observed that false alarm rates were

significantly lower when a vigilance task was performed in the presence of an independent co-actor and evaluative observer, respectively.

Recent examinations of the effect of social presence on vigilance have been largely driven by theories of social facilitation, which generally argue that the presence of others improves performance on simple tasks but impairs performance on complex tasks, based on empirical findings (Bond & Titus, 1983). However, task performance is not the only consequence of the vigilance decrement. Vigilance tasks have been found to be both mentally demanding and stressful (Warm et al., 2008), and there is evidence that social presence may heighten these affective responses. For example, Claypoole & Szalma (2017) observed that participants who completed a vigilance task in the presence of a supervisor reported higher feelings of task engagement and state anxiety, though this effect was not replicated in later studies (Claypoole & Szalma, 2018b). Thus, the effect of different types of social presence on both performance and affective state merit further examination.

Given that social facilitation theory makes predictions for task performance, it is logical that vigilance and other human performance researchers have adopted the theory in examinations of social presence and performance. However, social facilitation is far from the only social psychology finding that might have implications for performance, workload, and stress in vigilance. Considering the stressful nature of vigilance tasks, social support specifically is an area of social psychological research that may affect both performance and affective states resulting from vigilance. Social support is purported to attenuate the stress response, leading to long-term health and longevity benefits (Cassel, 1976; Cobb, 1976). In an attempt to isolate the causal mechanisms behind this effect, researchers examined the effect of social support on stressful, sometimes cognitively based laboratory tasks. Interestingly for vigilance researchers,

social support has indeed been found to attenuate stress and even improve performance in the laboratory (e.g., Tanaka et al., 1990; Tardy et al., 1992; Thorsteinsson & James, 1999). However, such research was used essentially as a proxy to inform theories of how social support is beneficial in the long-term, rather than to investigate the effects of social support on task performance. Thus, while promising, little attention has been devoted to examining the effect of social support on cognitive performance specifically. Given the stressful nature of vigilance, if social support indeed attenuates stress, then socially supportive presence may be a fruitful avenue to improve both performance and affective state when performing vigilance tasks. However, social support has, to date, not been examined in the context of social presence and vigilance. The present dissertation therefore seeks to address this research gap through a sequence of experimental studies.

First, a review of the vigilance literature, with particular consideration for the role of stress and social presence is presented. Then, the social support literature is reviewed and relevant gaps in the literature are identified, serving as the basis for an empirical examination of the potential role of social support on performance, workload, and stress in vigilance. Following the literature reviews, two experiments are outlined which will investigate the effect of social support on vigilance alongside existing manipulations of social presence in vigilance. In Experiment One, two novel social support manipulations for vigilance based on prior literature are examined in the context of a sensory vigilance task. The effect of these support manipulations on performance, workload, and stress, will be compared to the effect of a merely present observer, evaluative observer, and performing the task alone. In Experiment Two, the extent of these social presence manipulations will be assessed across two event rates (i.e., high and low). After a thorough examination of the statistical results, theoretical and practical

implications are considered, to be concluded by a discussion of the limitations and future directions for the study of social presence in vigilance.

CHAPTER TWO: VIGILANCE

Historical Origins

Vigilance is commonly defined as an operator's ability to maintain attention to infrequently occurring signals over an extended period of time (Davies & Parasuraman, 1982). Any dissertation on the topic of vigilance would be remiss not to address its oft-cited, practical origins. During World War II, airborne radar operators tended to miss detecting enemy submarines as time on watch increased. To study this operational failure, Mackworth (1948; 1950) developed the now famous Clock Test, in which participants were asked to monitor a clock and respond when the hand on the clock made a larger jump than usual. Corroborating observations of radar operators' decline in performance over time, Mackworth observed that participants missed more critical signals (i.e., larger jumps of the hands) the longer they monitored the clock, an effect now known as the vigilance decrement (Davies & Parasuraman, 1982).

Task Characteristics: The Vigilance Taxonomy

In the decades since Mackworth's seminal experiments, the vigilance decrement has become a near ubiquitous finding in sustained attention research (see Fraulini, Hancock, Neigel, Claypoole & Szalma, 2017). Additionally, a number of task characteristics that can influence the vigilance decrement have since been identified. Parasuraman and Davies' (1977) taxonomy of vigilance delineates four task dimensions that can affect the vigilance decrement: type of signal

discrimination (successive or simultaneous), sensory modality (visual or auditory), source complexity (single or multiple displays to be monitored), and event rate (fast or slow).

Signal discrimination refers to the way in which the observer is to determine whether a critical signal is present. The task can either require them to compare the current stimuli to one held in memory (i.e., a successive discrimination), or to a stimulus already on the display (i.e. a simultaneous discrimination; Parasuraman et al., 1987). As might be expected, vigilance tasks requiring successive discrimination are perceived to be more mentally demanding than ones requiring simultaneous discrimination, which is also reflected in lower performance during these tasks (Parasuraman & Mouloua, 1987). Sensory modality has been defined as either auditory or visual (Parasuraman & Davies, 1977), though tactile vigilance tasks have also been developed (e.g., See et al., 1995; Calhoun et al., 2005). Performance on vigilance tasks with auditory signals tends to be higher than those with visual signals (Davies & Parasuraman, 1982; Szalma et al. 2004, Warm & Jerison, 1984).

Another dimension of the taxonomy, source complexity, refers to whether an observer is required to monitor one or multiple sources of signals during the vigilance task (Parasuraman & Davies, 1977). For example, observers can be required to monitor either one or multiple displays, with multiple displays generally associated with lower performance and higher mental workload (e.g., Teo & Szalma, 2011). Lastly, event rate refers to the rate at which stimuli are presented, with high event rates (i.e., 24 events or more per minute for most laboratory tasks) being associated with lower performance (e.g., Davies & Parasuraman, 1982) than low event rates. In addition to these four dimensions, the distinction between cognitive and sensory tasks has been argued to be the fifth dimension of vigilance tasks. While sensory tasks require perceptual discrimination, cognitive tasks require symbolic discrimination. For example, in a sensory task,

critical signals may be determined by differences in color, size, or volume (Davies & Parasuraman, 1982; Mouloua & Parasuraman, 1995). By contrast, cognitive tasks might require observers to discriminate based on mathematical (e.g., Teo & Szalma, 2011) or lexical (e.g., Neigel et al., 2018) differences among stimuli. Although cognitive tasks are generally more mentally demanding than sensory ones (e.g., Warm et al., 1984), the effects of cognitive discrimination on performance are less clear. While a meta-analysis found that the vigilance decrement was more likely to occur with sensory tasks (See et al., 1995), others have found that cognitive tasks were associated with lower performance (Teo & Szalma, 2011).

Practical Relevance

The vigilance decrement poses a critical problem for many threat detection-related tasks, including military surveillance (Johnson & Merullo, 2000), cockpit monitoring (Satchel et al., 1993), baggage screening (Meuter et al., 2016), and cyber security (Sawyer et al., 2014). Additionally, the vigilance decrement is of particular concern given growth of automation in the workplace. Rather than directly controlling technological systems, many operators have instead become *monitors* of automated systems, only to intervene when problems arise (Warm et al., 2008). Subsequently, the ability to monitor a display for critical signals over an extended period of time will likely be a crucial component of even more operational tasks in the years to come. Beyond performance, vigilance has also been associated with increased mental workload and stress (Warm et al., 2008), which can both exacerbate performance decrements (Szalma et al., 2004) and pose concerns for the affective well-being of operators who must engage in vigilance.

Theoretical Perspectives on the Vigilance Decrement

For all its practical relevance, the problem of the vigilance decrement is also a theoretically interesting, yet perplexing one, that has been the subject of debate over the last

several decades. Early theorists suggested that the vigilance decrement results from under-arousal (Davies & Parasuraman, 1982). However, arousal theory has since fallen out of favor due to its inability to explain the high stress and mental workload associated with vigilance tasks, as well as problems with the unitary arousal model itself (Hancock & Warm, 1989; Hockey & Hamilton, 1983). As a result, three competing theoretical explanations for the vigilance have emerged in recent research: resource theory mindlessness theory, and mind-wandering theory.

Resource Theory

As the explanatory power of arousal theory was revealed to be limited, resource theory subsequently emerged as the prevailing theoretical explanation for the vigilance decrement. Resource theory rests on the assumption that humans have a limited cognitive capacity, and as such, can only process limited amounts of information at a time (Kahneman, 1973; Moray, 1967). In other words, humans are believed to have limited "resources" available to allocate to a particular task, and when those resources are depleted, performance on the task will suffer. Moreover, resources are thought to be depleted by either task demands or by energetic state.

As might be clear from this explanation, resource theory stems from a largely metaphorical approach to explaining human performance. Indeed, the concept of cognitive resources has been extremely challenging to define and quantify, which is one of the biggest criticisms of resource theory (but see Langner & Eickhoff, 2013; Matthews, Warm, Reinerman-Jones, Langheim, Washburn, & Tripp, 2010; Reinerman- Jones, Matthews, and Langheim, & Warm, 2011 for recent examples of attempts to define resources physiologically). Nonetheless, resource theory does seem to map onto common vigilance findings. The decline in performance over time combined is, conceivably, indicative of a finite pool of resources that are depleted with time on task and further exacerbated by task characteristics that increase in mental workload and

stress (which would further tax available cognitive resources; Hancock & Warm, 1989). Moreover, the vigilance decrement as well as perceived workload and stress in vigilance have been reliably attenuated by rest breaks (e.g., Helton & Russell, 2015; Ross et al., 2014, Waldfogle et al., 2021). Such findings seem to corroborate resource theory as an explanation for the vigilance decrement. If it is the case that 'resources' deplete with time on task, it would make sense that a rest break would help 'replenish' those resources. However, critics would be justified in arguing that this is still a "roundabout" way to support resource theory.

Despite its problems, it is worth noting resource theory has advanced considerably from the original instantiation of the theory, which proposed a single pool of cognitive resources that could be allocated to a task or multiple tasks (Kahneman, 1973), creating an attentional bottleneck similar to Broadbent's (1958) 'filter theory.' However, this perspective failed to adequately account for experimental findings indicating that, for example, dual-task performance was improved when one task was visual and the other was auditory as opposed to two visual tasks (e.g., Treisman & Davies, 1973). To address this problem, Wickens (1984) proposed a *multiple* resource theory model, in which visual, auditory, spatial, and verbal capacities are separate 'pools' of resources. In terms of performance, Wickens' model proposes that the more overlap between the resources a task demands, the faster those resources will be depleted, and the faster performance will decline. With regard to vigilance, proponents of resource theory would subsequently argue that the decrement stems from a deficit in available mental resources (e.g., Hancock & Warm, 1989), and this perspective remains the preeminent explanation for the vigilance decrement.

Mindlessness Theory

Reminiscent of early arousal theories, some researchers have again pointed to cognitive underload as an explanation for the vigilance decrement. In one such iteration, mindlessness theory posits that the vigilance decrement arises from the monotonous nature of the task. As a result of monotony, boredom and fatigue increase, which in turn cause the lapses in attention that lead to the vigilance decrement (Robertson et al., 1997). In other words, the repetitive and monotonous nature of vigilance causes operators to respond "mindlessly," responding to signals automatically without devoting attention to whether or not a critical signal is actually present (e.g., Manly et al., 1999). This perspective is ostensibly supported by a performance decrement in the Sustained Attention to Response Task (SART), in which participants are asked to respond to non-signals and withhold responses to critical signals. However, this validity of the SART for asserting mindlessness theory has been called into question, with some researchers suggesting that the decrement in the SART could be the result of an inability to maintain required motor responses for extended period of time, rather than mindlessness (Dillard et al., 2014).

Similar to its drive-theory based predecessors, the mindlessness theory of vigilance also fails to account for the high mental demand and stress that participants often report after vigilance tasks. If the participant were truly in a "mindless" state, it is difficult to conceive of how they would also be report being mentally taxed and stressed. Indeed, one study revealed that participants reported task-*related* cognitive interference both in the SART and a traditional vigilance task (Grier et al., 2003). Rather than being in a 'mind-*less*' state, such results suggest the opposite; participants *are* thinking about the task and even worrying about it, suggesting a mind-*ful* mental state during vigilance (Grier et al., 2003).

Mind-wandering Theory

Mind-wandering theory has more recently emerged as a remedy to the criticisms of mindlessness theory. Task-unrelated thoughts (TUT's) have been found, rather consistently, to increase with time on vigilance tasks. (Kluger & DeNisi, 1996; Matthews et al., 2002; Robertson, 1997). Rather than a mindless approach, mind-wandering theory suggests that TUT's are evidence that the mind *is* engaged during vigilance tasks; just not on the task itself. In other words, attention shifts away from the vigilance task and is instead directed inward as time goes on, resulting in the vigilance decrement (Smallwood & Schooler, 2006; Thomson et al., 2015). However, this notion has been challenged by research indicating that that mind-wandering was not associated with decreased performance, regardless of task type or difficulty (Neigel et al., 2019). Thus, the tenets of underload theories remain undermined by consistent empirical findings regarding subjective perceptions and affective effects of vigilance. Specifically, stress and mental workload appear to be key components of the vigilance experience, which give insight into the theoretical mechanisms underlying the vigilance decrement.

Stress in Vigilance

Theories of Stress and Human Performance

Arousal theory

Like theories of the vigilance decrement, arousal theory was influential in the historical trajectory of stress research in vigilance. Arousal theorists typically characterized stress in terms of an individual's physiological response (i.e., arousal) to a given stressor, such that both over-arousal and under-arousal can be causes of stress (e.g., Cannon, 1932; Selye, 1976). Regarding performance, arousal theory is best represented by the Yerkes-Dodson law, which posits that the relationship between performance and stress takes an inverted U-shape (and see Hebb, 1955).

The Yerkes-Dodson law thus implies that there is an optimal mid-range of arousal where performance is highest, but that performance will suffer at extreme ends of the arousal scale. However, as occurred with theories of the vigilance decrement, the unitary arousal theory of stress has since fallen out of favor. Specifically, Hancock & Szalma (2006) identified four key criticisms of arousal theory for stress in human performance: lack of correlation between physiological indices of arousal (Hovanitz, Chin, & Warm, 1989; Parasuraman, 1984), failure to determine the effects of stressors on arousal independent of performance (Hockey, 1986), difficulty with falsification of the theory (Hancock & Ganey, 2003; Hockey, 1984; Holland & Hancock, 1991), and the unidimensional nature of the theory (Hockey & Hamilton, 1983).

Appraisal theory

Unitary arousal theory focuses on a single dimension of stress, physiological arousal, without addressing the differential effects of stressors on cognition (e.g., selectivity of attention, memory function; Hockey & Hamilton, 1983). Subsequently, modern theories treat stress more as a multi-dimensional construct rather than a unidimensional one. Specifically, modern theories largely assume that stress involves an appraisal and a regulatory mechanism (Hancock & Szalma, 2006). The appraisal component stems from Lazarus & Folkman's (1984) conceptualization of stress. In this framework, stress arises from a primary and secondary appraisal of the environment. In the primary appraisal, the individual assesses the stressor and determines whether or not it presents a threat to their well-being or goals (Szalma & Hancock, 2007). Then, in the secondary appraisal, the individual determines whether or not they possess the appropriate coping strategies or resources to deal with the stressor. If the stressor in question is both perceived as a threat, and the individual does not have the adequate means to address the threat, then the negative effects of stress will manifest. However, appraisal theory lacks some

specificity when applied to human performance. For example, it is unclear which specific task parameters will be appraised as stressful both in general and amongst different individuals (Szalma & Hancock, 2007).

Adaptability Theories

Building on lessons from arousal and appraisal theories, as well as human performance-related findings, Hancock and Warm (1989) put forth what they termed the dynamic model of stress and sustained attention. Not unlike Wickens' (1984) expansion of resource theory into multiple resource theory, Hancock and Warm's model extends and delineates the Yerkes-Dodson inverted U-model of stress and performance, with the exception that arousal is *not* proposed as the driving mechanism of the effect of stress on performance. The dynamic model proposes that stress can indeed be characterized by over or under-stimulation (i.e., hyper-stress or hypo-stress, respectively) on the extreme ends of the stress axis, which harkens back to arousal theories of stress. Crucially, however, the model emphasizes that in most situations, humans are capable of adapting to stress without much detriment to performance, whether by behavioral or physiological means. Subsequently, adaptability is reflected in the psychological and physiological zones of adaptability that encompass the mid-range of the inverted U. It is only when the stressor causes the individual to breach these zones of adaptability that negative effects on task performance will emerge. In other words, stress negatively affects performance when it exceeds the operator's ability to adapt to the stress, invoking the central tenets of appraisal theory.

Although the adaptivity aspect of Hancock and Warm's (1989) model addresses some of the limitations of the Yerkes-Dodson curve, it does not detail how exactly individuals deal with task-related stress. Hockey's (1997) compensatory control model attempts to address this

theoretical gap, identifying two negative feedback loops that comprise compensatory effort in response to stress. The first loop, or the lower level, is hypothesized to automatically control effort for simple or well-learned tasks. For such tasks, there should be minimal effort required to keep performance high and stress within the adaptable range. Subsequently, relying existing or automatic skills should be sufficient to keep performance and stress within an optimal range for 'easy' tasks (i.e., active coping). However, if the demands of the task exceed the capabilities of the lower level, more effort must be exerted to regulate stress and performance levels. In the model, the upper level is responsible for both identifying when the lower level is no longer sufficient (i.e., the effort monitor) and when resources should be allocated to the higher level to cope with the resulting stress (i.e., supervisory controller). Once resources are re-directed to the higher level, one of two types of coping can be implemented: strain or passive. In strain coping, effort is increased to maximum capacity, maintaining performance at the cost of energetic resources. On the other hand, changing the task goals, or "passive coping (p. 82)" can reduce energetic costs but may be more detrimental to performance.

Measuring Stress in Vigilance

While Hockey's model is a noteworthy step toward understanding adaptive responses to task-based stress, it should be noted that the concepts of the model are quite abstract and difficult to measure. The Dundee Stress State Questionnaire (DSSQ; Matthews et al., 1999; 2002) represents a quantitative assessment of task-related stress by identifying three underlying (i.e., 'secondary') dimensions of the phenomenon: distress, worry, and task engagement. The three dimensions are themselves composed of 11 'primary' factors relating to affect, motivation, and cognition. Of the three secondary factors, only worry is exclusively cognitive in nature, as it reflects self-esteem, self-focus, and cognitive interference. Distress, on the other hand, includes

affective components such as tension (e.g., nervousness, jitteriness) and hedonic tone (i.e., pleasant or unpleasant mood). However, distress also includes the confidence and control primary scale, which refers to one's confidence in their control and ability to succeed in the given task. Finally, task engagement is the only secondary factor to encompass cognitive, affective, and motivational states, as it generally refers to enthusiasm and interest for the given task. The three secondary factors are also associated with specific patterns of appraisal and coping, or 'core relational themes' (Lazarus, 1999). While task engagement is typically underscored by task-focused coping, challenge appraisal, and low use of avoidance, distress is characterized by emotion-focused coping, threat appraisal, and low perceived controllability. Worry is also, surprisingly, associated with some of the same patterns as both task engagement and distress, including both task-focused coping and emotion-focused coping, as well challenge appraisal and threat appraisal. However, worry is differentiated by its consistent association with avoidance coping. (Matthews et al., 2002; 2013).

Since its inception, the DSSQ has continued to be empirically validated across multiple task types, task parameters, and stressors (see Matthews et al., 2013 for a review). In vigilance specifically, the DSSQ has been extremely useful in identifying patterns of stress related to performing vigilance tasks. While task engagement tends to decrease, distress tends to increase in vigilance tasks, while worry typically does not change substantially (e.g., Matthews, 2021; Matthews et al., 2010, Szalma et al., 2004, Teo & Szalma, 2011; Warm et al., 2008). Additionally, task engagement seems to reliably predict performance, as multiple vigilance studies have found a positive association between task engagement and sensitivity (e.g., Helton et al., 2008; Shaw et al., 2010; Szalma et al., 2004). Taken together, research using the DSSQ

implies that vigilance is, indeed, a stressful task that cannot be adequately explained by underload theories of vigilance.

Vigilance and the Social Environment

Given the concerning implications of the vigilance decrement for high stakes tasks, a substantial portion of vigilance research is devoted to identifying factors that may attenuate the decrement. Among such attempts, task characteristics (e.g., vigilance taxonomy; Parasuraman & Davies, 1997, knowledge of results; Colquhoun, 1966, Szalma et al., 2006), environmental aspects (e.g., rest breaks; Helton & Russell, 2017, monetary rewards; Esterman et al., 2016), and individual differences (e.g., personality; Matthews et al., 1990, sex; Koelega & Brinkman, 1986) have been shown to affect performance on vigilance tasks. However, less attention has been devoted to aspects of the social context that may influence performance, although there is evidence that the social environment can indeed affect performance on vigilance tasks (Putz, 1975).

Social Facilitation: The Role of Evaluative Presence

In one of the oldest social psychology findings (Triplett, 1898), it has been reliably observed that the presence of another person while completing a task has effects on the performance of a wide variety of tasks. These effects appear to depend on the difficulty of the task; performance on simple tasks is improved in the presence of another person while the converse is true for complex tasks, an effect referred to as social facilitation (Bond & Titus, 1983).

Theories of Social Facilitation

One of the prevailing theoretical frameworks for social facilitation is Zajonc's Drive Theory, which posits that the mere presence of another person during the task increases arousal,

thereby increasing the dominant response for the task. In a complex task, the dominant response is to answer incorrectly, while in a simple task the dominant response is to answer correctly (Zajonc, 1965). In contrast, Cottrell (1972) argued that the mere presence of another person is not sufficient to induce social facilitation; the participant must believe that the other person present is evaluating their performance and feel subsequent apprehension about being evaluated. The concern about being evaluated, Cottrell argues, is what increases arousal to improve or impair performance. This hypothesis initially appeared to be supported by empirical evidence but was subsequently found to be a weak predictor of social facilitation effects on performance in a meta-analysis (Bond & Titus, 1983). Bond (1982) suggested that social facilitation effects may arise from the motivation to present oneself as competent, though this theory is limited in scope as it only applies to the learning of new tasks (for a review, see Claypoole, 2018).

Social Presence and Vigilance

A limited body of research suggests that social presence affects performance in vigilance. An early study by Bergum & Lehr (1963) found that being monitored by an authoritative figure, in their case a military commanding officer, resulted higher overall detections and a smaller decrement in performance over time. This finding was subsequently examined experimentally by manipulating the attitude of the experimenter to be either democratic or autocratic during instructions (Ware et al., 1964). Results indicated that completing a vigilance task in the presence of a democratic versus an autocratic experimenter was associated with higher correct detections overall and as a function of time (i.e., smaller decrement), which supports the idea that social presence indeed affects performance on vigilance tasks.

Although social presence research in vigilance mostly stopped after these early studies (although see Putz, 1975), more recent work has yielded interesting results that warrant further

examination. Yu and Wu (2015) observed that the presence of an audience during a baggage screening task resulted in the typical social facilitation effect, but only for response time. Response time was faster during simple tasks and slower during complex task in the presence of an audience, but response accuracy was unaffected by social presence. Despite the absence of accuracy effects, faster response times that do not come at the cost of lower accuracy may be favorable in certain applied contexts. For example, military tasks often require quick but accurate responses (e.g., Landsberg et al., 2012).

Claypoole & Szalma (2017) examined the effects of performing a vigilance task in the presence of a supervisor, merely present observer, or performing the task alone. Results indicated that participants in the supervisor and observer conditions had lower false alarms and response times but reported higher task engagement and state anxiety. Similarly, Claypoole & Szalma, (2018b) observed that participants who completed a vigilance task in the presence of an evaluative observer had a significantly lower proportion of false alarms than participants who performed the task alone. However, the presence of a merely present observer did not yield significant differences in performance compared to the alone condition, an effect that was later replicated in Claypoole et al., 2019.

The role of social presence in vigilance has also been extended to other forms of social presence. Co-action, which refers to "individuals all simultaneously engaged in the same activity (Zajonc, 1965, p. 149)," has also been examined in the context of social facilitation. Klinger (1969) examined co-action in the context of vigilance, and observed that evaluative co-action (i.e., when co-actors receive information about each other's performance) was more beneficial for performance than non-evaluative co-action, which suggested that evaluation apprehension may be a crucial component of the effect of co-action on performance. However, more recent

work has shown that evaluation potential does not appear to be necessary for co-actors to affect performance.

Funke et al. (2016)'s manipulation of co-acting did not include knowledge of the other actor's performance, and they only told participants that they would be responsible for the same task but should not communicate or collaborate. The results of this study indicated that co-action resulted in higher correct detections and lower post-task distress. Furthermore, Claypoole & Szalma (2018a) found that completing a vigilance task in the presence of an independent co-actor (i.e., who completed the task alongside them but was not responsible for the same task) resulted in significantly fewer false alarms, a more conservative response bias, and lower perceived workload. Taken together, research on social presence in vigilance suggests social presence can influence both performance and subjective reactions to vigilance tasks, but the effects may vary as a function of type of social presence and dependent measures. In particular, a limited body of research has suggested that social support influences performance on some cognitive tasks, and may therefore affect performance, workload, and stress in vigilance.

CHAPTER THREE: SOCIAL SUPPORT

Most studies in the realm of social presence and vigilance involve rather simple manipulations of social presence, where the person in the room during the vigilance task has little to no interaction with the vigilance operator. That such minimal interventions have an effect on cognitive performance is, in itself, an intriguing finding that likely reflects a profound connection between cognition and the social environment. Among social facilitation theorists, this relationship has been largely attributed to human reactions to evaluation potential. However, research in social support suggests that performance may also be affected by the degree to which social presence is perceived as supportive, a notion that has yet to be explored in the vigilance realm. Moreover, social interactions in the real world may be considerably more complex than what is captured in existing manipulations of social presence in vigilance.

Defining Support

Social support is a multidimensional construct that, most generally, refers to information that causes an individual to feel cared for, valued, and part of a mutually supportive social network (Cobb, 1976). Research in social support was sparked by two landmark findings that that the social environment has effects on physical health outcomes and psychological well-being (Cassel, 1976; Cobb, 1976). While this effect has largely continued to replicate (e.g., McMahon et al., 2020; Vila, 2021), researchers have struggled to specify a clear operational definition of social support, and efforts to do so have resulted in multiple proposed dimensions and conceptualizations of support.

Most researchers now agree that social support can be most broadly conceptualized as either structural or functional support (Lett et al., 2005). Structural support refers to

characteristics of an individual's social network, such as size, frequency of contact, and type of relationships (e.g., familial, workplace, school). On the other hand, functional support refers to the tangible support that the social network provides, which are further categorized as emotional (i.e., self-esteem), instrumental (i.e., tangible resources), informational (i.e., provision of information), or appraisal (i.e., help with situation appraisal) support. Additionally, some research has found that the actual, tangible support that another person provides is conceptually and statistically distinct from the general sense or feeling of being supported (Sarason et al., 1990a). Functional support can thus be further delineated by either received support or perceived support (Lett et al., 2005).

While most social support research and theories have focused on its role in long-term health and wellbeing, there is some evidence that it is beneficial for improving performance on cognitive tasks like mental arithmetic and word puzzles (e.g., Tanaka et al., 1990; Tardy, 1992). Additionally, a meta-analysis of social support's effects on cardiovascular reactivity (e.g., heart rate, blood pressure), cortisol levels, and skin conductance as outcome variables found that social support during stressful laboratory tasks (e.g., Mental Arithmetic Tasks, Public Speaking) reduces physiological stress (Thorsteinsson & James, 1999). Given the stressful nature of vigilance, social support may thus improve performance, perceived workload, and stress related to vigilance, which the present dissertation seeks to explore.

Social Support and Performance

To examine the effect of social support on stress experimentally, laboratory-based examinations of social support have been conducted, typically by manipulating social support during a stressful, laboratory-based task (Thorsteinsson & James, 1999). A meta-analysis of these experiments did reveal an overall positive effect of social support on cardiovascular stress.

