Individual Attentional Capacity to Perform Safely:

Developing the Workplace Attention Trifactor Scale

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Abstract

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Abstract: A self-reported measure of work-related attention capacities was developed and validated in the current dissertation. The 12-item Workplace Attention Trifactor Scale (WATS) was created from the conceptual integration of two streams of psychological research: James Reason's occupational safety work on human errors, and Posner and Petersen's cognitive neuroscience work on the three attention networks. Exploratory and confirmatory factor analyses demonstrated the WATS to have three attentional domains. Alerting attention referred to the vigilance and sustained wakefulness during working hours (e.g., "*I stayed attentive at work*"). Orienting attention referred to the prompt and accurate alignment of attention to the source of the stimuli (e.g., "*My eyes were quick to pick up on important details in my work*"). Executive control of attention referred to adaptive resolution of conflicting or competing stimuli (e.g., "*I was able to prioritize the work tasks that required my immediate attention*"). All three domains of the WATS had indirect effects on reports of incidents and injuries at work through work-related cognitive failures of attention. The WATS had good test-retest reliability over a three-month period, with the orienting domain being the most stable (r = .69), alerting (r = .66), then executive control (r = .38). Self-reports on the WATS was compared to performance scores on the Attention Network Test (ANT), a cognitive task that test for the efficiency of the three attention networks. The lack of convergent validity between the two forms of measurement suggested that the WATS and the ANT were tapping into different aspects of attention. In a field setting, the WATS, rather than the ANT, was predictive of informant-reported safety compliance and participation. Theoretical implications of a three-factor model of workplace attention and practical utility of a self-assessed work-related attention measure were discussed.

December 15th, 2016

Individual Attentional Capacity to Perform Safely:

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Safety is a critical issue at the workplace. Despite efforts in safety training and practices, incidents still occur at work. Most of these incidents are attributed to human errors, which are inadvertent human failures in execution of actions (Norman, 1981; Reason, 1990). In fact, the most common types of human errors responsible for fatalities and incidents are skill-based slips and lapses from inattention (Baysari, Caponecchia, McIntosh, & Wilson, 2009; Salminen & Tallberg, 1996). Thus, it may be that workers involved in occupational incidents lack the attentional capacity to perform safely, rather than simply lack compliance or knowledge of how to perform safely. Therefore, a greater understanding of what contributes to individuals' ability to be safe can be just as important as safety-related training and protocols.

James Reason (1979; 1990) pioneered and popularized the work on human errors, attentional slips and lapses. Reason (2000) later recognized that focusing on human errors lead to a person-approach and appointment of blame during accident investigations. Instead, he proposed the system-approach in which human errors are expected, and rather than controlling workers it is the conditions that individuals work under that should be changed. The Swiss Cheese Model (Reason, 2000) posits that active failures such as human errors are bound to happen, but severity of the consequences can be reduced with multiple layers of defenses (the cheese) at the work conditions, work equipment, and management-level. A catastrophic incident occurs when the ‘holes’ in these layers of defenses line up and cannot stop a particular active failure from causing significant damages.

This proposition drives the current research on safety culture today, yet, Reason’s earlier work on attentional slips and lapses had become increasingly unheeded. I argue that understanding of how attention impacts human performance still merits research ‘attention’. This research can inform the most appropriate work conditions to facilitate attentive performance, thus filling in the appropriate holes in the layers of defenses. The objective of this dissertation is to integrate Reason’s (1979; 1990) work on occupational safety with these more recent theoretical advances in cognitive psychology to take a deeper look at the underlying attentional processes of the human errors responsible for occupational incidents. More recently, Posner and Peterson (1990; see also Petersen & Posner, 2012) posited that there are three different types of attention networks: alerting, orienting, and executive control (all these elements will be discussed later). Understanding individual attention can inform better defenses in organizations against slips and lapses and also provide accommodate and training for individuals who are inattentive.

My dissertation includes a scale development study, two scale validation studies, and a longitudinal field study. Over the course of these four studies I will demonstrate the necessity of having a measure of attention capacity rather than attention errors. In the first study, I developed a self-report measure of the three attention networks at work called the Workplace Attention Trifactor Scale. In the second study, I validated the measurement from the first study by confirming its three factor structure and its association with error and safety outcomes. In the third study, I introduced a cognitive task that tests for the three attention networks called the Attention Network Test (Fan, McCandliss, Sommer, Raz, & Posner, 2002), and examined the test-retest reliability and convergent validity between it and the Workplace Attention Trifactor Scale. In the fourth study, I used the Workplace Attention Trifactor Scale alongside with the Attention Network Test in a work setting to examine how attentional capacities, measured subjectively and objectively, predicted safety performance, incidents, and injuries at work.

Types of Human Errors

To understand attention slips and lapses, one must start with appreciating the broader scope of human errors. Traditionally, human failures can be categorized as two types depending on whether the consequential actions are planned or not (Reason 1990; see Figure 1). When an unplanned consequence is caused by an unintended physical action, the error is known as a *slip* (e.g., mixing up the numbers while attempting to dial someone). Similarly, when the error is caused by a deficit in short-term memory, it is considered to be a *lapse* (e.g., forgetting someone's name after being introduced to them). Both are considered to be skill-based errors under Rasmussen's (1983) skill-rule-knowledge classification of human performance. A slip is usually more observable than a lapse because the mechanism of error is action-based rather than memory-based (Reason, 1990). Conversely, when the action is chosen and executed as planned, but still leads to unintentional consequences, this type of error is considered to be a *mistake* (Reason, 1990). According to Rasmussen (1983), mistakes are either rule-based or knowledge-based. A rule-based mistake is when the individual understands the rules and procedures for attaining behavioural outcomes, yet the error lies in the planned execution of action (e.g., using an outdated map and getting lost). Conversely, a knowledge-based mistake occurs when there are no rules or procedures available to help the individual understand how to proceed with the situation (e.g., walking around with no map at all). This can be attributed to lack of experience, training, or proper equipment.

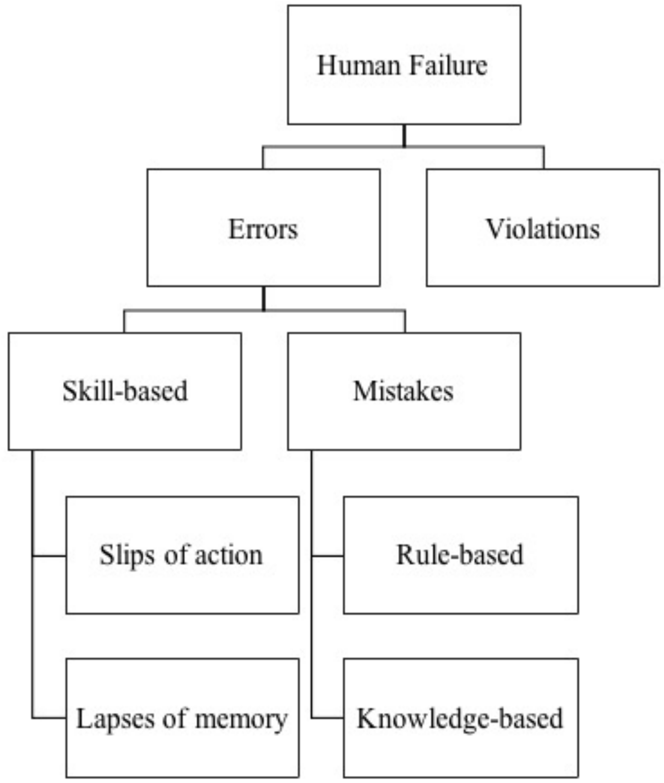

Figure 1. Types of human failures (Reason, 1990).

Deliberate human failures that cause incidents are *violations*, which are purposeful shortcuts or failures to follow through with procedures (e.g., improper cleanup of a job site due to the desire to leave work early; Reason, 1990). A violation is different from a mistake because even though both are a result of planned actions, a violation leads to intended outcomes while a mistake leads to unintended outcomes. Since violations are purposeful deviations from safety behaviours, they can be counteracted by increasing safety compliance or motivation to follow safety rules. Yet, violations are only the second most common predictors of incidents, while skill-based slips and lapses have been identified to be the first (Hobbs, Williamson, & Van Dongen, 2010; Salminen & Tallberg, 1996; Baysari et al., 2009). Thus, these efforts do not target the most prevalent cause of incidents at work because an incident resulting from an error (i.e., slip, lapse, or mistake) differs from an incident caused by a violation (Reason 1990).

The Role of Attention in Slips and Lapses

While a mistake can be mitigated by training workers to be more competent and by providing feedback on performance, a slip or lapse is considered to be unaffected by competency and knowledge training because it is typically committed by experienced, highly-trained, and well-motivated workers despite their best intentions. Slips and lapses are most likely to occur in highly familiar settings when attention is diverted by distractions from tasks that are automatic and require little conscious effort (Norman, 1981; Reason, 1990). Skill-based errors are committed by experienced workers performing well-practiced tasks. Therefore, the underlying issue with slips and lapses is not with compliance or motivation, but rather with attention.

Within the study of human factors and occupational safety, slips and lapses are considered as the outcomes of missed attentional checks. Attentional checks are performed by skilled individuals during well-practiced actions to ensure that the actions are running according to plan, and that the plan is still the appropriate one to achieve the desired outcomes (Reason, 1990). Failures of attentional checking occur when attention is being taken up by a distraction or preoccupation away from the action sequence (Norman, 1981; Reason, 1979; 1990). Missed attentional checks can be categorized as either *inattention* or *overattention* (Reason, 1990). Inattention occurs when the attentional checks are omitted and do not occur (Reason 1990). Inattention is caused by either preoccupation of attention by distractors, reduced intention over extended time or familiarity with the task, and by interference by similar tasks (Reason, 1979; 1990; Reason & Mycielska, 1982; Norman, 1981). Overattention occurs when the attentional check is administered at an inappropriate time during the action sequence (Reason, 1990). An overattention failure typically occurs when there is too much attention devoted to a highly automated action, or after a long period of absence from the task at hand. Automatic actions are guided by heuristic mental models and is a form of top-down processing, while controlled actions require deliberate focus on cues and is considered to be bottom-up processing (Wickens et al., 2004).

Attention and Safety Performance

Reason's (1979) overview on attentional checks was established using critical incident reports and was successful in operationalizing how slips and lapses manifest as work behaviours. His work spurred numerous studies in the 1970's and 1980's examining performance-based measures of attention in relation to work performance, errors, and safety. Later on, those studies gave way to studies using self-reported means of assessing slips and lapses. A brief overview of both types of measurements of attention is presented below.

Performance-based Slips and Lapses

Divided Attention. The research on divided attention operates under the premise that attention is a finite reservoir of resources (Kahneman, Ben-Ishai, & Lotan, 1973). Allocation of attention to task is necessary for deeper levels of processing, however, deployment of attention is limited (Reason, 1990). Dual-task interference errors can manifest as a complete breakdown of performance, decremented performance (e.g., slower response rate), or as 'cross-talk' errors where one task biases the response in the other (Long, 1975; Kinsbourne & Hicks, 1978). This is similar to Reason's (1990) depiction of inattention. Errors are more likely to occur when the two tasks have high structural similarity, because that increases the likelihood that an individual will use the same processing resources (Wickens, Lee, Liu, & Becker, 2004). For example, two auditory tasks are harder to perform concurrently than one auditory and one visual task. Likewise, if the tasks use similar items, there will also be a higher chance of interference errors due to confusion (Fracker & Wickens, 1989; Gillie & Broadbent, 1989; Wickens & Hollands, 2000). The risk of errors can be mitigated with practice of handling the two tasks at once, because with more practice an individual is more likely to pick up features that differentiate the two tasks, thus reducing their task similarity (Kinsbourne, 1981). Risk of error can also be decreased if one of the tasks is higher in automaticity, because an automated task is usually highly practiced, executes quickly with little mental thought, and requires less mental resources (Schneider, 1985; Logan, 1985). Therefore, as the degree of automaticity goes up, the more mental resources there are available to be invested in other tasks (Wickens et al., 2004).

Another attention-related component that draws on individuals' mental resources is *sustained attention*. Sustained attention is the ability to continuously maintain vigilance and preparedness during task performance. Sustained attention is commonly assessed using the Sustained Attention to Response Task, which induces performance impairments measured by reaction times and errors due to monotony in a vigilance task paradigm (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). In conclusion, the resource theory of attention posits that attention resources are limited and that drawing on the same processing resources (i.e., performing two similar tasks simultaneously) or performing a monotonous and long task can increase the likelihood of skill-based errors. This is similar to Reason's (1990) depiction of overattention.

Attention Selectivity. *Attention selectivity* is the ability to focus on relevant cues while ignoring irrelevant cues, and also the efficient switching of attention from one set of relevant task cues to another. *Attention switching* is a form of time-sharing strategy of task management (Wickens et al., 2004). Switching between tasks can be beneficial, especially when parallel procession or divide attention is impossible. In fact, switching attention from one task to another at a high rate is the equivalent of parallel processing of those two tasks.

The selectivity of attention is driven by salience, effort, expectancy, and value (Reason, 1990; Wickens et al., 2004). Salience is a bottom-up process that tends to capture attention (e.g., a loud car horn). Expectancy and value are top-down processes that allocate attention. For example, the response to meaningful cues such as the sound of human voices, or the call of one's own name is associated with attention selectivity. A well-skilled worker who has an accurate mental model of event expectancies and costs can display effective attention switching. Trained pilots frequently scan the skies using their selective attention because the cost of missing air traffic is large (Wickens, Goh, Helleberg, Horrey, & Talleur, 2003).

However, under certain circumstances, attention selectivity is more likely to fail, such as when expectancy is wrongfully misinterpreted (e.g., being primed on the attentive channel to direct attention towards something that appears on the inattentive channel; Reason, 1990). An effortful task may dampen selective attention (e.g., scanning short distances rather than long ones). Failures are also more common when the cues are not salient, such as when spatial separation in space between cues is smaller (i.e., cues are closer together; Treisman, 1964), or when the situation or cue is high in ambiguity (Reason, 1990). This is similar to Reason's (1990) depiction of inattention.

Overall, studies on auditory and visuospatial attention revealed that individuals are fairly good at allocating their attention to one channel while ignoring irrelevant cues (Reason, 1990; Woodworth, 1938). However, switching attention takes more effort than focusing attention. Individuals are more prone to committing errors when the duration of switching is short (Reason, 1990). On the other hand, very slow switching in a multitask environment can lead to attention fixation called cognitive tunneling (Kerstholt, Passenier, Houttuin, & Schuffel, 1996; Moray & Rotenberg, 1989). A higher rate of errors in attention switching is linked to poor job performance of military pilots (Gopher & Kahneman, 1971) and poor safety records of professional drivers (Kahneman et al., 1973).

A commonly used task for assessing selective attention and attention switching is the dichotic listening task (e.g., Gopher & Kahneman, 1971). In the dichotic listening paradigm, earphones in the two ears each present a different message to the individual. Efficiency in shadowing (i.e., repeat every word on one channel) or monitoring (i.e., detect certain targets in either channels; Woodworth, 1938) are assessed. Auditory selective attention is a predictor of driving incidents (Arthur, Barrett, & Alexander, 1991). Aside from attention to auditory information, studies that use a visual task analogous to the dichotic listening test (i.e., two visual stimuli simultaneously on the screen) found that poor visual selective attention is related to driving performance and incident rates (Avolio, Kroeck, & Panek, 1985; Ranney & Pulling, 1989). Poor visual attention is considered to be the most consistent predictor of accident liability (Porter, 1988). The cause of the greatest number of fatal incidents in commercial aviation is due to failure of visual selective attention regarding the plane's altitude above the ground (Phillips, 2001; Wiener, 1977). Overall, behavioural-based cognitive tests tap into the cognitive processes that encourage safety. These studies suggest that attention is a finite resource of the brain and can be depleted to affect performance of sustained attention, selectivity of attention, and proper switching of attention.