Crucially, however, the methods by which social support has been manipulated in the laboratory have varied greatly. For example, some studies utilize mere presence as social support, where a person (typically a friend of the participant) is present during the task and is asked to "silently cheer on" the participant or touch their wrist during the task (e.g., Edens, 1992; Kors et al., 2011). Other studies have enacted support by providing supportively worded instructions for the task via the experimenter (e.g., Tanaka et al., 1990; Tardy, 1992). Additionally, there are studies that used existing friends of the participant as the support provider (Christenfeld et al., 1997; Kors et al., 2011) while still others used a stranger (Searle et al., 2001; Tardy, 1992). These inconsistencies complicate both empirical conclusions on the effectiveness of social support, and its potential application to improving cognitive performance. Moreover, given the stress-based impetus for social support research, actual performance on the task is less frequently emphasized (and subsequently, less frequently reported) in the body of laboratory-based social support literature.

Of the studies in this area that do report performance outcomes, most did not find effects of support on performance, but did find that social support often reduced cardiovascular stress. A tabular representation of these studies is presented in Table 1. It should be noted that of the studies that did not find performance effects, most utilized the "silent supporter" method, where a friend of the participant was encouraged to "cheer on" the participant and/or touch their wrist during the task. It is likely the case that these types of manipulations were too weak to elicit any effects on performance. Moreover, such manipulations lack a theoretical basis, in that they do not directly address the demands of the task. Per Cohen and McKay (1985), support should be most effective when it addresses the root cause of the stress, which in the case of vigilance is the

stressful nature of the task. Indeed, when support was enacted more tangibly, performance effects seemed to arise.

Utilizing a method quite similar to Deci et al. (1994), Sarason & Sarason (1986) enacted support by having the experimenter acknowledge the value of the subject's participation, emphasize that they were there to help, and offer tangible support by informing them that they would be available in the next room while the participant worked on the task to answer any questions if needed. Participants in the control group did not receive these supportive instructions and were found to have completed significantly fewer anagrams (i.e., rearrange a set of words to create a meaningful English word) than those in the supportive condition. Using the same support manipulation, Tanaka (1990) conducted a similar study, but with the addition of a stress manipulation. Specifically, participants completed a series of word puzzles where letters were scrambled and needed to be re-arranged into meaningful English or Hiragana words. In addition to their random assignment to the support or no-support condition, participants were randomly assigned to a high stress or low stress condition. In the high stress condition, a video camera was present during the task and participants were told that their behavior while performing the task was being recorded and would be analyzed. In the low stress condition, there was no camera present, and participants were not told that their behavior would be evaluated. Interestingly, this stress manipulation was effectively an evaluation manipulation, which could thus elicit socially facilitative effects. Tanaka (1990) observed a positive effect of support on performance, such that participants who received support completed more anagrams than those who did not, though this effect was not statistically significant. Additionally, anxiety was attenuated for participants in the high-stress condition who also received social support.

It should be noted that the support manipulation used by Sarason & Sarason (1986) and Tanaka (1990) conflated two distinct types of social support. Specifically, the acknowledgement of appreciation for the subject's participation is more akin to emotional support, while the offer for help is more akin to instrumental support. Subsequently, Tardy (1992) separated out these two dimensions in a study with three conditions: instrumental support, emotional support, and no support. In the instrumental condition, the experimenter told the participant that they would remain in the room while they completed the task to assist them if needed, encouraged them to ask questions, and emphasizes that they would like to help the participant. In the emotional support conditions, participants were instead told that they were making an important contribution to the study, that their participation would help researchers better understand how people solve problems, and that their participation was appreciated. Participants in the no support conditions received neither of these instructions. Results showed that participants in the support conditions completed significantly more anagrams than those in the control condition, and that those in the instrumental condition completed significantly more anagrams than those in the emotional condition. Given previous effects of other types of social presence on performance in vigilance (e.g., Claypoole & Szalma, 2017, 2018a, 2018b, Funke et al., 2016, Yu & Wu, 2015), it may well be the case that socially *supportive* presence could also positively influence performance, workload, and stress associated with vigilance. Moreover, theories of social support directly imply that social support improves well-being by attenuating the stress response. Given the stressful nature of vigilance (Warm et al., 2008), it stands to reason that social support could affect performance in vigilance as it has on other types of cognitive tasks.

Table 1. Studies examining the effect of social support on performance

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
Thorsteinsson et al (1998)	Computer-based firefighting simulation	Video tape of a confederate saying supportive statements (e.g., "That's good," "You're doing fine," "You're more than halfway through, and still doing fine.") while "monitoring" the participant	Confederate "monitoring" participant in silence	N/A	No, but stress (heart rate + cortisol) and perceived task difficulty were lower
Edens (1992)	Mental arithmetic, mirror-tracing task	Touching participant's wrist	No touching	Support giver (friend, stranger, or alone)	No, but friend presence reduced stress

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
Gerin (1995)	"Safari" game: small animals formed at the far left of the screen and ran at varying speeds, participant moves cursor around screen and clicks when animal is under cursor)	Participant brought roommate, who was told: "Your job is to be X's buddy; that is, she's going to play a video game and do her best on it, and you're here to support her and root for her, although not out loud. In fact, all we want you to do is to sit next to X, and although you shouldn't talk or touch her, just try to communicate that you are in her corner as best you can by watching the game and feeling good when she does well."	Alone	Stress (high vs. low): In high stress condition, experimenter verbally urged the subject on, "harassing" to go faster	No, but support increased subjective stress ratings and diastolic BP (though stress ratings were rather low)
Kamarck (1995)	Stroop task and mental arithmetic task	Friend support: Friend described as "support partner" with designated	Alone	Social Threat (high vs. low): In the high threat condition, experimenter wore a	No, but participants in high threat + no support had significant increases in

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
		role "to silently cheer you on." Friend sat next to participant and touched their wrist. To reduce evaluation potential, friend listened to white noise while completing their own set of questionnaires		laboratory coat, introduced himself as a doctor, and acted in a cold, impersonal fashion. Participants were also reminded of experimenter's presence during the task. In the Low threat condition, experimenter dressed informally and offered his first name in the introduction. Participants were not reminded of the experimenter's presence.	SBP and DBP, but those in high threat + no support did not.
Kamarck (1990)	Mental arithmetic, concept formation task	Friend support: Friend was told that their role was to be a "support partner" and "silently cheer them on," asked to touch subject on writs throughout	Alone		No, but heart rate was reduced for both tasks and systolic BP was attenuated for mental arithmetic task

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
		task, but given own tasks to complete and wore a headset to minimize evaluation potential			
Kors (1997)	Mental arithmetic	Friends in both evaluation conditions were instructed to be "nonverbally" supportive of the subjects. They were provided with some concrete suggestions of support (not specified in paper) but were encouraged to do what seemed natural in order to support their friend. Friends assigned to both evaluation conditions were told that they should	Alone	Evaluation (evaluative friend vs. non-evaluative friend): In the non-evaluative condition, a white board was angled so that subject could not see answers or questions, and the friend was given picture books to look through during the task. In the evaluative condition, the friend could see the participant's answers and was not given picture books to look through.	No, but participants in non-eval condition showed reduced systolic BP compared to alone (eval condition did not differ from alone or non-eval)

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
		not talk or actively interact with the subject during the baseline or task periods and should not stare continuously at the subject.			
Tardy (1992)	Anagrams	Instrumental support (Received written message stating: “I will remain here while you complete the task so that I may assist you if needed. Don't hesitate to ask me questions. I'd like to help you.”) vs. Emotional Support (Received written message stating: (“You are making an important contribution to this study. Your cooperation will help us better	No support		Yes; participants in instrumental condition completed significantly more anagrams than those in the control group.

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
		understand how people solve problems. I appreciate your participation in this experiment.") vs. Both (received both written support messages)			
Tanaka (1990)	Word puzzles	Experimenter said: "I will be in the next room while you work on the word puzzles. If you need me for any reason or if you have any questions, don't hesitate to come to see me. I appreciate your participation in this experiment, and I would be happy to provide any assistance you should need."	No support	Stress (high vs. low) In the high stress condition, a video camera present, and participants were told that their behavior was being recorded and would be analyzed. In the low stress condition, no camera was present, and participants were not told their behavior would be analyzed.	No, but participants in the support condition had lower physiological anxiety (i.e., pulse rate) than those in the non-support condition when in the high stress condition, but there were no significant differences in anxiety in the low stress condition.

Paper	Task Type	Support Condition	Control Condition	Other Manipulations	Did support improve performance ?
Sarason & Sarason (1986)	Anagrams	Experimenter said: “I’ll be next door while you work on the anagrams. If you need me for any reason or if you have any questions, don't hesitate to come in. I appreciate your participation in this experiment, and I'd like to be helpful if you should need any help."	No support		Yes. Participants in support condition completed significantly more anagrams than those in the control condition. Cognitive interference was also significantly lower for participants in the support condition.

Theories of Social Support

Direct effects vs. buffering hypothesis

At its inception, theoretical mechanisms for how social support affects stress and health were limited to two perspectives: the direct effects hypothesis and the buffering hypothesis. The direct effects (also referred to as ‘main effects’) model posits that social support is beneficial for health regardless of the presence of stress, while the buffering model hypothesizes that social support is *only* beneficial in the presence of stress. In other words, the buffering model supposes that social support attenuates the negative effects of stress on health and well-being, but only when stress is present (Cohen & McKay, 1984). Subsequent studies have found evidence for

both of these perspectives; evidence for the buffering model is usually found when the support is functional (i.e., tangible forms of support), but evidence for the direct effects model appears when the support is structural (i.e., social network characteristics; Cohen & Wills, 1985; Lett et al., 2005). In other words, functional support seems to be most effective when a stressor is present, but structural support is beneficial for well-being in general. However, the direct effects and buffering models on their own leave much to be desired, as they provide little insight into the mechanisms underlying social support effects. The lack of a theory-driven approach beyond these two models led to wide variability of measures and methodology in social support research, resulting in a largely disjointed conceptualization of social support (Sarason et al., 1990).

Cohen and McKay (1984) attempted to address this limitation by proposing a multidimensional buffering model of social support, in which the effectiveness of support depends on congruency between stress coping demands and available coping resources from the individual's support network. This model is based on appraisal theory, which argues that stress occurs when an individual appraises a situation as threatening but exceeds their available resources to cope with the situation (Lazarus & Folkman, 1984). The authors proposed that, in the presence of stress, social support attenuates the stress response by providing the individual with resources (e.g., informational, emotional support) to help them either re-appraise the situation as less threatening, or cope more effectively with the stress. The authors go on to specify that the degree to which social support is effective depends on how closely the support matches the coping demands of the stressor. For example, when an individual is experiencing stress related to self-esteem or social isolation, emotional support will be more effective than informational or instrumental support because it focuses more directly on the individual's feelings about themselves. In contrast, if an individual appraises a situation as threatening,

informational or instrumental support may be more effective in that they may give alternative coping strategies or tangible resources to address the threat. Regarding the present dissertation, stress theories of vigilance might imply that social support could be effective for performance through its improvement of coping, as stress coping has been identified as a component of task-related stress (e.g., Matthews et al., 2002).

Self-determination Theory

Interestingly, Cohen and McKay's (1985) hypothesis for emotional support also invokes elements of psychological need theories. The authors argue that feelings of belonging may protect against stress in general by helping an individual maintain a positive affect and also by providing a support network to "buffer" against any stressors that directly reduce an individual's feeling of belonging. In other words, the need to belong is an essential element of well-being, and social support serves to fulfill that need, in turn protecting against stress. This perspective is in line with findings from the self-determination theory of motivation, which posits three basic, universal human needs: autonomy, competence, and relatedness (Deci & Ryan, 1985).

Autonomy, in general, refers to the need to feel that one's actions both come from the self (i.e., not forced by others or by the environment) and are in line with one's own sense of self and personal goals. Competence refers to the desire to influence the environment and attain "valued outcomes within it (Deci & Ryan, 2000, p. 231). Finally, the need for relatedness is equivalent to Baumeister and Leary's (1995) need to belong; in other words, it is the need to feel "connected to others (Deci & Ryan, 2000, p. 231)." These needs have been conceptualized as "nutriments" that are essential to human psychological well-being in the same way that food and water are essential for physiological well-being (Deci & Ryan, 2009, p. 441). Thwarting satisfaction of these three needs has detrimental effects on psychological well-being, and task engagement,

which is of particular interest to vigilance research (Deci et al., 1994). Although performance was not measured, Deci et al. found that participants engaged with a monotonous computer-based task for a longer period of time when the experimenter acknowledged the monotony of the task, provided a rationale for the task, and used less controlling language (e.g., 'must' vs. 'can;" pp. 129). With regard to vigilance specifically, Neigel (2017) observed that in many cases, autonomy-supportive instructions reduced perceived workload, but effects of autonomy-support on performance varied greatly depending on task parameters (i.e., cognitive vs. sensory task, source complexity). Such results suggest that supporting autonomy may be, at least, a potentially effective way to improve subjective perceptions of vigilance tasks.

While Cohen and McKay most closely focused on the role of relatedness needs in social support, it may be the case that social support also functions by fulfilling autonomy and competence needs. Moreover, previous investigations of the role of intrinsic motivation in vigilance have focused on facilitating autonomy and competence (Neigel, 2017), but it may the case that social support, and thus fulfilment of the need for relatedness, may also affect performance, stress, and well-being. Further investigation is also needed on the connections between psychological needs and social support.

Triadic Hypothesis

While Cohen and McKay's theory was well-developed in a theoretical sense, empirical research does not appear to clearly support it. Studies have not shown reliable effects of specific types of support on stress and well-being outcomes, and some have even found that general measures of social support are more predictive of outcomes than specific types of support (Sarason et al., 1990a). Sarason et al. (1990a; 1990b) hypothesized that the reason stress-focused theories have yielded inconsistent empirical findings is because they neglect to address the

specific contexts under which support is provided and received. Stress-focused theories argue that the effectiveness of social support depends on congruity between the coping demands of the situation and the coping resources available from the support network. However, emphasizing only the situation, and not and intra- and interpersonal factors, limits the scope of stress-focused theories of social support. For example, one study observed that victims of heart attacks and their spouses often undermined each other's coping with the event (Silver et al., 1990), suggesting that stressful events that affect members of an individual's support network may reduce the beneficial effects of social support. Additionally, Pierce et al. (1990) found that social support is less effective when there is interpersonal conflict between the support provider and receiver, which suggests that interpersonal factors that are not typically accounted for in stress-focused theories moderate the effects of social support provision. Finally, intrapersonal factors may also play a role in the effectiveness of social support. For example, attachment styles and personality traits may affect how individuals perceive available support in the future (Sarason et al., 1990b), which in turn may attenuate the potential benefits of social support.

Given these findings, Sarason et al. (1990b) proposed that the effectiveness of social support results from the interaction of situational, intrapersonal, and interpersonal context in which support is provided. Empirical tests of this theory have partially supported its validity. In one study, researchers measured students' expectations of social support from their mothers, and later had them perform a speech task after receiving supportive messages from their mother before and after the task. Results indicated that students who had higher expectations of support indeed perceived the messages as more supportive than those with lower expectations of support (Pierce et al., 1992), suggesting that intrapersonal factors like expectations of support do influence the effectiveness of support.

It should be noted that Sarason et al.'s (1990b) triadic hypothesis may still perhaps be explained in terms of stress. The effectiveness of social support could perhaps depend on the degree of stress present in each of the three contexts: situational, interpersonal, and intrapersonal. Stress buffering theories typically dichotomize a situation as either stressful or not stressful to make predictions about the effectiveness of social support. While this may be a necessary first step, Sarason et al.'s findings suggest that stress buffering theories could be extended to incorporate the triadic hypothesis. If it is the case that a situation is stressful, a next step in the stress-buffering model may be determining the degree to which stress is present in the interpersonal and intrapersonal contexts under which it is given. For example, evaluation potential has been shown to affect the relationship between social support and stress (Kors et al., 1997; Thorsteinsson et al., 1999).

Evaluative Presence and Social Support

One potential factor that may be detrimental to the interpersonal context of social support, and thus weaken its effectiveness, is social facilitation. For all its apparent benefits, in some cases social support is associated with *higher* levels of stress. For example, one study had participants complete a speech task in the presence of a supportive or non-supportive observer, or alone. It was subsequently observed that participants in the alone condition had significantly lower levels of cardiovascular stress than those in the support and non-support conditions, though the comparison was not significant when a Bonferroni correction was used (Anthony & O'Brien, 1999). Such findings are inconsistent with the idea that social support should decrease stress and have led researchers to examine potential moderators of social support. In Anthony & O'Brien's (1999) study, support was provided by a confederate who was a stranger to the participant, which has been hypothesized to increase stress. Indeed, Christenfield et al., (1997)

found that support from a friend attenuates stress more than support from a stranger. However, other studies have observed that support from a friend can sometimes be more stressful than support from a stranger (Thorsteinsson and James, 1999). These findings highlight both the role of interpersonal factors in the effectiveness of social support and suggest there may be other moderating factors in this relationship.

Sheffield and Carroll (1995) manipulated support by having a confederate either agree or disagree with a participant's answers on an art discrimination task. They found that participants in the unsupportive condition had higher cardiovascular reactivity than the alone condition but found no effect of the supportive condition on reactivity. These findings led the authors to suggest that evaluation potential may interfere with the effects of social support. Sheffield and Carroll (1995) hypothesized that their results could be due to methodology. In their manipulation, the confederate evaluated and provided feedback on some aspect of the participant's performance. Whether that feedback was positive or negative, their evaluative presence was likely inherently stimulating, which may explain why even a supportive confederate could increase stress. Indeed, Kors et al. (1997) found that evaluation attenuates the effect of social support on women's cardiovascular reactivity during a laboratory task. Evaluative presence was subsequently identified as a moderator of social support in Thorsteinsson and James' (1999) meta-analysis. Effect sizes of heart rate and systolic blood pressure were higher when evaluation potential was low versus when it was high, indicating that social support may be most effective in conditions of low evaluation potential. In this meta-analysis, evaluation was also shown to influence the effectiveness of support from a friend; support from a friend did not attenuate stress when the potential for evaluation during the given task was high. Additionally, Hilmert et al. (2002) observed that during a public speaking task, participants who received

social support had lower cardiovascular reactivity (CVR) when also in the presence of a white-coated experimenter, but higher CVR when the experimenter was absent. These findings suggest that any examination of social support in task performance must address the issue of evaluation potential.

Some of the challenges in developing comprehensive theories of social support are mirrored in social facilitation. Inconsistencies in methodology and differences in operational definitions of social presence plague both bodies of research, resulting in two practically interesting but theoretically underdeveloped social presence constructs. For social support in particular, little theory exists as to how support might improve performance, despite the fact that task performance is inherent to most experimental evaluations of the effect of social support on stress.

The Theoretical Case for Social Support in Vigilance

Taken together, research on social support does suggest that the supportive presence of others may have beneficial effects on performance. Vigilance tasks tend to impose a high mental workload and are stressful to the observer (Warm et al., 2008). Stress, in turn, decreases performance when it exceeds the adaptational capabilities of the observer (Hancock & Warm, 1989). In other words, when the task demands exceed the observer's capacity to effectively respond, performance declines. Indeed, it has been found that task engagement decreases and stress increases on vigilance tasks with longer time on watch (Szalma et al., 2004). Thus, while vigilance tasks are boring, they are also inherently mentally demanding and stressful. Finding ways to attenuate stress may then be a promising avenue for improving both well-being and performance during vigilance tasks. Given that social support is purported to function by its reduction of stress, support may thus also improve performance on vigilance tasks.

Outside of its potential alleviation of stress, it may be the case that social support directly interacts with attention. In the context of a driving task, Kimbler et al (2012) found that social support during the task was associated with lower self-reported instances of distracting thoughts (Kimbler et al., 2012), which has led them to hypothesize that social support may influence attentional resources. Additionally, Sarason & Sarason (1986) observed that participants who received social support during their anagram task also scored lower on a measure of cognitive interference. It should be noted that Tardy (1992) was unable to replicate this effect, although the manipulations of social support in these two studies differed, perhaps critically, in that support was provided verbally in Sarason & Sarason's study but in written format in Tardy's study. It may be the case that the written manipulation was not salient enough to elicit the effect of social support on cognitive interference. While limited, these studies suggest that social support may improve performance by alleviating cognitive interference. However, this theoretical perspective is extremely underdeveloped, due to most studies focusing on health or well-being related outcomes rather than the specific effect of social support on cognitive processes.

Others have suggested that social support may interact with motivation to affect task performance and associated stress. Given inconsistent findings in the effect of social support on CVR, Teoh and Hilmert (2018; also see Teoh, 2015) hypothesized that, in some cases, social support may *attenuate* CVR, acting as a 'comfort' in times of stress. In other cases, social support may *heighten* CVR, acting as an encouragement for the individual to take some sort of action to cope or deal with the stressor, which may explain why some studies have found support for the stress-buffering hypothesis while others have not. For example, the stress buffering and stress inducing effects observed in Hilmert et al. (2002) could be explained by this 'dual-effects' model. When the white-coated experimenter was present, social support served to assuage the

stress and anxiety imposed by the experimenter, subsequently reducing CVR. When the experimenter was absent, however, the lack of evaluation apprehension lowered arousal and task engagement. Instead of attenuating CVR then, social support heightened CVR by functioning as an encouragement to devote more effort toward the task. To test these predictions, Teoh (2015) had participants complete a public speaking task on a topic that was either engaging or non-engaging, based on pilot work. During the speech, participants either did or did not receive social support from an audience. Results indicated that engagement moderated the effect of social support on cardiovascular reactivity, such that there was no significant effect of support on CVR when the speech topic was engaging. Additionally, participants who gave speech on a non-engaging topic *and* received support showed greater cardiovascular reactivity, which the authors interpreted as evidence for their support-as-encouragement hypothesis. However, when the topic *was* engaging, social support did *not* reduce CVR, contrary to the support-as-comfort hypothesis.

Although task engagement in this study was not based empirically validated measures like the DSSQ and did not consider the effect of support on performance, the dual-effects theory has some interesting implications for the effect of social support on vigilance. Affective responses to vigilance tasks are characterized *both* by low task engagement *and* high distress (e.g., Szalma et al., 2004). In other words, vigilance is both boring and stressful. If Teoh and Hilmert's theory extends to task performance, it may be the case that social support can improve performance by either increasing motivation and encouraging effort towards the task, or by assuaging stress and anxiety. The former would be more in line with underload theories of vigilance; the task operator is disengaged, so improving performance would need to increase engagement. By contrast, overload theories of vigilance would suggest that vigilance imposes such high levels of stress that few cognitive resources are left for the task. In that case, if social

support were to have an effect, it would need to relieve the excess stress (i.e., act as a 'comfort' rather than an 'encouragement'). Although these constructs have yet to be examined in the vigilance literature, their investigation would be crucial to a better understanding of the effect of the social environment on performance, workload, and stress in vigilance.

Gaps in the Literature

Taken together, the potential effects of social support on stress, cognitive interference, and motivation, suggest that social support could affect vigilance performance, stress, and mental workload. However, the present dissertation is the first to explore this idea all together. Thus, there are fundamental gaps in the literature that must be addressed.

Beginning with the vigilance realm, the limited studies of social presence in vigilance have typically employed quite basic forms of social presence, likely due to the social facilitation-based approach of this research. In recent studies of social presence in vigilance (e.g., Claypoole & Szalma, 2017; 2018a, 2018b; Funke et al., 2016, Yu & Wu, 2015), the observer or co-actor did not verbally interact with the participant. While it is interesting that this limited form of social presence still had effects on vigilance, in the real-world, social interactions during cognitively demanding tasks may be more complex. For example, an evaluator might be verbally supportive (or unsupportive), give performance-based feedback, or otherwise converse with the participant during the task. Thus, while it is necessary to replicate existing social presence manipulations, research on social presence in vigilance should also consider more complex forms of social presence (e.g., socially supportive or unsupportive presence) that operators may encounter when performing vigilance tasks in applied settings.

In examining more rich forms of social presence, a number of questions remain to be answered. What is the effect of these different types of social presence on performance,

workload, and stress compared to existing manipulations? If the effects are different, why? It may be the case that more complex forms of social presence are distracting and might thus decrease performance. In the case of socially supportive presence, theory would suggest that social presence directly attenuates stress, and thus should improve performance. Moreover, how would these effects differ across task types and parameters? In other words, how far do the effects of social presence on vigilance extend? Given that the role of the social environment in vigilance is a relatively nascent area of research, such research questions have yet to be thoroughly investigated.

Regarding the social support literature, perhaps the biggest gap relevant to the present dissertation is the lack of theory-based predictions on the effect of social support on cognitive performance. Although cognitive task performance is frequently used in experimental examinations of social support, there has been little consideration as to how or why social support might also affect performance. In other words, cognitive performance has been used as a vehicle to study the effects of social support on stress, rather than a focal variable. However, if it is the case that social support *can* improve performance on cognitive tasks via its reduction of stress, then this may be a crucial finding for the improvement of performance not just in vigilance, but other operationally relevant tasks.

Additionally, it remains difficult to untangle whether social presence affects performance by its potential for evaluation or its potential for social support. Although efforts have been made to reduce evaluation potential (e.g., the white board occluding participant performance from the supporter in Kors et al., 1997), it may be the case that social presence is interpreted as evaluative even when the manipulation is specifically designed to prevent evaluation. Moreover, there has been extremely limited research on the relationship between social support and attentional

resources, despite some speculation that the two processes may affect each other based on observed effects of social support on distracting thoughts (Kimbler et al., 2012) and cognitive interference (Sarason & Sarason, 1986). Similar to research on social presence in vigilance, some of the inconsistencies in the social support literature may be explained by the rather simple manipulations of support that has been utilized in many studies (e.g., the silent supporter method). It may be the case that such manipulations are too weak to elicit the beneficial effects of support in the laboratory that arise in long-term, longevity-based examinations. Moreover, silent-supporter type manipulations do not necessarily address the specific task demands or internal states that contribute to stress. It may be fruitful to manipulate social support in a way that directly addresses empirically validated psychological needs. All in all, it seems clear that both the effect of the social context on vigilance *and* the effect of social support on cognitive performance are empirically underdeveloped. Thus, these areas are ripe for continued experimentation, which the present dissertation seeks to explore.

CHAPTER FOUR: THE PRESENT DISSERTATION

Although vigilance tasks are likely performed in the presence of others in the real-world, there is surprisingly little empirical research examining how and why social presence might affect performance, workload, and stress in vigilance. Of that research, none have yet explored the effect of social support on vigilance, despite evidence that both have the potential to attenuate stress and improve performance on other cognitive tasks. Thus, the present dissertation seeks to compare the effects of social support on performance, workload, and stress to the effects of existing social presence manipulations in vigilance, in an effort to better understand the effect of the social environment on vigilance.

A secondary goal of this dissertation is to lay the groundwork for replicable manipulations of social support for sustained attention. As described in the preceding literature review, lab-based social support research has long suffered from the absence of an empirically validated experimental paradigm to enact social support in the laboratory. Moreover, the effect of social support on task performance specifically has only been examined in a very limited number of tasks. Thus, in developing an experimental manipulation of social support for vigilance specifically, it is methodologically preferable to stay as close to existing manipulations of social presence in vigilance as possible. In other words, building the novel social support manipulations off of a social presence manipulation that has *already* been shown to affect vigilance should be more likely to allow for the observation of social support effects.

The presence of an evaluative observer has been previously associated with higher correct detections and lower false alarm rates in vigilance (Claypoole & Szalma, 2018; Claypoole & Szalma, 2019). Evaluation apprehension has been a challenge to address in social

support research, as it may reduce the beneficial effects of social support for stress (Thorsteinsson & James, 1999). However, even by reducing evaluation apprehension by having the other person in the room complete a separate task, wear headphones, and be out of sight of the participant's screen, there is no guarantee that the presence of another person will not be perceived as evaluative. For example, even a "supportive" statement like "You are doing fine (see Searle et al., 1999)" is inherently evaluative, as it implies that the observer was monitoring the participant's performance enough to know that they were doing fine. Tanaka et al. (1990) addressed this issue by having the experimenter leave the room during the task, only providing socially supportive instructions before the participant began the task. On the other hand, however, this less salient manipulation may have impeded the authors' ability to enact effective social support. Moreover, social support during task performance in the real world is likely to have an evaluative component; it is hard to imagine a situation where an operator would receive unconditional social support without some sort of performance-based feedback, if they are completing the task in the presence of another person.

Rather than taking potentially fruitless steps to eliminate evaluation entirely, the experimental manipulation of social support in this dissertation extended the existing evaluative observer manipulation and independent co-actor manipulations in vigilance (Claypoole, 2017; 2018a; 2018b) with the creation of a 'supportive' observer, 'supportive co-actor,' 'non-supportive' observer, and a 'non-supportive' co-actor, who will provide statements to the participant throughout the vigilance task. in an effort to examine the potential effects of social support across two different types of social presence. The effect of these types of social presence will be directly compared to evaluative presence, mere presence, independent co-actor presence,

and performing the vigilance task alone, all manipulations which have been examined in the context of vigilance in previous research.

Based on Cohen & Mckay's (1984) model of social support, social support will be effective at buffering stress only to the degree to which the support 'matches' the coping demands of the stressor. Fortunately, the stress profile of vigilance has been rather well-established through years of research using the DSSQ (e.g., Matthews, 2021; Matthews et al., 2010, Szalma et al., 2004, Teo & Szalma, 2011; Warm et al., 2008). Thus, the supportive and non-supportive statements used as experimental manipulations of support will be derived directly from the DSSQ items pertaining to stress in vigilance (i.e., task engagement and distress). The items from the task engagement and distress subscales of the DSSQ will be modified to be supportive or non-supportive based on both social support and self-determination theory, toward a more theory-based manipulation of social support, which many other studies have lacked.

To reiterate, the primary goals of the present dissertation are to (1) explore the effect of social support versus non-support on performance, workload and stress related to vigilance in (2) two different forms of social presence, as well as (3) compare the effects of these novel manipulations to the effects of existing social presence manipulations in vigilance. Secondarily, this dissertation aims to provide a foundation for the experimental manipulation of social support in the laboratory. More broadly, however, the present dissertation seeks to continue to bridge the gap between social psychology and human factors psychology, two fields which might greatly inform each other but that rarely interact in existing literature.

CHAPTER FIVE: PILOT STUDY

The present dissertation began with a pilot study as an initial manipulation check of the supportive and non-supportive conditions. As previously described, the statements provided in the supportive and non-supportive conditions of each study are directly based on the task engagement and distress scales of the DSSQ, in an effort to accurately target the sources of stress in vigilance. First, each of the items were adapted to include supportive language based on based on Deci & Ryan's (2004) and Deci et al (1994)'s statements to support intrinsic motivation, which are quite similar to statements used in previous social support manipulations (Sarason & Sarason, 1985; Tanaka et al., 1990, Tardy, 1992). For example, "I know this task might be dull, but you're making an important contribution to scientific research," is analogous to the emotional support manipulation in Tardy (1992). Thus, this manipulation is meant to bridge the theoretical gap between the social support literature and the self-determination theory literature, which is inherently based on the *support* of psychological needs. Then, an analogous non-supportive statement was created by removing the supportive language and replacing it with controlling language, again based on Deci & Ryan (2004). A full list of the statements along with the DSSQ items they were based on is presented in Table 2.

Each statement begins with an acknowledgement of the stress associated with the task, followed by at least one encouraging statement in the supportive condition, or a controlling statement in the non-supportive condition (e.g., "I know you might be tired" + "but try to stay alert" + "I know you can do it"). Each supportive statement and it's corresponding non-supportive statement have been matched for an equal number of semantic phrases and statement length.

Table 2. Supportive and Non-Supportive Experimenter Statements by original DSSQ item

Primary Factor	Secondary Factor	Questionnaire Items	Experimenter Supportive Statement	Experimenter Non-supportive Statement
Task Engagement	**Energetic Arousal**	• I felt alert. • I did not feel tired.	I know you might be tired but try to stay alert. I know you can do it.	This task makes you tired; you need to stay alert. You must be able to do it.
	Motivation	• How motivated were you to do the task? • Do you think the content of the task was: (scale from very dull to very interesting)	I know this task might be dull, but you're making an important contribution to scientific research. Stay motivated!	This task is dull, but it must be researched. You need to be motivated to complete this task.
	Concentration	• I found it hard to maintain my concentration for more than a short time. •My mind wandered a great deal.	You may be finding it hard to stay concentrated, but it's normal to feel like your mind is wandering.	You need to stay concentrated. Do not let your mind wander.
Distress	**Tense Arousal**	• I felt tense. • I did not feel calm.	It's easy to feel tense during this task but try to stay calm. I know you have the skills to do this.	This task makes you feel tense. You must stay calm. You should have the skills to do this.
	Hedonic Tone	• I felt dissatisfied.	I know this task might make you feel dissatisfied, but it's an important one to research. We really appreciate your participation.	This task induces feelings of dissatisfaction, but it needs to be researched. Your participation is required.

Primary Factor	Secondary Factor	Questionnaire Items	Experimenter Supportive Statement	Experimenter Non-supportive Statement
	Confidence /Control	• Generally, I felt in control of things. • I felt as smart as others.	You may be feeling like you're not in control of the task, but don't worry. You're just as capable as others. I'm here for anything you need.	This task makes people feel that they are not in control. You may not be as capable as others. I am not able to help you.

Table 3. Supportive and Non-Supportive Co-Actor Statements by original DSSQ item

Primary Factor	Secondary Factor	Questionnaire Items	Co-actor Supportive Statement	Co-Actor Non-Supportive Statement
Task Engagement	**Energetic Arousal**	• I felt alert. • I did not feel tired.	I'm starting to feel tired, but let's try to stay alert. I know we can do it.	This task makes people tired. You need to stay alert. You need to be able to do it.
	Motivation	• How motivated were you to do the task? • Do you think the content of the task was: (scale from very dull to very interesting)	I know this task feels dull, but I know we're making an important contribution to scientific research. Let's stay motivated!	This task is dull, but it must be researched. You need to be motivated to complete this task.
	Concentration	• I found it hard to maintain my concentration for more than a short time. •My mind wandered a great deal.	I'm finding it hard to stay concentrated, but I'm sure it's normal to feel like your mind is wandering.	You need to stay concentrated. Don't let your mind wander.
Distress	**Tense Arousal**	• I felt tense. • I did not feel calm.	This task makes me feel tense, but let's try stay calm. I know we have the skills to do this.	This task makes you feel tense. You have to stay calm. You should have the skills to do this.
	Hedonic Tone	• I felt dissatisfied.	This task feels dissatisfying to complete, but I know it's an important one to research. I bet the researchers really appreciate our participation.	This task is dissatisfying but it needs to be researched. Your participation is required.

Primary Factor	Secondary Factor	Questionnaire Items	Co-actor Supportive Statement	Co-Actor Non-Supportive Statement
	Confidence/Control	• Generally, I felt in control of things. • I felt as smart as others.	I'm feeling like I'm losing control of this task, but I'm sure we're just as capable as others. I'm here for anything you need.	This task feels out of our control. We may not be as capable as others. I am not able to help you.

Methodology

Participants

95 participants were recruited from the University of Central Florida via the SONA Psychology Research Participation System. Participation in this experiment was completely voluntary, though some participants may have received course credit for their participation.

Software Platforms

The pilot study was conducted online via Qualtrics. Participants were able to complete the study at a location and time of their choosing. They were also able complete the study on a desktop computer, laptop, tablet, or mobile phone.

Measures

Rating Perceived Social Support

For the experimenter statements, participants were asked to respond to the following prompt on a scale of 1 to 5 (not at all supported to very much supported), based on Teoh and Hilmert's (2015) Perceived Social Support Scale: "Imagine that you were completing a task for research in the presence of a **supervisor.** Rate the following statements based on how **supported**

you would feel if the supervisor said them to you while you were performing the task." For the set of co-actor statements, they were asked to respond to the following prompt on the same scale: "Imagine that you were completing a task for research alongside **another research participant**. Rate the following statements based on how **supported** you would feel if the **research participant** said them to you while you were performing the task." Within each set of statements (i.e., experimenter or co-actor), the order of the items was randomized. In other words, participants saw a combined list of the supportive and non-supportive statements in random order. The design of this pilot study was within-subjects, such that all participants rated both the experimenter and co-actor statements.

Procedure

After consenting to participate in the study, participants were presented with a list of the experimenter statements and co-actor statements, which were presented at random.

Results

Differences in perceived supportiveness among the statements were assessed via paired samples-tests, with each pair consisting of a supportive statements and its corresponding non-supportive statement. For both the experimenter and co-actor statements, results indicated that all of the supportive statements were rated as significantly more supportive than the non-supportive statements, and the magnitude of these effects were large (see Tables 2 and 3).

Table 4. Paired sample t-test results for each pair of experimenter statements

Statement Pair	Supportive		Non-supportive		*t*(94)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
"I know you might be tired but try to stay alert. I know you can do it." **vs.** ***"This task makes you tired; you need to stay alert. You must be able to do it."***	3.36	1.32	1.66	1.41	10.697	<.001	1.10
"I know this task might be dull, but you're making an important contribution to scientific research. Stay motivated!" **vs.** ***"This task is dull, but it must be researched. You need to be motivated to complete this task."***	3.58	1.28	1.68	1.40	11.83	<.001	1.21
"You may be finding it hard to stay concentrated, but it's normal to feel like your mind is wandering. **vs.** ***You need to stay concentrated. Do not let your mind wander."***	3.22	1.26	1.69	1.44	8.78	<.001	.90
"It's easy to feel tense during this task but try to stay calm. I know you have the skills to do this." **vs.** ***"This task makes you feel tense. You must stay calm. You should have the skills to do this."***	3.69	1.24	2.04	1.44	9.55	<.001	.98
"I know this task might make you feel dissatisfied, but it's an	3.17	1.36	1.63	1.35	9.31	<.001	.955

Statement Pair	Supportive		Non-supportive		*t*(94)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
important one to research. We really appreciate your participation." **vs.** ***"This task induces feelings of dissatisfaction, but it needs to be researched. Your participation is required."***							
"You may be feeling like you're not in control of the task, but don't worry. You're just as capable as others. I'm here for anything you need." **vs.** ***"This task makes people feel that they are not in control. You may not be as capable as others. I am not able to help you."***	3.83	1.37	.78	1.10	15.72	<.001	1.61

Table 5. Paired sample t-test results for each pair of co-actor statements

Statement Pair	Supportive		Non-supportive		*t*(94)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
"I'm starting to feel tired, but let's try to stay alert. I know we can do it." **vs.** ***"This task makes people tired. You need to stay alert. You need to be able to do it."***	3.21	1.33	1.72	1.32	9.49	<.001	0.97
I know this task feels dull, but I know we're making an important contribution to scientific research. Let's stay motivated! **vs.** ***"This task is dull, but it must be researched. You need to be motivated to complete this task."***	3.35	1.26	1.58	1.25	10.47	<.001	1.08
"I'm finding it hard to stay concentrated, but I'm sure it's normal to feel like your mind is wandering." **vs.** ***"You need to stay concentrated. Don't let your mind wander."***	2.72	1.23	1.77	1.36	6.08	<.001	0.62
"This task makes me feel tense, but let's try to stay calm. I know we have the skills to do this." **vs.** ***"This task makes you feel tense. You have to stay calm. You should have the skills to do this."***	3.31	1.26	2.07	1.48	6.85	<.001	0.70
"This task feels dissatisfying but I know it's an important one to research. I bet the researchers	2.82	1.41	1.54	1.41	6.81	<.001	0.70

Statement Pair	Supportive		Non-supportive		*t*(94)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
really appreciate our participation." **vs.** ***"This task is dissatisfying but it needs to be researched. Your participation is required."***							
"I'm feeling like I'm losing control of this task, but I'm sure we're just as capable as others. I'm here for anything you need." **vs.** ***"This task feels out of our control. We may not be as capable as others. I am not able to help you."***	3.25	1.34	.82	1.02	13.07	<.001	1.34

CHAPTER SIX: METHODOLOGY

An experiment was conducted to examine the effect of socially supportive and non-supportive observers and co-actors on performance, workload, and stress in a vigilance task. This experiment is the first to directly explore the effect of social support on vigilance as presently defined. The novel support manipulations were also compared to four existing experimental manipulations of social presence in vigilance: an evaluative observer (i.e., who is monitoring the participant's performance), a merely present observer (i.e., who is *not* monitoring performance), an independent co-actor (who performed the same task on a computer next to the participant), and completing the task alone. Specifically, this experiment was designed to address the following research questions:

RQ1: Does the provision of socially supportive statements during a vigilance task improve performance, workload, and stress over non-supportive statements?

RQ2: Do the effects of socially supportive and non-supportive statements on performance, workload, and stress differ when provided by an observer versus a co-actor?

RQ3: Do the effects of socially supportive and non-supportive statements on performance, workload and stress differ from the effects of existing social presence manipulations (i.e., evaluative observer, mere presence, independent co-actor)?

> **RQ3.1:** Do the effects of the existing social presence manipulations on performance, workload, and stress replicate previous findings?

RQ4: How does providing socially supportive or non-supportive statements during the vigilance task affect performance, workload and stress compared to performing the vigilance task alone?

Based on prior literature, it is hypothesized that:

H1:

The provision of socially-supportive statements will yield higher performance, lower workload and distress, and higher task-engagement than the provision of non-supportive statements.

H2:

Socially supportive statements, when delivered by a co-actor, will yield higher performance, lower workload and distress, and higher task-engagement than supportive statements delivered by an observer.

H3:

Among the social presence conditions, participants in the supportive conditions will achieve the highest performance, report the highest task engagement, and report the lowest levels of distress and workload, followed by the independent co-actor, evaluative observer, non-supportive observer, and mere presence conditions.

H3B:

Participants in the existing social presence conditions (i.e., independent co-actor, evaluative observer, and mere presence) will achieve higher performance than those in the alone condition.

H4:

Participants in all the statement conditions (i.e., supportive observer, non-supportive observer, supportive co-actor, and non-supportive co-actor will achieve higher performance than those in the alone condition, with participants in the supportive conditions outperforming those in the non-supportive conditions.

Methodology

Participants

Based on a power analysis for an ANOVA with repeated measures, between factors in G*Power 3.1.9.6 (see Table 2; Faul, Erdfelder, Lang & Buchner, 2007), 232 participants were needed to detect a medium effect size, but a total of 241 participants were recruited to account for outliers and missing data. Participants were recruited from the University of Central Florida via the SONA Psychology Research Participation System. Participants ranged in age from 18-53 years old, with a mean age of 19 (SD = 2.876). Regarding sex and gender, 58.5% (N = 141) of participants reported that they were females assigned at birth, and 50.6% (N = 122) of participants identified as women. Lastly, 54.8% of participants identified as White (N = 132). Participation in this experiment was completely voluntary, though participants received course credit for their participation.

Table 6. Power Analysis for Experiment One

Experiment	Effect size (f)	α Error Probability	Power (1-β Error Probability)	Number of Measurements	Number of Groups	Number of Participants
1	0.25	0.05	0.95	4	8	232

Software Platforms

The vigilance task was presented using SuperLab software (version 4.5) on a desktop computer. Participants were seated approximately 50.8 centimeters from the computer screen in a cubicle with uniform lighting. Questionnaires were presented on the same computer via

Qualtrics. All raw data was combined and exported using IBM statistical package for Social Sciences (Version 26.0; IBM Corporation, Armonk, N0Y, US) and Microsoft Excel.

Design and Experimental Conditions

The present study utilized a between-subjects design. Participants were assigned at random to one of eight experimental conditions, which are summarized in Table 7.

Observer Conditions

In all of the observer conditions, the experimenter also served as the task observer. In the evaluative observer condition (see Claypoole & Szalma, 2018a), the experimenter stayed in the room with the participant while they completed the task. The experimenter told the participant that they would be monitoring and taking notes on their performance during the task. During the task, the experimenter audibly wrote notes on a clipboard periodically, to create the sense that they were indeed monitoring performance.

In the social support condition, rather than writing notes on a clipboard, the experimenter instead gave supportive statements every three minutes throughout the task. To control for the effect of verbal statements, in a separate condition, a non-supportive observer gave corresponding neutral statements every three minutes, each of which were created to be non-supportive counterparts to the supportive statements. The full list of the statements can be found in Table 2.

The evaluative observer condition was also included as a control to the two novel support conditions. A separate condition utilized the merely present observer manipulation (Claypoole & Szalma, 2018a; Claypoole et al., 2019) to partially control for evaluation apprehension (but again, even a merely present observer may still be interpreted as evaluative; Claypoole &

Szalma, 2018a). In this condition, the experimenter explicitly told the participant that they would not be monitoring their performance but would instead be doing their own work at a desk adjacent to the participant and out of view of their screen.

Co-actor Conditions

For all co-actor conditions, the participant was informed that informed that the study required two participants to complete, and the second participant (in actuality, a confederate co-actor) had arrived earlier and was in the other room completing surveys. The experimenter then instructed the participant to go into a separate room to complete the pre-task questionnaires alone, in an effort to ensure that questionnaire responses were not contaminated by social presence (Claypoole & Szalma, 2018b). After completing the pre-task questionnaires, the experimenter brought the confederate into the experimental room to complete the task alongside the participant.

Before beginning the task, the experimenter stated that although the two 'participants' would be completing the same task, their performance would be evaluated independently. This statement was provided to minimize feelings of competitiveness between the participant and confederate (Claypoole & Szalma, 2018b). The participant and co-actor were not able to see one another's screens, as a cubicle wall was present between the two computer work stations. After completing the task, the confederate and participant were told that they would now complete the post-task questionnaires on the same computer as the pre-task questionnaires, leaving the participant to complete the remaining questionnaires alone in the experimental room.

In the independent co-actor condition, the co-actor did not speak to the participant at all during the task. Instead, they sporadically pressed the space bar to give the illusion that they were completing the task, following the protocol of Claypoole & Szalma (2018b). The

participant and co-actor were also told not to communicate or work together on the task. The co-actor was also instructed to respond arbitrarily throughout the task.

The supportive and non-supportive co-actor conditions (i.e., co-actor statement conditions) followed the same structure as the corresponding observer conditions, except that the supportive statements and non-supportive statements were provided by the co-actor rather than the experimenter. Additionally, the statements were modified to remove references to the participant's performance, as the participant's screen was completely occluded from the co-actor. A full list of the co-actor statements can be found in Table 2. In the co-actor statement conditions, before beginning the task, the experimenter informed the participant and co-actor that the next part of the study required one of them to read a set of statements out loud during the task, and that this would be assigned at random. The experimenter then asked the participant and co-actor to choose a number between one and ten. The experimenter then stated that the co-actor's number was closer, and handed them a printed sheet containing the statements.

Lastly, to allow for the assessment of all social presence conditions versus no social presence, participants in the alone condition completed the task in a room by themselves. See Table 7 for a summary of experimental conditions.

Table 7. Summary of Experimental Conditions

Experimental Condition	Description
Evaluative Observer	Told participants that their performance would be monitored by the researcher. Sat behind participant and wrote on clipboard.
Supportive Observer	Sat behind participant and uttered supportive statements every 3 minutes.
Non-Supportive Observer	Sat behind participant and uttered non-supportive statements every 3 minutes.
Mere Presence	Told participants they would be doing own work that the researcher would not be monitoring them. Sat at desk adjacent to participant.
Independent Co-Actor	Sat at desk next to participant and responded sporadically to the task. No communication with participant.
Supportive Co-Actor	Sat at desk next to participant and responded sporadically to the task, while uttering supportive statements every 3 minutes.
Non-Supportive Co-Actor	Sat at desk next to participant and responded sporadically to the task, while uttering non-supportive statements every 3 minutes.
Alone	Participant completed task alone, with no one else in the room.

Experimental Task

The vigilance task utilized in this experiment was a cognitive discrimination task based on Deaton & Parasuraman (1993; see also Teo & Szalma, 2011). Participants were required to monitor a display of two-digit numbers and press the spacebar when they detected a critical signal. A critical signal was defined as cases in which the two digits differed by a value of zero or one. Each set of digit pair was presented for 150 milliseconds, after which a blank screen was

shown for 1350 milliseconds (interstimulus interval). The task lasted 24 minutes in duration, with 4 continuous periods of 6 minutes in length. There were 5 critical signals presented in each period for a total of 20 critical signals during the vigil. The timing of the critical signals was randomized within each period and then held constant for all participants.

Measures

Stress

Perceived stress was measured before and after the task using the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 1999, 2002, 2013). The DSSQ measures task related stress via 11 subscales which comprise a total of three secondary factors (task engagement, distress, and worry). Task engagement measures concentration, energy, and motivation. Distress measures tension, hedonic tone, and confidence-control, while worry measures self-esteem, self-focus, concentration and both task-relevant and task-irrelevant cognitive interference. (Matthews et al., 2003; see Appendix B).

Workload

Perceived workload was measured after the task using the NASA Task Load Index (NASA-TLX; Hart, 2006; Hart & Staveland, 1988). Participants first responded to the six scales of the measure: mental demand, temporal demand, physical demand, performance, effort,, and frustration. Then, participants completed pairwise comparisons of each of the six subscales by indicating which subscale in each pair was the more important contributor to their experience of workload. These ratings were then used to compute a global workload score as a weighted average of the six subscale ratings.

Procedure

Upon arrival, participants were brought into the experimental room, asked to remove any timepieces, and silence their cellphone. For the purpose of experimental control, the experimenter was always female. After administering the informed consent, the experimenter left the room. The participant then completed a demographic questionnaire, followed by the Pre-DSSQ questionnaire. After completing the pre-task questionnaires, the experimenter re-entered the room, read the task instructions, reviewed example stimuli, and answered any questions the participant may have had. A 5-minute practice session followed to acquaint participants with the task. Depending on the experimental condition, either the experimenter or co-actor was present during the practice session, except in the alone condition where the participant completed the practice session alone. No feedback was provided during the practice session, which was immediately followed by the 24-minute experimental task. For participants in the evaluative observer, supportive observer, non-supportive observer, and mere presence conditions, the experimenter remained in the room throughout the duration of the vigilance task. For participants in the alone or co-actor conditions, the experimenter returned to the room once the task was completed and instructed the participant to complete the post-task questionnaires (i.e., DSSQ-Post, NASA-TLX, IMI, PLoE, Perceived Social Support). The experimenter and co-actor (depending on assigned condition) again left the room during the completion of the post-task questionnaires. After completing the post-task questionnaires, participants were provided a debriefing form and were thanked for their participation.

CHAPTER SEVEN: RESULTS

Exclusion Criteria

Of the 244 participants who completed the study, data from one was initially removed from the sample due to not completing the vigilance task, and data from two others were removed for completing the vigilance task incorrectly (i.e., pressing the spacebar for only neutral signals instead of only critical signals). Additionally, outliers were identified via two methods. First, z-scores were calculated for performance during each period of the vigil on each of the dependent performance measures (i.e., correct detections, false alarms, median response time, sensitivity, and response bias). Participants whose scores who were more than 3 standard deviations away from the mean in at least 3 out of 4 periods on any given measure were identified as potential outliers. Then, boxplots were constructed for each measure and each period to identify participants whose scores fell outside of the boxplot. Participants whose scores were outside of the boxplot on 3 or more periods for two or more measures (e.g., an outlier for three periods on correct detections and false alarms) were also identified as potential outliers. Finally, participants who were identified as potential outliers both with the z-score method and with the boxplot method were deemed to be outliers and were subsequently excluded from analyses. 5 such participants met these criteria, yielding a final sample of 236 participants (see Table 6 for a breakdown of participants by condition). See Appendix D for summary graphs of results across all experimental conditions, and Appendix E for tables of means and standard deviations of dependent variables across experimental conditions.

Table 8. Final sample sizes by condition

	Evaluator	Mere Presence	Supportive Observer	Non-Supportive Observer	Co-Actor	Supportive Co-Actor	Non-Supportive Co-Actor	Alone
N	30	31	30	30	30	28	29	28

Research Questions 1 and 2

Statistical Approach

To assess the effect of supportive and non-supportive statements on performance, stress and workload, and whether their effects differed when provided by an observer versus a co-actor, only participants in experimental conditions where statements were provided were included in the analyses to address the first two research questions, hereto referred to as 'statement conditions.' For performance measures (i.e., proportion of correct detections, proportion of false alarms, median response time, perceptual sensitivity, and response bias), mixed 2 (Supportive Statements vs. Non-Supportive Statements) X 2 (Observer vs. Co-actor) X 4 (Period on Watch) ANOVAs were conducted, with repeated measures on the third factor. For measures in which the assumption of sphericity was violated, as assessed by Mauchly's test of sphericity, adjusted p-values and Greenhouse-Geisser epsilons are also reported. Similarly, 2(Supportive Statements vs. Non-Supportive Statements) X 2 (Observer vs. Co-actor) X 2 ANOVAs with repeated measures on the third factor were conducted on normed DSSQ primary scales (i.e., self-esteem, self-focus, task-relevant interference, task-irrelevant interference, tense arousal, hedonic tone, confidence-control, motivation, energetic arousal, and concentration) and secondary scales (i.e., task engagement, distress, worry) scale scores. Both the primary and secondary scales were analyzed to better assess the specific effects of social presence on task-related stress. Additionally, the normed scores are reported to better facilitate interpretation of the results, and thus the combined motivation scale is included in subsequent analyses rather than the separate success and intrinsic motivation scales.

With regard to coping styles via the CITS, 2(Supportive Statements vs. Non-Supportive Statements) X 2 (Observer vs. Co-actor) between-subjects ANOVAs were conducted on the

subscale scores for task-focused coping, emotion-focused coping, and avoidant coping. A similar approach was used to analyze effects of experimental condition on workload; 2(Supportive Statements vs. Non-Supportive Statements) X 2 (Observer vs. Co-actor) between-subjects ANOVAs were conducted on the weighted TLX subscale scores (i.e., mental demand, temporal demand, physical demand, perceived workload, effort, and frustration) as well as global workload scores.

Performance Analyses

Results of the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) X 4 (Period on Watch) ANOVAs revealed that across all statement conditions, typical patterns of vigilance were observed, such that proportion of correct detections ($F(3, 339) = 4.586$, $p = .004$, $\eta^2p = .039$), proportion of false alarms ($F(3, 245.670) = 9.805$, $p < .001$, $\eta^2p = .080$, $\varepsilon = .725$) and perceptual sensitivity ($F(2.805, 316.930) = 4.074$, $p = .009$, $\eta^2p = .035$, $\varepsilon = .935$) significantly decreased with time on watch, while median response time ($F(3, 339) = 32.515$, $p < .001$, $\eta^2p = .223$) and response bias $F(2.488, 281.124) = 8.041$, $p < .001$, $\eta^2p = .066$, $\varepsilon = .829$ significantly increased as a function of period on watch. However, there were no significant period by condition interactions (all $p > .128$, all $\eta^2p < .017$). Additionally, significant between subjects effects were only observed for median response time and response bias (all other $p > .067$, all $\eta^2p < .037$).

Regarding median response time, there was a significant main effect of observer vs. co-actor ($F(1, 113) = 4.307$, $p = .040$, $\eta^2p = .020$), such that participants in the co-actor statement conditions ($M = 883.616$, $SD = 1154.116$) had higher median response times on average than participants in the observer statement conditions ($M = 834.833$, $SD = 165.023$), with a medium effect size ($d = .31$; see Figure 1).