Self-reported Slips and Lapses

Slips and lapses in attention have been assessed using self-reported questionnaires as cognitive failures. Cognitive failures are defined as mistakes or failures to perform an action that an individual is normally capable of executing under normal cognitive functioning (Wallace, Kass, & Stanny, 2002). The Cognitive Failure Questionnaire (Broadbent, Cooper, Fitzgerald, & Park, 1982) assesses one's impression of their everyday memory, attention, and action slips and errors, and is believed to be a measurement of trait 'absent-mindedness' because of the stability of scores over time. The distractibility subscale of the cognitive failures questionnaire, which is considered to be attention-specific, predicts overall performance at work (Wallace & Vodanovich, 2003). Higher self-reported and informant-reported cognitive failures scores are negatively related to vigilance performance on the Sustained Attention Responses Task (Robertson et al., 1997).

Another measurement called Attention-Related Cognitive Errors Scale (Cheyne, Carriere, & Smilek, 2006) was developed based on Reason's work to assess only everyday attention cognitive failures, since the Broadbent et al.'s (1982) measure consisted of attention, memory, and execution failures. This measure captures both slips and lapses of attention. The items refer to tasks that are familiar and mostly caused by inattention, although the measure focuses more on the behavioural outcomes of slips and lapses rather than the mechanism of how they occur. Self-reported scores on the Attention-Related Cognitive Errors Scale are positively related to error rates on the Sustained Attention to Response Task (Cheyne et al., 2006).

To measure context-related susceptibility to cognitive failures, Wallace and Chen (2005) developed a work-related cognitive failures scale from Broadbent et al.'s (1982) work. This measure also captures the behavioural outcomes of slips and lapses, but the items refer to tasks that are common in the workplace. Similar to the Attention-related Cognitive Error Scale, these tasks are familiar and mostly caused by inattention. Compared to the original cognitive failures measure, work-related cognitive failures are more predictive of safety behaviours and incidents at work (Wallace & Chen, 2005). Work-related cognitive failures are positively related to unsafe behaviours, incidents, and mishaps, and negatively related to safety behaviours and performances at work (Larson, Alderton, Neideffer, & Underhill, 1997; Wallace & Vodanovich, 2003). Driving safety is another context-specific area of inattention research. Self-reported driving lapses are positively related to self-reported cognitive failures scores (Roca, Lupiáñez, López-Ramón, & Castro, 2013).

Although there are self-reported measures of attention slips and lapses, there is no existing measure of the attentional capacities that may precede human errors. This gap in research resonated with workplace practices; most organizational defenses against human errors focus on identifying errors and changing work conditions in attempts reducing them, rather than identifying the attention capacities for effective performance and promoting work conditions that enhance them. Thus, developing a self-reported scale of attention has both research and practical implications.

A Cognitive Neuroimaging Conceptualization of Attention

For the theoretical foundation of developing a measure of workplace attention, I now turn to well-researched theories in the cognitive psychology literature. Posner and Petersen's (1990) seminal review on attention proposes that there are three attention networks: an alerting network, an orienting network, and an executive control network. Their work is based on neuroimaging research, which demonstrates that these three attention networks have their distinct anatomical areas and cognitive functions. More importantly, these attention networks are considered as the sources of attentional influence, rather than the processing systems that can be affected by attention. Cognitive neuroscience research since then has supported Posner and Petersen's (1990) conceptualization of three networks of attention (see Petersen & Posner, 2012 for a review).

Alerting Network

Alerting is defined as achieving and maintaining a state of high sensitivity to incoming stimuli (Posner & Rothbart, 2007). The alerting component anatomically refers to the brain stem, which plays a role in arousal (Petersen & Posner, 2012). The alerting component produces and maintains vigilance during task performance. There are two types of alertness: *phasic* and *tonic*. Phasic alertness is the ability to increase response readiness after exposure to a warning stimulus (Fan & Posner, 2004). An example of phasic alertness is the increase in preparedness to slow down on the road after seeing a stoplight turning from green to yellow. Tests that assess change in phasic alertness use a warning signal prior to the target event (Petersen & Posner, 2012). The warning signal improves the response time to a target event by increasing alertness.

Tonic alertness is the cognitive control of wakefulness and arousal in absence of an external cue (Fan & Posner, 2004). It corresponds to the daily fluctuations in vigilance based on circadian rhythm, and is sensitive to other diurnal changes in the body such as body temperature and cortisol secretion (Petersen & Posner, 2012). An example of tonic alertness is the general vigilance in any given situation and time of day. Tonic alertness is best assessed by long and boring tests that measure sustained vigilance. Tonic alertness as assessed by reaction times is slowest during the morning and night, and is quickest during the middle of the day (Posner, 1975). Vigilance tests and neuroimaging research show that tonic alertness is lateralized to the right hemisphere (Posner & Petersen, 1990). Phasic alertness, or more specifically the process recruited by a warning signal, is linked to left hemisphere activity (Coull, Frith, Büchel, & Nobre, 2000; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005). Warning signals also activate the locus coeruleus, which releases norepinephrine in the brain (Aston-Jones & Cohen, 2005).

Orienting Network

Orienting is the act of aligning attention with the source of sensory signals (Posner & Rothbart, 2007). Attention orienting can be overt, as in when eye movements accompanies the movement of attention, or it can be covert without any movement. An example of overt orienting is turning the head towards the direction of the voice that called out your name. An example of covert orienting is when your name is called, you shift your attentional modalities to the one of hearing (rather than other types of senses). The orienting network prioritizes sensory input by selecting a modality of sensory information (e.g., visual, auditory) or location from sensory input (Petersen & Posner, 2012).

The orienting network is linked to activation of the parietal cortex, the frontal regions, and the posterior regions (Petersen & Posner, 2012). The parietal cortex has also been implicated in directing motor or eye movement as part of orienting attention. Later research uncovered that in addition to the original dorsal system there is also a ventral system associated with orienting attention network (Corbetta & Shulman, 2002). The ventral system consists of the temporoparietal junction and the ventral frontal cortex, and is important when a target is invalidly cued and individuals have to break the attentional focus at the cued location to switch to the target location.

The act of orienting attention may appear to utilize phasic alerting attention, since the alignment of senses to a stimulus implies being aware of it, however, studies have shown that the orienting network is independent of the alerting network (Fan et al., 2002; Fernandez-Duque & Posner, 1997). These two types of attention are associated with different neurotransmitters; norephineprhine is linked to the phasic alerting, while acetylcholine is associated with the orienting network in drug studies with humans and monkeys (Beane & Marrocco, 2004; Marrocco & Davidson, 1998).

Executive Control Network

Executive control refers to the detection of target within a field of distracting cues. The moment of detection produces interferences across the systems, which can slow the detection of another target (Duncan, 1980). An example of good executive control is to be able to focus on the most important voice in a room full of other individuals talking, and to effectively change that focus if another important voice decides to speak up. This example of focal attention (target detection and awareness) utilizes the medial frontal cortex and the anterior cingulate cortex (Petersen & Posner, 2012). The anterior cingulate cortex is also an area of the brain that actives when there is a cognitive conflict (e.g., withholding a dominant response to perform a subdominant response). Thus, this network is speculated to be related to top-down processing.

Evidence supports the fact that there are two separate executive control networks (Petersen & Posner, 2012). While the medial frontal and anterior cingulate cortex are associated with sustained maintenance of executive control across tasks, lateral frontal and parietal regions are activated with executive control at the beginning of tasks (Dosenbach et al., 2006). Furthermore, there is no functional correlation in activity between these two sets of regions (Dosenbach et al., 2007). Thus, the conclusion is that in the dual network view, the cingulo-opercular control system acts as a stable background maintenance for task performance, while the frontoparietal system is related to task switching, task initiation, and adjustments within performance trials (Dosenbach, Fair, Cohen, Schlagger, & Peterson, 2008).

Study 1: Development of the Workplace Attentional Trifactor Scale

The three attention network conceptualization serves as a strong foundation for developing a self-reported measurement for attention processes that are responsible for slips and lapses. There are parallels between the three attention networks and the performance-based work done in occupational safety. The concept of alerting attention is analogous to sustained attention; both attentional abilities refer to response preparedness and vigilance. The concept of orienting attention is similar to the attention selectivity; both attentional abilities refer to honing in and focusing attention on the relevant stimuli. Finally, the concept of executive control is comparable to attention switching; both concerns the ability to focus on the most important stimuli while evaluating and disregarding others, and effectively changing that focus to more adaptive stimuli when applicable.

There are two other reasons why using the three attention networks theory can further the understanding of attention at work. The three attention networks theory clearly contrasts the different types of attentional processes underlying slips and lapses. At the same time, the three attention networks theory demonstrates how the different types of attention relate to each other, rather than the isolated performance-based research on vigilance, selective attention, and attention switching. Finally, the focus on attention processes that are responsible for slips and lapses rather than the behavioural outcomes of human errors allows the measure to assess state of readiness proactively rather than retroactively. For my first study I aimed to create a valid self-report measurement called the Workplace Attention Trifactor Scale based on the three attention networks with clear differentiation between attentional alerting, orienting, and executive control.

Hypothesis 1: The items on the Workplace Attention Trifactor Scale will factor into its three dimensions of alerting, orienting, and executive control of attention in the exploratory factor analysis.

Study 1 Methods

Procedures

Item generation. I followed the scale development process recommended by Hinkin and Schriesheim (1989). A review of the literature on the three attention networks was used as a starting point for defining the construct and its content domains. I operationally defined the three attention network content domains by modifying Posner and Peterson's (1990) of alerting, orienting, and executive control of attention to be work-specific. The alerting content domain referred to attentional capacities at work that had to do with general wakefulness and preparedness to react to stimulus. The orienting content domain referred to attentional capacities at work that had to do with aligning attention to the source of the stimulus and filtering out irrelevant details; this could be physical (e.g., moving the eyes) or mental (e.g., focusing on a voice while ignoring other chatter in the background). The executive control content domain referred to attentional capacities at work that had to do with resolving conflicting stimuli that were competing for attention; this involved switching or focusing attention to the more important stimulus or the correct stimulus. In these definitions, "*irrelevant*" and "*conflicting*" had different meanings. Irrelevant stimuli were unrelated to the primary task at hand, while conflicting stimuli might be related, but were not the most adaptive.

I relied on the literature search of the research in occupational safety (sustained attention, attention selectivity, attention switching) and the content domain definitions to generate items that described the behaviours that demonstrated exceptional alerting, orienting, and executive control of attention. I also reframed relevant negatively-framed items from existing measures of slips and lapses (e.g., Work-related Cognitive Failure Scale; Wallace & Chen, 2005) into its positive equivalent. Following that, I met with the subject matter experts in cognitive psychology for an unstructured discussion to confirm the content domain definitions and to review the items I generated. The literature review and subject matter experts helped optimize the content validity of the final instrument.

Q-sort. An independent focus group of subject matter experts in assessment (graduate students in industrial-organizational psychology) examined the list of preliminary items for face validity and sorted the items in the content domain that they believed it represents. Subject matter experts could sort an item into more than one content domain if they believed it falls under more than one attention network (see Appendix A for the Q-sort instructions). Agreement was determined by item sorting unanimously under their corresponding content domain. Items with agreement lower than 50%, with more than one dominant content domain, or had a dominant content domain that was not the hypothesized one were further scrutinized and revised.

Exploratory factor analysis. After the revisions from the Q-sort, the preliminary items were administered to participants using Qualtrics as an online survey software for the exploratory factor analysis. Participants were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook; see Appendix B for online advertisement). The inclusion criteria for participants was that they had to be above the age of 19 and be employed for at least three months in a non-white collar occupation (i.e., blue collar, pink collar, grey collar workers). Non-white collar workers were chosen because their jobs were more likely to be safety-relevant than white collar workers. After providing consent, participants were presented with a questionnaire that assessed basic demographics (gender, age, race, occupation, job tenure, history of safety training) and work experiences over the past three months, using the preliminary Workplace Attention Trifactor Scale items, the Attention-related Cognitive Errors Scale, the Work-related Cognitive Failures Questionnaire, and the safety compliance and safety participation measures. The participants also reported the number of work-related minor and major incidents, and minor and major injuries they sustained over the past three months (see Appendix C for the questionnaire). Following successful completion of the study, the participants' contacts were entered in a draw for one $50 VISA cash prize as compensation for their involvement in the study. Two attentional check questions were placed in the survey as a mean of quality control for inattentiveness. The two questions asked the participants to choose a particular response on a 5-point Likert-type scale. Survey responses that did not pass the two attentional checks were discarded from the dataset. Exploratory factor analysis was conducted on the data using principal axis factoring with a direct oblimin rotation.

Sample

For the item generation stage, two subject matter experts in cognitive psychology, Dr. Jason Ivanoff and Dr. Yoko Ishigami, helped confirm the content domain definitions and review the preliminary list of items. For the Q-sort stage, 11 subject matter experts in assessment (graduate students in industrial-organizational psychology; 9 women, 2 men), examined the list of preliminary items for face validity and sorted the items in the content domain that they believed it represents.

For the exploratory factor analysis, 270 participants were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook). Sixty-nine survey responses did not pass the two attentional checks, which asked the participants to choose a particular response on a 5-point Likert-type scale, and were discarded from the dataset. The final sample size for the exploratory analyses was 201 participants (75 men, 122 women, 4 individuals who identify with a gender other than male or female). Participants' age ranged from 19 to 60 years (*M* = 28.35 years, *SD* = 8.76 years). Participants worked in either blue-collar (28.4%), pink-collar (44.3%), or grey-collar (27.4%) industries and their work tenure ranged from three months to 30 years (*M* = 39.65 months, *SD* = 56.30 months). A blue-collar worker's job description comprises of skilled or unskilled manual labour. A pink-collar worker's job pertains to the service industry. A grey-collar worker's job description includes both blue-collar and white-collar components (manual labour and desk-work). Participants were majority Caucasian (77.6%) and Asian (14.4%), with 4% as mixed race, 2% Hispanic, 1% African-American, .5% Middle Eastern, and .5% First Nation. Most of the participants had their highest level of education completed in university (33.8%), high school (30.8%), and college (29.9%), with 4.5% who obtained a post-graduate degree and 1% who had less than high school education. Seventy percent of the sample received safety training at work.

Study 1 Results

Item Generation

Twenty-nine preliminary items were created in total through deductive item generation (Hinkin, 1998). Eleven items were generated for the alerting content domain, seven items for the orienting content domain, and 11 items for the executive control content domain (see Table 1).

Table 1

Preliminary Items for the Workplace Attention Trifactor Scale

Original item	Hypothesized content domain	Dominant/ Secondary content domain	Agreement (%)	Q-sort decision
Alerting items				
I stayed alert during work.	Alerting	Alerting	100	Alerting
I remained vigilant at work.	Alerting	Alerting	90	Alerting
I stayed attentive at work.	Alerting	Alerting	85	Alerting
I was quick to respond to important work-related details.	Alerting	Alerting	75	Alerting
I was aware of my surroundings at work.	Alerting	Alerting	64	Alerting
I reacted promptly when things at work come up unexpectedly.	Alerting	Alerting	64	Alerting; rewrite to "I reacted promptly when things at work came up unexpectedly".
I was aware of the things that went on in my working environment.	Alerting	Alerting	58	Alerting
I was able to sustained my attention over long	Alerting	Alerting	55	Alerting; rewrite to "I was able to

work tasks.				sustain my attention over long work tasks”.
I maintain attention on my work responsibilities.	Alerting	Alerting/ orienting	45	Kept as alerting; rewrite to “I maintained attention on my work responsibilities”.
I maintained focus on my work tasks.	Alerting	Executive control/ alerting	42	Kept as alerting.
I noticed important details in my work environment.	Alerting	Orienting/ alerting	45	Changed to orienting.
<u>*Orienting items*</u>				
I disregarded things irrelevant to my work.	Orienting	Orienting	100	Orienting
I filtered out irrelevant information at work.	Orienting	Orienting	91	Orienting
I turn my head towards where my attention is expected.	Orienting	Orienting	82	Orienting
I responded quickly when my name was called.	Orienting	Orienting	77	Orienting
When someone called my name, I directed my attention to them.	Orienting	Orienting	73	Orienting
My ears were quick to pick up on noises that required my attention.	Orienting	Orienting	58	Orienting

My eyes were quick to pick up on details in my working environment.	Orienting	Alerting	64	Kept as orienting; rewrite to “My eyes were quick to pick up on important details in my work”.
Executive control items				
I handle conflicting details effectively at work.	Executive control	Executive control	92	Executive control; rewrite to “I handled conflicting details effectively at work”.
I was able to multitask effectively at work.	Executive control	Executive control	91	Executive control
I was able to prioritize the work tasks that required my immediate attention.	Executive control	Executive control	82	Executive control
I worked through confusing task effectively.	Executive control	Executive control	67	Executive control; rewrite to “I worked through confusing tasks effectively”.
I was able to switch between work tasks effectively.	Executive control	Executive control	64	Executive control
I switched attention effectively from one task to another.	Executive control	Executive control	58	Executive control
I identified misleading details at work.	Executive control	Executive control/ orienting	55	Executive control; rewrite to “I spotted misleading details at work”. Add similar item for misguiding.

I was able to focus on work despite distractions.	Executive control	Orienting/ executive control	45	Changed to orienting.
I worked without being affected by interruptions	Executive control	Orienting	54	Kept as executive control.
I was able to focus on work despite interruptions	Executive control	Orienting	67	Kept as executive control.
I was able to ignore distractions at work	Executive control	Orienting	75	Changed to orienting.

Q-sort

An independent focus group of 11 subject matter experts in assessment (graduate students in industrial-organizational psychology; 2 men, 9 women) sorted the items in the content domain that they believed it represented. Agreement was determined by the percentage of subject matter experts sorting the items under their corresponding content domains. Items with agreement lower than 50% and/or sorted into a content domain that was not the hypothesized one were flagged for further revisions. Based on this criteria, one item had lower than 50% agreement within its intended content domain, and seven items were sorted into a content domain that was not the hypothesized one, making it a total of eight items that needed to be scrutinized (see Table 1).

For the item that had low agreement, but was sorted into their intended content domain, the item was kept in the original content domain (*"I maintain attention on my work responsibilities"*). This was because I anticipated the items to be difficult to sort due to the seemingly inter-related nature of attention networks to non-cognitive psychology subject matter experts. If the majority of subject matter experts were able to pick up the intended content domain even though agreement was under 50%, I accepted it as that content domain.

For the seven items that were sorted into a content domain that was not their hypothesized one, I reviewed each item to see if the item could be rewritten to better fit the intended content domain. For "*My eyes were quick to pick up on details in my working environment*" which was sorted into alerting rather than orienting, I changed it to "*My eyes were quick to pick up on important details in my working environment*" to emphasize that it was not general awareness of background details but instead the movement of the eyes to pick up on relevant details. Three items were changed to the sorted content domain (*"I noticed important details in my work environment"* changed from alerting to orienting; *"I was able to focus on work despite distractions"* changed from executive control to orienting; *"I was able to ignore distractions at work"* changed from executive control to orienting). Three items were kept in their intended content domain because after careful review of the content domain definition and the items, I considered it the best domain for them. *"I maintained focus on my work tasks"* was kept as alerting because there was not an explicit mention of conflict in the item for it to be considered as executive control. "*I worked without being affected by interruptions*" and "*I was able to focus on work despite interruptions*" were kept as executive control because I considered interruptions to be cues that purposefully draws the attention away from the focal cues, rather than cues that are irrelevant. At the end of the Q-sort procedure, there were ten items on the alerting content domain, ten items on the orienting content domain, and ten items on the executive control content domain.

Exploratory Factor Analysis

Two hundred and seventy participants were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook). Sixty-nine survey responses did not pass the two attentional checks, which asked the participants to choose a particular response on a 5-point Likert-type scale, and were discarded from the dataset. Furthermore, the data was screened for multivariate outliers based on leverage and influence of the individual cases (Flora, LaBrish, & Chalmers, 2012). A check for

Mahalanobis distances revealed eight cases were problematic ($\chi^2(30) = 59.70$). However, a check for Cook's distances revealed all the cases to be under 1. Since high Mahalanobis distance values are not necessarily bad leverage points, and large residuals are not necessarily influential (Yuan & Zhong, 2008), I chose to retain those cases. In the end the final sample size for the exploratory analyses was 201 participants.

To prevent items in the exploratory factor analysis loading together due to the similarities of the words used rather than the semantics (e.g., the items with the word 'irrelevant' loaded together), prescreening of the items was conducted prior to the factor analysis. The inter-item correlations for each proposed content domain were calculated to examine which items out of the group of similarly worded items detracted from the internal validity of the content domain (see Table 2). Those items were removed from the analyses. In the end there were seven items on the alerting content domain, seven items on the orienting content domain, and seven items on the executive control content domain for the exploratory factor analysis.

Table 2

Initial Inter-item Correlations for the Workplace Attention Trifactor Scale (N = 201)

	Cronbach's Alpha if item is deleted	Decision
Alerting (α = .92)		
I maintained attention **on my work** responsibilities.	.915	Keep
I maintained focus **on my work** tasks.	.917	Delete
I was aware of my surroundings at work.	.915	Keep
I was aware of the things that went on in my working environment.	.918	Delete
I stayed attentive at work.	.907	Keep
I stayed alert during work.	.911	Delete
I was quick to respond to important work-related details.	.917	Keep
I remained vigilant at work.	.908	Keep
I was able to sustain my attention over long work tasks.	.917	Keep
I reacted promptly when things at work came up unexpectedly.	.918	Keep
Orienting (α = .86)		
I was able to focus on work despite **distractions.**	.834	Keep
I was able to ignore **distractions** at work.	.838	Delete
I responded quickly when **my name was called.**	.844	Keep
When someone **called my name**, I directed my attention to them.	.845	Delete
I filtered out **irrelevant** information at work.	.841	Keep
I disregarded things **irrelevant** to my work.	.856	Delete

My eyes were quick to pick up on important details in my work.	.831	Keep
I noticed important details in my work environment.	.851	Keep
My ears were quick to pick up on noises that required my attention.	.844	Keep
I turn my head towards where my attention is expected.	.840	Keep
Executive control (α = .87)		
I was able to focus on work despite **interruptions.**	.848	Keep
I worked without being affected by **interruptions.**	.881	Delete
I **identified** misguiding information **at work.**	.856	Keep
I **identified** misleading details **at work.**	.883	Delete
I **switched** attention **effectively** from one **task** to another.	.846	Keep
I was able to switch between work **tasks effectively.**	.846	Delete
I was able to prioritize the work tasks that required my immediate attention.	.854	Keep
I was able to multitask effectively at work.	.843	Keep
I handled conflicting details effectively at work.	.845	Keep
I worked through confusing tasks effectively.	.847	Keep

Principal axis factoring with direct oblimin rotation was conducted in SPSS for the 21 items. Factor analysis was chosen over principal component analysis because the latter does not differentiate between shared and unique variance which could lead to inflated variance if the factors are uncorrelated (Gorsuch, 1997; McArdle, 1990). Factor analysis only examines shared variance and is not susceptible to this inflation (Osborne & Costello, 2009). Principal axis factoring was chosen over the maximum likelihood method because the item means were high, and that suggested there may be a ceiling effect or a violation of normality. For non-normal data, principal axis factoring is preferred (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Direct oblimin, an oblique rotation, was chosen to account for the potential correlation among factors (Osborne & Costello, 2009). The factorability of the initial 21 items was examined. The Kaiser-Meyer-Olin measure of sampling adequacy was .94, which was above the recommended value of .5 (Tabachnick & Fidell, 2007), and the Barlett's test of sphericity was significant ($\chi^2(210) = 2463.24$, $p < .001$). All the commonalities were all above .30. Using the Kaiser-Guttman retention criterion of eigenvalues great than 1.0, a three-factor model was extracted. Using a varimax rotation, the rotated model accounted for 54.21% of the total variance (22.53%, 19.03%, and 12.65% respectively). The scree plot suggested that a two-factor model could also work (Figure 2), but when I forced a two-factor model the results were one large 17-item factor with all three types of attention items, and one small 4-item factor with alerting attention items. A four-factor was forced as well but the fourth factor did not have any substantial items loading because all 21-items loaded higher on the other three factors. I settled on the three-factor model because the items factored more cleanly into their expected theoretical attention domains. Initial factor loadings of the three-model factor are presented in Table 3.

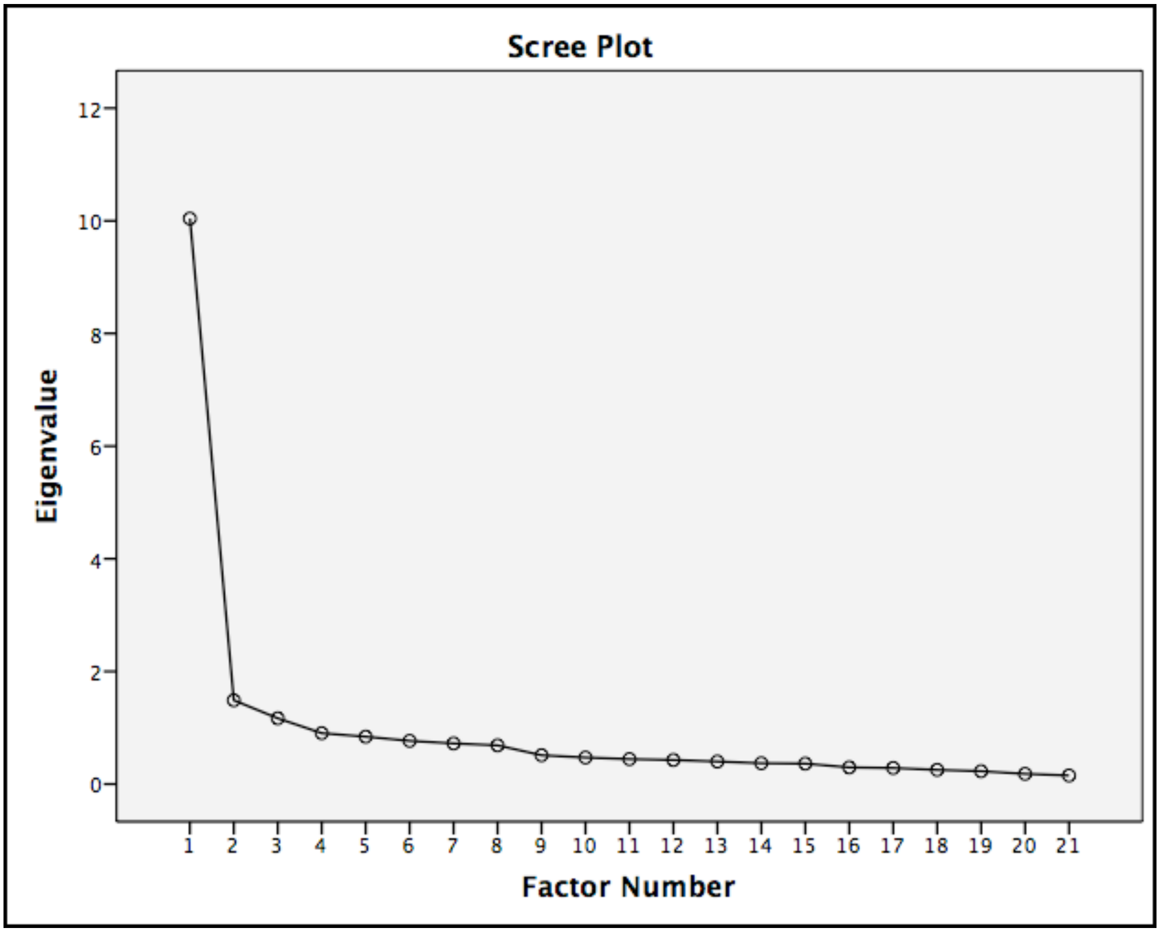

Figure 2. Scree plot of the initial 21 items from the Workplace Attention Trifactor Scale.

Table 3

Initial Factor Loadings for the Workplace Attention Trifactor Scale (N = 201)

	Factor		
	1	2	3
I handled conflicting details effectively at work.	**.93**	.11	-.03
I was able to multitask effectively at work.	**.87**	.00	-.09
I worked through confusing tasks effectively.	**.74**	-.03	.02
I was able to prioritize the work tasks that required my immediate attention.	**.56**	-.11	.10
I filtered out irrelevant information at work.	**.53**	.12	.16
I was able to focus on work despite distractions.	**.51**	-.24	.10
I identified misguiding information at work.	**.49**	-.06	.07
I was able to focus on work despite interruptions.	**.49**	-.23	.13
I switched attention effectively from one task to another.	**.49**	-.26	.06
I reacted promptly when things at work came up unexpectedly.	**.47**	-.15	.23
I noticed important details in my work environment.	**.45**	-.21	-.05
I stayed attentive at work.	.18	**-.82**	-.10
I maintained attention on my work responsibilities.	-.13	**-.78**	.10
I remained vigilant at work.	.16	**-.77**	-.06
I was able to sustain my attention over long work tasks.	.00	**-.70**	.04
I was quick to respond to important work-related details.	.20	**-.42**	.21
I was aware of my surroundings at work.	.17	**-.40**	.28
I responded quickly when my name was called.	-.02	.05	**.73**
I turn my head towards where my attention is expected.	.01	-.08	**.63**

My ears were quick to pick up on noises that required my attention.	.19	-.08	**.51**
My eyes were quick to pick up on important details in my work.	.37	-.08	**.48**

The guideline for examining factor loadings was taken from Hinkin, Tracey, and Enz (1997); a loading more than .40 was considered appropriate, as well as a loading that was twice as strong on its appropriate factor than on any other factors. Inadequate loadings and cross loadings were deleted one by one ("*I reacted promptly when things at work came up unexpectedly*"; "*I was able to focus on work despite distractions*"; *"I switched attention effectively from one task to another*"; "*I was able to focus on work despite interruptions*"; "*I was aware of my surroundings at work*"; "*I was quick to respond to important work-related details*") and the factor analyses were repeated after each deletion until one of the factors reached a minimum of four items. The factor loadings changed slightly after each item was deleted, but I systematically removed the poorest loading each time. I was left with seven items on the first factor, four items on the second factor and four items on the third factor. The items on the first factor were mostly related to executive control of attention, with the exception of two orienting items "*I filtered out irrelevant information at work*" and "*I noticed important details in my work environment*". The items on the second factor were related to alerting attention. The items on the third factor were related to orienting attention but pertained to overt orienting behaviours.

I chose to take the first four items on each factor as my final scale (see Table 4). The final commonalities ranged from moderate to high (.38 to .73; see Table 4). Inter-factor correlations and internal consistencies were high (see Table 5; Cronbach alphas are presented in the diagonals). The three-factor model was chosen as the ideal model because it was the most parsimonious, had adequate total variance explained, and had clear loadings on the three attention content domains of alerting, orienting, and executive control. Direct oblimin rotation revealed negative factor loadings on the alerting domain. This indicated that there might be factor score indeterminacy, which is mathematical issue in exploratory factor analysis since there can be an infinite number of sets of scores that would fit the same pattern coefficients (Wilson, 1928). An infinite set of scores renders it impossible to truly determine if an individual possesses the attentional qualities or lacks them, since both sets of factor scores are possible (Grice, 2001). Yet, the purpose of presenting a rotated solution in Study 1 is for seeking a simple structure for the ease of interpretation, therefore, I chose to try an orthogonal varimax rotation as recommended by Kim and Mueller (1978). Using a varimax rotation eliminated the negative factor loadings and allowed for an easier interpretation of the results, and the items loaded in almost the same way as the direct oblimin solution with the exception of the two lowest loadings on the orienting attention domain ("*My ears were quick to pick up on noises that required my attention*"; "*My eyes were quick to pick up on important details in my work*"). Furthermore, using an orthogonal rotation allowed for reporting total explained proportion of the variance. The final rotated three-factor model explained 60.45% of the variance (22.31%, 22.06%, and 16.08% respectively). The inter-factor correlations were computed by correlating the composite scores of the three attentional domains, since the by definition there is no inter-factor correlations in an orthogonal rotation. Hypothesis 1 was fully supported.