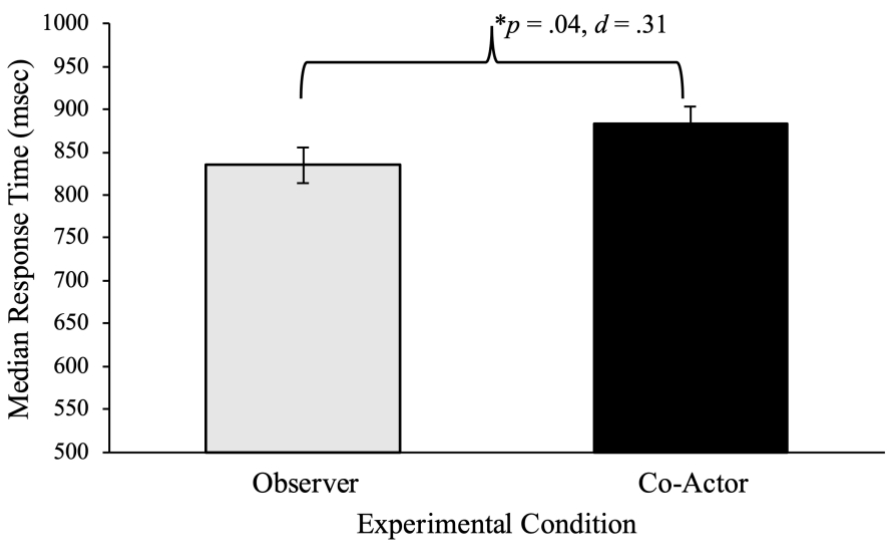


Figure 1. Differences in median response time between the observer and co-actor statement conditions. *Note.* Error bars are standard errors.

Regarding response bias, there was a significant main effect of supportive vs. non-supportive statements ($F(1, 113) = 3.918$, $p = .050$, $\eta^2p = .034$), such that participants who received non-supportive statements ($M = .902$, $SD = .112$) were more conservative on average than those who received supportive statements ($M = .839$, $SD = .301$), with a small effect size ($d = .28$; see Figure 2).

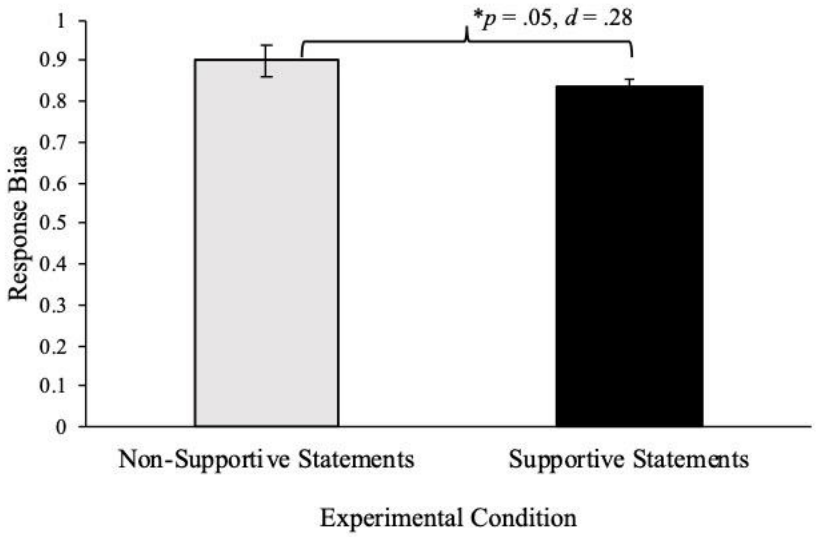


Figure 2. Differences in response bias between the observer and co-actor statement conditions. *Note.* Error bars are standard errors.

Stress Analyses

Task Engagement

Regarding the task engagement secondary scale, the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) X 2 (Phase) ANOVA revealed a significant phase effect, such that overall task engagement significantly increased from pre- to post-task ($F(1, 113) = 134.747$, $p < .001$, $\eta^2p = .544$). However, there were no significant phase by condition interactions (all $p > .09$, all $\eta^2p < .025$), or significant between-subjects effects of condition (all $p > .298$, all $\eta^2p < .01$).

Regarding the primary subscales, energetic arousal significantly decreased from pre to post-task ($F(1, 113) = 7.791$, $p < .001$, $\eta^2p = .127$), while motivation and concentration significantly increased (all $p < .001$, all $\eta^2p < .494$). On motivation and energetic arousal, these significant phase effects are qualified by two significant phase by social presence interactions.

On motivation, there was a significant phase by Observer/Co-Actor interaction ($F(1, 113) = 10.720$, $p < .001$, $\eta^2p = .087$; see Figure 3). Tests of simple effects revealed a significant difference between observer and co-actor conditions for pre-task motivation scores ($F(1, 115) = 1.174$, $p = .010$, $\eta^2p = .010$), such that participants in the co-actor conditions ($M = -.604$, $SD = .810$) reported significantly lower motivation than those in the observer conditions ($M = -.442$, $SD = .814$; $d = .20$). At post-task, there was also a significant difference between participants in the observer and co-actor conditions ($F(1, 115) = 4.189$, $p = .043$, $\eta^2p = .035$), such that participants in the co-actor conditions ($M = .5785$, $SD = .984$) reported significantly higher motivation than those in the observer conditions ($M = .179$, $SD = 1.119$; $d = .38$)

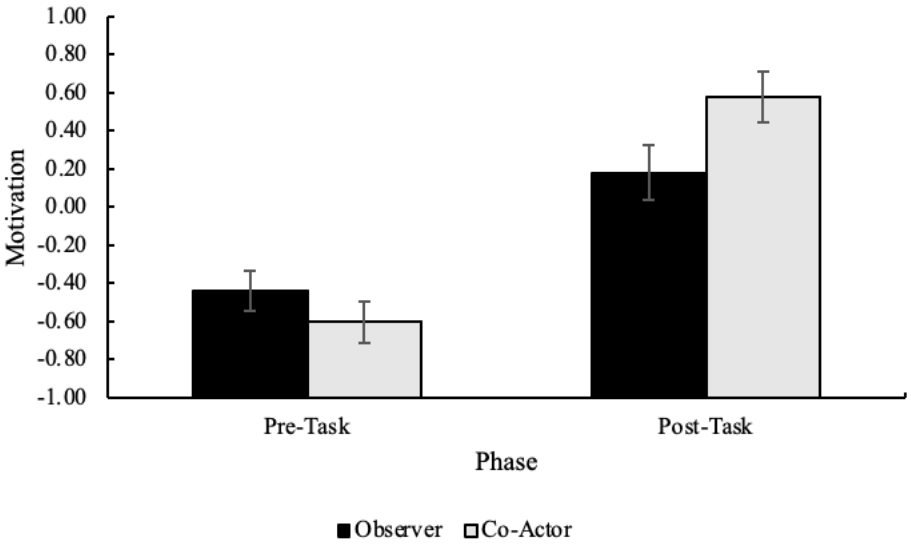


Figure 3. Motivation scores as a function of phase and experimental conditions. *Note.* Error bars are standard errors.

Similarly, there was a significant phase by Observer/Co-Actor interaction on energetic arousal ($F(1, 113) = 4.488$, $p = .036$, $\eta^2p = .038$; see Figure 4). Tests of simple effects revealed a significant difference between condition at pre-task, such that participants in the co-actor conditions ($M = .067$, $SD = .969$) reported significantly higher energetic arousal than those in the

observer conditions (M = -.115, SD = 1.087, d = .20). At post-task, there was again a significant difference in energetic arousal between conditions, such that participants in the co-actor conditions (M = -.490, SD = 1.087) reported significantly lower energetic arousal than those in the observer conditions (M = -.289, SD = .845; d = .21). There were no additional phase by condition interactions (all $p > .112$, all $\eta^2p < .087$) or between-subjects effects (all $p > .412$, all $\eta^2p < .006$) on the primary subscales for task engagement.

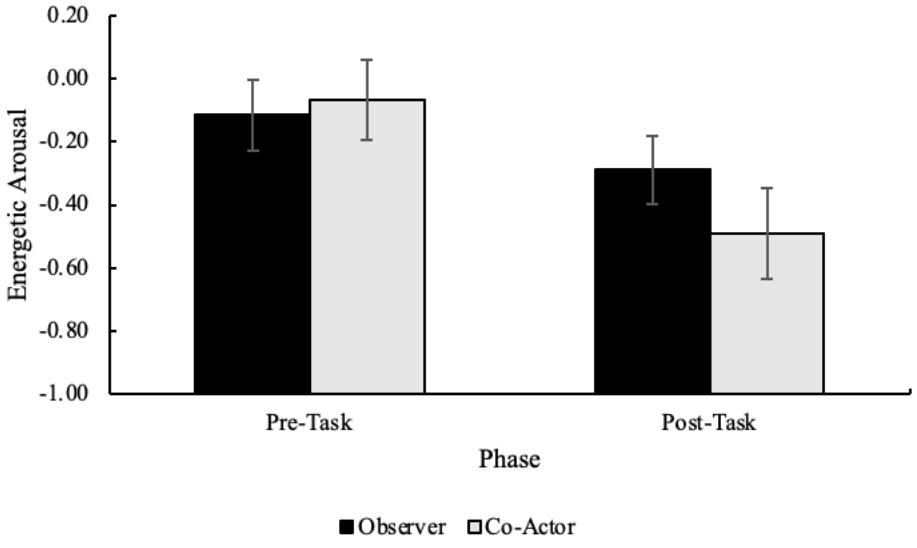


Figure 4. Energetic arousal scores as a function of phase and experimental conditions. *Note.* Error bars are standard errors.

Distress

Regarding distress, the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) X 2 (Phase) ANOVA indicated a significant phase effect, such that distress significantly increased from pre- to post-task ($F(1, 113) = 115.065$, $p < .001$, $\eta^2p = .505$), but there were no significant phase by condition interactions (all $p > .327$, all $\eta^2p < .025$) or between-subjects effects (all $p > .298$, all $\eta^2p < .01$).

Similarly, on the distress primary scales (i.e., tense arousal, hedonic tone, and confidence/control), there were significant phase effects on tense arousal and hedonic tone, such significantly increased from pre- to post-task while hedonic tone significantly decreased (all $p <$ .001, all $\eta^2p <$ .35). However, there was no significant change in confidence/control from pre- to post-task (F(1, 113) = .183, p = .669, η^2p = .002). Additionally, there were no significant phase by condition interactions (all $p >$ .071, all $\eta^2p <$ .029) or between-subjects effects (all $p >$ .468, all $\eta^2p <$ .005) on any of the distress primary subscales.

Worry

Regarding worry, the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) X 2 (Phase) ANOVA again revealed a significant phase effect, such that worry significantly increased from pre- to post-task (F(1, 113) = .59.566, $p <$ .001, η^2p = .345). As with task engagement and distress, there were no significant phase by condition interactions (all $p >$ .594, all $\eta^2p <$ .003) or between-subjects effects (all $p >$ .948, all $\eta^2p <$ .001). Similarly, on the worry primary scales, there were significant phase effects, such that self-focus and task-relevant interference significantly increased (all $p <$ .001, all $\eta^2p >$ .184), while self-esteem and task-irrelevant interference (all $p <$ .001, all $\eta^2p >$ .217) significantly decreased. As with worry overall, however, there were no significant phase by condition interactions (all $p >$ .122, all $\eta^2p <$ .021) or significant between-subjects effects of condition (all $p >$ .189, all $\eta^2p <$ .015).

Coping

Results of the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) between-subjects ANOVA did not reveal any significant between-subjects effects of condition or interactions between conditions on any of the three coping styles scales (i.e., task-focused coping, emotion-focused coping, and avoidant coping; all $p >$ .079, all $\eta^2p <$ .027).

Workload Analyses

Regarding workload, the Results of the 2 (Supportive vs. Non-Supportive Statements) X 2 (Observer vs. Co-Actor) between-subjects ANOVA indicated a significant main effect of support on effort, ($F(3, 113) = 4.610$, $p = .034$, $\eta^2p = .039$), such that participants in the supportive statement conditions reported significantly higher levels of effort ($M = 203.017$, $SD = 122.547$) than those in the non-supportive statement conditions ($M = 157.475$, $SD = 102.226$; $d = .40$; see Figure 5). There were no additional significant main effects or interactions of condition on any of the NASA-TLX subscales, or on global workload (all $p > .101$, all $\eta^2p < .039$).

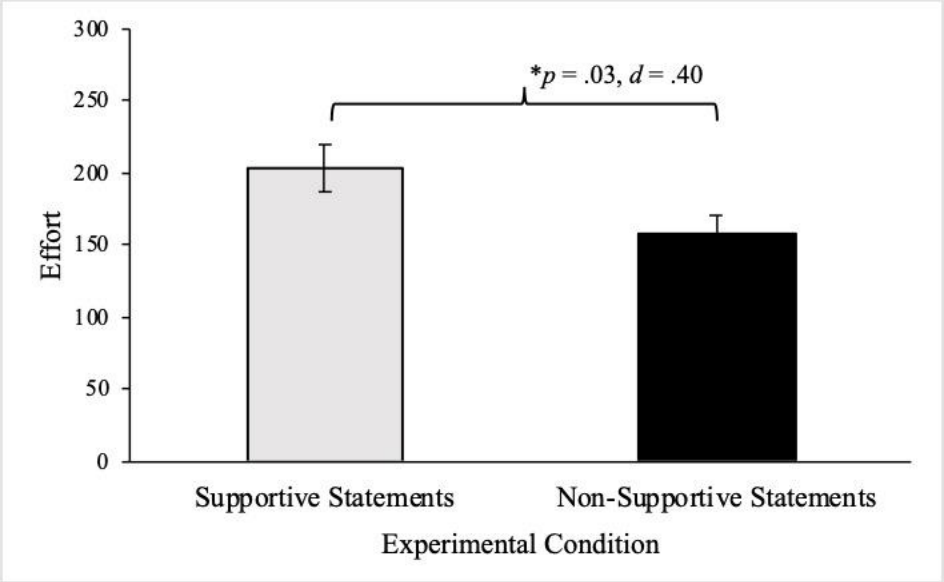


Figure 5. Differences in self-reported effort between the supportive and non-supportive statement conditions. *Note.* Error bars are standard errors.

Research Question 3

Statistical Approach

To compare the effects of supportive and non-supportive statements on performance, stress and workload to those of existing social presence manipulations (i.e., mere presence, evaluative observer, and independent co-actor) only participants in the experimental conditions were included in the subsequent analyses. For performance measures (i.e., proportion of correct detections, proportion of false alarms, median response time, perceptual sensitivity, and response bias), mixed 7 (Social Presence Condition) X 4 (Period on watch) ANOVAs were conducted, with repeated measures on the second factor. For measures in which the assumption of sphericity was violated, as assessed by Mauchly's test of sphericity, the adjusted p-values Greenhouse-Geisser epsilon is also reported. Similarly, 7 (Social Presence Condition) X 2 (Phase) mixed ANOVAs with repeated measures on the second factor were conducted on DSSQ primary (i.e., self-esteem, self-focus, task-relevant interference, task-irrelevant interference, tense arousal, hedonic tone, confidence-control, intrinsic motivation, success motivation, energetic arousal, and concentration) and secondary (i.e., task engagement, distress, worry) scale scores.

With regard to coping mechanisms via the CITS, one-way between-subjects ANOVAs were conducted on the subscale scores for task-focused coping, emotion-focused coping, and avoidant coping. A similar approach was used to analyze effects of condition on workload; one-way between-subjects ANOVAs were conducted on the weighted TLX subscale scores (i.e., mental demand, temporal demand, physical demand, perceived workload, effort, and frustration) as well as global workload scores.

Performance Analyses

Across all experimental conditions, the 7 (Social Presence Condition) X 4 (Period on watch) mixed ANOVAs indicated that correct detections and perceptual sensitivity significantly decreased with period on watch while median response time significantly increased (all $p < .001$, all $\eta^2p > .06$), as is typical for vigilance tasks. False alarms significantly decreased ($F(3, 603) = 15.878$, $p < .001$, $\eta^2p = .073$) and response bias significantly increased ($F(3, 603) = 18.887$, $p < .001$, $\eta^2p = .086$), indicating that participants across all experimental conditions became significantly more conservative in responding over time on task. However, there were no significant period by condition interactions on any of the dependent performance measures (all $p > .103$, all $\eta^2p < .041$).

Analyses of between subjects-effects revealed a significant main effect of condition on proportion of correct detections ($F(6, 201) = 2.551$, $p = .021$, $\eta^2p = .071$). Tukey's post-hoc tests indicated that participants in the Non-Supportive Observer Condition ($M = .922$, $SD = .119$) had significantly higher proportions of correct detections than participants in the Independent Co-Actor condition ($M = .808$, $SD = .196$; $p = .049$, $d = .700$), as illustrated in Figure 6. There were no other significant pairwise comparisons between conditions on proportion of correct detections (all $p > .122$).

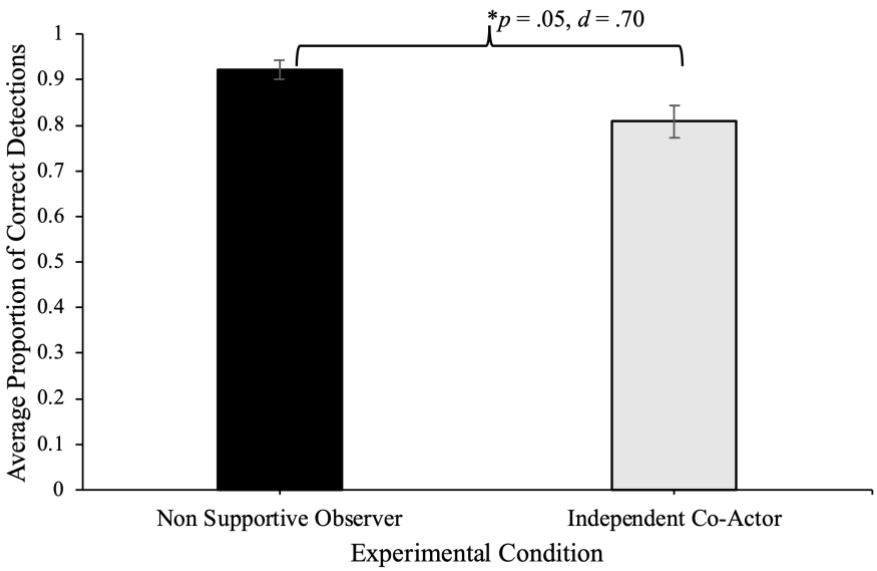


Figure 6. Differences in average proportion of correct detections between the non-supportive observer and independent co-actor conditions. *Note.* Error bars are standard errors.

Additionally, there was a significant main effect of condition on perceptual sensitivity ($F(6, 201) = 2.551$, $p = .021$, $\eta^2p = .071$). Per Tukey's post hoc tests, participants in the Non-Supportive Observer condition ($M = .974$, $SD = .029$) achieved significantly higher perceptual sensitivity than those in the Mere Presence ($M = .944$, $SD = .044$; $p = .027$, $d = .800$) and independent co-actor ($M = .941$, $SD = .051$; $p = .0.15$ $d = .790$) conditions, as illustrated in Figure 7. There were no other significant pairwise comparisons between conditions perceptual sensitivity (all $p > .187$). There was also a significant main effect of condition on median response time ($F(6, 198) = 2.417$, $p = .028$, $\eta^2p = .068$), but upon inspection of Tukey's post-hoc tests, there were no significant pairwise comparisons between conditions (all $p > .070$). There were also no other significant main effects of condition on any of the other dependent performance measures (all $p > .178$, all $\eta^2p < .037$).

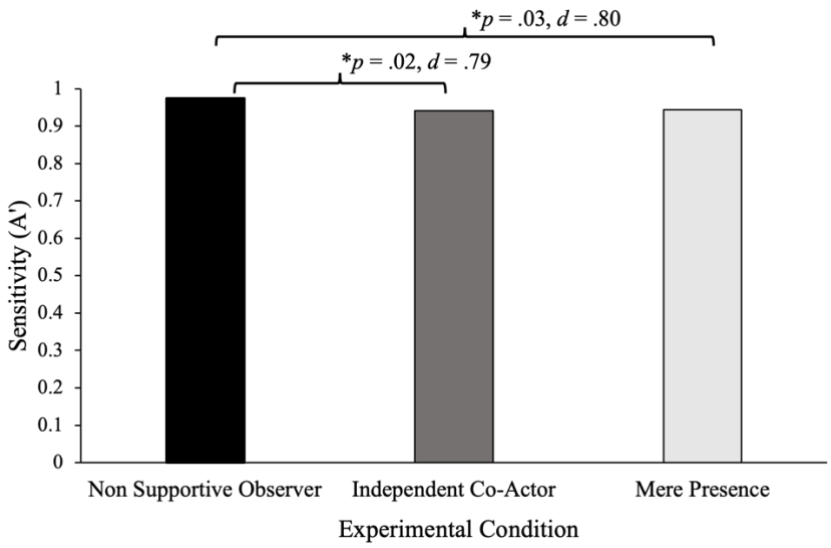


Figure 7. Differences in average sensitivity (A') between the non-supportive observer, independent co-actor, and mere presence conditions. *Note.* Error bars are standard errors.

Stress Analyses

Task Engagement

On the task engagement secondary scale, the 7 (Social Presence Condition) X 2 (Phase) mixed ANOVA indicated a significant phase effect, such that overall task engagement significantly increased from pre to post-task ($F(1, 201) = 325.026$, $p < .001$, $\eta^2p = .618$), but there was no significant phase by condition interaction ($F(6, 201) = 1.275$, $p = .270$, $\eta^2p = .037$), or significant between-subjects effect of condition ($F(6, 201) = 1.357$, $p = .234$, $\eta^2p = .039$). However, on the motivation primary scale, there was a significant phase by condition interaction, $F(6, 201) = 3.269$, $p = .004$, $\eta^2p = .089$. Tests of simple effects revealed a significant main effect of condition on pre-task motivation scores ($F(6, 201) = .806$, $p = .023$, $\eta^2p = .315$), but no pairwise comparisons between conditions were significant according to Tukey's post-hoc tests (all $p > .529$). On post-task motivation scores, there was again a significant main effect of

condition ($F(6, 201) = 2.377$, $p = .031$, $\eta^2p = .807$), but no significant pairwise comparisons between conditions per Tukey's post-hoc tests (all $p > .067$).

Regarding the remaining primary factors for task engagement, concentration significantly increased while energetic arousal significantly decreased from pre- to post-task (all $p < .001$, all$\eta^2p > .073$). However, there were no significant phase by condition interactions (all $p > .092$, all $\eta^2p < .089$) or between-subjects effects of condition (all $p > .554$, all $\eta^2p < .024$).

Distress

On the distress secondary scale, the 7 (Social Presence Condition) X 2 (Phase) mixed ANOVA also indicated a significant phase effect, such that distress significantly increased from pre to post-task, $F(1, 201) = 178.802$, $p < .001$, $\eta^2p = .471$. As with task engagement, however, there was no significant phase by condition interaction ($F(6, 201) = 1.799$, $p = .101$, $\eta^2p = .051$), or between-subjects effect of condition ($F(6, 201) = .775$, $p = .590$, $\eta^2p = .023$). Similarly, there were significant pre to post-task changes for all of the distress primary scales, such that tense arousal and confidence-control significantly increased (all $p < .001$, all $\eta^2p < .023$), while hedonic tone significantly decreased, $F(1, 201) = 1.646$, $p < .001$, $\eta^2p = .286$. However, as with the distress secondary scale, there was no significant phase by condition interactions (all $p > .136$, all $\eta^2p < .047$) or between-subjects effect of condition (all $p > .708$, all $\eta^2p < .018$).

Worry

Results of the 7 (Social Presence Condition) X 2 (Phase) mixed ANOVA revealed a significant increase in worry from pre to post-task across conditions $F(1, 201) = 112.611$, $p < .001$, $\eta^2p = .359$), but again no significant phase by condition interaction $F(6, 201) = .904$, $p = .493$, $\eta^2p = .026$) or between subjects effect of condition, $F(6, 201) = .387$, $p = .887$, $\eta^2p = .011$).

This pattern of results also occurred for the worry primary scales (i.e., self-esteem and task-irrelevant interference significantly decreased while self-focus and task relevant cognitive interference significantly increased (all $p < .001$, all $\eta^2p < .051$), but no significant phase by condition interactions (all $p > .102$, all $\eta^2p < .026$) or between-subjects effects of condition (all $p > .260$, all $\eta^2p < .037$).

Coping

Results of the one-way between subjects ANOVA did not reveal any significant main effects of condition on any of the coping styles subscales (i.e., task-focused coping, emotion-focused coping, and avoidant coping; all $p > .392$, all $\eta^2p < .031$).

Workload Analyses

On the NASA-TLX, the one-way between subjects ANOVA indicated a significant main effect of condition on perceived workload ($F(6, 201) = 2.153$, $p = .049$, $\eta^2p = .060$). However, none of the pairwise comparisons of conditions were significant per Tukey's post-hoc tests (all p > .062). There were no other significant main effects of condition on any of the subscales or on global workload (all $p > .392$, all $\eta^2p < .031$)

Research Question 3B

Statistical Approach

As a follow-up to the analyses for Research Question 3, the three existing manipulations of social presence in vigilance (i.e., evaluative observer, mere presence, and independent co-actor) were compared to the alone (or control) condition to assess whether the present experiment replicated previous findings of social presence's effect on vigilance. For performance measures (i.e., proportion of correct detections, proportion of false alarms, median response time, perceptual sensitivity, and response bias), 4 (Condition) X 4 (Period on watch) mixed ANOVAs were conducted, with repeated measures on the second factor. For measures in which the assumption of sphericity was violated, as assessed by Mauchly's test of sphericity, the adjusted p-values and Greenhouse-Geisser epsilon are also reported. Similarly, 4 (Condition) X 2 ANOVAs with repeated measures on the second factor were conducted on DSSQ primary (i.e., self-esteem, self-focus, task-relevant interference, task-irrelevant interference, tense arousal, hedonic tone, confidence-control, intrinsic motivation, success motivation, energetic arousal, and concentration) and secondary (i.e., task engagement, distress, worry) scale scores.

With regard to coping responses via the CITS, one-way between-subjects ANOVAs were conducted on the subscale scores for task-focused coping, emotion-focused coping, and avoidant coping. A similar approach was used to analyze effects of condition on workload; one-way between-subjects ANOVAs were conducted on the weighted TLX subscale scores (i.e., mental demand, temporal demand, physical demand, perceived workload, effort, and frustration) as well as global workload scores.

Performance Analyses

Across all conditions included in the analyses (i.e., evaluative observer, mere presence, independent co-actor, and alone), the 4 (Condition) X 4 (Period on watch) mixed ANOVAs revealed that proportion of correct detections, false alarms, and perceptual sensitivity significantly decreased while median response time and response bias significantly increased (all $p < .001$, all $\eta^2p > .067$) with time on watch. However, there were no significant phase by condition interactions (all $p > .292$, all $\eta^2p < .031$) or significant between-subjects effects of condition on any of the performance outcomes (all $p > .082$, all $\eta^2p < .058$).

Stress Analyses

Task Engagement

Results of the 4 (Condition) X 2 (Phase) mixed ANOVAs revealed that task engagement, concentration, and motivation significantly increased (all $p > .158$, all $\eta^2p < .047$) from pre- to post-task, while energetic arousal ($p = .158$, all $\eta^2p = .017$) did not change significantly. However, there were no significant phase by condition interactions (all $p > .079$, all $\eta^2p < .057$), or significant main effects of condition on any of the task engagement primary scales (all $p > .081$, all $\eta^2p < .057$).