Table 4

Final Factor Loadings of the Workplace Attention Trifactor Scale (N = 201)

				Direct oblimin rotation			Varimax rotation		
	M	*SD*	h^2	Alerting	Orienting	Executive control	Alerting	Orienting	Executive control
I maintained attention on my work responsibilities.	4.22	0.74	.73	**-.83**	.09	-.16	**.80**	.14	.36
I stayed attentive at work.	4.02	0.74	.52	**-.82**	-.09	.16	**.78**	.17	.34
I remained vigilant at work.	3.97	0.81	.70	**-.80**	-.04	.12	**.74**	.22	.13
I was able to sustain my attention over long work tasks.	3.96	0.81	.47	**-.66**	.03	.05	**.63**	.19	.25
I responded quickly when my name was called.	4.32	0.67	.38	.08	**.73**	.002	.07	**.67**	.18
I turn my head towards where my attention is expected.	4.33	0.69	.44	-.08	**.70**	-.04	.20	**.66**	.17
My ears were quick to pick up on noises that required my attention.	4.18	0.81	.55	-.09	**.51**	.19	.24	**.55**	.33
My eyes were quick to pick up on important details in my work.	4.14	0.77	.68	-.10	**.48**	.36	.30	**.58**	.49

I handled conflicting details effectively at work.	3.86	0.80	.65	.03	.03	**.84**	.24	.27	**.76**
I was able to multitask effectively at work.	4.02	0.83	.60	-.02	-.02	**.81**	.27	.22	**.73**
I worked through confusing tasks effectively.	3.96	0.71	.58	-.05	.02	**.74**	.28	.24	**.68**
I was able to prioritize the work tasks that required my immediate attention.	4.28	0.74	.49	-.09	.12	**.58**	.29	.30	**.58**

Table 5

Inter-factor Correlations and Cronbach Alphas for the Exploratory Factor Analysis (N = 201)

		1	2	3
1	Alerting	.88		
2	Orienting	$.58^{***}$	.80	
3	Executive Control	$.70^{***}$	$.65^{***}$	.86

Note: *** $p < .001$

Study 1 Discussion

The purpose of Study 1 was to develop a Workplace Attention Trifactor Scale, a subjective-report measurement of the three attention networks in the context of workplace performance. Results of the exploratory factor analysis implied that individuals could differentiate between three different types of work-related attentional behaviours: alerting, overt orienting, and executive control. The alerting network referred to attentional capacities at work that had to do with general wakefulness and preparedness to react to stimulus. The overt orienting network referred to attentional capacities at work that had to do with physical alignment of attention to the source of the stimulus. The executive control network referred to attentional capacities at work that had to do with resolving conflicting stimuli that were competing for attention (i.e., switching or focusing attention to a more important stimulus or the correct stimulus). The three attention subscales have good internal consistency (α = .80 - .88).

These findings were similar to the three attention network theory posited by Petersen and Posner (2012), with the exclusion of covert orienting behaviours from the factor of orienting attention (e.g., focusing on someone's voice while ignoring other chatter in the background). It might be because individuals perceived overt and covert orienting as two distinct types of attention rather than one homogenous construct. However, when a four-factor model was explored in the factor analysis, the fourth factor did not have any substantial item loadings; all 21-items loaded higher on the other three factors. This implied that covert orienting behaviours, which reflected an internal state of orienting senses, might be too abstract to be captured adequately in a behavioural-based measurement.

There were several limitations to study 1. First, I used assessment subject matter experts for the q-sort, and although their expertise in item review was valuable, the sorting of the items under the three attentional domains might be more clean if I had used cognitive psychology subject matter experts instead. Ideally, both types of subject matter experts should had been utilized. Second, several grammatical mistakes were missed by the assessment subject matter experts and myself. A couple of the items in the exploratory factor analysis were in present tense when I meant to phrase them in past tense ("*I turn my head towards where my attention is expected*"; "*I handle conflicting details effectively at work*"). Although none of these items were selected for the final scale, the portray of these items in the wrong tense might had influenced the sorting.

Study 2: Validation of the Workplace Attention Trifactor Scale

The findings from Study 1 supported the hypothesized three factor structure of the Workplace Attention Trifactor Scale to consist of an alerting, overt orienting, and executive control factor. However, these findings were exploratory, and in order to validate the Workplace Attention Trifactor Scale, the factor structure needs to be replicated in an independent sample. The purpose of Study 2 was to validate the three-factor model of the measure with an independent sample. Furthermore, the construct validity of the Workplace Attention Trifactor Scale was assessed. Based on the literature review of Reason's work (1979; 1990; 2000), I expected scores on the Workplace Attention Trifactor Scale to be negatively related to existing measures of attention-related errors. Individuals who possess better attentional capacities should commit less slips and lapses. With respect to workplace safety outcomes, I expected scores on the Workplace Attention Trifactor Scale to be negatively related to reports of incidents and injuries, and positively related to safety compliance and participation. Individuals who possess better attentional capacities should be less likely to be involved in workplace incidents and to be injured at work. Individuals who possess better attentional capacities should be capable for maintaining a good standard for safety performance.

Finally, I expected workplace attention to have an indirect effect on safety outcomes at work through work-related attention errors. Skill-based errors are the most common precursor of workplace incidents and fatalities (Baysari et al., 2009; Salminen & Tallberg, 1996), thus individuals who possess better attentional capacities should be less likely to be involved in workplace incidents and to be injured at work because they did not commit as many attention-related errors at work.

Hypothesis 2.1: The three factors of the Workplace Attention Trifactor Scale will be replicated in the confirmatory factor analysis sample.

Hypothesis 2.2: The three dimensions of the Workplace Attention Trifactor Scale will be related to existing measures of attention-related errors. Specifically, high scores on the Workplace Attention Trifactor Scale will be associated with lower scores on the Attention-related Cognitive Errors Scale and the attention portion of the Work-related Cognitive Failures Questionnaire.

Hypothesis 2.3: The three dimensions of the Workplace Attention Trifactor Scale will be related to existing measures of safety outcomes. Specifically, high scores on the Workplace Attention Trifactor Scale will be associated with less reported incidents and injuries, and higher scores on safety compliance and participation scale.

Hypothesis 2.4: The three dimensions of the Workplace Attention Trifactor Scale will be indirectly related to safety outcomes through work-related attention cognitive failures. Specifically, scores on the attention portion of the Work-related Cognitive Failures Questionnaire will mediate the relationship between scores on the Workplace

Attention Trifactor Scale and reports of incidents, injuries, safety compliance and safety participation.

Study 2 Methods

Procedures

Confirmatory factor analysis. The reduced Workplace Attention Trifactor Scale after the exploratory factor analysis was administered to participants using Qualtrics as an online survey software for the exploratory factor analysis. Participants were recruited using snowball sampling method on social media with the same advertisement from Study 1 (Reddit, Kijiji, Facebook; see Appendix B for the advertisement ad). The inclusion criteria for participants was that they had to be above the age of 19 and be employed for at least 3 months in a non-white collar occupation (i.e., blue collar, pink collar, grey collar workers). After providing consent, participants were presented with a questionnaire similar to the one from Study 1, but with the condensed 12-item Workplace Attention Trifactor items rather than the 30-items (see Appendix D for the questionnaire). The questionnaire contained items that assessed basic demographics (gender, age, race, occupation, job tenure, history of safety training) and work experiences over the past three months, using the shortened Workplace Attention Trifactor Scale, the Attention-related Cognitive Errors Scale, the Work-related Cognitive Failures Questionnaire, and the safety compliance and safety participation measures. The participants also reported the number of work-related minor and major incidents, and minor and major injuries they sustained over the past three months. Following successful completion of the study, the participants were entered in a draw for one $50 VISA cash prize as compensation for their involvement in the study.

Construct validity. Correlation analyses were conducted to examine the relationship between the three domains of attention with measurements of attention errors (Attention-related Cognitive Errors Scale, attention portion of the Work-related Cognitive Failure Questionnaire) and safety outcomes (incidents, injuries, safety compliance and safety participation). Mediational analyses were conducted using PROCESS (Hayes, 2013) to examine the indirect effect of attention on safety outcomes through work-related cognitive failures of attention.

Measures

Incidents and injuries. The frequency of incidents and injuries in the past three months was reported using questions based on modified operational definitions by Wallace and Vodanovich (2003) for minor and major incidents and injuries at work. A minor incident was operationalized as something that delayed the operations of a project. A major incident was one that resulted in a halt in operations. A minor injury was an injury that did not result in bodily harm that required medical attention beyond basic first aid. A major injury was an injury that resulted in bodily harm that required medical attention. Participants indicated the frequency that they experienced these types of incidents ($\text{range}_{\text{minor incident}}$: 0-20; $\text{range}_{\text{major incident}}$: 0-2) and injuries ($\text{range}_{\text{minor injuries}}$: 0-70; $\text{range}_{\text{major injuries}}$: 0-2).

Attention-related cognitive errors. Cognitive errors related to attention in the past three months were measured using Cheyne et al.'s (2006) Attention-related Cognitive Error Scale (α = .90), which consists of 12 items answered on a five point Likert-type scale with the anchors *"1 = Never"* to *"5 = Very often."* A sample item was

"*When reading I find that I have read several paragraphs without being able to recall what I read."* A higher summed score indicated more attention cognitive errors committed.

Work-related cognitive attention failures. Work-specific cognitive attention failures in the past three months were measured using Wallace and Chen's (2005) subscale of the same name (α = .82), which consisted of five items answered on a five point Likert-type scale with the anchors *"1 = Never"* to *"5 = Very often."* A sample item for memory failures was *"Do not fully listen to instruction."* A higher summed score on a dimension indicated more cognitive attention failures committed.

Safety performance. The type of safety performance assessed were safety compliance, which is the act of following safety rules and regulations, and safety participation, which is the willingness to participate in extra-role safety behaviors (Neal, Griffin, & Hart, 2000). Safety compliance and participation at work in the past three months were measured using Neal and Griffin's (2006) eight items scale, with four items for the safety compliance subscale (α = .91) and four items for the safety participation subscale (α = .86). Participants answered on a five point Likert-type scale with the anchors *"1 = Strongly disagree"* to *"5 = Strongly agree"* about the extent they exhibited the type of safety performance at work. A sample item for safety compliance was "*I use all the necessary safety equipment to do my job,"* and a sample item for safety participation was *"I promote the safety program within the organization."* A higher summed score on a dimension indicated more of that type of safety performance exhibited.

Sample

For the confirmatory factor analysis, a sample independent of the exploratory factor analysis sample was recruited. One hundred and twenty-four participants were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook). Seventeen snowball sampling survey responses did not pass the two attentional checks, which asked the participants to choose a particular response on a 5-point Likert-type scale, and were discarded from the dataset. The final sample size for the confirmatory factor analysis was 107 participants (37 men, 69 women, 1 individual who identify with a gender other than male or female). Participants' age ranged from 19 to 64 years (*M* = 29.25 years, *SD* = 9.52 years). Participants worked in either blue-collar (42.1%), pink-collar (41.1%), or grey-collar (16.8%) industries and their work tenure ranged from three months to 336 months (*M* = 42.45 months, *SD* = 56.05 months). Participants were majority Caucasian (85%) and Asian (5.6%), with 4.7% as mixed race, 2.8% Hispanic, .9% First Nations, and .9% Middle Eastern. Most of the participants had their highest level of education completed in college (33.6%), university (29 %), or high school (27.1%). Eight percent of the participants had a post-undergraduate degree, and .9% had less than a high school diploma. Seventy-five percent of the sample received safety training at work.

For the construct validity analyses, the exploratory factor analysis sample was combined with the confirmatory factor analysis sample. The total sample size was 308 participants (112 men, 191 women, 5 individuals who identify with a gender other than male or female). Participants' age ranged from 19 to 64 years (*M* = 28.67 years, *SD* =

9.03 years). Participants worked in either pink-collar (43.2%), blue-collar (33.1%), or grey-collar (23.7%) industries and their work tenure ranged from three months to three years (*M* = 40.66 months, *SD* = 56.13 months). Participants were majority Caucasian (80.2%) and Asian (11.4%), with 4.2% as mixed race, 2.3% Hispanic, .6% First Nations, .6% Middle Eastern, and .6% African. Most of the participants had their highest level of education completed in university (32.1 %), college (31.2%), or high school (29.5%). Six percent of the participants had a post-undergraduate degree, and 1% had less than a high school diploma. Seventy-two percent of the sample received safety training at work.

Study 2 Results

Confirmatory Factor Analysis

A sample independent of the exploratory factor analysis sample was recruited for the confirmatory factor analysis. One hundred and twenty-four participants were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook). Seventeen snowball sampling survey responses did not pass the two attentional checks, which asked the participants to choose a particular response on a 5-point Likert-type scale, and were discarded from the dataset. Furthermore, the data was screened for multivariate outliers based on leverage and influence of the individual cases (Flora et al., 2012). A check for Mahalanobis distances revealed four cases that were problematic ($\chi^2(12) = 32.91$). However, a check for Cook's distances revealed all the cases to be under 1. Since high Mahalanobis distance values are not necessarily bad leverage points, and large residuals are not necessarily influential (Yuan & Zhong, 2008), I chose to retain those cases. In the end the final sample size for the confirmatory factor analysis was 107 participants.

The model test for the confirmatory factor analysis was based on the covariance matrix and used ML estimation as implemented in Mplus 7.2 (Muthen & Muthen, 1998-2013). Fit indices for three competing models representing the 12 positively-framed items are presented in Table 6. The hypothesized three oblique factor model was a better fit to the data than the one factor($\chi^2_{\text{difference}}(3) = 25.24$, $p < .001$) or the three factor orthogonal ($\chi^2_{\text{difference}}(3) = 125.81$, $p < .001$) models. The CFI and TFI indexes were both above .95, which suggested a good fit (Hu & Bentler, 1998, 1999). Furthermore, the RMSEA and the SRMR were below .06 and .08 respectively and the test of close fit was not significant (PCLOSE = .81), all of which also suggested a good and close fit. Standardized parameter estimates for the model are presented in Table 7. Model parameters for the three oblique factor model were significant and explained moderate-low to high amounts of item variance ($R^2 = .22 - .72$). Table 8 presents the disattenuated correlations between the three factors; Cronbach alphas were presented in the diagonals. Disattenuated correlations remove the potential effect of measurement error on the correlations (Jensen, 1998), thus provide a better estimate of the true correlations between factors. Hypothesis 2.1 was fully supported.

Table 6

Fit Indices for the Three Models (N = 107)

Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR
One factor	78.64^{*}	54	.94	.93	.07	.06
Three factor (orthogonal)	179.21^{***}	54	.71	.65	.15	.27
Three factor (oblique)	53.40	51	1.00	1.00	.02[a]	.05

Note: * $p < .05$; *** $p < .001$; [a] PCLOSE = .81

Table 7

Standardized Parameters Estimates for the Three-Factor Oblique Model (N = 107)

	Alerting	Orienting	Executive control	h^2
I was able to sustain my attention over long work tasks.	.59			.35
I maintained attention on my work responsibilities.	.62			.39
I remained vigilant at work.	.85			.72
I stayed attentive at work.	.79			.63
My ears were quick to pick up on noises that required my attention.		.65		.42
I responded quickly when my name was called.		.66		.44
My eyes were quick to pick up on important details in my work.		.76		.57
I turn my head towards where my attention is expected.		.63		.39
I worked through confusing tasks effectively.			.66	.43
I handled conflicting details effectively at work.			.67	.45
I was able to multitask effectively at work.			.67	.14
I was able to prioritize the work tasks that required my immediate attention.			.47	$.22^{*}$

Note: For all values, $p < .001$ unless indicated; * $p < .05$

Table 8

Disattenuated inter-factor Correlations for Three-factor Oblique Model (N = 107)

		1	2	3
1	Alerting	.80		
2	Orienting	.91***	.77	
3	Executive control	.72***	.75***	.72

Note: *** $p < .001$

Construct Validity

Means, standard deviations, and correlations of Study 2 variables for the combined exploratory and confirmatory factor analyses sample are presented in Table 9. Composite scores on the three dimensions of the Workplace Attention Trifactor Scale were correlated with composite scores on the Attention-Related Cognitive Errors Scale and the attention portion of the Work-related Cognitive Failures Questionnaire. There were significant negative correlations between the scores on the alerting, orienting, and executive control domains and the scores on the Attention-Related Cognitive Errors Scale and the attention portion of the Work-related Cognitive Failures Questionnaire. These correlations were moderate to large in magnitude, with the Attention-Related Cognitive Errors Scale ranged from -.38 to -.43 and the attention portion of the Work-related Cognitive Failures Questionnaire ranged at a larger magnitude from -.50 to -.62. Hypothesis 2.2 was fully supported.