Distress

Across all conditions, the 4 (Condition) X 2 (Phase) mixed ANOVAs indicated that distress, tense arousal, and confidence-control significantly increased, while hedonic tone significantly decreased from pre- to post-task (all $p < .001$, all $\eta^2p > .119$). Analyses revealed a significant phase by condition interaction on hedonic tone scores ($F(3, 114) = 2.975$, $p = .035$, $\eta^2p = .073$). At pre-task, there were no significant differences between conditions ($F(3, 114) = .429$, $p = .733$, $\eta^2p = .011$). At post-task, there was also no significant difference between

conditions, though the effect size of the interaction was larger ($F(3, 114) = 1.779$, $p = .052$, $\eta^2p = .065$). There were no additional significant phase by condition interactions (all $p > .532$, all $\eta^2p < .019$), or main effects of condition on any of the distress scales (all $p > .086$, all $\eta^2p < .056$).

Worry

Results of the 4 (Condition) X 2 (Phase) mixed ANOVAs indicated that worry, self-focus, and task-relevant interference significantly increased, while self-esteem and task-irrelevant interference significantly decreased (all $p < .001$, all $\eta^2p > .153$). While there were no significant phase by condition interactions (all $p > .085$, all $\eta^2p < .056$), there were significant main effects of condition on self-esteem and task-relevant interference (all $p < .045$, all $\eta^2p > .068$). Regarding self-esteem, participants in the evaluative observer ($M = -2.349$, $SD = 1.06$) condition had significantly higher self-esteem on average than those in the alone condition ($M = -3.03$, $SD = .96$; $d = .67$; see Figure 8). Despite the main effect of condition on task-relevant interference, however, there were no significant pairwise comparisons upon inspection of Tukey's post hoc tests (all $p > .080$).

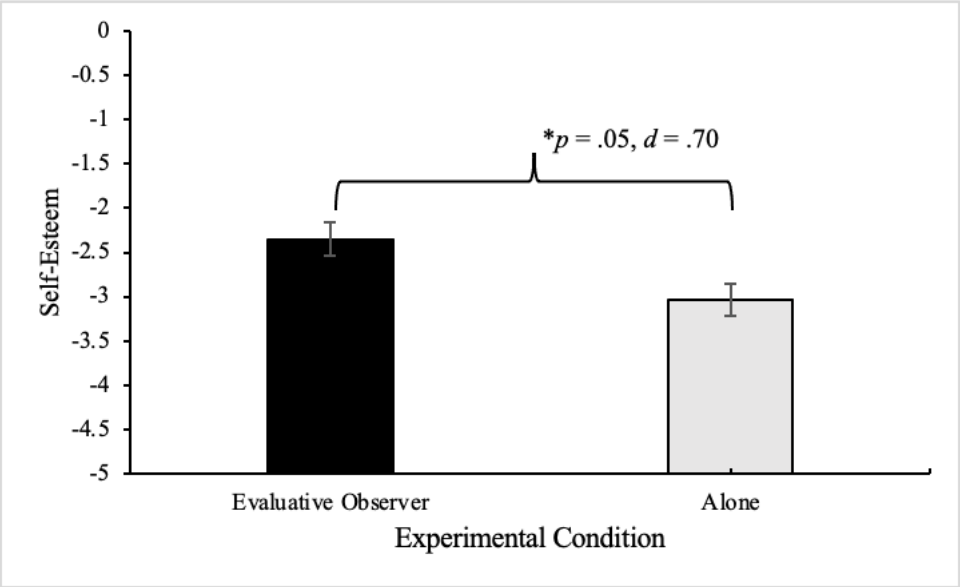


Figure 8. Differences in self-esteem between the evaluative observer and alone conditions. *Note.* Error bars are standard errors.

Coping Styles

Results of the one-way between subjects ANOVA indicated that there were no significant main effects of condition on scores for any of the three coping styles (all $p > .091$, all $\eta^2 p < .055$).

Workload Analyses

Per the one-way between subjects ANOVA, there were no significant main effects of condition on any of the NASA-TLX subscales, or on global workload (all $p > .051$, all $\eta^2 p < .065$).

Research Question 4

Statistical Approach

To compare the effects of supportive and non-supportive statements on performance, stress and workload to performing a vigilance task alone, only participants in the statement conditions and alone conditions were included in the subsequent analyses. For performance measures (i.e., proportion of correct detections, proportion of false alarms, median response time, perceptual sensitivity, and response bias), mixed 5 (Condition) X 4 (Period on watch) ANOVAs were conducted, with repeated measures on the second factor. For measures in which the assumption of sphericity was violated, as assessed by Mauchly's test of sphericity, the adjusted p-values and Greenhouse-Geisser epsilon are also reported. Similarly, 5 (Condition) X 2 ANOVAs with repeated measures on the second factor were conducted on DSSQ primary (i.e., self-esteem, self-focus, task-relevant interference, task-irrelevant interference, tense arousal, hedonic tone, confidence-control, intrinsic motivation, success motivation, energetic arousal, and concentration) and secondary (i.e., task engagement, distress, worry) scale scores.

With regard to coping responses the CITS, one-way between-subjects ANOVAs were conducted on the subscale scores for task-focused coping, emotion-focused coping, and avoidant coping. A similar approach was used to analyze effects of condition on workload; one-way between-subjects ANOVAs were conducted on the weighted TLX subscale scores (i.e., mental demand, temporal demand, physical demand, perceived workload, effort, and frustration) as well as global workload scores.

Performance Analyses

Across all conditions included in the analyses (i.e., supportive observer, non-supportive observer, supportive co-actor, non-supportive co-actor, and alone), results of the 5 (Condition) X 4 (Period on watch) mixed ANOVAs revealed that the proportion of correct detections, false alarms, and perceptual sensitivity significantly decreased (all $p < .001$, all all$\eta^2p > .045$) while median response time and response bias significantly increased (all $p < .001$, all $\eta^2p > .064$) as a function of period on watch. However, there were no significant period by condition interactions (all $p > .203$, all $\eta^2p < .036$) or between subjects effects of condition on any performance outcomes (all $p > .140$, all $\eta^2p < .049$).

Stress Analyses

Task Engagement

Results of the 5 (Condition) X 2 (Phase) indicated that across all conditions included in the analyses, task engagement, motivation, and concentration significantly increased (all $p < .001$, all $\eta^2p > .093$), while energetic arousal significantly decreased from pre- to post-task ($F(1, 139) = 14.239$, $p < .001$, $\eta^2p = .093$). There was a significant phase by condition interaction on motivation ($F(1, 139) = 3.019$, $p = .020$, $\eta^2p = .080$), but upon inspection, none of the pairwise comparisons between conditions were significant, per Tukey's post hoc tests (all $p > .950$). There were no other significant phase by condition interactions (all $p > .416$, all all$\eta^2p < .039$), or between-subjects effects of condition on any of the task engagement primary scales (all $p > .811$, all $\eta^2p < .011$).

Distress

Results of the 5 (Condition) X 2 (Phase) analyses for the distress secondary scale and primary scales yielded a similar pattern to those of task engagement. There were significant

changes from pre- to post-task across all conditions, such that distress and tense arousal significantly increased (all $p < .001$, all $\eta^2p < .365$) while hedonic tone significantly decreased ($F(1, 139) = 43.768$, $p < .001$, $\eta^2p = .239$). However, there was no significant change in confidence/control scores from pre- to post-task ($F(1, 139) = 2.327$, $p = .129$, $\eta^2p = .016$). Additionally, there were no significant phase by condition interactions (all $p > .106$, all $\eta^2p < .045$) or between-subjects effects of condition on any of the distress scales (all $p > .461$, all $\eta^2p < .025$).

Worry

Across all conditions, the 5 (Condition) X 2 (Phase) ANOVAs indicated significant differences in scores from pre- to post-task on both the worry secondary scale and primary scales. Worry overall, self-focus, and task-relevant interference significantly increased (all $p < .001$, all $\eta^2p > .202$), while self-esteem and task irrelevant interference significantly decreased from pre-to post-task (all $p < .001$, all $\eta^2p > .274$). However, there were no significant phase by condition interactions (all $p > .228$, all $\eta^2p < .039$) or between-subjects effects of condition on any of the task engagement scales (all $p > .329$, all $\eta^2p < .032$).

Coping Styles

The one-way between-subjects ANOVA did not reveal any significant main effects of condition on any of the coping styles subscales (i.e., task-focused coping, emotion-focused coping, and avoidant coping; all $p > .191$, all $\eta^2p < .043$).

Workload Analyses

Per the one-way between-subjects ANOVAs, there were no significant main effects of condition on any of the NASA-TLX subscales, or on global workload (all $p > .109$, all $\eta^2 p < .052$).

CHAPTER EIGHT: DISCUSSION

Over many decades, the study of human vigilance has yielded a rather reliable pattern of results; performance on vigilance tasks decline over time (Davies & Parasuraman, 1982) and vigilance tasks are consistently reported to be both mentally demanding and stressful (Warm et al., 2008). Vigilance researchers have made significant progress in uncovering the perceptual and cognitive features of vigilance tasks that drive these effects (e.g., Parasuraman & Davies, 1977; Parasuraman & Mouloua, 1987). However, other psychological factors that may affect vigilance (e.g., motivation, emotion, social perception) have been comparably understudied, a microcosm of the human factors field as a whole (Szalma, 2014).

While it has not been explored extensively in the vigilance literature, the social environment in which vigilance tasks are performed is likely to affect performance, stress, and workload in vigilance. Notably, the presence of evaluative observers, merely-present observers, and independent co-actors during vigilance tasks have been shown to reduce false alarms, increase task engagement, and increase correct detections (Claypoole & Szalma, 2018a; 2018b; Funke et al., 2016). However, existing manipulations of social presence in vigilance have been trather static, in that the forms of social presence employed have involved little communication between the person present in the room and the person performing the task. In the real world though, human performance under social presence is likely to be more dynamic in nature, involving more direct interaction with the task operator.

In the spirit of coming to a more holistic understanding of the factors that affect performance, workload, and stress in vigilance beyond cognitive and perceptual factors, the present dissertation employed four novel manipulations of social presence that drew from

findings in social support literature, which has suggested that the presence of social support during stressful tasks may alleviate stress and subsequently improve performance (Thorsteinsson & James, 1999). The effects of these novel manipulations were compared to both existing manipulations of social presence in vigilance and to performing the same task alone. Thus, the central goal for this dissertation was to explore social support in vigilance and how its effects (or non-effects) on performance, workload, and stress compare to those of existing manipulations of the social environment for vigilance. Collapsed across conditions, the results of this experiment generally replicated the typical vigilance performance effects and established patterns of workload and stress in vigilance. However, the comparison of experimental conditions yielded some perplexing results, which are discussed below in terms of the research questions they sought to address.

Research Questions 1 and 2: Support vs. Non-Support Across Observer and Co-Actor Presence

The first two research questions this dissertation sought to examine (1) whether the provision of socially supportive statements during a vigilance task improved performance, and reduced workload, and stress over non-supportive statements and (2) whether those effects differed when provided by an observer versus a co-actor. Based on theories of social support, it was hypothesized that participants in the supportive conditions would (1) achieve higher performance, report lower distress, and mental workload, and report higher task engagement than those in the non-supportive conditions, and that (2) social support from a co-actor would be more effective for improving performance, workload, and stress than social support from an observer.

Regarding performance, the differential effects of supportive versus non-supportive statements on performance seemed to manifest only in response bias; participants who received

non-supportive statements exhibited a more conservative response bias on average than those who received supportive statements. Perhaps because vigilance operators realize how infrequently critical signals occur over the course of the task (Craig, 1978) response bias in vigilance tends to become more conservative over time and is strongly affected by signal probability (See et al., 1997). Given that signal probability was held constant for all participants, the present results suggest that the provision of non-supportive statements during the vigilance task generally drove participants toward a more conservative response bias.

On one hand, it seems logical that the nature of the non-supportive statements, which emphasize that the participant *must* stay alert, concentrated, etc., would nudge participants toward being more cautious in responding than the supportive statements, which generally emphasize that they should *try* to stay alert, concentrated, etc. On the other hand, this interpretation would contradict theories of self-determination for performance, which have suggested that controlling language undermines intrinsic motivation, and may thus negatively affect performance (Deci et al., 1994; Szalma, 2014; Neigel, 2017). While a conservative response bias does not necessarily indicate better performance, in tasks where the cost of a false alarm is high a conservative response bias may be preferable to a lenient one, in which case the differential effects of supportive versus non-supportive statements on response bias would be pertinent. It may be the case response bias is more effectively changed by providing statements that support extrinsic rather than intrinsic motivation, but this hypothesis necessitates considerable further research.

Regarding social support theories, the implication of this effect again depends on the task context; in situations where a more lenient response bias is preferable, providing social support may be more beneficial for performance than providing non-supportive statements, and vice

versa. On a more granular level, however, these findings may represent an interesting nuance between the supportive and non-supportive statements created for this dissertation.

The multidimensional buffering model of social support suggests that social support should be most effective when it matches the coping requirements of the stressor (Cohen & McKay, 1984), which was the impetus for developing the supportive and non-supportive statements used in the present experiment based on typical sources of stress in vigilance via the DSSQ (e.g., Matthews, 2021; Matthews et al., 2010, Szalma et al., 2004, Teo & Szalma, 2011; Warm et al., 2008). In pilot work, it was shown that the supportive statements were indeed perceived as significantly more supportive than the non-supportive statements, as assessed via participant's answers to the question "how supported would you feel if a (supervisor/another participant) said this statement to you during the task," based on Teoh and Hilmert's (2018) Perceived Social Support Scale. However, that question does not address what *type* of support the statements were perceived as (e.g., emotional, informational, appraisal support; Lett et al., 2005).

Given that this dissertation is the first to examine social support for vigilance, the supportive statements included various forms of support, in an effort to examine social support more generally as a foundation for further research. However, it may be the case that the non-supportive statements, while worded rather crassly, still functioned as a form of informational support. In other words, while the supportive statements may have *felt* more supportive, the non-supportive statements may have *functioned* supportively in practice, as they still gave the participant information on the task demands (e.g., "this takes makes you tired") and may have thus functioned as a form of informational support. Future research on this hypothesis would be needed to truly untangle the differences in perceived type of support between the supportive and

non-supportive statements, but these findings may suggest a more nuanced framework of the types of social support. Even when social support may not sound explicitly supportive, it may be that the content of the support matters more for performance than the emotional tone in which it is delivered.

Additionally, results indicated that participants who received supportive statements, rather than non-supportive statements, reported having to put more effort into the task than those who received non-supportive statements, per their weighted responses to the Effort subscale of the NASA-TLX. Given that response bias does not necessarily indicate better performance, these results, combined with the finding that participants in the non-supportive condition had a more conservative response bias, indicate a performance insensitivity, such that sensitivity did not change but effort increased. To date, there have not been any attempts to examine whether response bias in vigilance correlates to measures of mental workload, but the present results suggest that this might be an interesting relationship to examine.

If it is the case that response bias in vigilance becomes more conservative over time because the operator realizes the infrequency of critical signals (Craig, 1978), then perhaps maintaining a lenient response bias requires more effort than a conservative one. In other words, a lenient response bias may indicate a failure to understand the underlying task parameters, resulting in the operator feeling that they need to allocate more effort toward the task and subsequently respond more frequently. Of course, this hypothesis has yet to be tested, but may nonetheless reveal an insightful relationship between response bias and self-report measures of mental workload.

Analyses also indicated that receiving statements from a co-actor, regardless of whether they were supportive or non-supportive, resulted in slower median response times. Previous

research using independent co-actors (who did not verbally interact with the participant) has not found an effect of co-acting on response time (Claypoole, 2018, Claypoole & Szalma, 2018b, Funke et al., 2016). These results may indicate that receiving statements from someone perceived to be a peer is more distracting than receiving them from an experimenter.

Several concepts from social psychology may help to elucidate this effect. It may be the case that statements from a co-actor induce feelings of social comparison that distract from the task. Social comparison theory argues that in the absence of objective information, individuals will compare themselves to others out of a drive to continuously self-evaluate (Festinger, 1954). Although participants in the present study were explicitly told that their performance would be evaluated separately from the co-actor's, and were visually precluded from seeing the co-actor's screen, the presence of the co-actor may still have induced feelings of social comparison. Additionally, whether supportive or non-supportive, the co-actor's statements inherently referred to the participant's performance, potentially providing additional fodder for social comparison to occur.

Some studies have suggested that social comparison, when self-threatening, takes up attentional resources resulting in task performance decrements (Normand & Croizet, 2013). Thus, the statements provided by the co-actor may have threatened participant's self-evaluation of their performance, therefore distracting them from the task and resulting in slower response times. Participants in the co-actor statement conditions did not report significantly higher task-relevant or irrelevant interference. Nonetheless, it is possible that the statements from the co-actor induced social comparison without the participant's awareness. Alternatively, social loafing, or the "tendency for individuals to expend less effort when working collectively than when working individually (Karau & Williams, 1993, p. 681)" may also explain why participants

in the co-actor statement conditions had slower response times than those in the observer statement conditions. Again, while they were told their performance would be evaluated separately, it is still possible that the presence of the co-actor who was performing the same task induced social loafing effects that resulted in slower response times.

Taken together, the results pertaining to research questions 1 and 2 of the present dissertation did not directly support the hypotheses, as the provision of social support did not generally improve performance or reduce stress and workload. However, the results did yield interesting insights into the novel effect of non-supportive presence on vigilance, indicating that non-supportive presence resulted in a more conservative response bias and lower perceived effort than supportive presence. Additionally, the present results suggest that receiving statements throughout the vigilance task from a co-actor, another novel social presence manipulation for vigilance, resulted in higher response times than receiving them from an observer.

Research Question 3: Novel Manipulations vs. Existing Manipulations

The current dissertation also sought to examine (3) whether the effects of socially supportive and non-supportive statements on performance, workload and stress differed from the effects of existing social presence manipulations, and (3a) whether the effects of the existing social presence manipulations replicated previous findings. It was hypothesized that participants in the supportive conditions would achieve the highest performance, report the highest task engagement, and report the lowest levels of distress and workload, followed by the independent co-actor, evaluative observer, non-supportive observer, and mere presence conditions. Regarding replication, it was hypothesized that participants in the existing social presence conditions (i.e., independent co-actor, evaluative observer, and mere presence) would achieve higher performance than those in the alone condition.

Regarding the question of replication, the results from this dissertation did not appear to replicate previous findings, despite using the same experimental protocols and task parameters as previous studies in this area. The existing social presence manipulations (i.e., evaluative observer, mere presence, and independent co-actor) utilized in this dissertation were derived from Claypoole (2018)'s experimental paradigm for examining social facilitation in vigilance. Claypoole and Szalma (2018a; 2018b; 2019) observed that participants who completed a vigilance task in the presence of an evaluative observer had significantly lower false alarms than those who completed the task alone, and that participants who completed a vigilance task in the presence of an independent co-actor exhibited lower false alarms, a more conservative response bias, and lower perceived workload those who completed the task alone. These effects were not replicated in the present dissertation.

While perplexing, the present study's failure to replicate previous results (despite using the same task and experimental protocols) is not entirely surprising in the context of recent replication issues within social psychology (e.g., Earp & Trafimow, 2015). Although some have pushed back on the severity of the so-called replication crisis and its implications (e.g., Pettigrew, 2018; Shimmack, 2020), it would be imprudent to ignore the high numbers of replication failures and effect sizes differences identified in large scale-replication efforts (e.g., Klein et al., 2018; Camerer et al., 2018). Especially given the relatively few studies that have used the current experimental paradigm of social presence in vigilance, it is unsurprising that the difficulty in replicating social psychological effects has reared its head in the present dissertation.

Although the effects of prior social presence manipulations were not replicated, some differences arose between these manipulations and the novel social support manipulations created as part of this dissertation, though not in the hypothesized directions. Participants in the

non-supportive observer condition made significantly more correct detections than those in the independent co-actor condition and exhibited higher overall sensitivity than those in the mere presence and independent co-actor conditions. These results suggest that, contrary to hypotheses, the presence of a non-supportive observer can improve performance relative to other forms of social presence during a vigilance task. Claypoole & Szalma (2018a) and Claypoole (2018) found no differences in performance between the evaluative observer and mere presence conditions, and neither of these studies directly compared the effect of an evaluative observer to an independent co-actor. The significant differences between the non-supportive observer condition and the independent co-actor and mere presence conditions may speak to theories of evaluation apprehension for performance.

Cottrell (1972) argued that evaluation apprehension drives the social facilitation effect, such that an evaluative presence is necessary to evoke social facilitation. Although this explanation relies on the tenet's of Zajonc's (1965) now outdated drive theory, there is still a large body of evidence to suggest that evaluative presence has *an* effect on performance, even if it is not the underlying cause of social facilitation effects (Bray & Sugarman, 1980; Geen & Gange, 1977; Claypoole, 2018). In the case of the present results, the non-supportive observer condition is inherently more evaluative than the independent co-actor and mere presence conditions, as it involved the provision of statements during the task that directly referenced the participant's task performance. Therefore, it is possible that the positive effect of the non-supportive observer on correct detections and sensitivity compared to the mere presence and independent co-actor conditions can be attributed to the evaluative nature of the statements given in that condition. If so, these results would help explain the lack of significant differences in performance between the evaluative observer and mere presence conditions observed in both the

present study and prior research (Claypoole, 2018; Claypoole & Szalma, 2018a). Compared to the evaluative observer condition, the non-supportive condition is again inherently more evaluative given the performance-based nature of the statements. Thus, it is possible that the evaluative observer condition on its own was not sufficient to elicit the effects of evaluation potential on performance compared to the mere presence condition.

In sum, the results of analyses pertaining to Research Questions 3 and 3B did not support a priori hypotheses. Nonetheless, the significant differences in performance that arose between the non-supportive, mere presence, and independent co-actor conditions provide some insight into the effect of evaluation on performance, which remains a debated topic in the social facilitation literature (Claypoole, 2018).

Research Question 4: Novel Manipulations vs. Alone

Lastly, the present dissertation sought to assess how providing socially supportive or non-supportive statements during the vigilance task would affect performance, workload and stress compared to performing the vigilance task alone. It was hypothesized that Participants in all the statement conditions (i.e., supportive observer, non-supportive observer, supportive co-actor, and non-supportive co-actor) would achieve higher performance than those in the alone condition, with participants in the supportive conditions outperforming those in the non-supportive conditions.

Perhaps most surprisingly of all the results of this dissertation, there were no significant differences in performance, workload, or stress between the statement conditions and the alone condition, or between any other social presence conditions and the alone condition. These results thus suggest that social presence without verbal interaction is neither beneficial nor detrimental to performance, workload, and stress in vigilance, contrary to prior research. However, there may

be other explanations as to the lack of significant differences between the social presence conditions and the alone condition.

Although an a priori power analysis was conducted based on a medium effect size of .25, it is possible that the true effect size of social presence on performance is even small. While it did not directly assess social presence and performance, a large-scale replication effort estimated that the effect size for a variety of psychological effects plummeted to .15 compared to original findings of .60 (Klein et al., 2018). To some, these findings may suggest that the study of social psychological effects is futile. On the contrary, I believe that such results present a fascinating challenge for experimental psychologists. With existing experimental paradigms now under scrutiny, the metaphorical door is open for new methods, taxonomies, and protocols to try to capture the social psychological world in a controlled, experimental setting. This is an endeavor that will require creativity, openness to new ideas, and extensive collaboration and communication among the scientific community; null results included. It is my hope that the new experimental paradigm created for this dissertation, and the amalgamation of scientific literatures it took to create this paradigm, represents a step toward a more replicable and reliable era for the investigation of the social environment and its effects on human cognition.

Theoretical and Practical Implications

Of all the social presence conditions examined in the present dissertation, the non-supportive observer condition emerged as significantly different, and in some cases more favorable, for performance than other social presence conditions. First, participants in the non-supportive observer condition exhibited a more conservative response bias than those in the supportive observer condition. Additionally, participants in the non-supportive observer condition had a significantly higher average proportion of correct detections than those in the

independent co-actor condition, and significantly higher sensitivity than those in both the independent co-actor and mere-presence conditions.

Of the studies examining the effect of the social environment on vigilance, the non-supportive observer condition is perhaps most akin to the 'autocratic' observer in Bergum & Lehr's (1963) study, in military personnel received random 'visits' from a commanding officer during a vigilance task. Although the authors noted that conversation was "held to a minimum (p. 75), the commanding officer did verbally point out failures to detect critical signals during their visits. The controlling nature of the statements in the non-supportive observer condition (e.g., you *must* stay calm, you *need* to be able to do this) and the commanding officer presence in Bergum & Lehr's study, on the surface, seem that they would foster extrinsic, rather than intrinsic motivation. In the case of vigilance, it may be case that fostering intrinsic motivation (which the supportive statements in this dissertation were more amenable to) is too lofty a goal, as suggested by Szalma (2014). In other words, intrinsic motivation may be too difficult to induce in the face of the inherently boring, taxing, and mentally demanding nature of vigilance tasks. On the other hand, extrinsic motivation, may be more attainable in comparison. This notion would also be in line with findings that monetary rewards can improve performance on vigilance tasks (Esterman et al., 2016). Thus, the non-supportive observer condition may have fostered more extrinsic motivation, resulting in more favorable for performance than other forms of social presence. As discussed previously, this hypothesis would require considerable further experimentation to adequately assess, but the present results nonetheless suggest that social presence may help to induce extrinsic motivation and subsequently improve performance for vigilance compared to other forms of social presence.

The results of the present dissertation also pose some interesting implications for theories of vigilance more generally. Resource theory, which argues that the vigilance decrement stems from a deficit in available mental resources (e.g., Hancock & Warm, 1989; Parasuraman et al., 1987), is currently the dominant explanation for the vigilance decrement. Regarding the present dissertation, the statement conditions should logically divert more attentional resources away from the task than the other social presence conditions, as they require participants to listen to statements while performing the task. However, the provision of statements, whether supportive or non-supportive, did not seem to exacerbate the vigilance decrement. As discussed, in some cases the provision of statements resulted in improved performance overall, though they did not attenuate the decrement. Even the social presence conditions that did not involve statements should also consume attentional resources that, per resource theory, would result in a larger performance decrement.

That social presence, both in previous studies and in the present dissertation, did not degrade and in some cases even improved performance, could be seen as empirical support for underload theories of vigilance. If the vigilance decrement is indeed due to mindlessness (e.g., Manly et al., 1999) or mind-wandering (e.g., Smallwood & Schooler, 2006; Thomson et al., 2015), perhaps social presence serves to refocus participants on the task rather than to reduce attentional resources that would decrease performance. However, as suggested by Claypoole (2018), findings regarding the improvement of performance on vigilance as a function of social presence may instead suggest a more nuanced perspective on resource allocation for vigilance.

In its simplest form, resource theory cannot fully explain why social presence might improve performance, as social presence is likely to consume attentional resources, which should theoretically decrease performance. However, as previously discussed, resource theory has seen

considerable developments since this rather simplistic instantiation, as seen in Wickens (1984) multiple resource model. In line with this more complex conceptualization of attentional resources, it may be the case that social presence functions as a component of the environment that can either improve or hinder performance based on the demands of the task. Claypoole (2018) suggested a compensatory effort model of social facilitation, such that social presence moderates effort allocation depending on task demands, resulting in effects on performance. In the present dissertation, it was observed that participants in the supportive statement conditions reported higher levels of effort on the NASA-TLX. Although this increase in subjective effort did not seem to affect performance, these results lend further credence to the idea that social presence may affect effort allocation. Combined with the superiority of the non-supportive observer condition for performance in comparison to the independent co-actor and mere presence conditions, the results of the present dissertation suggest a more complex interaction between social presence and performance on vigilance than previously believed. The effect of verbal statements from another human in the room, and the supportive or non-supportive nature of those statements, should now be considered in the wider effort to taxonomize the effects of the social environment on vigilance, as the present dissertation has shown that they can affect both performance and mental workload in vigilance tasks.