Table 9

Means, Standard Deviations, and Correlations of Study 2 Variables (N = 308). Cronbach Alphas are reported in the diagonals where applicable.

	Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9
1	WATS-alerting	4.03	0.65	.80								
2	WATS-orienting	4.24	0.58	.57***	.77							
3	WATS-executive control	4.01	0.62	.59***	.60***	.72						
4	ARCES	2.43	0.71	-.42***	-.38***	-.43***	.90					
5	WCF-attention	2.35	0.77	-.62***	-.52***	-.50***	.64***	.82				
6	Incidents	1.01	2.07	-.23***	-.18**	-.23***	.23***	.26***				
7	Injuries	2.62	6.55	-.09	-.08	-.13*	.13*	.15*	.07			
8	Safety compliance	4.06	0.81	.29***	.28***	.27***	-.33***	-.31***	-.12*	-.17**	.91	
9	Safety participation	3.66	0.92	.36***	.30***	.31***	-.27***	-.32***	-.19**	-.18**	.60***	.86

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; Workplace Attention Trifactor Scale (WATS); Attention-related Cognitive Errors Scale (ARCES); Work-related Cognitive Failures of Attention (WCF-attention)

There were significant negative correlations between the scores on the alerting, orienting, and executive control domains and number of incidents caused. These correlations were small in magnitude, ranging from -.18 to -.23. Number of injuries experienced was only significantly correlated with the executive control domains ($r(306) = -.13$, $p < .05$). There were significant positive correlations between the three attention domains and safety compliance. These correlations were moderate in magnitude and ranged from .27 to .29. There were significant positive correlations between the three attention domains and safety participation. These correlations were moderate in magnitude but larger than the correlations with safety compliance and ranged from .30 to .36. Hypothesis 2.3 was supported for the safety outcomes of reports of incidents, safety compliance, and safety participation. It was only partially supported for executive control of attention and reports of injuries

Six mediated regressions were conducted to examine the indirect effect of attention networks capacities on incidents and injuries through work-related cognitive errors of attention. The total effect of alerting attention on incidents was significant (B = -0.72, $SE = .18$, $p < .001$), and the indirect effect of work-related cognitive failures of attention was below zero ($ab = -0.38$, 95% CI = -0.76 – -0.09), suggesting that there was a significant indirect effect of alerting attention on incidents through attention cognitive failures. The direct and indirect effects of the alerting and incidents model are presented in Figure 3a. The total effect of alerting attention on injuries was not significant (B = -0.93, $SE = 0.58$, *ns*), however, the indirect effect of work-related cognitive failures of attention was below zero ($ab = -0.91$, 95% CI = -2.05 – -0.13), suggesting that there was a significant indirect effect of alerting attention on injuries through attention cognitive failures. The direct and indirect effects of the alerting and injuries model are presented in Figure 3b.

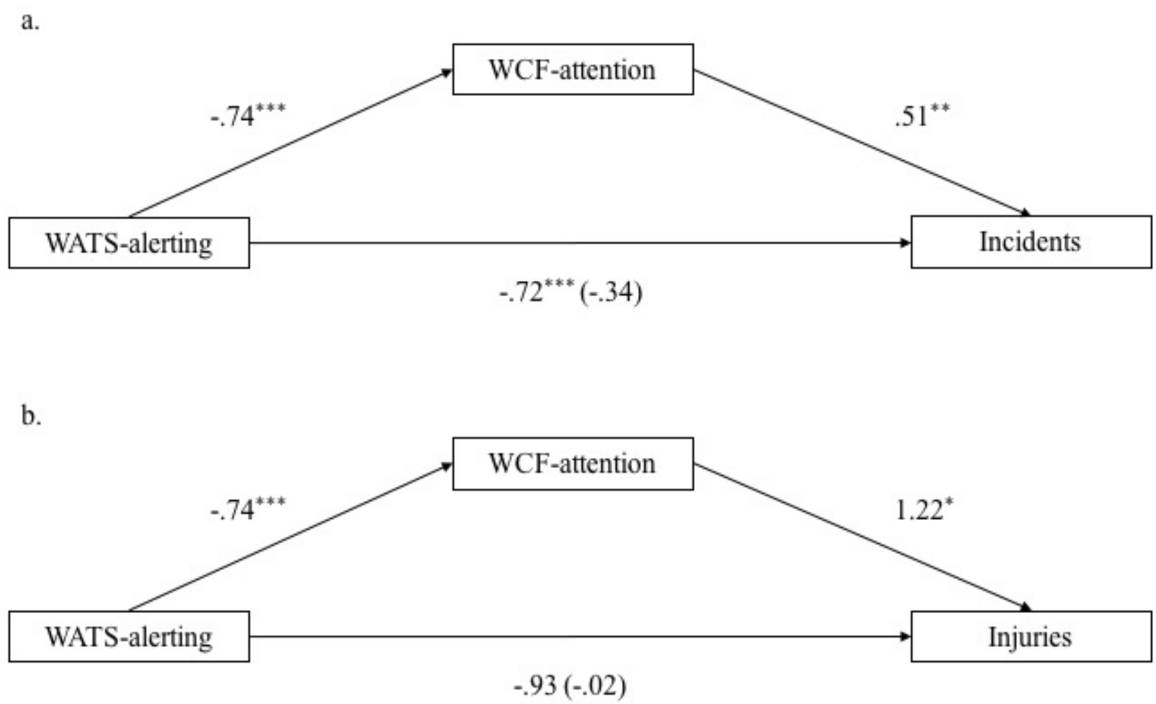

Figure 3. Direct and indirect effects of alerting attention on (a) incidents and (b) injuries through work-related cognitive failures of attention. There was a significant indirect effect of alerting attention on incidents through work-related cognitive failures of attention (*ab* = -.38, 95% CI = -0.76 – - 0.89). There was a significant indirect effect of alerting attention on injuries through work-related cognitive failures of attention (*ab* = -.91, 95% CI = -2.05 – -0.13).

The total effect of orienting attention on incidents was significant (B = -0.64, *SE* = .20, $p < .01$), and the indirect effect of work-related cognitive failures of attention was below zero (*ab* = -0.40, 95% CI = -0.78 – -0.14), suggesting that there was a significant indirect effect of orienting attention on incidents through attention cognitive failures. The direct and indirect effects of the orienting and incidents model are presented in Figure 4a. The total effect of orienting attention on injuries was not significant (B = -0.90, *SE* = 0.64, *ns*), however, the indirect effect of work-related cognitive failures of attention was below zero (*ab* = -0.82, 95% CI = -1.80 – -0.14), suggesting that there was a significant indirect effect of orienting attention on injuries through attention cognitive failures. The direct and indirect effects of the orienting and injuries model are presented in Figure 4.2.

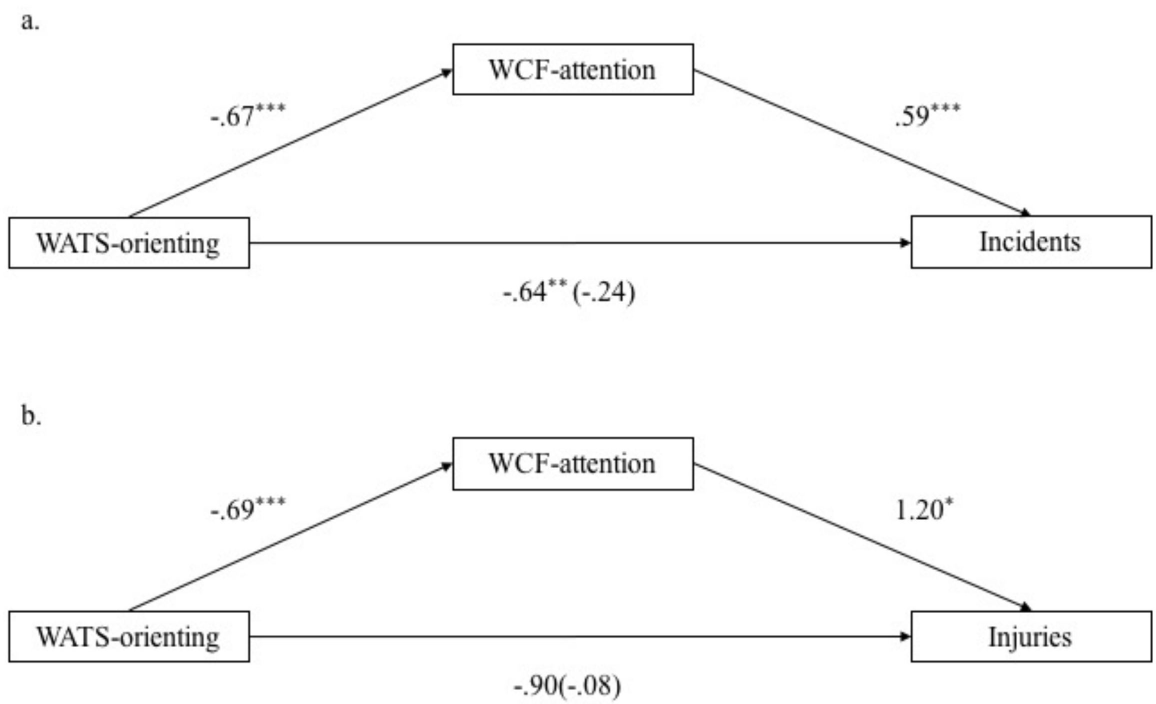

Figure 4. Direct and indirect effects of orienting attention on (a) incidents and (b) injuries through work-related cognitive failures of attention. There was a significant indirect effect of orienting attention on incidents through work-related cognitive failures of attention (*ab* = -0.40, 95% CI = -0.78 – -0.14). There was a significant indirect effect of orienting attention on injuries through work-related cognitive failures of attention (*ab* = -0.82, 95% CI = -1.80 – -0.14).

The total effect of executive control attention on incidents was significant (B = -0.80, *SE* = .19, $p < .001$), and the indirect effect of work-related cognitive failures of attention was below zero (*ab* = -0.32, 95% CI = -0.62 – -0.11), suggesting that there was a significant indirect effect of executive control attention on incidents through attention cognitive failures. The direct and indirect effects of the executive control and incidents model are presented in Figure 5a. The total effect of executive control attention on injuries was significant (B = -1.37, *SE* = 0.62, $p < .05$), and the indirect effect of work-related cognitive failures of attention was below zero (*ab* = -0.61, 95% CI = -1.52 – -0.01), suggesting that there was a significant indirect effect of executive control attention on injuries through attention cognitive failures. The direct and indirect effects of the orienting and injuries model are presented in Figure 5b. Hypothesis 2.4 was fully supported.

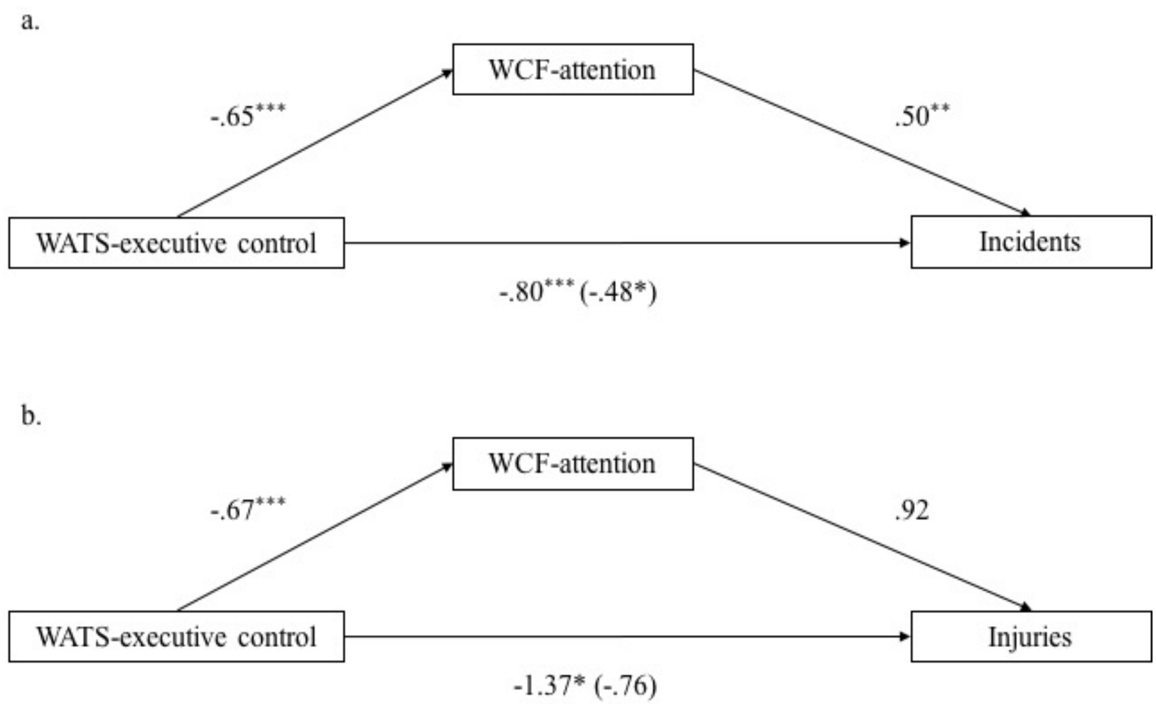

Figure 5. Direct and indirect effects of executive control attention on (a) incidents and (b) injuries through work-related cognitive failures of attention. There was a significant indirect effect of executive control attention on incidents through work-related cognitive failures of attention (*ab* = -0.32, 95% CI = -0.62 – -0.11). There was a significant indirect effect of executive control attention on injuries through work-related cognitive failures of attention (*ab* = -0.61, 95% CI = -1.52 – -0.01).

Study 2 Discussion

The purpose of Study 2 was to validate the factor structure of the Workplace Attention Trifactor Scale and to determine if the scale had construct validity. Results of the confirmatory factor analysis corroborated the three-factor model found in Study 1's exploratory factor analysis. Furthermore, all three types of workplace attention had an indirect effect on incidents and injuries through the occurrence of work-related cognitive failures of attention. These results suggested that self-reports of alerting, orienting, and executive control of attention were associated with less work-related attention errors, which was then associated with less incidents and injuries. The Workplace Attention Trifactor Scale could be used to assess attentional capacity to perform work duties with minimal slips, lapses, and risk of incidents and injuries.

However, in Study 2 the correlation between the alerting attention domain and the orienting attention domain was quite high ($r(105) = .91$, $p < .001$). This might pose constraints on the number of ways that the Workplace Attention Trifactor Scale could be used for predicting safety outcomes. Using both alerting and orienting domains to predict outcomes might introduce multicollinearity into the prediction model, which would affect the stability of the estimates of individual predictors. Therefore, while the Workplace Attention Trifactor Scale as a whole could be used to predict outcomes, the scale might not be appropriate for comparing the estimates of attention domains within a single model, particularly the alerting and orienting domain, if inter-factor correlations remain high.

Several limitations to Study 2 should be considered. First, there might be common method bias in the interpretation of the results since all the data was self-reported. Second, Study 2's surveys asked participants to recall their work behaviours in the past three months. This time-frame was chosen to maximize on the reporting of the number of incidents and injuries, however the long length of the time-frame might had compromised the quality of recall of other study variables, some of which were arguably more transient in nature (i.e., attention). Finally, depicting mediation relationships with cross-sectional data can generate biased estimates (Maxwell & Cole, 2007). Mediational relationships imply causal processes over time, which are more suitably captured with a longitudinal rather than cross-sectional design. Therefore, to overcome these limitations, further validation of the Workplace Attention Trifactor Scale was required.

Study 3: Further Validation of the Workplace Attention Trifactor Scale

In Study 2 the three-factor model of work-related attention was confirmed, and the three types of attention assessed by the Workplace Attention Trifactor Scale had an indirect effect on incidents and injuries through the occurrence of work-related cognitive failures of attention. In Study 3, I conducted further analyses to validate the Workplace Attention Trifactor Scale by examining the test-retest reliability of the self-reported scores over a period of three months, and by comparing daily self-reported scores to the performance on the Attention Network Test, a cognitive task that was created based on Posner and Petersen's (1990) theory of the three attention networks, for convergent validity. To overcome some of the limitations in Study 2 for convergent validity analyses, the attentional capacity for the day was examined, rather than over the past three months, and the Attention Network Test served as an objective measurement of attentional capacity.

The Attention Network Test

The attention network test was developed to examine alerting, orienting, and executive attention networks in one brief task (Fan et al., 2002). The test uses differences in reaction times and total error in response to conditions to assess the efficiency of each network (Macleod et al., 2010; Posner & Rothbart, 2007). The role of the individual during the task is to identify the direction of a middle arrow on a computer screen that appears above or below the center and is flanked by arrows pointing in the same direction (congruent) or opposite directions (incongruent; see Figure 6 for the test paradigm). In the neutral condition, the middle arrow appears alone. The presentation of the arrows is preceded by one of three types of temporally informative cue - a center cue, a double cue, or a spatially informative cue – which indicates that the arrow will appear soon, or no cue (temporally uninformative). A center cue consists of an asterisk in the center of the screen. A double cue consists of two asterisks below and above the center of the screen. The spatially informative cue has an asterisk in the area that the middle arrow will appear in. The spatially informative cue is 100% accurate in the attention network test.

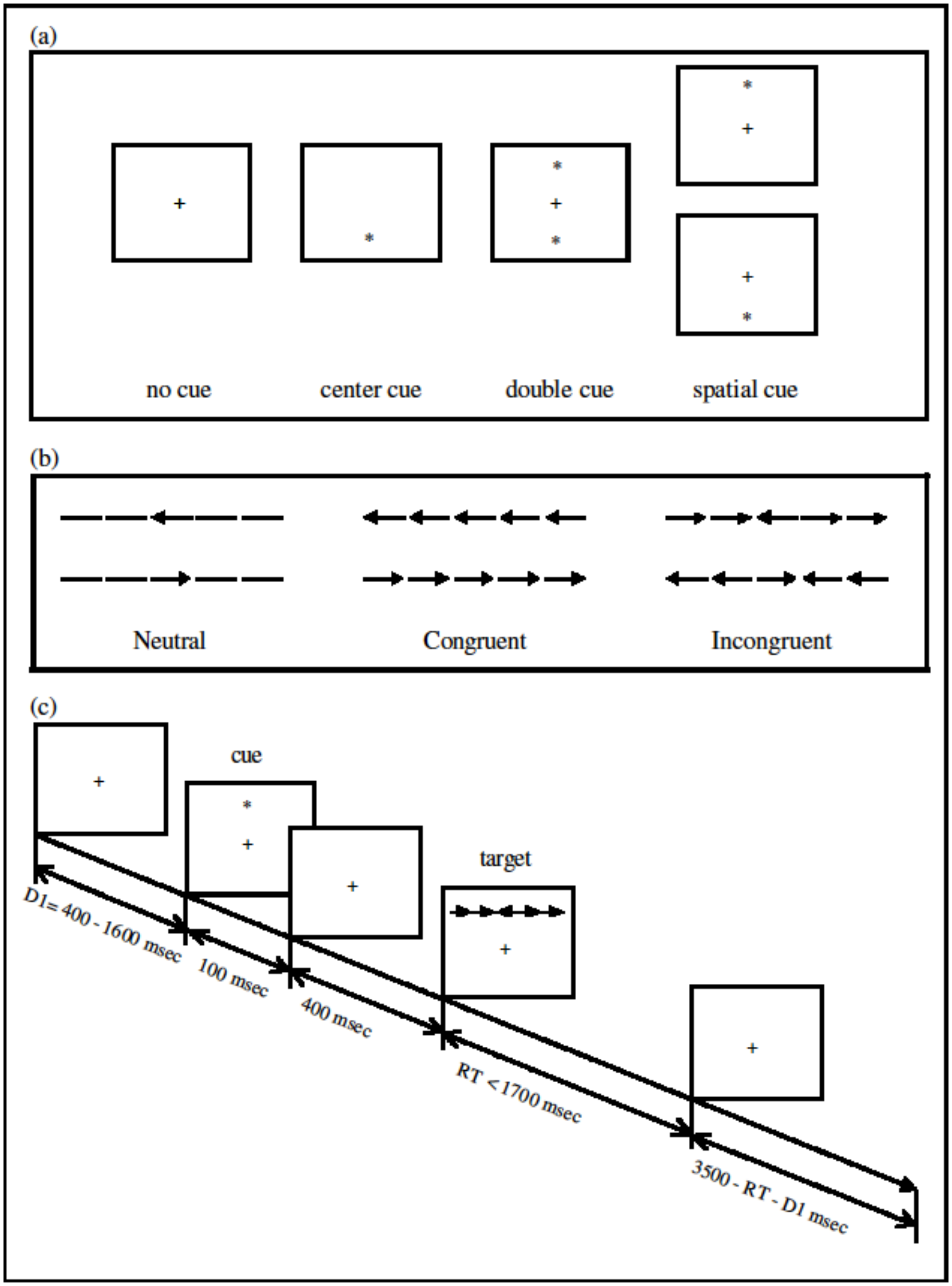

Figure 6. The attention network test paradigm (Fan et al., 2002).

The efficiency of the attention networks can be calculated using the mean reaction times from the accurate trials from the attention network test (Posner & Rothbart, 2007; Macleod et al., 2010). The alerting network score is calculated by subtracting the mean reaction times in the temporally informative double cue condition from the temporally uninformative no cue condition. The alerting network assessed phasic alertness. Tonic alertness may be calculated by subtracting the overall mean reaction times collapsed across condition in the first experimental block from the last block, but it is not a common calculation amongst researchers (Sparkes, 2006). The orienting network score is calculated by subtracting the mean reaction times in the spatially uninformative central cue condition from the spatially informative cue condition (Macleod et al., 2010; Posner & Rothbart, 2007). A larger orienting score can be attributed to the difficulty in disengaging from the center cue (Fan & Posner, 2004). The executive control network score is calculated by subtracting the mean reaction times for congruent from incongruent target trials as a measure of conflict resolution (Macleod et al., 2010; Posner & Rothbart, 2007). Subtractions can also be calculated using the total errors from the conditions to calculate attention network efficiency based on error rates. All further mentions of efficiency of attention networks in terms of reaction times and errors rates in this dissertation are referencing the difference in mean reaction times and total errors in the two conditions, unless explicitly stated otherwise. Mentions of performance in the no cue, double cue, center cue, and congruent and incongruent conditions refer to mean reaction times and total errors, unless explicitly stated otherwise.

The test-retest reliability of the network scores vary; Fan et al. (2001; 2002) reported test-retest reliability of reaction times on the Attention Network Test to be the most stable for the executive control network (r = .81; Fan et al., 2001; r = .77; Fan et al., 2002), followed by orienting network r = .41; Fan et al., 2001; r = .61; Fan et al., 2002) and the alerting network (r = .36; Fan et al., 2001; r = .52; Fan et al., 2002). In a review of the Attention Network Test, Macleod et al., (2010) calculated that the within-subject variance in reaction times was the smallest with the executive control network (305 ms), and it became significantly larger with the orienting (352 ms, $p < .05$) and the alerting network (406 ms, $p < .05$). Conversely, between-subject variance was the largest with the executive control network (1655 ms, CI 95% [1447 ms, 1898 ms]), and it was significantly larger than the orienting network (818 ms, CI 95% [751 ms, 885 ms]), which was significantly larger than the alerting network (689 ms, CI 95% [626 ms, 750 ms]). In terms of the within-subject variance in error rates, the executive control network (6.9%) was significantly lower than the alerting (7.3%, $p < .01$) and orienting (7.5%, $p < .01$) error rates, but there were no differences between the alerting and orienting networks' within-subject variance. With the between-subject variance in error rates, the executive control network (47.3%, CI 95% [40.1%, 55.1%]) was significantly higher than the alerting (10.4%, CI 95% [9.1%, 11.7%]) and orienting (8.9%, CI 95% [7.9%, 10.0%]) error rates, but there were no differences between the alerting and orienting networks' within-subject variance.

However, the Macleod et al. (2010) pointed out that the variances in scores may not be a flaw of the attention network test itself due to its strong validity, but more likely the natural variability of the mind to extraneous factors (e.g., sequence effects, general inattentiveness, fatigue, measurement error). I expected the relative reliability of the executive control, orienting, and alerting attention domains measured on the Workplace Attention Trifactor Scale to follow the same pattern as the Attention Network Test; the test-retest reliability would be the largest with executive control, then orienting and alerting attention. I also expected that the three domains of attention measured by the Workplace Attention Trifactor Scale would be correlated to the performance (reaction times and error rates) on the corresponding domain of the Attention Network Test.

Hypothesis 3.1: The test-retest reliability of the Workplace Attention Trifactor Scale will be the highest for executive control, followed by orienting, and then alerting.

Hypothesis 3.2: The three domains of the Workplace Attention Trifactor Scale will be related to existing measures of safety outcomes in both timepoints. Specifically, high scores on the Workplace Attention Trifactor Scale will be associated with less reported incidents and injuries, and higher scores on safety compliance and participation scale.

Hypothesis 3.3: The domains on the Workplace Attention Trifactor Scale will demonstrate convergent validity with the Attention Network Test. Specifically, self-reported alerting, orienting, and executive control of attention will be negatively correlated with the reaction times and error rates on the alerting, orienting, and executive control components of the Attention Network Test, respectively.

Hypothesis 3.4: Performance on the Attention Network Test will be related to existing measures of safety outcomes. Specifically, shorter reaction times and lower error rates will be associated with less reported incidents and injuries, and higher scores on safety compliance and participation scale.

Study 3 Methods

Sample

For the test-retest reliability analyses, 48 participants (13 men, 35 women) responded to the call for a follow-up study. All survey responses passed the two attentional checks, which asked the participants to choose a particular response on a 5-point Likert-type scale. Participants' age ranged from 19 to 61 years (*M* = 31.46 years, *SD* = 11.35 years). Eleven of the participants have switched jobs since the last time they participated. Participants worked in either blue-collar (29.2%), pink-collar (43.8%), or grey-collar (27.1%) industries and their work tenure ranged from three months to 30 years (*M* = 54.52 months, *SD* = 79.78 months). Participants were majority Caucasian (80.2%) and Asian (11.4%), with 4.2% as mixed race, 2.3% Hispanic, .6% African-American, .6% Middle Eastern, and .6% First Nation. Most of the participants had their highest level of education completed in university (32.1%), college (31.2%), and high school (29.5%), with 6.1% who obtained a post-graduate degree and 1% who had less than high school education. Sixty-nine percent of the sample received safety training at work; no new safety training was received since the last time they participated.

For the convergent validity analyses, 35 participants (9 men, 26 women) were recruited using snowball sampling method on social media (Reddit, Kijiji, Facebook). Participants' age ranged from 19 to 60 years (*M* = 28.35 years, *SD* = 8.76 years). Participants worked in either white-collar (28.6%), blue-collar (31.4%), pink-collar (34.3%), or grey-collar (5.7%) industries and their work tenure ranged from three months to 30 years (*M* = 39.65 months, *SD* = 56.30 months). Participants were majority Caucasian (82.9%) and Asian (11.4%), with 2.9% Hispanic, and 2.9% First Nation. Fifty-one percent of the sample received occupational safety training at their work. Majority of the individuals completed the study after a morning shift (71.4%), with some completing it after an afternoon shift (17.1%), evening shift (8.6%), and overnight shift (2.9%).

Procedures

Test-retest reliability. Participants from the exploratory and confirmatory factor analyses samples were contacted three months after Study 1 and 2 for an opportunity to participate in a follow-up study to test the stability of the three domains of the Workplace Attention Trifactor Scale over time, and also the stability of the three domains' association with safety outcomes (see Appendix E for the recruitment email). The inclusion criteria for participants was that they had to be employed for at least 3 months in a non-white collar occupation (i.e., blue collar, pink collar, grey collar workers), although they did not have to be employed in the same organization or position from when they took the study the first time. After providing consent, participants were presented with questionnaire that assessed their change of job (if applicable) and their attention at work in the past three months using the Workplace Attention Trifactor Scale items (see Appendix F for the questionnaire). Following successful completion of the study, the participants were entered in a draw for one $50 VISA cash prize as compensation for their involvement in the study.

Convergent validity. The correlations between the three domains of the Workplace Attention Trifactor Scale and the three networks of the Attention Network Test and safety outcomes were examined using participants recruited through snowball sampling methods using social media platforms (e.g., Facebook, Reddit, Kijiji; see Appendix G for the advertisement ad). The inclusion criteria for participants was that they had to be above the age of 19, employed, and had access to a computer at home that was connected to internet.

Interested participants were provided the link to a Qualtrics questionnaire, where they were instructed to start after the end of a work day (See Appendix H for the questionnaire). They first filled out a demographics questionnaire containing questions assessing basic demographics (gender, age, race), and details about their job position (occupation type, job tenure, history of safety training). At the end of the demographics questionnaire they were given a subject ID and then directed to Millisecond website to download Inquisit 4 Web (Draine, 2015) and complete the Attention Network Test on their computer. At the end of the cognitive testing participants were rerouted back to the questionnaire to rate their attentional performance for that day using the self-reported Workplace Attention Trifactor Scale, their safety compliance and participation for that day, and any incidents or injuries they may have caused or experienced that day. Participants who completed the study fully were entered in a prized draw for one $100 VISA cash prize.

Measures

The same measures used in the validation study (Study 2) were used for Study 3. For the test-retest sample, attention at work in the past three months was measured using the 12-items Workplace Attention Trifactor Scale validated in Study 2 ($\alpha_{alerting}$ = .85; $\alpha_{orienting}$ = .86; $\alpha_{executive\ control}$ = .76). The frequency of incidents and injuries in the past three months were reported using questions based off of modified operational definitions by Wallace and Vodanovich (2003) for minor and major injuries and incidents at work.

The type of safety performance assessed were safety compliance and safety participation (Neal et al., 2000). Safety compliance and participation at work in the past three months were measured using Neal and Griffin's (2006) scale, which consisted of the safety compliance subscale (α = .95) and the safety participation subscale (α = .90). For the convergent validity sample, all items were reframed to daily assessments rather than experiences over the past three months ($\alpha_{alerting}$ = .69; $\alpha_{orienting}$ = .62; $\alpha_{executive\ control}$ = .75; $\alpha_{compliance}$ = .94; $\alpha_{participation}$ = .88).

Tasks

Attention Network Test. The attention network test (Fan et al., 2002) was administered using the Inquisit 4 Web program (Draine, 2015). This 15-minute version of the test was self-administered on the participants' computer, and a data file was produced and recorded in the data bank of the Inquisit 4 Web program (Draine, 2015) after the completion of a trial. Following Fan et al.'s (2002) original description of the task, the stimuli were a row of arrow(s) against a gray background. The target was an arrow at the center pointing either left or right. The target was flanked by arrows pointing in the same direction (congruent), opposite directions (incongruent), or appeared on its own (neutral). The role of the individual during the task was to identify the direction of a target arrow and respond by pressing the 'E' key for arrows pointing to the left and the 'I' key for arrows pointing to the right.

Each trial had five events (see Figure 6). Firstly, there was a fixation period of a crosshair symbol in the middle of the screen for a random variable duration (400-1600 msec). Secondly, a warning cue was presented for 100 msec. This warning cue was followed by another fixation period for 400 msec. Then the target arrow and its flankers appeared for no longer than 1700 msec and disappeared once the participants make a response. The final posttarget fixation period was presented for a variable duration based on the duration of the first fixation and reaction times of the participant (duration of the first fixation and the reaction times of the participations subtracted from 3500 msec). These five events constituted one trial and were 4000 msec in length.

The warning conditions was either a center cue, a double cue, a spatially informative cue, or no cue. The cue conditions consisted of asterisks and were temporally informative, which allowed participants to be aware that the target was coming. A center cue consisted of an asterisk in the center of the screen. A double cue consisted of two asterisks below and above the center of the screen. The spatially informative cue had an asterisk in the area that the middle arrow appeared in. The spatially informative cue was 100% accurate in the attention network test.