In a practical sense, the results of the present dissertation may inform best practices for performing applied vigilance tasks in the real world, while in the presence of others. While it may not be feasible for organizations to implement non-supportive observers, for example, the results of this dissertation imply that organizations should take a hard look at the environment under which they have operators perform vigilance tasks. Particularly when such vigilance tasks are safety-critical (e.g., TSA monitoring, threat detection, medical display monitoring), the

presence of others and, as demonstrated in the present dissertation, the verbal behavior of these others could mean the difference between a detected signal and a missed signal. So long as vigilance tasks in applied settings are performed in the presence of others, empirical conclusions on the effects of social presence on vigilance will remain a pressing area of research. By examining novel manipulations of social presence, the present dissertation has taken a step toward taxonomizing the effects of social presence on vigilance for use in future applied settings.

Limitations and Future Directions

The present dissertation sought to evaluate a novel method for studying the effect of social presence on vigilance, and yielded important results that will inform future research in this area. Nonetheless, it was not without some noteworthy limitations. First, the results of the present dissertation did not replicate previous findings regarding social presence in vigilance, despite using the same task and experimental protocols. However, given the extremely limited number of studies using such protocols, this failure to replicate is not entirely surprising considering the previously discussed difficulties in replicating social psychological effects. However, the present dissertation's failure to replicate previous findings does complicate the broader interpretation of social presence's effect on vigilance. Replication efforts will be crucial in clarifying these effects, particularly as they pertain to the performance of vigilance tasks in real-world settings.

On a related note, the practical implications of the present dissertation are limited by the participant sample. The use of college undergraduates in psychology research has been routinely criticized for its lack of generalizability (e.g., Cooper et al., 2010; Sears et al., 1986). While it does appear that the vigilance decrement replicates with more diverse and applied samples (e.g., Kelley et al., 2020; Mouloua & Parasuraman, 1995), it is possible that social presence

manipulations for vigilance affect college undergraduates differently than professional vigilance operators or even populations of different ages. For example, Sears et al. (1986) suggested that college undergraduates have "strong needs for peer approval" and "tendencies to be compliant to authority" (p. 527). Thus, the social presence manipulations utilized both in the present dissertation and in previous studies of social presence in vigilance may have different effects on performance, stress, and workload for non-undergraduate populations. While undergraduate samples are considerably easier to obtain, future researchers should endeavor to investigate the effects with more diverse and applied participant samples, particularly if these findings are to be used to improve the performance of vigilance tasks in the real-world.

Additionally, the novel social presence manipulations created for this dissertation have important limitations to consider. As previously discussed, the supportive statements used what could be considered a variety of types of social support (e.g., emotional: "I know you can do it;" informational: "this task makes people tired"). Moreover, although pilot work indicated that the non-supportive statements were indeed perceived as less supportive than the supportive statements, they still may have been perceived as informational support during the task. Without a valid measure to assess in-task perceptions of types of social support, it was not possible to assess this hypothesis in the present dissertation. However, future research should consider manipulating the type of support provided during vigilance tasks, to assess whether certain types of support might be more beneficial for the improvement of performance, workload, and stress in vigilance.

Looking toward the future, the results of the present dissertation (and in particular its failure to replicate previous findings) do somewhat muddy the already murky waters of the effect of social presence on vigilance. Given these inconsistencies, it may seem premature to begin to

extend social presence in vigilance paradigms into the virtual space. However, doing so may help both elucidate the effects of in-person social presence on vigilance while also examining how social presence effects might differ when implemented virtually, whether remotely or in the context of virtual environments.

For example, a study by Kothgassner et al. (2019) compared the effects of social support provided by a virtual avatar, virtual agent, face-to-face human, or no support on a mock interview task. Results indicated that participants who completed the task with support from a human or virtual avatar (which they were told was a real human operating the avatar remotely) had significantly lower heart rates and self-reported worry than those who completed the task with no support or agent support (which they were told was a computer program), suggesting that support even support received by a virtual human can attenuate stress. The experimental conditions utilized in Kothgassner et al.'s study could be rather easily combined with the supportive/non-supportive paradigm in the present dissertation to investigate their effects on vigilance. Recent findings have also indicated that the vigilance decrement can be successfully replicated remotely (Waldfogle, 2023), which considerably extends the realm of possible social presence manipulations, whether in-person or virtual, that can be examined in vigilance research. Emerging technologies like machine learning and artificial intelligence, and more relevantly human's social perceptions of these technologies, may also have a role to play in expanding our understanding of the effects of the social environment on vigilance.

Conclusion

The present dissertation sought to examine the effect of social support on performance, stress, and workload in vigilance as it compared to non-support, existing manipulations of social presence in vigilance, and to performing the task alone. Puzzlingly, comparisons of the novel

manipulations to performing the task alone were non-significant, as were comparisons of the existing social presence manipulations to the alone condition. However, the novel manipulations had a few differential effects on performance and workload as compared to the other social presence conditions, and to each other.

Participants in the non-supportive observer condition specifically had a significantly higher average proportion of correct detections than those who completed the task in the presence of an independent co-actor, and significantly higher sensitivity than those in both the independent co-actor and merely present observer conditions. These results seem to indicate that the verbal interaction with a vigilance operator affects performance and workload differently than more static forms of social presence where the person in the room with operator does not speak to them. Moreover, participants who completed the task in the presence while receiving non-supportive statements exhibited a more conservative response bias, but reported significantly lower levels of effort, than those who completed the task while receiving supportive statements. Thus, these results shed further light on the effect of verbal interactions with vigilance operator, indicating the supportive nature of these interactions may have differential effects on performance and workload in vigilance.

Taken together, the methodological approach created as part of this dissertation, and the empirical results its investigation yielded, represent a step toward a more holistic understanding of the myriad ways in which the social environment can affect cognitive performance. While a robust taxonomy for these effects will require considerable replication and extension, the present dissertation has demonstrated that reaching into the social psychological body of knowledge and applying its findings to the study of vigilance can yield insightful - if perplexing - findings. The study of vigilance, and human factors psychology more broadly, would be benefit from

continuing to build bridges with areas of psychology that have been historically understudied, as the findings of the present dissertation have highlighted.

APPENDIX A: IRB APPROVAL LETTER

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

January 25, 2023

Dear Allison Garibaldi:

On 1/25/2023, the IRB determined the following submission to be human subjects research that is exempt from regulation:

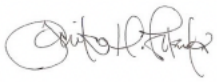
Type of Review:	Initial Study
Title:	Analyzing Human Performance in Attention
Investigator:	Allison Garibaldi
IRB ID:	STUDY00005044
Funding:	None
Grant ID:	None
Documents Reviewed:	• HRP-251- FORM - Faculty Advisor Scientific-Scholarly Review fillable form JLS signed.pdf, Category: Faculty Research Approval; • Basic Psychological Needs.docx, Category: Survey / Questionnaire; • Causality Orientations.pdf, Category: Survey / Questionnaire; • Co-Actor Perceived Social Support Scale.pdf, Category: Survey / Questionnaire; • Demographics.docx, Category: Survey / Questionnaire; • Example Stimuli.pptx, Category: Test Instruments; • Experimenter Perceived Social Support Scale.pdf, Category: Survey / Questionnaire; • Intrinsic Motivation scale.doc, Category: Survey / Questionnaire; • IPIP domain scales.doc, Category: Survey / Questionnaire; • NASA-TLX.docx, Category: Survey / Questionnaire; • Need Relevant Motivations.docx, Category: Other; • Need to Belong.docx, Category: Survey / Questionnaire; • Rating Perceived Social Support Questionnaire.docx, Category: Survey / Questionnaire; • Relatedness Need Satisfaction.docx, Category:

	Survey / Questionnaire; • State-Trait-Anxiety-Inventory.pdf, Category: Survey / Questionnaire; • Study 5044 Co-Actor Statements.docx, Category: Other; • Study 5044 DSSQ-Long.doc, Category: Survey / Questionnaire; • Study 5044 Experimenter Statements_TF.docx, Category: Other; • Study 5044 HRP-254-FORM Explanation of Research-STUDIES 2 AND 3 (1)_TF edits.pdf, Category: Consent Form; • Study 5044 HRP-254-FORM Explanation of Research-STUDY 1 (1)_TF edits.pdf, Category: Consent Form; • Study 5044 HRP-255-FORM - Request for Exemption.docx, Category: IRB Protocol; • Study 5044 HRP-509 - TEMPLATE-Debriefing Statement - STUDY3.pdf, Category: Debriefing Form; • Study 5044 HRP-509 - TEMPLATE-Debriefing Statement STUDY 2.pdf, Category: Debriefing Form;

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,



Tamiko Fukuda
UCF IRB

APPENDIX B: THE DUNDEE STRESS STATE QUESTIONNAIRE

STATE QUESTIONNAIRE

General Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

Before you start, please provide some general information about yourself.

Age..... (years) Sex. M F (Circle one)
Occupation.....
If student, state your course.....
Date today..... Time of day now.....

1. MOOD STATE

First, there is a list of words which describe people's moods or feelings. Please indicate how well each word describes how you feel **AT THE MOMENT**. For each word, circle the answer from 1 to 4 which best describes your mood.

	Definitely	Slightly	Slightly Not	Definitely Not
1. Happy	1	2	3	4
2. Dissatisfied	1	2	3	4
3. Energetic	1	2	3	4
4. Relaxed	1	2	3	4
5. Alert	1	2	3	4
6. Nervous	1	2	3	4
7. Passive	1	2	3	4
8. Cheerful	1	2	3	4
9. Tense	1	2	3	4
10. Jittery	1	2	3	4
11. Sluggish	1	2	3	4
12. Sorry	1	2	3	4
13. Composed	1	2	3	4
14. Depressed	1	2	3	4
15. Restful	1	2	3	4
16. Vigorous	1	2	3	4
17. Anxious	1	2	3	4
18. Satisfied	1	2	3	4
19. Unenterprising	1	2	3	4
20. Sad	1	2	3	4
21. Calm	1	2	3	4
22. Active	1	2	3	4
23. Contented	1	2	3	4
24. Tired	1	2	3	4
25. Impatient	1	2	3	4
26. Annoyed	1	2	3	4
27. Angry	1	2	3	4
28. Irritated	1	2	3	4
29. Grouchy	1	2	3	4

2. MOTIVATION

Please answer some questions about your attitude to the task you are about to do. Rate your agreement with the following statements by circling one of the following answers:

Extremely – 4 Very much – 3 Somewhat – 2 A little bit – 1 Not at all – 0

1. I expect the content of the task will be interesting	0	1	2	3	4
2. The only reason to do the task is to get an external reward (e.g. payment)	0	1	2	3	4
3. I would rather spend the time doing the task on something else	0	1	2	3	4
4. I am concerned about not doing as well as I can	0	1	2	3	4
5. I want to perform better than most people do	0	1	2	3	4
6. I will become fed up with the task	0	1	2	3	4
7. I am eager to do well	0	1	2	3	4
8. I would be disappointed if I failed to do well on the task	0	1	2	3	4
9. I am committed to attaining my performance goals	0	1	2	3	4
10. Doing the task is worthwhile	0	1	2	3	4
11. I expect to find the task boring	0	1	2	3	4
12. I feel apathetic about my performance	0	1	2	3	4
13. I want to succeed on the task	0	1	2	3	4
14. The task will bring out my competitive drives	0	1	2	3	4
15. I am motivated to do the task	0	1	2	3	4

3. THINKING STYLE

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you expect to perform on the task. Below are some statements which may describe your style of thought RIGHT NOW. Read each one carefully and indicate how true each statement is of your thoughts AT THE MOMENT. To answer, circle one of the following answers:

Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

1.	I'm trying to figure myself out.	0 1 2 3 4
2.	I'm very aware of myself.	0 1 2 3 4
3.	I'm reflecting about myself.	0 1 2 3 4
4.	I'm daydreaming about myself.	0 1 2 3 4
5.	I'm thinking deeply about myself.	0 1 2 3 4
6.	I'm attending to my inner feelings.	0 1 2 3 4
7.	I'm examining my motives.	0 1 2 3 4
8.	I feel that I'm off somewhere watching myself.	0 1 2 3 4
9.	I feel confident about my abilities.	0 1 2 3 4
10.	I am worried about whether I am regarded as a success or failure.	0 1 2 3 4
11.	I feel self-conscious.	0 1 2 3 4
12.	I feel as smart as others.	0 1 2 3 4
13.	I am worried about what other people think of me.	0 1 2 3 4
14.	I feel confident that I understand things.	0 1 2 3 4
15.	I feel inferior to others at this moment.	0 1 2 3 4
16.	I feel concerned about the impression I am making.	0 1 2 3 4
17.	I feel that I have less scholastic ability right now than others.	0 1 2 3 4
18.	I am worried about looking foolish.	0 1 2 3 4
19.	My attention is directed towards things other than the task.	0 1 2 3 4
20.	I am finding physical sensations such as muscular tension distracting.	0 1 2 3 4
21.	I expect my performance will be impaired by thoughts irrelevant to the task.	0 1 2 3 4
22.	I have too much to think about to be able to concentrate on the task.	0 1 2 3 4
23.	My thinking is generally clear and sharp.	0 1 2 3 4
24.	I will find it hard to maintain my concentration for more than a short time.	0 1 2 3 4
25.	My mind is wandering a great deal.	0 1 2 3 4
26.	My thoughts are confused and difficult to control.	0 1 2 3 4
27.	I expect to perform proficiently on this task.	0 1 2 3 4
28.	Generally, I feel in control of things.	0 1 2 3 4
29.	I can handle any difficulties I encounter	0 1 2 3 4
30.	I consider myself skillful at the task	0 1 2 3 4

4. TIIINKING CONTENT

This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought **DURING THE LAST TEN MINUTES** or so, by circling a number from the list below.

1= Never 2= Once 3= A few times 4= Often 5= Very often

1.	I thought about how I should work more carefully.	1 2 3 4 5
2.	I thought about how much time I had left.	1 2 3 4 5
3.	I thought about how others have done on this task.	1 2 3 4 5
4.	I thought about the difficulty of the problems.	1 2 3 4 5
5.	I thought about my level of ability.	1 2 3 4 5
6.	I thought about the purpose of the experiment.	1 2 3 4 5
7.	I thought about how I would feel if I were told how I performed.	1 2 3 4 5
8.	I thought about how often I get confused.	1 2 3 4 5
9.	I thought about members of my family.	1 2 3 4 5
10.	I thought about something that made me feel guilty.	1 2 3 4 5
11.	I thought about personal worries.	1 2 3 4 5
12.	I thought about something that made me feel angry.	1 2 3 4 5
13.	I thought about something that happened earlier today.	1 2 3 4 5
14.	I thought about something that happened in the recent past (last few days, but not today).	1 2 3 4 5
15.	I thought about something that happened in the distant past	1 2 3 4 5
16.	I thought about something that might happen in the future.	1 2 3 4 5

STATE QUESTIONNAIRE

General Instructions

This questionnaire is concerned with your feelings and thoughts while you were performing the task. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

1. MOOD STATE

First, there is a list of words which describe people's moods or feelings. Please indicate how well each word describes how you felt **WHILE PERFORMING THE TASK**. For each word, circle the answer from 1 to 4 which best describes your mood.

	Definitely	Slightly	Slightly Not	Definitely Not
1. Happy	1	2	3	4
2. Dissatisfied	1	2	3	4
3. Energetic	1	2	3	4
4. Relaxed	1	2	3	4
5. Alert	1	2	3	4
6. Nervous	1	2	3	4
7. Passive	1	2	3	4
8. Cheerful	1	2	3	4
9. Tense	1	2	3	4
10. Jittery	1	2	3	4
11. Sluggish	1	2	3	4
12. Sorry	1	2	3	4
13. Composed	1	2	3	4
14. Depressed	1	2	3	4
15. Restful	1	2	3	4
16. Vigorous	1	2	3	4
17. Anxious	1	2	3	4
18. Satisfied	1	2	3	4
19. Unenterprising	1	2	3	4
20. Sad	1	2	3	4
21. Calm	1	2	3	4
22. Active	1	2	3	4
23. Contented	1	2	3	4
24. Tired	1	2	3	4
25. Impatient	1	2	3	4
26. Annoyed	1	2	3	4
27. Angry	1	2	3	4
28. Irritated	1	2	3	4
29. Grouchy	1	2	3	4

2. MOTIVATION AND WORKLOAD

Please answer the following questions about your attitude **to the task you have just done**. Rate your agreement with the following statements by circling one of the following answers:

Extremely – 4 Very much – 3 Somewhat – 2 A little bit – 1 Not at all – 0

1.	The content of the task was interesting	0	1	2	3	4
2.	The only reason to do the task is to get an external reward (e.g. payment)	0	1	2	3	4
3.	I would rather have spent the time doing the task on something else	0	1	2	3	4
4.	I was concerned about not doing as well as I can	0	1	2	3	4
5.	I wanted to perform better than most people do	0	1	2	3	4
6.	I became fed up with the task	0	1	2	3	4
7.	I was eager to do well	0	1	2	3	4
8.	I would be disappointed if I failed to do well on this task	0	1	2	3	4
9.	I was committed to attaining my performance goals	0	1	2	3	4
10.	Doing the task was worthwhile	0	1	2	3	4
11.	I found the task boring	0	1	2	3	4
12.	I felt apathetic about my performance	0	1	2	3	4
13.	I wanted to succeed on the task	0	1	2	3	4
14.	The task brought out my competitive drives	0	1	2	3	4
15.	I was motivated to do the task	0	1	2	3	4

16. Please rate the MENTAL DEMAND of the task: How much mental and perceptual activity was required?

Low 0 1 2 3 **4** 5 6 7 8 9 10 High

17. Please rate the PHYSICAL DEMAND of the task: How much physical activity was required?

Low 0 1 2 3 **4** 5 6 7 8 9 10 High

18. Please rate the TEMPORAL DEMAND of the task: How much time pressure did you feel due to the pace at which the task elements occurred?

Low 0 1 2 3 4 5 6 **7** 8 9 10 High

19. Please rate your PERFORMANCE: How successful do you think you were in accomplishing the goals of the task?

Low 0 1 2 3 **4** 5 6 7 8 9 10 High

20. Please rate your EFFORT: How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low 0 1 2 3 4 5 6 7 8 9 10 High

21. Please rate your FRUSTRATION: How discouraged, irritated, stressed and annoyed did you feel during the task?

Low 0 1 2 3 4 5 6 7 8 9 10 High

3. THINKING STYLE

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you believed you performed on the task. Below are some statements which may describe your style of thought during task performance. Read each one carefully and indicate how true each statement was of your thoughts **WHILE PERFORMING THE TASK**. To answer circle one of the following answers: Extremely – 4 Very much – 3 Somewhat – 2 A little bit – 1 Not at all – 0

1.	I tried to figure myself out.	0 1 2 3 4
2.	I was very aware of myself.	0 1 2 3 4
3.	I reflected about myself.	0 1 2 3 4
4.	I daydreamed about myself.	0 1 2 3 4
5.	I thought deeply about myself.	0 1 2 3 4
6.	I attended to my inner feelings.	0 1 2 3 4
7.	I examined my motives.	0 1 2 3 4
8.	I felt that I was off somewhere watching myself.	0 1 2 3 4
9.	I felt confident about my abilities.	0 1 2 3 4
10.	I was worried about whether I am regarded as a success or failure.	0 1 2 3 4
11.	I felt self-conscious.	0 1 2 3 4
12.	I felt as smart as others.	0 1 2 3 4
13.	I was worried about what other people think of me.	0 1 2 3 4
14.	I felt confident that I understood things.	0 1 2 3 4
15.	I felt inferior to others.	0 1 2 3 4
16.	I felt concerned about the impression I was making.	0 1 2 3 4
17.	I felt that I had less scholastic ability than others.	0 1 2 3 4
18.	I was worried about looking foolish.	0 1 2 3 4
19.	My attention was directed towards things other than the task.	0 1 2 3 4
20.	I found physical sensations such as muscular tension distracting.	0 1 2 3 4
21.	My performance was impaired by thoughts irrelevant to the task.	0 1 2 3 4
22.	I had too much to think about to be able to concentrate on the task.	0 1 2 3 4
23.	My thinking was generally clear and sharp.	0 1 2 3 4
24.	I found it hard to maintain my concentration for more than a short time.	0 1 2 3 4
25.	My mind wandered a great deal.	0 1 2 3 4
26.	My thoughts were confused and difficult to control	0 1 2 3 4
27.	I performed proficiently on this task.	0 1 2 3 4
28.	Generally, I felt in control of things.	0 1 2 3 4
29.	I was able to handle any difficulties I encountered	0 1 2 3 4
30.	I consider myself skillful at the task	0 1 2 3 4

4. THINKING CONTENT

This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought during THE LAST TEN MINUTES (while performing the task), by circling a number from the list below.

1– Never 2– Once 3– A few times 4– Often 5– Very often

1.	I thought about how I should work more carefully.	1 2 3 4 5
2.	I thought about how much time I had left.	1 2 3 4 5
3.	I thought about how others have done on this task.	1 2 3 4 5
4.	I thought about the difficulty of the problems.	1 2 3 4 5
5.	I thought about my level of ability.	1 2 3 4 5
6.	I thought about the purpose of the experiment.	1 2 3 4 5
7.	I thought about how I would feel if I were told how I performed.	1 2 3 4 5
8.	I thought about how often I get confused.	1 2 3 4 5
9.	I thought about members of my family.	1 2 3 4 5
10.	I thought about something that made me feel guilty.	1 2 3 4 5
11.	I thought about personal worries.	1 2 3 4 5
12.	I thought about something that made me feel angry.	1 2 3 4 5
13.	I thought about something that happened earlier today.	1 2 3 4 5
14.	I thought about something that happened in the recent past (last few days, but not today).	1 2 3 4 5
15.	I thought about something that happened in the distant past	1 2 3 4 5
16.	I thought about something that might happen in the future.	1 2 3 4 5

5. OPINIONS OF THE TASK

Next, please answer some questions about the task. Please indicate what you thought of the task while you were performing it. Please try to rate the task itself rather than your personal reactions to it. For each adjective or sentence circle the appropriate number, on the six point scales provided (where 0 = not at all to 5 = very much so).

Threatening	0 1 2 3 4 5	Enjoyable	0 1 2 3 4 5
Fearful	0 1 2 3 4 5	Exhilarating	0 1 2 3 4 5
Worrying	0 1 2 3 4 5	Informative	0 1 2 3 4 5
Frightening	0 1 2 3 4 5	Challenging	0 1 2 3 4 5
Terrifying	0 1 2 3 4 5	Stimulating	0 1 2 3 4 5
Hostile	0 1 2 3 4 5	Exciting	0 1 2 3 4 5

The task was a situation:

Which was likely to get out of control	0 1 2 3 4 5
In which you were unsure of how much influence you have	0 1 2 3 4 5
In which somebody else was to blame for difficulties	0 1 2 3 4 5
In which you had to hold back from doing what you really want	0 1 2 3 4 5
Which you could deal with effectively	0 1 2 3 4 5
In which efforts to change the situation tended to make it worse	0 1 2 3 4 5
In which other people made it difficult to deal with the problem	0 1 2 3 4 5
Which was just too much for you to cope with	0 1 2 3 4 5

6. DEALING WITH PROBLEMS

Finally, think about how you dealt with any difficulties or problems which arose while you were performing the task. Below are listed some options for dealing with problems such as poor performance or negative reactions to doing the task. Please indicate how much you used each option, specifically as a **deliberately chosen way of dealing with problems**. To answer circle one of the following answers:

Extremely = 4 Very much = 3 Somewhat = 2 A little bit = 1 Not at all = 0

I ...

1.	Worked out a strategy for successful performance	0	1	2	3	4
2.	Worried about what I would do next	0	1	2	3	4
3.	Stayed detached or distanced from the situation	0	1	2	3	4
4.	Decided to save my efforts for something more worthwhile	0	1	2	3	4
5.	Blamed myself for not doing better	0	1	2	3	4
6.	Became preoccupied with my problems	0	1	2	3	4
7.	Concentrated hard on doing well	0	1	2	3	4
8.	Focused my attention on the most important parts of the task	0	1	2	3	4
9.	Acted as though the task wasn't important	0	1	2	3	4
10.	Didn't take the task too seriously	0	1	2	3	4
11.	Wished that I could change what was happening	0	1	2	3	4
12.	Blamed myself for not knowing what to do	0	1	2	3	4
13.	Worried about my inadequacies	0	1	2	3	4
14.	Made every effort to achieve my goals	0	1	2	3	4
15.	Blamed myself for becoming too emotional	0	1	2	3	4
16.	Was single-minded and determined in my efforts to overcome any problems	0	1	2	3	4
17.	Gave up the attempt to do well	0	1	2	3	4
18.	Told myself it wasn't worth getting upset	0	1	2	3	4
19.	Was careful to avoid mistakes	0	1	2	3	4
20.	Did my best to follow the instructions for the task	0	1	2	3	4
21.	Decided there was no point in trying to do well	0	1	2	3	4

APPENDIX C: THE NASA-TASK LOAD INDEX

NASA-TLX

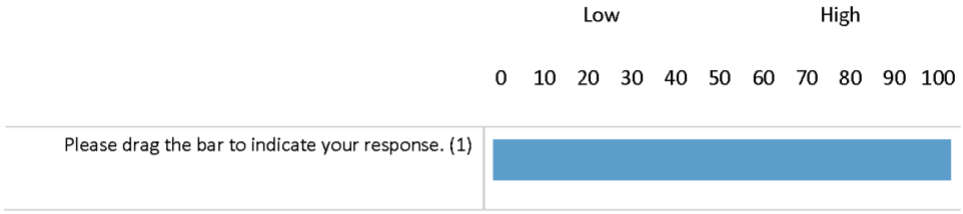
We are not only interested in assessing your performance but also the experiences you had during the experiment. In the most general sense, we are examining the "workload" you experienced. Since workload is something that is experienced individually by each person, there are no set "rulers" that can be used to estimate the workload associated with different activities. One way to find out about workload is to ask people to describe the feelings they experienced while performing a task. The set of six rating scales that I will give you was developed for you to use in evaluating your experiences during this task. Please read the descriptions of the scales carefully. If you have any questions about any of the scales in the table, please ask me about them.

For each of the six scales, you will evaluate the task by typing in a multiple of 5 that can range from 0 to 100 to reflect the point that matches your experience. Pay close attention to each scale's endpoint descriptions when making your assessments. Please note that when the rating scale for PERFORMANCE appears, a low score means you think you did well, while a high score means that you think you did poorly.

Upon completing each scale, use the mouse to click on the arrow button to go on to the next scale. Read the description for each scale again before making your rating.

Mental Demand:

How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?



Physical Demand:

How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Please drag the bar to indicate your response. (1)	

Temporal Demand:

How much time pressure did you feel due to the rate or pace at which the task or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Low High

0 10 20 30 40 50 60 70 80 90 100

Please drag the bar to indicate your response. (1)	

Performance:

How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

GOOD POOR

0 10 20 30 40 50 60 70 80 90 100

Please drag the bar to indicate your response. (1)	

Effort:

How hard did you have to work (mentally and physically) to accomplish your level of performance?

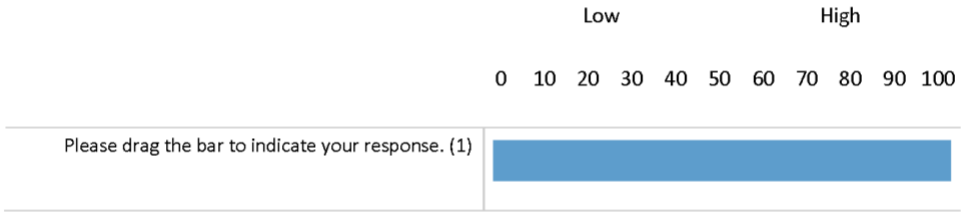
Low High

0 10 20 30 40 50 60 70 80 90 100

Please drag the bar to indicate your response. (1)	

Frustration:

How insecure, discouraged, irritated, stressed, and annoyed vs. secure, gratified, content, relaxed, and complacent did you feel during the task?