A session of the attention network test consisted of one practice block with 24 trials and three experimental blocks of 96 trials presented in random order (4 cue conditions × 2 target locations × 2 target directions × 3 flanker conditions × 2 repetitions). Participants were instructed to focus on the central fixation crosshair throughout the task and to respond as quickly and accurately as possible.

Study 3 Results

Test-retest Reliability

Means, standard deviations, correlations and Cronbach's alpha are presented in Table 10. The internal consistency of the Workplace Attention Trifactor Scale at Time 1 and Time 2 (three months after Time 1) ranged from .76 to .86 (Time 1: $\alpha_{alerting}$ = .85; $\alpha_{orienting}$ = .86; $\alpha_{executive\ control}$ = .76; Time 2: $\alpha_{alerting}$ = .81; $\alpha_{orienting}$ = .83; $\alpha_{executive\ control}$ = .80). The test-retest reliability for all three attention domains were significant and positive. The orienting domain was the largest in magnitude at .69, followed by the alerting domain at .66, and lastly the executive control domain at .38. A test of significant differences between correlations revealed that the magnitudes of the correlations were not significantly different from each other (orienting-alerting: z = 0.22, ns; orienting-executive control: z = 1.79, ns; alerting-executive control: z = 1.57, ns). Hypothesis 3.1 was partially supported.

Table 10

Means, Standard Deviations, and Correlations of Study 3 Variables for Test-Retest Reliability (N = 48). Cronbach Alphas are reported in the diagonals where applicable.

	Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Alerting T1	3.94	0.61	.85													
2	Orienting T1	4.16	0.69	.68***	.86												
3	Executive control T1	3.87	0.57	.60***	.67***	.76											
4	Alerting T2	3.96	0.52	.66***	.54***	.48**	.81										
5	Orienting T2	4.18	0.56	.58***	.69***	.47**	.77***	.83									
6	Executive control T2	3.93	0.55	.33*	.43**	.38**	.58***	.53***	.80								
7	Incidents T1	1.50	3.25	-.14	-.12	-.14	-.15	-.17	-.09								
8	Injuries T1	2.79	6.37	-.22	-.31*	-0.23	-.43**	-.32*	-.32*	.19							
9	Safety compliance T1	4.04	0.78	.36*	.30*	.13	.36*	.26^{a}	.12	.01	-.42**	.91					
10	Safety participation T1	3.71	0.93	.42**	.43**	.23	.38**	.43**	.13	-.24^{a}	-.43**	.69***	.89				
11	Incidents T2	0.60	1.18	-.11	-.19	-.37*	-.18	-.18	-.26	.46**	.25	-.19	-.14				

12	Injuries T2	2.10	4.26	-.20	-.26	-.05	-.39**	-.36*	-.09	.08	.70***	-.32*	-.44**	.14			
13	Safety compliance T2	4.14	0.76	.48**	.49***	.28^{a}	.63***	.43**	.40**	-.04	-.51***	.67***	.52***	-.12	-.38**	.95	
14	Safety participation T2	3.77	0.93	.40**	.48**	.34*	.44**	.42**	.19	-.10	-.29*	.43**	.68***	.07	-.26^{a}	.56***	.90

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; ^{a} $.05 < p < .10$

At Time 1 and 2, composite scores on the three dimensions of the Workplace Attention Trifactor Scale were correlated with total number of incidents and injuries, and the composite scores for safety compliance and participation. For Time 1, there were significant negative correlations between the scores on the orienting domain ($r(46) = -.31$, $p < .05$) and number of injuries. Number of incidents was not significantly correlated with the attention domains. There were significant positive correlations between the alerting ($r(46) = .36$, $p < .05$) and orienting domains ($r(46) = .30$, $p < .05$) and safety compliance. There were significant positive correlations between the alerting ($r(46) = .42$, $p < .05$) and orienting domains ($r(46) = .43$, $p < .05$) and safety participation. For Time 2, there were significant negative correlations between the scores on the alerting ($r(46) = -.39$, $p < .01$) and orienting domains ($r(46) = -.36$, $p < .05$) and number of injuries experienced. The number of incidents was not significantly correlated with the attention domains. There were significant positive correlations between all three attention domains and safety compliance. The magnitude of these relationships were large and ranged from .40 to .63. Only the alerting ($r(46) = .44$, $p < .01$) and orienting domains ($r(46) = .42$, $p < .01$) were significantly positively correlated with safety participation. Hypothesis 3.2 was supported only for orienting domain and injuries, safety compliance, and safety participation, also for alerting domain and compliance, and participation across the two timepoints.

Convergent Validity

Means, standard deviations, correlations and Cronbach's alpha are presented in Table 11. Composite scores on the three dimensions of the Workplace Attention

Trifactor Scale and the reaction times and error rates on the Attention Network Test were correlated with total number of incidents and injuries, and the composite scores for safety compliance and participation. The only significant correlation was between orienting attention and safety participation ($r(33) = .40$, $p < .05$). There were no significant correlations between the reaction times and error rates on the Attention Network Test and the total number of incidents and injuries, and the composite scores for safety compliance and participation. The internal consistency of the Workplace Attention Trifactor Scale ranged from .62 to .75 ($\alpha_{alerting} = .69$; $\alpha_{orienting} = .62$; $\alpha_{executive\ control} = .75$). The convergent validities of the Workplace Attention Trifactor Scale to the Attention Network Test reaction times were not significant, but orienting attention was trending ($r(33) = .32$, $.05 < p < .10$). Orienting attention measured by the Workplace Attention Trifactor Scale was positively correlated with the reaction times on the orienting portion of the Attention Network Test. Hypothesis 3.3 and Hypothesis 3.4 were not supported.

Table 11

Means, Standard Deviations, and Correlations of Study 3 Variables for Convergent Validity (N = 35)

	Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Alerting	3.88	0.51	.69												
2	Orienting	4.15	0.54	.65***	.62											
3	Executive control	3.91	0.55	.57***	.50***	.75										
4	Alerting RT-ANT	59.99	38.03	-.12	-.09	-.21										
5	Orienting RT-ANT	20.89	20.93	.07	.32[a]	.20	-.13									
6	Executive control RT-ANT	88.43	32.98	-.02	.04	.01	.23	-.24								
7	Alerting Errors-ANT	0.74	2.24	.02	-.13	-.06	.40*	.17	.03							
8	Orienting Errors-ANT	-1.46	2.25	.03	.11	-.05	-.04	.41*	-.12	-.12						
9	Executive control Errors-ANT	-10.54	16.90	-.15	-.29	-.05	.07	.35*	-.14	.08	.004					
10	Incidents	0.20	0.47	.05	.01	.12	-.04	-.07	.04	-.20	.03	-.33				
11	Injuries	0.26	1.36	-.08	.14	.23	-.17	-.12	.15	.16	-.17	-.03	-.08			
12	Safety compliance	3.97	0.82	.02	.27	.18	.04	.001	-.11	.09	.04	-.24	.21	-.28	.94	
13	Safety participation	3.64	0.89	.15	.40*	.12	.05	-.06	.06	-.04	.004	-.17	.33[a]	-.17	.64***	.88

Note: * $p < .05$; *** $p < .001$; [a] $.05 < p < .10$

Study 3 Discussion

The purpose of Study 3 was to examine the test-retest reliability of the Workplace Attention Trifactor Scale and the convergent validity of the self-report measure with the Attention Network Test. Scores on all three of the attention domains of the Workplace Attention Trifactor Scale at Time 1 were positively correlated with scores at Time 2 (three months after Time 1). This suggested that the Workplace Attention Trifactor Scale was stable over a three-month time period. The associations between orienting domain and injuries, safety compliance, and safety participation, and the associations between alerting domain and compliance, and participation were consistent over the two timepoints, but executive control of attention was not consistently related to safety outcomes. It appeared that alerting and orienting attention, the relatively more stable attentional capacities, were linked to better safety outcomes. The relatively low test-retest reliability of the executive control attention domain may explain its lack of associations with safety outcomes.

Although not significantly different, the relative magnitude of the test-retest reliability amongst the three attention domains were reversed in the Workplace Attention Trifactor Scale and the Attention Network Test (Fan et al., 2001; Fan et al., 2002); rather than executive control, orienting, and alerting attention being the most stable, it was orienting, alerting, and then executive control for the self-report measure. A difference in timeframe for repeated administration of the two types of assessment might be responsible for this observation. Fan et al.'s (2001, 2002) examined stability within a day, and the time between the first and second sessions was half an hour (Fan et al.,

2001) to 10 minutes (Fan et al., 2002). The stability of the Workplace Attention Trifactor Scale was examined over an average of three months, which was a substantially longer timeframe than the Attention Network Test studies. When the items on the Workplace Attention Trifactor Scale were framed as a three-month recall, the measurement might be assessing more trait-like attentional capacities, while the Attention Network Test was assessing state-like attentional capacities. Alerting attention might be influenced by factors that fluctuate over the course of the day, but be stable over long periods of time. For example, vigilance could be influenced by time spent awake, but be recharged every night by sleep. Individuals attempting to recall their vigilance over the last few months may come to a final evaluation that averaged out the daily experiences. Executive control of attention might be influenced by learning and experience, which build over time. Individuals attempting to recall their executive control over the last few months may be more aware of improvements or retrogression in that ability.

Convergent validity analyses revealed that the scores on the three self-reported attention domains were not correlated with the reaction times and error rates on the Attention Network Test. This implied that although both the self-report measurement and task-based measurment were based off the same attention network theory (Petersen & Posner, 2012), they were measuring different aspects of attention, even on a daily level. A closer look at the items on the Workplace Attention Trifactor Scale revealed that the items on the alerting domain of the Workplace Attention Trifactor Scale covered general vigilance behaviours, which were more related to tonic alerting. However, the alerting portion of the Attention Network Test assessed phasic alerting performance (Ishigami & Klein, 2009). During the development of the Workplace Attention Trifactor Scale, covert orienting items were removed to keep the three-factor solution parsimonious, hence the self-reported orienting domain of the scale might not be comparable to orienting attention performance on the Attention Network Test. Furthermore, the Attention Network Test performances were calculated using difference scores from one task condition to another, which may had prevented it from being comparable to the items in the Workplace Attention Trifactor Scale. For example, performance in the executive control portion of the Attention Network Test was calculated using the difference in performance between the incongruent and the congruent flanker conditions, yet the items in the executive control domain of the Workplace Attention Trifactor Scale assessed only the individual's ability to overcome conflict rather than both conflicting and non-conflicting situations.

Another possible explanation for the lack of convergent reliability was that in this particular sample of participants the internal consistencies of the three attention domains of the Workplace Attention Trifactor Scale were below acceptable levels (.62-.75), which suggested that the Workplace Attention Trifactor Scale might not be measuring the three attention networks adequately. Low internal consistencies might also impact the test-retest reliability of the scale as well. A larger sample size would increase the power of the analyses and might help uncover the potential relationships between the self-reported measure and the cognitive tasks.

Aside from criticizing the incompatibility of the two types of attention measurements, the lack of significant associations between a self-reported and a performance-based attention measure might be theoretically justified. The Workplace Attention Trifactor Scale might be capturing individual's metacognition or metaknowledge, which is the awareness of their own cognitive abilities and the regulation of cognitive activity (Moses & Baird, 1999). Metacognition has been studied in human factors psychology as perceptual processes and long-term memory knowledge that are linked to decision-making behaviours (Wickens et al., 2004; Wright et al., 2000). In cognitive psychology, the concept of metacognition is closely linked to the executive control (Fernandex-Duque, Baird, & Posner, 2000) because both concepts concern the ability to monitor and control cognitive processes. The correlations between the error rates of the executive control portion of the Attention Network Test (although insignificant) alluded to this. The magnitude of the correlations between self-reported attention and performance on the Attention Network Test were the largest for executive control error rates across alerting and orienting self-reported domains (self-reported alerting, $r(33) = -.15$, *ns*; self-reported orienting, $r(33) = -.29$, *ns*) rather with the error rates of their associated domains. Reaction times did not show the same relationship, yet reaction times might not be the best indicator of metacognition, because past research showed that individuals would slow down their speed if they were aware of mistakes as an effort to maintain accuracy in responses (Robertson et al., 1997).

Some limitations in Study 3 should be noted. First, self-reporting in Study 3 posed a more serious theoretical issue than Study 2's concern for common method bias:

if individuals were not attentive, then the validity of their retrospective recall might be undermined. Second, the placement of the Attention Network Test after a work day might be a limitation in the current study. Participants were instructed to carry out the study after work, so their performance assessed after a day of working should reflect the deficits in attentional capacities rather than the extent of their attentional capacities, which was what the Workplace Attention Trifactor Scale measured. Third, the Attention Network Test did not include instructions for maintaining a certain distance and angle of eyes from the computer screen during testing. Being closer to the screen allowed for images to be perceived as larger, which might confound the performance on the test.

Study 4: Field Utility of the Workplace Attention Trifactor Scale

The Workplace Attention Trifactor Scale was developed and validated through three studies that examined and confirmed the factor structure, and established construct validity with error and safety outcomes and test-retest validity over a period of three months. However, the Workplace Attention Trifactor Scale did not demonstrate convergent validity with the Attention Network Test even though the two form of measurement were based off the same three attention network theory. If the two methods of measuring the three attention networks were indeed measuring different aspects of attention, the question now turns to which measurement could be the better predictor of injuries, incidents, and safety performance at work. Both methods of measurement will be tested in the field to examine the practical utility of using them as an indicator of capacity to work safely.

To overcome some of the issues with validity and clarity of interpreting the findings in Study 1 to 3, informant reports of participant's attentional capacities and safety performance were incorporated in Study 4's design. As well, data were collected using a longitudinal daily diary study paradigm to minimize recall bias and to allow for causal interpretation of the data on a daily level rather than over a period of three months, so the self-report measure and the performance task can be compared using the same frame of time. Participants were asked to perform the Attention Network Test prior to a work shift so their attentional performance would reflect capacities rather than deficits in the three types of attention. Participants were asked to provide a self-assessment on the Workplace Attentional Trifactor Scale after work so they can reflect on how their attention were at work.

Following up on Study 3's discussion, if the Workplace Attention Trifactor Scale was indeed assessing individuals' metacognition of their attentional capacities, I would expect that the self-report would be more effective in predicting safety outcomes than the Attention Network Test because metacognition is associated with the anticipated effort to gain information or perform tasks (Wright et al., 2000). While objective attentional performance on the Attention Network Test reflected the capability of attention, I believed that subjective self-assessment of attentional capacities would more likely result in better safety performance because metacognition has a component of effort and motivation. For instance, individuals who reported themselves to have high levels of attentional capacities would anticipate less effort necessary to work safely, thus motivating workers to exhibit good safety performance. Therefore, I hypothesized that:

Hypothesis 4.1: Self-reported attention will predict informant ratings of attention better than objectively assessed attention. Specifically, attention on the Workplace Attention Trifactor Scale, rather than attention on the Attention Network Test, will be positively associated with informant reports of attention.

Hypothesis 4.2: Self-reported alerting attention will predict safety performance and injuries better than objectively assessed alerting attention. Specifically, alerting attention on the Workplace Attention Trifactor Scale, rather than alerting attention on the Attention Network Test, will be positively associated with self-reported and informant reported safety compliance and safety participation, and negatively associated with incidents and injuries.

Hypothesis 4.3: Self-reported orienting attention will predict safety performance and injuries better than objectively assessed orienting attention. Specifically, orienting attention on the Workplace Attention Trifactor Scale, rather than orienting attention on the Attention Network Test, will be positively associated with informant-reported safety compliance and safety participation, and negatively associated with incidents and injuries.

Hypothesis 4.4: Self-reported executive control attention will predict safety performance and injuries better than objectively assessed executive control attention. Specifically, executive control attention on the Workplace Attention Trifactor Scale, rather than executive control attention on the Attention Network Test, will be positively associated with informant-reported safety compliance and safety participation, and negatively associated with incidents and injuries.

Study 4 Methods

Sample

Participants were shift workers recruited with the help of the Nova Scotia Government and General Employee Union from hospitals and correctional facilities as well as from snowball sampling (Reddit, Kijiji, Facebook). Inclusion criteria for the participants was that they had to be above the age of 19, employed in a non-white collar occupation (blue collar, pink collar, or grey collar), and had a supervisor or a coworker who could provide objective ratings of their attentional performance for the duration of the study.