Rating scales of this sort are extremely useful, but their usefulness is limited by the tendency people have to interpret them in different ways. People differ in which scales they think were the most important contributors to workload for a task.

The next step in your evaluation is to assess the relative importance of the six factors in determining how much workload you experienced. You will be presented with pairs of rating scale titles (e.g. EFFORT vs. MENTAL DEMAND) and asked to choose which of the two items was more important to your experience of workload in the task that you just performed.

Please consider your choices carefully and try to make them consistent with your scale ratings. Refer back to the rating scale definitions if you need to as you proceed. There is no correct pattern of responses. We are only interested in your opinions.

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Effort (1)
- ○ Performance (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Temporal Demand (1)
- ○ Frustration (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Temporal Demand (1)
- ○ Effort (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Physical Demand (1)
- ○ Frustration (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Performance (1)
- ○ Frustration (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Physical Demand (1)
- ○ Temporal Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Physical Demand (1)
- ○ Performance (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Temporal Demand (1)
- ○ Mental Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Frustration (1)
- ○ Effort (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Performance (1)
- ○ Mental Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Performance (1)
- ○ Temporal Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Mental Demand (1)
- ○ Effort (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Mental Demand (1)
- ○ Physical Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Effort (1)
- ○ Physical Demand (2)

For each of the pairs following pairs (e.g., mental demand vs. effort) please select which one of the two items was more important to *your experience of workload*.

- ○ Frustration (1)
- ○ Mental Demand (2)

Page Break

APPENDIX D: SUMMARY GRAPHS

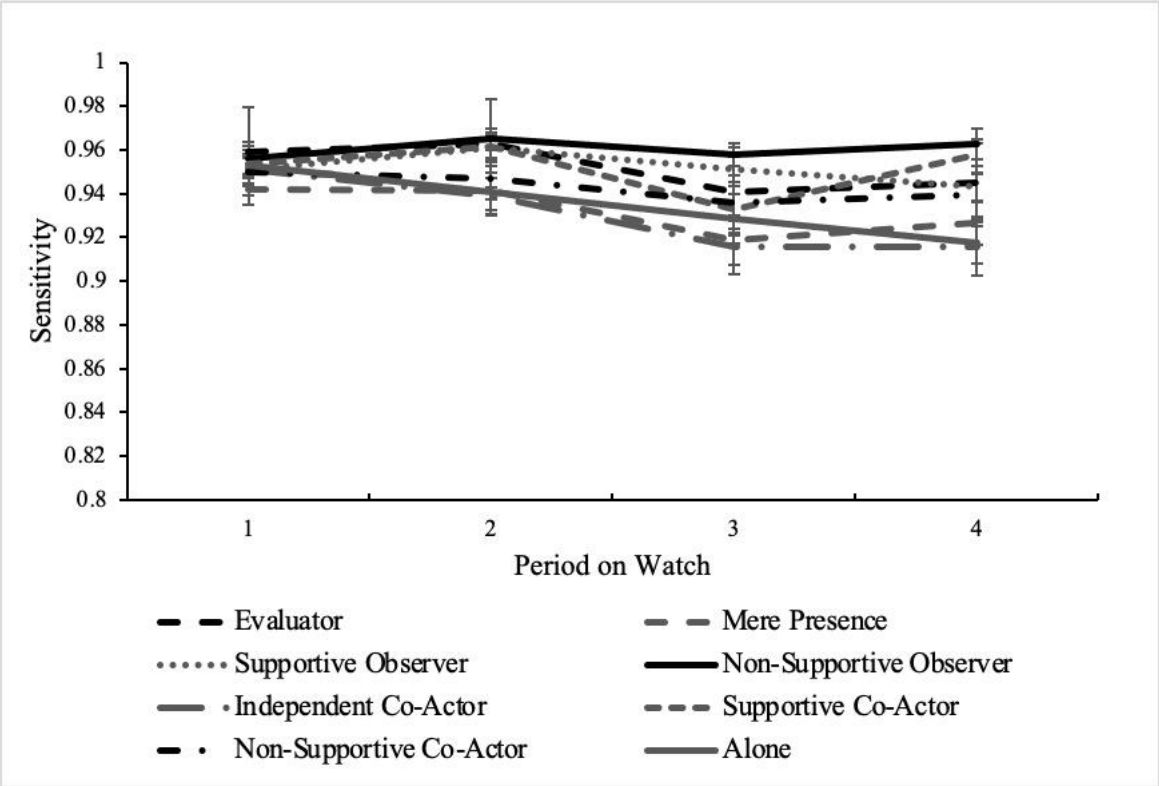


Figure 9. Sensitivity (A') as a function of period on watch and experimental conditions. *Note.* Error Bars are standard errors.

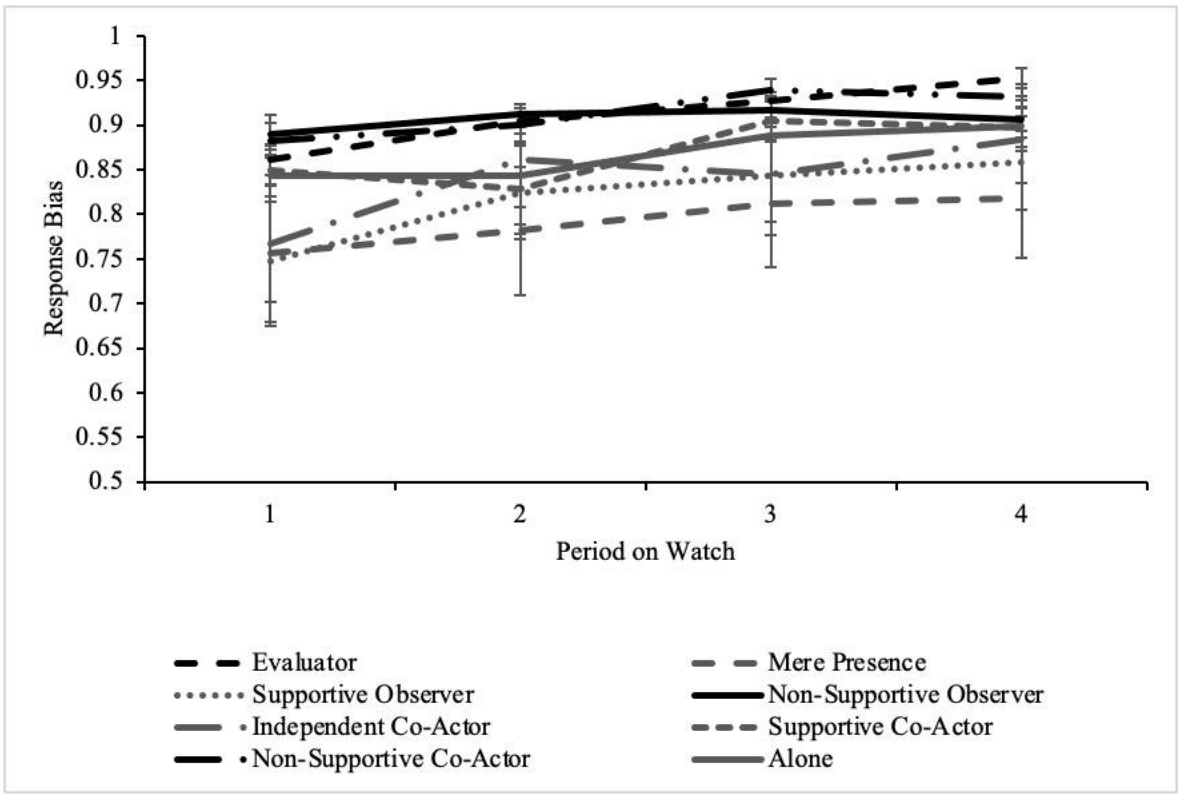


Figure 10. Response Bias as a function of period on watch and experimental condition. *Note.* Error bars are standard errors.

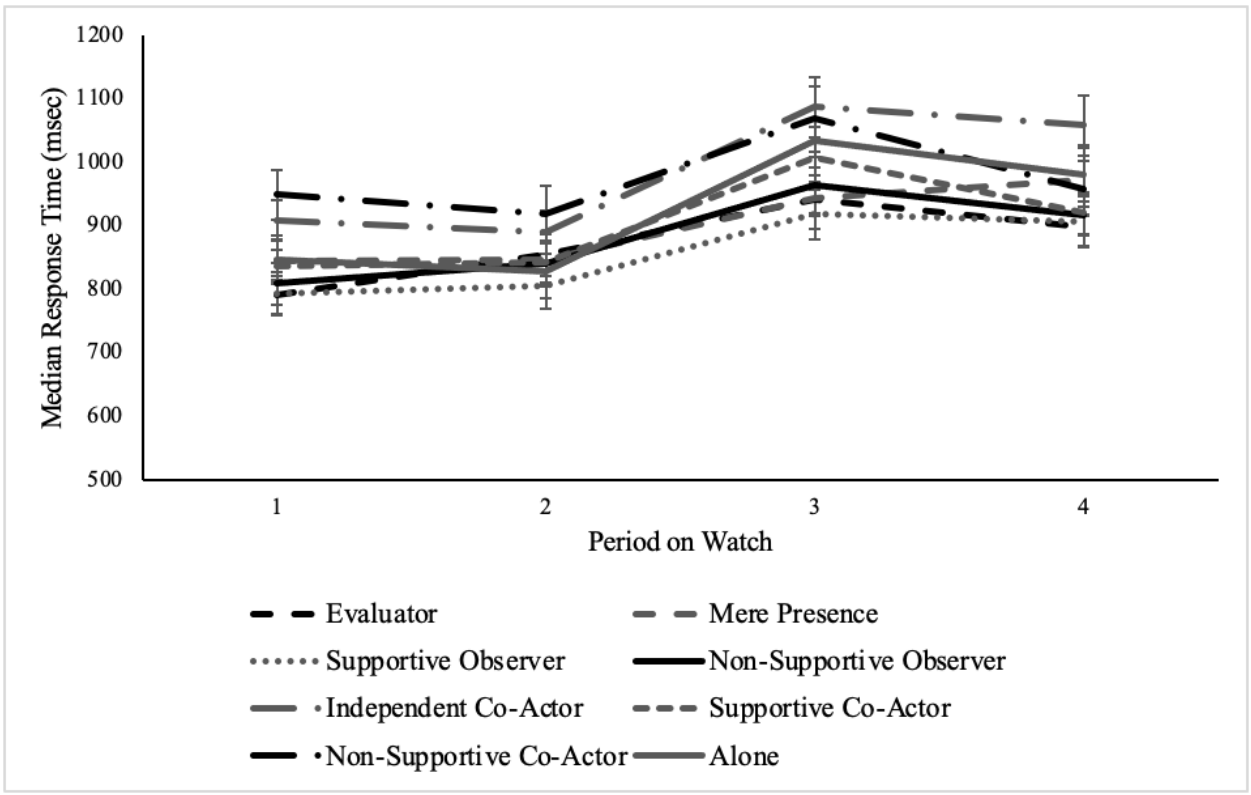


Figure 11. Median response time as a function of period on watch and experimental conditions. *Note.* Error bars are standard errors.

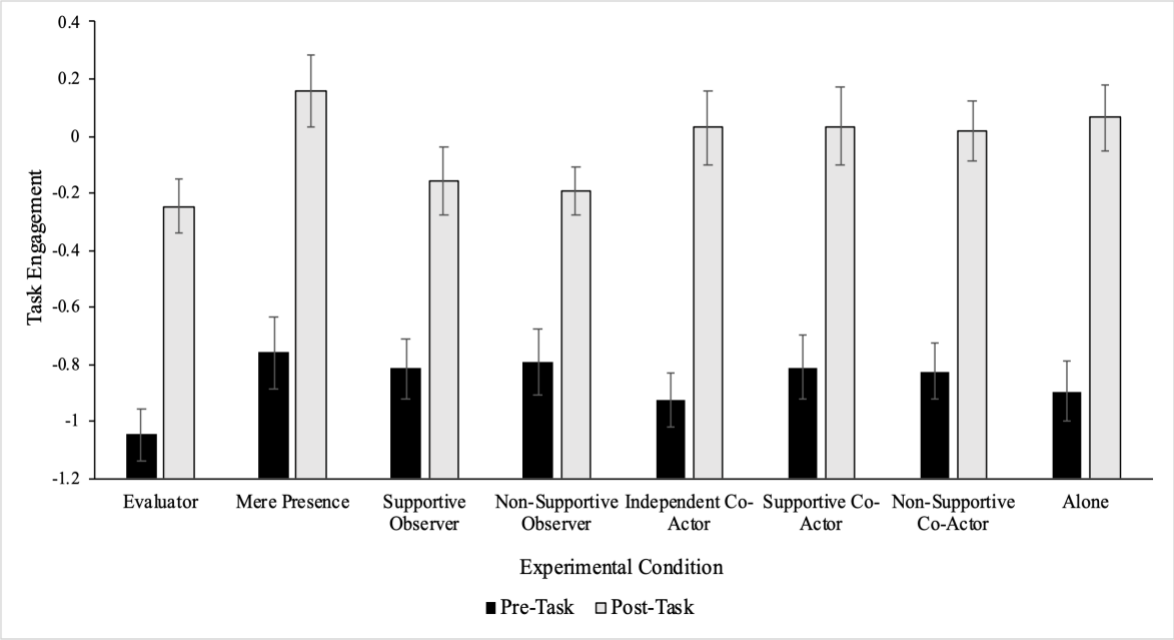


Figure 12. Differences in task engagement from pre-to post-task for all experimental conditions. *Note.* Error bars are standard errors.

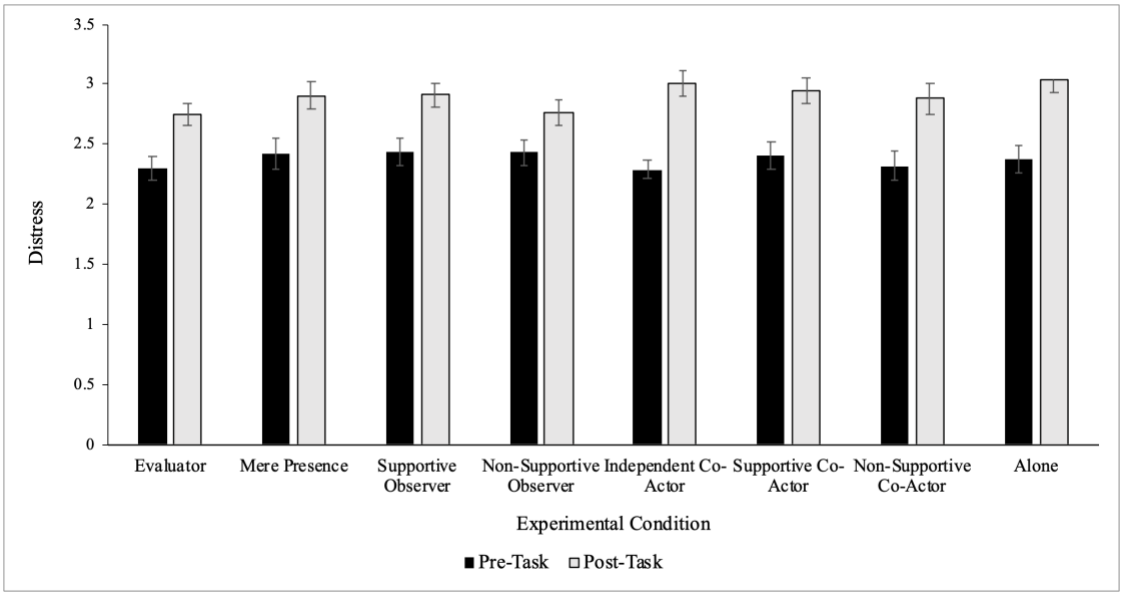


Figure 13. Differences in distress from pre- to post-task for all experimental conditions. *Note.* Error bars are standard errors.

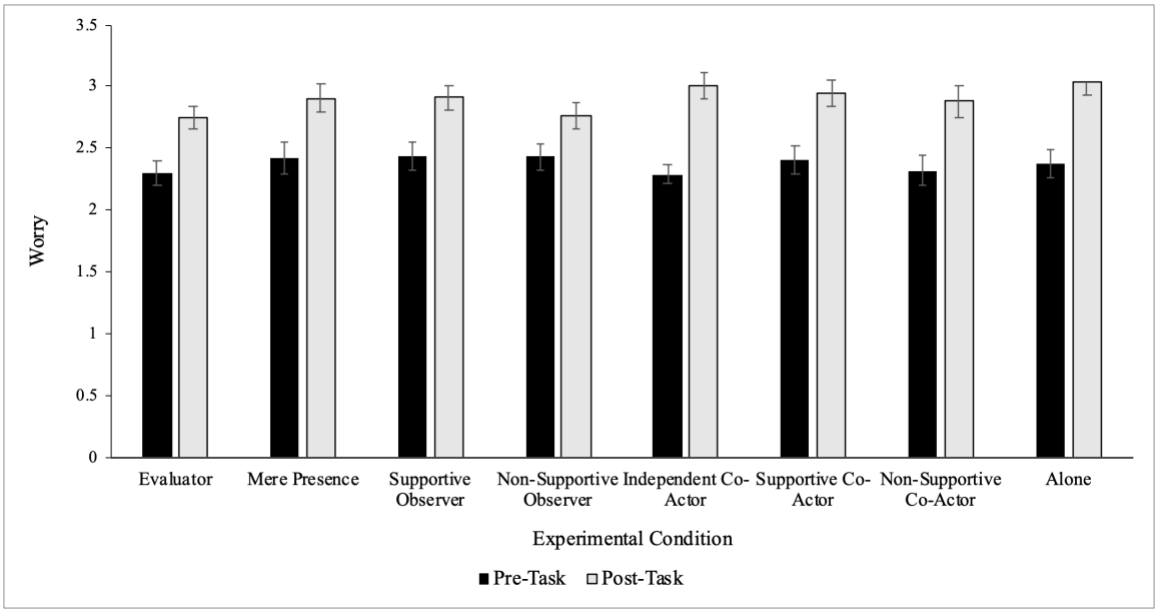


Figure 14. Differences in worry from pre- to post-task for all experimental conditions. *Note.* Error bars are standard errors.

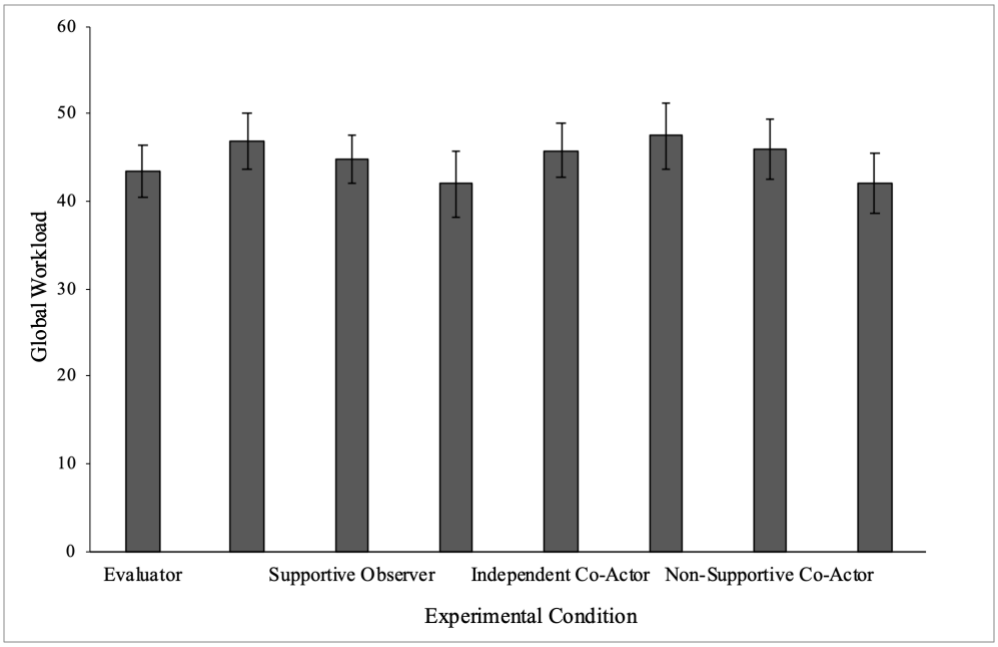


Figure 15. Global workload scores for all experimental conditions. *Note.* Error bars are standard errors.

APPENDIX E: SUPPLEMENTAL TABLES

Table 9. Means and Standard Deviations of Proportion of Correct Detections across Experimental Conditions

	Period 1		Period 2		Period 3		Period 4		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer (N = 30)	.9200	.1349	.9333	.1516	.8333	.2040	.8467	.2209	.8833	.1322
Mere Presence (N = 31)	.8645	.1743	.8710	.2224	.7613	.2895	.7935	.2449	.8226	.1820
Supportive Observer (N = 30)	.9067	.1552	.9467	.1383	.8933	.1461	.8600	.1499	.9017	.0951
Non-Supportive Observer (N = 30)	.9067	.1799	.9400	.1303	.9067	.1363	.9333	.1688	.9217	.1187
Independent Co-Actor (N = 30)	.9067	.1721	.8400	.2061	.7400	.2931	.7467	.2776	.8083	.1957
Supportive Co-Actor (N = 28)	.9071	.1386	.9357	.1224	.8143	.2172	.9143	.1145	.8929	.1103
Non-Supportive Co-Actor (N = 29)	.8828	.1466	.8621	.2145	.8138	.2669	.8207	.2411	.8448	.1622
Alone (N = 28)	.9143	.1380	.9000	.1846	.7857	.2772	.8286	.2016	.8571	.1520

Table 10. Means and Standard Deviations of False Alarms across Experimental Conditions

	Period 1		Period 2		Period 3		Period 4		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer (N = 30)	.0058	.0051	.0026	.0048	.0038	.0056	.0019	.0037	.0035	.0028
Mere Presence (N = 31)	.0251	.0607	.0211	.0515	.0246	.0642	.0220	.0573	.0232	.0581
Supportive Observer (N = 30)	.0223	.0493	.0158	.0488	.0144	.0500	.0151	.0469	.0169	.0479
Non-Supportive Observer (N = 30)	.0055	.0094	.0017	.0036	.0022	.0043	.0024	.0048	.0029	.0035
Independent Co-Actor (N = 30)	.0223	.0543	.0151	.0469	.0175	.0509	.0165	.0487	.0179	.0498
Supportive Co-Actor (N = 28)	.0134	.0307	.0098	.0301	.0113	.0449	.0057	.0204	.0100	.0310
Non-Supportive Co-Actor (N = 29)	.0084	.0140	.0050	.0100	.0017	.0050	.0020	.0043	.0043	.0065
Alone (N = 28)	.0149	.0461	.0113	.0418	.0116	.0431	.0108	.0338	.0121	.0408

Table 11. Means and Standard Deviations of Median Response Time across Experimental Conditions

	Period 1		Period 2		Period 3		Period 4		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer ($N = 30$)	790.47	166.38	853.93	177.26	941.80	145.55	898.10	178.38	841.85	133.01
Mere Presence ($N = 31$)	844.85	169.54	847.03	218.18	943.92	263.18	972.37	298.84	868.57	191.52
Supportive Observer ($N = 30$)	792.47	183.98	804.90	194.12	917.92	212.39	907.32	215.00	820.22	172.74
Non-Supportive Observer ($N = 30$)	808.65	189.05	839.47	187.99	964.42	242.40	917.23	183.49	849.45	158.50
Independent Co-Actor ($N = 30$)	908.70	164.34	890.59	181.03	1086.96	247.70	1058.16	253.19	933.46	137.21
Supportive Co-Actor ($N = 28$)	836.38	138.24	841.71	162.37	1006.79	253.80	919.88	178.99	848.23	128.65
Non-Supportive Co-Actor ($N = 29$)	945.81	214.91	919.19	233.01	1068.17	281.92	958.78	232.77	917.76	170.53
Alone ($N = 28$)	846.75	203.61	828.75	230.93	1033.27	283.97	980.29	223.16	861.32	151.54

Table 12. Means and Standard Deviations of Sensitivity (A') across Experimental Conditions

	Period 1		Period 2		Period 3		Period 4		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer (N = 30)	.9593	.0294	.9630	.0334	.9410	.0456	.9450	.0472	.9647	.0326
Mere Presence (N = 31)	.9417	.0375	.9415	.0606	.9188	.0624	.9264	.0543	.9443	.0438
Supportive Observer (N = 30)	.9513	.0348	.9612	.0370	.9513	.0316	.9433	.0355	.9653	.0256
Non-Supportive Observer (N = 30)	.9562	.0405	.9649	.0277	.9577	.0291	.9629	.0383	.9741	.0292
Independent Co-Actor (N = 30)	.9513	.0386	.9387	.0471	.9155	.0667	.9155	.0709	.9413	.0513
Supportive Co-Actor (N = 28)	.9535	.0344	.9616	.0266	.9329	.0572	.9580	.0269	.9645	.0318
Non-Supportive Co-Actor (N = 29)	.9500	.0345	.9466	.0484	.9359	.0657	.9393	.0519	.9550	.0406
Alone (N = 28)	.9529	.0478	.9535	.0399	.9287	.0594	.9368	.0494	.9554	.0399

Table 13. Means and Standard Deviations of Response Bias across Experimental Conditions

	Period 1		Period 2		Period 3		Period 4		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer ($N = 30$)	.8615	.0940	.9052	.0768	.9267	.0591	.9256	.0756	.8842	.1267
Mere Presence ($N = 31$)	.7563	.4259	.7816	.3996	.8122	.3958	.8187	.3742	.7759	.4773
Supportive Observer ($N = 30$)	.7474	.3963	.8244	.2864	.8428	.3591	.8581	.2886	.8059	.3779
Non-Supportive Observer ($N = 30$)	.8898	.1232	.9118	.0682	.9164	.0764	.9061	.0719	.8856	.0949
Independent Co-Actor ($N = 30$)	.7675	.3605	.8610	.2871	.8541	.2917	.8837	.2665	.8334	.3482
Supportive Co-Actor ($N = 28$)	.8487	.1507	.8291	.2673	.9050	.1581	.8978	.1171	.8742	.1867
Non-Supportive Co-Actor ($N = 29$)	.8831	.1031	.9005	.0982	.9392	.0655	.9319	.0728	.9192	.1271
Alone ($N = 28$)	.8437	.1549	.8434	.2859	.8886	.2318	.8995	.1515	.8535	.2393

Table 14. Means and Standard Deviations of DSSQ Secondary Scales across Experimental Conditions

	Pre-Task Engagement		Post-Task Engagement		Pre-Distress		Post-Distress		Pre-Worry		Post-Worry	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer ($N = 30$)	-1.05	.49	-.25	.51	-.57	.88	-.11	.76	2.30	.53	2.74	.49
Mere Presence ($N = 31$)	-.76	.70	.16	.70	-.83	.66	-.19	.79	2.42	.70	2.91	.65
Supportive Observer ($N = 30$)	-.82	.57	-.16	.65	-.91	.84	-.01	.93	2.43	.63	2.91	.54
Non-Supportive Observer ($N = 30$)	-.79	.64	-.19	.46	-.72	.86	-.15	1.07	2.43	.59	2.76	.61
Independent Co-Actor ($N = 30$)	-.93	.52	.03	.70	-.55	.77	.11	.89	2.29	.43	3.00	.57
Supportive Co-Actor ($N = 28$)	-.81	.58	.03	.72	-.99	.58	-.13	.77	2.41	.63	2.95	.56
Non-Supportive Co-Actor ($N = 29$)	-.82	.52	.02	.57	-.83	.67	.14	.88	2.32	.66	2.88	.72
Alone ($N = 27$)	-.90	.55	.06	.59	-.93	.74	-.41	.74	2.38	.57	3.04	.56

Table 15. Means and Standard Deviations of NASA-TLX Scores across Experimental Conditions

	Mental Demand		Physical Demand		Temporal Demand		Perceived Workload		Effort		Frustration		Global Workload	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Evaluative Observer ($N = 30$)	49.60	28.82	7.73	8.37	43.33	28.89	70.27	22.46	51.63	26.63	42.83	28.11	43.41	16.80
Mere Presence ($N = 31$)	44.68	29.28	10.35	9.82	58.32	29.31	68.61	24.35	51.97	28.76	49.81	29.00	46.83	18.04
Supportive Observer ($N = 30$)	54.00	24.25	11.07	11.66	39.67	27.05	70.73	18.63	59.70	27.20	33.33	29.26	44.84	15.38
Non-Supportive Observer ($N = 30$)	47.90	30.67	15.70	22.61	48.47	28.25	81.33	17.73	52.50	29.62	38.87	30.05	41.94	20.85
Independent Co-Actor ($N = 30$)	49.93	27.46	11.07	14.11	53.43	28.78	65.43	24.10	51.67	27.19	48.97	26.06	45.80	17.03
Supportive Co-Actor ($N = 28$)	54.64	28.15	9.57	12.71	52.71	31.84	71.32	26.08	57.11	28.30	46.32	29.66	47.39	20.60
Non-Supportive Co-Actor ($N = 29$)	50.72	27.95	10.90	17.06	54.76	28.65	72.79	20.39	58.55	23.56	52.07	32.34	46.86	18.67
Alone ($N = 27$)	48.81	25.82	9.19	13.31	45.88	32.27	64.42	25.25	55.42	25.68	48.19	30.63	43.04	17.78

LIST OF REFERENCES

Anthony, J. L., & O'Brien, W. H. (1999). An evaluation of the impact of social support manipulations on cardiovascular reactivity to laboratory stressors. *Behavioral Medicine*, *25*(2), 78-87.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 592.

Bem, D. J., Utts, J., & Johnson, W. O. (2011). Must psychologists change the way they analyze their data? Journal of Personality and Social Psychology, 101, 716 –719.

Bergum, B.O., & Lehr, D.J. (1963) Effects of authoritarianism on vigilance performance. *Journal of Applied Psychology, 47,* 75-77.

Broadbent, D. E. (1958). *Perception and communication.* Elmsford, NY, US.

Bond, C. F. (1982). Social facilitation: A self-presentational view. *Journal of Personality and Social Psychology*, *42*(6), 1050.

Bond, C. F., & Titus, L. J. (1983). Social facilitation: A meta-analysis of 241 studies. *Psychological Bulletin*, *94*(2), 265–292.

Bray, R. M., & Sugarman, R. (1980). Social facilitation among interacting groups: Evidence for the evaluation-apprehension hypothesis. *Personality and Social Psychology Bulletin*, *6*(1), 137-142.

Caggiano, D.M., & Parasuraman, R. (2004). The role of memory representation in the vigilance decrement. *Psychonomic Bulletin & Review*, *11*, 932-937.

Camerer, C. F., Dreber, A., Holzmeister, F., Ho, T. H., Huber, J., Johannesson, M., ... & Wu, H. (2018). Evaluating the replicability of social science experiments in Nature and Science between 2010 and 2015. *Nature human behaviour*, *2*(9), 637-644.

Cannon, W. (1932). *The wisdom of the body.* New York: Norton.

Cassel, J. (1976). The contribution of the social environment to host resistance.*American journal of epidemiology*, *104*(2), 107-123.

Calhoun, G. L., Draper, M. H., Guilfoos, B. J., & Ruff, H. A. (2005, September). Tactile and aural alerts in high auditory load UAV control environments. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 49, No. 1, pp. 145-149). Sage CA: Los Angeles, CA: Sage Publications.

Christenfeld, N., Gerin, W., Linden, W., Sanders, M., Mathur, J., Deich, J. D., & Pickering, T. G. (1997). Social support effects on cardiovascular reactivity. *Psychosomatic Medicine*, *59*(4), 388–398.

Claypoole, V.L., "Understanding Human Performance and Social Presence: An Analysis of Vigilance and Social Facilitation" (2018). *Electronic Theses and Dissertations, 2004-2019*. 5876. https://stars.library.ucf.edu/etd/5876.

Claypoole, V.L., & Szalma, J. L. (2018a). Facilitating sustained attention: Is mere presence sufficient? *American Journal of Psychology*, *131*(4), 417–428.

Claypoole, V.L., & Szalma, J. L. (2018b). Independent coactors may improve performance and lower workload: Viewing Vigilance Under Social Facilitation. *Human Factors*, *60*(6), 822–832. https://doi.org/10.1177/0018720818769268

Claypoole, V.L, & Szalma, J. L. (2017). Examining social facilitation in vigilance: a hit and a miss. *Ergonomics*, *60*(11), 1485–1499. https://doi.org/10.1080/00140139.2017.1308563

Cobb, S. (1976). Social support as a moderator of life stress. *Psychosomatic Medicine*, *38*(5), 300–314.

Cohen, S., McKay, G. (1984). Social support, stress and the buffering hypothesis: A theoretical analysis. *Handbook of psychology and health*, *2*, 253.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, *98*(2), 310–357.

Colquhoun, W. P. (1966). Training for vigilance: A comparison of different techniques. *Human Factors*, *8*, 7-12.

Cooper, C. A., McCord, D. M., & Socha, A. (2010). Evaluating the college sophomore problem: The case of personality and politics. *The Journal of psychology*, *145*(1), 23-37.

Cottrell, N. B. (1972). Social facilitation. In C. G. McClintock (Ed.), *Experimental Social Psychology* (pp. 185–236). New York: Holt, Rinehart & Winston.

Craig, A. (1978). Is the vigilance decrement simply a response adjustment towards probability matching?.Human Factors, 20(4), 441-446.

Davies, D. R., & Parasuraman, R. (1982). *The psychology of vigilance*. London, UK: Academic.

Deaton, J. E., & Parasuraman, R. (1993). Sensory and cognitive vigilance: effects of age on performance and subjective workload. *Human Performance*, *6*(1), 71–97.

Deci, E.L., Eghrari, H., Patrick, B.C., & Leone, D. (1994). Facilitating internalization: The self-determination theory perspective. Journal of Personality, 62, 119-142.

Deci, E. L., & Ryan, R. M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268.

Deci, E. L., & Ryan, R. M. (2009). Self-determination theory: A consideration of human motivational universals. In P. J. Corr, & G. Matthews (Eds.), *The Cambridge handbook of personality psychology* (pp. 441–456). New York: Cambridge University Press.

Dillard, M. B., Warm, J. S., Funke, G. J., Funke, M. E., Finomore, V. S., Matthews, G., Shaw, T. H., & Parasuraman, R. (2014). The sustained attention to response task (SART) does not promote mindlessness during vigilance performance. *Human Factors, 56*, 1364 – 1379.

Earp, B. D., & Trafimow, D. (2015). Replication, falsification, and the crisis of confidence in social psychology. *Frontiers In Psychology*, *6*, 138286.

Edens, J. L. (1992). The effect of social support and physical touch on cardiovascular reactions to Mental Stress. *Journal of Psychosomatic Research*, *36*(4), 371–382.

Esterman, M., Grosso, M., Liu, G., Mitko, A., Morris, R., & DeGutis, J. (2016). Anticipation of monetary reward can attenuate the vigilance decrement. *PloS One*, *11*(7), e0159741.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175-191.

Festinger, L. (1954). A theory of social comparison processes. *Human relations*, *7*(2), 117-140.

Fraulini, N. W., Hancock, G. M., Neigel, A. R., Claypoole, V. L., & Szalma, J. L. (2017). A critical examination of the research and theoretical underpinnings discussed in Thomson, Besner, and Smilek (2016). *Psychological Review, 124*, 525-531.

Funke, G. J., Warm, J. S., Baldwin, C. L., Garcia, A., Funke, M. E., Dillard, M. B., ... & Greenlee, E. T. (2016). The independence and interdependence of coacting observers in regard to performance efficiency, workload, and stress in a vigilance task. *Human Factors*, *58*(6), 915-926.

Geen, R. G. & Gange, J. J. (1977). Drive theory of social facilitation: Twelve years of theory and research. *Psychological Bulletin, 84*, 1267-1288. *Laboratory Professionals, 8*, 1415.

Grier, R. A., Warm, J. S., Dember, W. N., Matthews, G., Galinsky, T. L., Szalma, J. L., & Parasuraman, R. (2003). The vigilance decrement reflects limitations in effortful attention, not mindlessness. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *45*, 349-359.

Hancock, P. A., & Ganey, H. C. N. (2003). From the inverted-U to the extended-U: The evolution of a law of psychology. *Human Performance in Extreme Environments*, *7*(1), 5–14

Hancock, P.A. & Szalma, J.L. (2006). Stress and Neuroergonomics. In: R. Parasuraman and M. Rizzo (Eds.), *Neuroergonomics: The brain at work.* Oxford: Oxford University Press (pp. 195-206)

Hancock, P. A., & Warm, J. S. (2003). A dynamic model of stress and sustained attention. *Journal of Human Performance in Extreme Environments*, *7*(1), 4.

Hancock, P.A., & Warm, J.S. (1989). A Dynamic Model of Stress and Sustained Attention. *Human Factors*, *31*(5), 519-537.

Hebb, D. O. (1955). Drives and the CNS (conceptual nervous system). *Psychological Review*, *62*(4), 243.

Helton, W.S., & Russell, P.N. (2015). Rest is best: The role of rest and task interruptions on vigilance. *Cognition, 134*, 165-173.

Helton, W. S., & Russell, P. N. (2017). Rest is still best: The role of the qualitative and quantitative load of interruptions on vigilance. *Human Factors*, 59(1), 91-100.

Helton, W. S., & Warm, J. S. (2008). Signal salience and the mindlessness theory of vigilance. *Acta Psychologica, 129*(1), 18-25.

Hilmert, C. J., Kulik, J. A., & Christenfeld, N. (2002). The varied impact of social support on cardiovascular reactivity. *Basic and Applied Social Psychology*, *24*(3), 229-240.

Hockey, R. (1984). Varieties of attentional state: The effects of environment. In R. Parasuraman & D. R. Davies (Eds.), *Varieties of attention* (pp. 449–483). New York: Academic Press

Hockey, R. (1986). Changes in operator efficiency as a function of environmental stress, fatigue, and circadian rhythms. In K. R. Boff, L. Kaufman, & J. P. Thomas (Eds.), *Handbook of human perception and performance: Vol. II. Cognitive processes and performance* (pp. 1–49). New York: Wiley.

Hockey, R., & Hamilton, P. (1983). The cognitive patterning of stress states. In G. R. J. Hockey (Ed.), *Stress and fatigue in human performance* (pp. 331–362). Chichester: Wiley.

Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. *Biological Psychology*, *45*, 73-93.

Holland, F. G., & Hancock, P. A. (1991, June). *The inverted-U: A paradigm in chaos.* Paper presented at the annual meeting of the North American Society for the Psychology of Sport

and Physical Activity, Asilomar, CA

Hovanitz, C. A., Chin, K., & Warm, J. S. (1989). Complexities in life stress-dysfunction relationships: A case in point—tension headache. *Journal of Behavioral Medicine*, 12, 55–75.

Johnson, R. F., & Merullo, D. J. (2000). *Caffeine, gender, and sentry duty: effects of a mild stimulant on vigilance and marksmanship*. *Pennington center nutrition series*, *10*, 272-289.

Kahneman D (1973). *Attention and effort.* Prentice Hall, New Jersey.

Karau, S. J., & Williams, K. D. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology, 65*(4), 681–706.

Kelley, A., Hayes, A., Mathews, C., & Bernhardt, K. (2020). Sustaining performance and vigilance during extended UAS operations. *ARMY AEROMEDICAL RESEARCH LAB FORT RUCKER AL. https://apps. dtic. mil/sti/citations/AD1109475*.

Kimbler, K. J., Margrett, J. A., & Johnson, T. L. (2012). The role of supportive messages and distracting thoughts on everyday problem-solving performance. *Experimental Aging Research*, *38*(5), 537–558

Klein, R. A., Vianello, M., Hasselman, F., Adams, B. G., Adams Jr, R. B., Alper, S., ... & Sowden, W. (2018). Many Labs 2: Investigating variation in replicability across samples and settings. *Advances in Methods and Practices in Psychological Science*, *1*(4), 443-490.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin, 119*, 254–284.

Koelega, H. S., & Brinkman, J. A. (1986). Noise and vigilance: An evaluative review. *Human Factors*, *28*(4), 465-481.

Kors, D. J., Linden, W., & Gerin, W. (1997). Evaluation Interferes with Social Support: Effects on Cardiovascular Stress Reactivity in Women. *Journal of Social and Clinical Psychology*, *16*(1), 1–23.

Kors, D. J., Linden, W., & Gerin, W. (2011). Evaluation interferes with social Support: effects on cardiovascular stress reactivity in Women. *Journal of Social and Clinical Psychology*, *16*(1), 1–23.

Kothgassner, O. D., Goreis, A., Kafka, J. X., Kaufmann, M., Atteneder, K., Beutl, L., ... & Felnhofer, A. (2019). Virtual social support buffers stress response: an experimental comparison of real-life and virtual support prior to a social stressor. *Journal of behavior therapy and experimental psychiatry*, *63*, 57-65.

Landsberg, C. R., Mercado, A. D., Van Buskirk, W. L., Lineberry, M., & Steinhauser, N. (2012, September). Evaluation of an adaptive training system for submarine periscope operations. In *Proceedings of the Human Factors and Ergonomics Society annual meeting* (Vol. 56, No. 1, pp. 2422-2426). Sage CA: Los Angeles, CA: SAGE Publications.

Langner, R., & Eickhoff, S.B. (2013). Sustaining Attention to Simple Tasks: A Meta-Analytic Review of the Neural Mechanisms of Vigilant Attention. *Psychological Bulletin*, *139*(4), 870-900.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer publishing company.

Lazarus, R.S. (1999) *Stress and emotion: A new synthesis*. New York: Springer.

Lett, H. S., Blumenthal, J. A., Babyak, M. A., Strauman, T. J., Robins, C., & Sherwood, A. (2005). Social support and coronary heart disease: epidemiologic evidence and implications for treatment. *Psychosomatic Medicine*, *67*(6), 869-878.

Lynch, J.J., & Convey, W. H. (1979). Loneliness, disease, and death: Altemative approaches. *Psychosomatics*, *20*(10), 702-708.

Mackworth, N. H. (1948). The breakdown of vigilance during prolonged visual search. *Quarterly Journal of Experimental Psychology*, *1*(1), 6–21.

Mackworth, N. H. 1950. "Researches on the Measurement of Human Performance." In *Selected Papers in the Design and Use of Control Systems*, edited by H. W. Sinaiko, 174–331. Reprinted from Medical Research Council Special Report Series 268, London, UK: H.M. Stationary Office.

Manly, T., Robertson, I.H., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. *Neuropsychologica*, *37*, 661-670.

Matthews, G., Campbell, S. E., Falconer, S., Joyner, L. A., Huggins, J., Gilliland, K., Grier, R., & Warm, J. S. (2002). Fundamental dimensions of subjective state in performance settings: Task engagement, distress, and worry. *Emotion*, *2*, 315-340.

Matthews, G., Davies, D. R., & Holley, P. J. (1990). Extraversion, arousal and visual sustained attention: The role of resource availability. *Personality and Individual Differences*, *11*(11), 1159-1173.

Matthews G., Szalma J. L., Panganiban A. R., Neubauer C., Warm J. S. (2013). Profiling task stress with the Dundee Stress State Questionnaire. In Cavalcanti L., Azevedo S.

(Eds.), *Psychology of stress: New research* (pp. 49–91). Hauppauge, NY: Nova Science Publishers.

Matthews, G., Joyner, L., Gilliland, K., Campbell, S. E., Falconer, S., & Huggins, J. (1999). Validation of a comprehensive stress state questionnaire: Towards a state 'Big Three'? In I. Mervielde, I. J. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe* (Vol. 7, pp. 335–350). Tilburg, the Netherlands: Tilburg University Press.

Matthews, G., Warm, J.S., Reinerman-Jones, L.E., Langheim, L.K., Washburn, D.A., & Tripp, L. (2010). Task Engagement, Cerebral Blood Flow Velocity, and Diagnostic Monitoring for Sustained Attention. *Journal of Experimental Psychology: Applied*, *16*(2), 187-203. DOI: 10.1037/a0019572

McMahon, G., Creaven, A.-M., & Gallagher, S. (2020). Perceived social support mediates the association between attachment and cardiovascular reactivity in young adults. *Psychophysiology*, *57*(3), e13496.

Meuter, R. F., & Lacherez, P. F. (2016). When and why threats go undetected: Impacts of event rate and shift length on threat detection accuracy during airport baggage screening. *Human factors*, *58*(2), 218-228.

Moray, N. (1967). Where is Capacity Limited? *Acta Psychologica*, 27, 84–92.

Mouloua, M., & Parasuraman, R. (1995). Aging and cognitive vigilance: Effects of spatial uncertainty and event rate. *Experimental Aging Research, 21*(1), 17-32.

Neigel, A. R. (2017). Beyond Compliance: Examining the Role of Motivation in Vigilance Performance. *Electronic Theses and Dissertations, 2004-2019*. 5876.

Neigel, A. R., Dever, D. A., Claypoole, V. L., Fraulini, N. W., Hancock, G. M., & Szalma, J. L. (2018). Sex Differences in Lexical Vigilance Performance. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 62, No. 1, pp. 731-735). Sage CA: Los Angeles, CA: SAGE Publications.

Neigel, A. R., Claypoole, V. L., Fraulini, N. W., Waldfogle, G. E., & Szalma, J. L. (2019). Where is my mind? Examining mind-wandering and vigilance performance. *Experimental Brain Research*, *237*(2), 557-571.

Normand, A., & Croizet, J. (2013). Upward Social Comparison Generates Attentional Focusing When the Dimension of Comparison is Self-Threatening. *Social Cognition, 31*(3), 336-348.

Parasuraman, R. (1984). The psychobiology of sustained attention. In J. S. Warm (Ed.), *Sustained attention in human performance* (pp. 61–101). Chichester: Wiley.

Parasuraman, R., & Davies, D. R. (1977). A taxonomic analysis of vigilance. In R. R. Mackie (Ed.), *Vigilance: Theory, operational performance, and physiological correlates* (pp. 559–574). New York: Plenum.

Parasuraman, R. & Mouloua, M. (1987). Interaction of signal discriminability and task type in vigilance decrement. *Perception & Psychophysics*, *41*(1), 17-22.

Parasuraman, R., Warm, J. S., & Dember, W. N. (1987). Vigilance: Taxonomy and utility. In L. S. Mark, J. S. Warm, & R. L. Huston (Eds.), *Ergonomics and human factors* (pp. 11–32). New York: Springer-Verlag.

Parasuraman R. (1996). Monitoring of automated systems. In Parasuraman R., Mouloua M. (Eds.), *Automation and human performance* (pp. 91–115). Mahwah, NJ: Erlbaum.

Pettigrew, T. F. (2018). The Emergence of Contextual Social Psychology. *Personality and Social Psychology Bulletin*, *44*(7), 963-971.

Pierce, G. R., Sarason, B. R., & Sarason, I. G. (1992). General and specific support expectations and stress as predictors of perceived supportiveness: An experimental study. *Journal of Personality and Social Psychology*, *2*, 297.

Putz, V. R. (1975). The effects of different modes of supervision on vigilance behaviour. *British Journal of Psychology*, *66*(2), 157–160.

Reinerman-Jones, L. E., Matthews, G., Langheim, L. K., & Warm, J. S. (2011). Selection for vigilance assignments: A review and proposed new direction. *Theoretical Issues in Ergonomics Science*, *12*(4), 273-296.

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Ytend, J. (1997). "Oops!": Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologica, 35*, 747-758.

Ross, H.A., Russell, P.N., & Helton, W.S. (2014). Effects of breaks and goal switches on the vigilance decrement. *Experimental Brain Research, 232*(6), 1729-1737.

Satchell, P. M. (1993). *Cockpit monitoring and alerting systems*. Aldershot, Hants, England: Ashgate.

Sarason, I. G., Pierce, G. R., & Sarason, B. R. (1990a). Social support and interactional processes: A triadic hypothesis. *Journal of Social and Personal Relationships*, *7*(4), 495-506.

Sarason, I. G., Sarason, B. R., & Pierce, G. R. (1990b). Social Support: The Search for Theory. *Journal of Social and Clinical Psychology*, *9*(1), 133–147.

Sawyer, B. D., Finomore, V. S., Funke, G. J., Mancuso, V. F., Funke, M. E., Matthews, G., & Warm, J. S. (2014, September). Cyber vigilance: effects of signal probability and event rate. In *Proceedings of the human factors and ergonomics society annual meeting* (Vol. 58, No. 1, pp. 1771-1775). Sage CA: Los Angeles, CA: Sage Publications.

Searle, B., Bright, J. E. H., & Bochner, S. (2001). Helping people to sort it out: The role of social support in the Job Strain Model. *Work and Stress*, *15*(4), 328–346.

Sears, D. O. (1986). College sophomores in the laboratory: Influences of a narrow data base on social psychology's view of human nature. *Journal of personality and social psychology*, *51*(3), 515.

See, J. E., Howe, S. R., Warm, J. S., & Dember, W. N. (1995). Meta-analysis of the sensitivity decrement in vigilance. *Psychological Bulletin, 117,* 230–249.

See, J. E., Warm, J. S., Dember, W. N., & Howe, S. R. (1997). Vigilance and signal detection theory: An empirical evaluation of five measures of response bias. *Human Factors*, *39*(1), 14-29.

Sedikides, C., Olsen, N., & Reis, H. T. (1993). Relationships as natural categories. *Journal of Personality and Social Psychology, 64*(1), 71–82.

Selye, H. (1976). *The stress of life* (Rev. ed.). New York: McGraw-Hill.

Shaw, T. H., Matthews, G., Warm, J. S., Finomore, V. S., Silverman, L., & Costa Jr, P. T. (2010). Individual differences in vigilance: Personality, ability and states of stress. *Journal of Research in Personality*, *44*(3), 297-308.

Sheffield, D., & Carroll, D. (1996). Task-induced cardiovascular activity and the presence of a supportive or undermining other. *Psychology & Health, 11*(4), 583-591. doi:10.1080/08870449608401991

Sheridan T. B. (2002). *Humans and automation: System design and research issues*, John Wiley and Sons.

Sheridan T. B. (2021) Human supervisory control of automation. In Salvendy G., Karwowski W. (Eds.), *Handbook of Human Factors and Ergonomics* (5th ed., Vol. 13. pp. 736–760). John Wiley & Sons Inc.

Schimmack, U. (2020). A meta-psychological perspective on the decade of replication failures in social psychology. *Canadian Psychology/Psychologie Canadienne*, *61*(4), 364.

Silver, R. C., Wortman, C. B., & Crofton, C. (1990). The role of coping in support provision: The self-presentational dilemma of victims of life crises. In B.R. Sarason, I.G. Sarason & G.R. Pierce (Eds) *Social Support: An Interactional View,* 397-426. New York: Wiley.

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological bulletin, 132*(6), 946.

Szalma, J. L., Hancock, P. A., Dember, W. N., & Warm, J. S. (2006). Training for vigilance: The effect of knowledge of result format and dispositional optimism and pessimism on performance and stress. *British Journal of Psychology*, *97*, 115-135.

Szalma, J.L., & Hancock, P.A. (2007). Task loading and stress in human-computer interaction: Theoretical frameworks and mitigation strategies. In: J.A. Jacko and A. Sears (Eds.), *Handbook for human-computer interaction in interactive systems, 2nd Ed*. (pp. 115-132). New York: Erlbaum Taylor & Francis Group.

Szalma, J. L., Warm, J. S., Matthews, G., Dember, W. N., Weiler, E. M., Meier, A., & Eggemeier, F. T. (2004). Effects of sensory modality and task duration on performance, workload, and stress in sustained attention. *Human Factors, 46*(2), 219–233.

Szalma, J. L. (2014). On the Application of Motivation Theory to Human Factors/Ergonomics: Motivational Design Principles for Human–Technology Interaction. *Human Factors*, *56*(8), 1453-1471.

Tanaka, K., Kojo, K., & Matsuzaki, M. (1990). The effects of experimentally provided Social support on task performance and anxiety. *The Japanese Journal of Experimental Social Psychology*, *29*(3), 65–69.

Tardy, C. H. (1992). Assessing the functions of supportive messages. *Communication Research*, *19*(2), 175–192.

Teo, G., & Szalma, J. L. (2011). The effects of task type and source complexity on vigilance performance, workload, and stress. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 55, No. 1, pp. 1180-1184). Sage CA: Los Angeles, CA: Sage Publications.

Teoh, A. N. (2015). *Dual effects of social support on cardiovascular reactivity: Social support as a comfort and an encouragement* (Doctoral dissertation, North Dakota State University).

Teoh, A. N., & Hilmert, C. (2018). Social support as a comfort or an encouragement: A systematic review on the contrasting effects of social support on cardiovascular reactivity. *British Journal of Health Psychology*, *23*(4), 1040-1065.

Thomson, D. R., Besner, D., & Smilek, D. (2015). A resource-control account of sustained attention: evidence from mind-wandering and vigilance paradigms. *Perspectives on Psychological Science, 10*(1), 82-96.

Thorsteinsson, E. B., & James, J. E. (1999). A meta-analysis of the effects of experimental manipulations of social support during laboratory stress. *Psychology and Health*, *14*(5), 869–886.

Treisman, A. & Davies, A. (1973). Divided attention to ear and eye. In Wolfe & L.Robertson (Eds.), *From perception to consciousness: Searching with Anne Treisman (pp.* 24– 31. Oxford University Press.

Triplett, N. (1898). The Dynamogenic Factors in Pacemaking and Competition. The American Journal of Psychology, 9(4), 507.

Vila, J. (2021). Social Support and Longevity: Meta-Analysis-Based Evidence and Psychobiological Mechanisms. *Frontiers in Psychology*, 12, 717164.

Waldfogle, Grace E., "Revisiting the Vigilance Taxonomy: Are Findings Consistent in a Remote Environment?" (2023). *Graduate Thesis and Dissertation 2023-2024*. 48. https://stars.library.ucf.edu/etd2023/48

Waldfogle, G. E., Garibaldi, A. E., Neigel, A. R., & Szalma, J. L. (2021). 'I need a break': the effect of choice of rest break duration on vigilance. *Ergonomics*, *64*(12), 1509-1521.

Ware, J. R., Kowal, B., & Baker Jr, R. A. (1964). The role of experimenter attitude and contingent reinforcement in a vigilance task. *Human Factors*, *6*(1), 111-115.

Warm, J. S., Howe, S. R., Fishbein, H. D., Dember, W. N., & Sprague, R. L. (1984). Cognitive Demand and the vigilance decrement. In A. Mital (Ed.), *Trends in Ergonomics/Human Factors I* (pp. 15–20). North Holland: Elsevier.

Warm, J. S., & Jerison, H. J. (1984). The psychophysics of vigilance. In J. S. Warm (Ed.), *Sustained attention in human performance* (pp. 15–59). Chichester, UK: Wiley.

Warm, J. S. (1984). *Sustained attention in human performance*. New York: Wiley.

Warm, J. S., Parasuraman, R., & Matthews, G. (2008). Vigilance requires hard mental work and is stressful. *Human Factors*, *50*(3), 433–441.

Wickens, C.D. (1984). Processing Resources in Attention. In R. Parasuraman & D.R. Davies (Eds.), *Varieties of Attention* (pp. 63-102). New York, NY: Academic Press.

Yu, R. F., & Wu, X. (2015). Working alone or in the presence of others: Exploring social facilitation in baggage X-ray security screening tasks. *Ergonomics*, *58*(6), 857-865.

Zajonc, R. B. (1965). Social facilitation. *Science, 149*, 269–274.