Eleven participants were recruited for the study (4 men, 7 women). Participants' age ranged from 22 to 61 years (*M* = 37.45 years, *SD* = 13.53 years). Participants' work tenure ranged from two years to 25 years (*M* = 11 years, *SD* = 9.13 years). Participants were majority Caucasian (81.8%) with one Asian (9.1%) and one mixed race (9.1%). Most of the participants had their highest level of education completed in college (81.8%) or university (18.2 %). All but one participant received safety training at work.

Procedures

Participants first attended a preliminary session with me prior to field data collection. The purpose of the preliminary session was to familiarize the participants with the longitudinal testing procedures and the Attention Network Test. I explained how to carry out the data sampling over the course of their shift work schedule, and sent them instructions for downloading the Attention Network Test on their computers, for filling out daily diaries, and for reminding their informants to fill out their daily ratings of the participants. Before starting the daily diaries, the participants filled out a one-time demographics questionnaire which contained questions assessing basic demographics (gender, age, race), and details about their job position (occupation type, job tenure, history of safety training; see Appendix I).

The longitudinal data collection period consisted of six data collection days with at least two of each type of shift in the shift rotation schedule (morning shift, evening shift, or night shift). The exact collection period varied depending on participants' work schedule, but none of the schedules had consecutive testing days to reduce learning effects. During the data collection day, participants completed with the Attention

Network Test on their computers before they left for work. During their work shift, they identified at least one informant and provided them with the daily rating questionnaire. At the end of their work shift, both the participants and their informants rated their attentional and safety performance for the day (see Appendix J for self-rating questionnaire and Appendix K for informant-rating questionnaire). Attentional performance for the day was assessed using the self-reported Workplace Attention Trifactor Scale measure, and the type of daily safety performance assessed were safety compliance and participation, and reports of incidents and injuries. Informants' responses were mailed back to the university rather than being collected by the participants for privacy purposes. This repeated for the remainder of the data collection period. Participants had the opportunity to earn $5 for each completed day of data collection (cognitive testing and performance ratings). A feedback report on their sleep quality and performance on the attention task was provided to them as additional incentive to complete the full study.

Measures

The same measures used in the convergent validity study (Study 3) were used for Study 4. Attention at work for the day was measured using the Workplace Attention Trifactor Scale developed in Study 1 but framed in a daily manner. Frequency of incidents and injuries for the day were assessed using the same four items from Study 1 to 3 based off of Wallace and Vodanovich's (2003) operational definition but framed in a daily manner. The type of safety performance assessed were safety compliance and participation. Safety compliance and participation at work was measured using the same

Neal and Griffin's (2006) scale from Study 3, which consisted of the safety compliance subscale and the safety participation subscale framed in a daily manner.

Tasks

Attention Network Test. The attention network test used was the same as the one from Study 3. The only modification was that the daily sessions consisted of three experimental blocks of 96 trials presented in random order (4 cue conditions × 2 target locations × 2 target directions × 3 flanker conditions × 2 repetitions) without a practice trial. Participants played the practice trial after they download the game as a check to see if the program worked on their computers, thus the practice trial was eliminated from the daily sessions.

Study 4 Results

Mean, standard deviations, and correlations of study's variables are presented in Table 12. The nature of the data is nested—daily observations within individuals—therefore, true correlations between Study 4's variables may be weaker than the report coefficients, since observations within individuals would be more highly correlated. Caution is suggested for interpretation of the correlation table.

The data were analyzed using the mixed model function in SPSS. Shift work observations (level 1) was nested within participants (level 2), creating a 2-level mixed model. Testing began with running a null model (with only the outcome in the model, no levels specified), the unconditional model (levels specified, but without predictors), and then the random intercept model with predictors (Heck, Thomas & Tabata, 2010). A random intercept model tested for the differences in intercept between participants, but assumed that the relationship between the predictor and outcome (slope) was the same for all individuals. The significance of the change in deviance from the null model, unconditional model, to the random intercept model was assessed using the -2 log likelihood test. Intraclass correlations were calculated for level 2 of all unconditional models. The intraclass correlation indicated the effect size of the model and the value represented the percentage of total variance that can be attributed to level-2, the between person level, prior to adding in predictors.

Table 12

Mean, Standard Deviations, and Correlations of Study 4's variables ($N_{observations}$ = 40; $N_{individuals}$ = 11)

	Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1	WATS-alerting	3.85	0.79													
2	WATS-orienting	4.28	0.58	.62***												
3	WATS-executive control	4.26	0.66	.69***	.59***											
4	Alerting RT-ANT	54.29	25.85	-.07	.10	.07										
5	Orienting RT-ANT	29.38	24.87	.10	-.11	.11	-.54***									
6	Executive control RT-ANT	80.05	23.28	.10	.08	.03	.22	-.38*								
7	Alerting errors-ANT	-0.98	2.28	.29[a]	.29[a]	.28[a]	-.002	.14	-.27							
8	Orienting errors-ANT	-0.45	2.50	.10	.30[a]	.20	-.05	.18	-.39*	.43**						
9	Executive control errors-ANT	-4.73	4.68	.001	-.09	-.09	-.33*	.51**	-.11	.27[a]	.35*					
10	Alerting-informant	4.53	0.53	.52**	.44**	.66***	-.07	.19	.11	.10	.32*	.13				
11	Orienting-informant	4.61	0.48	.60***	.45**	.69***	.08	.18	-.15	.16	.38*	-.04	.61***			
12	Executive control-informant	4.54	0.53	.44**	.46**	.73***	.07	.09	.19	-.06	.10	-.22	.74***	.66***		

13	Safety compliance-informant	18.35	1.88	.31^{a}	.39*	.45**	-.04	.07	-.06	.05	.14	-.08	.22	.49**	.38*	
14	Safety participation-informant	17.22	2.14	.38*	.33*	.41**	.08	.05	-.14	.16	.17	-.17	.34*	.51**	.40*	.68***

Note: * $p < .05$; *** $p < .001$; ^{a} $.05 < p < .10$; Workplace Attention Trifactor Scale (WATS); Reaction times (RT); Attention Network Test (ANT)

For hypothesis 4.1, six multi-level regressions were conducted. Each model consisted of two attentional predictors–self-reported attentional assessment and Attention Network Test performance (reaction times or error rates)–predicting the outcome of informant-reported attention. Two models examined the predictive validity of subjective and objective alerting, two models examined the predictive validity of subjective and objective orienting, and two models examined the predictive validity of subjective and objective executive control. Variance components was used as the covariance structure for the between-subject level and diagonal was used as the covariance structure for the within-subject level. A time variable was added into the model to control for the effects of repeated measurement over the course of the data collection schedule.

For the outcome of informant-reported alerting with alerting attention predictors, the -2 restricted log likelihood values decreased from the null model ($-2LL$ = 92.42) to the unconditional models ($-2LL$ = 65.21). The ICC calculation from the unconditional model showed the Level 2 (between-person) variance was small (ICC = .16), which suggested that most of the variance were in Level 1 (within-person). The -2 restricted log likelihood value for the random intercept model of self-reported alerting attention and reaction times on the alerting component of the Attention Network Test indicated that the random intercept model was a better fit to the data ($-2LL$ = 57.24; $\chi^2(3) = 7.97$, $p < .05$). Self-report alerting attention, not alerting reaction times on the Attention Network Test, was a significant predictor of informant-reported alerting attention (Table 13). Higher self-ratings of alerting attention were associated with higher informant-ratings of alerting attention ($B = 0.27$, $p < .05$).

Table 13

Alerting Attention and Informant-reported Attention Model Summaries (N = 40)

	Informant-reported alerting	
Parameters	*B*	*SE*
Reaction times Model		
Intercept	3.41	0.47^{***}
Timepoint	-0.04	0.04
Self-report alerting	0.27	0.10^{*}
ANT alerting	0.003	0.003
Error rates Model		
Intercept	3.78	0.41^{***}
Timepoint	-0.04	0.03
Self-report alerting	0.21	0.09^{*}
ANT alerting	-0.032	0.02

Note: $^{*}p < .05$; $^{***}p < .001$; Attention Network Test (ANT)

The -2 restricted log likelihood value for the random intercept model of self-reported alerting attention and error rates on the alerting component of the Attention Network Test indicated that the random intercept model was a better fit to the data (*-2LL* = 50.48; $\chi^2(3) = 14.73$, $p < .01$). Self-report alerting attention, not alerting error rates on the Attention Network Test, was a significant predictor of informant-reported alerting attention (Table 13). Higher self-ratings of alerting attention were associated with higher informant-ratings of alerting attention ($B = 0.21$, $p < .05$). Hypothesis 4.1 was fully supported for alerting attention in the reaction times and error rates models.

For the outcome of informant-reported orienting using orienting attention predictors, the -2 restricted log likelihood value decreased from the null model (*-2LL* = 79.32) to the unconditional models (*-2LL* = 52.39). The ICC calculation from the unconditional model showed the Level 2 (between-person) variance was small (ICC = .01), suggesting that most of the variance were in Level 1 (within-person). The -2 restricted log likelihood value for the random intercept model of self-reported orienting attention and reaction times on the orienting component of the Attention Network Test indicated that the random intercept model was not a better fit to the data, although the significance was trending (*-2LL* = 45.36; $\chi^2(3) = 7.03$, $.05 < p < .10$).

The -2 restricted log likelihood value for the random intercept model of self-reported orienting attention and error rates on the orienting component of the Attention Network Test indicated that the random intercept model was a better fit to the data (*-2LL* = 43.59; $\chi^2(3) = 8.80$, $p < .05$). Self-report orienting attention, not orienting error rates on the Attention Network Test, was a significant predictor of informant-reported orienting attention (Table 14). Higher self-ratings of orienting attention were associated with higher informant-ratings of orienting attention ($B = 0.27$, $p < .05$). Hypothesis 4.1 was fully supported for orienting attention in the error rates model but not for the reaction times model.

Table 14

Orienting Attention and Informant-reported Attention Model Summaries (N = 40)

	Informant-reported orienting	
Parameters	*B*	*SE*
<u>*Error rates Model*</u>		
Intercept	3.30	0.51^{***}
Timepoint	0.04	0.03
Self-report orienting	0.27	0.11^{*}
ANT orienting	-0.003	0.02

Note: * $p < .05$; *** $p < .001$; Attention Network Test (ANT)

For the outcome of informant-reported executive control using executive control attention predictors, the -2 restricted log likelihood value decreased from the null model (*-2LL* = 87.00) to the unconditional models (*-2LL* = 51.89). The ICC calculation from the unconditional model showed the Level 2 (between-person) variancs was small (ICC = .23), suggesting that most of the variance were in Level 1 (within-person). The -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data (*-2LL* = 31.78; $\chi^2(3) = 20.11$, $p < .001$). Random intercept model of informant-reported executive control was tested with self-report executive control and Attention Network Test executive control performance as predictors (Table 15). Both self-report executive control attention and executive control performance on the Attention Network Test were significant predictors of informant-reported executive control attention. Higher self-ratings of executive control attention ($B = 0.62$, $p < .001$) and longer reaction times on the executive control portion of the Attention Network Test ($B = 0.007$, $p < .001$) were associated with higher informant-ratings of executive control attention.

Table 15

Executive Control Attention and Informant-reported Attention Model Summaries (N = 40)

	Informant-reported executive control	
Parameters	*B*	*SE*
<u>*Reaction times Model*</u>		
Intercept	3.20	0.41***
Timepoint	0.08	0.02
Self-report executive control	0.24	0.09***
ANT executive control	0.007	0.002***
<u>*Error rates Model*</u>		
Intercept	2.10	0.40**
Timepoint	-0.01	0.04
Self-report executive control	0.56	0.09**
ANT executive control	-0.017	0.012

Note: ** $p < .01$; *** $p < .001$; Attention Network Test (ANT)

For the model using executive control error rates as a predictor, the Hessian matrix was not positive definite using diagonal as the covariance structure for the within-subject level, so autoregressive was used instead. The -2 restricted log likelihood value decreased from the null model (*-2LL* = 87.00) to the unconditional models (*-2LL* = 56.33). The ICC calculation from the unconditional model showed the Level 2 (between-person) variance was small (ICC = .86), suggesting that most of the variance was at that level. The -2 restricted log likelihood value for the random intercept model of self-reported executive control attention and error rates on the executive control component of the Attention Network Test indicated that the random intercept model was a better fit to the data (*-2LL* = 48.05; $\chi^2(3) = 8.28$, $p < .05$). Self-report executive control attention, not executive control error rates on the Attention Network Test, was a significant predictor of informant-reported executive control attention (Table 15). Higher self-ratings of executive control attention were associated with higher informant-ratings of executive control attention ($B = 0.56$, $p < .01$). Hypothesis 4.1 was supported for executive control attention in the reaction times and error rates models, although the relationship between reaction times and informant ratings of executive control attention was counterintuitive.

For hypotheses 4.2, 4.3, and 4.4, twelve multi-level moderated regressions were conducted. Each model consisted of two attentional predictors–self-reported attentional assessment and Attention Network Test performance (reaction times or error rates)–predicting the outcome of informant-reported safety compliance and participation. Four models examined the predictive validity of subjective and objective alerting (Hypotheses 4.2), four models examined the predictive validity of subjective and objective orienting (Hypotheses 4.3), and four models examined the predictive validity of subjective and objective executive control (Hypotheses 4.4). There were no reports of incidents and injuries, therefore those analyses were dropped from the study. Variance components was used as the covariance structure for the between-subject level, and autoregressive was used as the covariance structure for the within-subject level. A time variable was added into the model to control for the effects of repeated measurement over the course of the data collection schedule.

For the outcome of safety compliance using self-reported alerting attention and alerting reaction times on the Attention Network Test as predictors, the -2 restricted log likelihood value decreased from the null model (*-2LL* = 231.54) to the unconditional models (*-2LL* = 219.92). The ICC calculation from the unconditional model showed the Level 2 (between-person) variance was moderate (ICC = .32). The -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data (*-2LL* = 162.83; $\chi^2(3) = 57.09$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report alerting and

Attention Network Test alerting reaction times performance as predictors (Table 16). Neither forms of alerting attention assessment were associated with safety compliance.

Table 16

Alerting Attention and Safety Performance Model Summaries (N = 40)

	Safety compliance		Safety participation	
Parameters	*B*	*SE*	*B*	*SE*
<u>*Reaction times Model*</u>				
Intercept	16.16	1.82***	13.47	1.94***
Timepoint	0.02	0.21	-0.25	0.20
Self-report alerting	0.61	0.41	0.98	0.44*
ANT alerting	-.005	0.014	0.013	0.013
<u>*Error rates Model*</u>				
Intercept	15.89	1.81***	14.63	2.03***
Timepoint	-0.02	0.18	-0.16	0.18
Self-report alerting	0.65	0.42	0.81	0.47[a]
ANT alerting	-0.005	0.14	0.11	0.14

Note: * $p < .05$; *** $p < .001$; [a] $.05 < p < .10$; Attention Network Test (ANT)

For the outcome of safety compliance using self-reported alerting attention and alerting error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data (*-2LL* = 158.36; $\chi^2(3) = 61.56$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report alerting and Attention Network Test alerting error rates performance as predictors (Table 16). Neither forms of alerting attention assessment were associated with safety compliance. Hypothesis 4.2 was not supported for alerting attention using the reaction times and error rates models and safety compliance.

For the outcome of safety participation using self-reported alerting attention and alerting reaction times on the Attention Network Test as predictors, the -2 restricted log likelihood value decreased from the null model (*-2LL* = 243.89) to the unconditional models (*-2LL* = 230.93). The ICC calculation from the unconditional model showed the Level 2 (between-person) variance was moderate (ICC = .35). The -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data (*-2LL* = 171.26; $\chi^2(3) = 59.67$, $p < .001$). Random intercept model of safety participation at work was tested with self-report alerting and Attention Network Test alerting reaction times performance as predictors (Table 16). Self-report alerting attention, not alerting performance on the Attention Network Test, was a significant predictor of informant-report safety participation. Higher self-ratings of alerting attention were associated with higher informant-ratings of safety participation ($B = 0.98$, $p < .05$).

For the outcome of safety participation using self-reported alerting attention and alerting error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 167.06$; $\chi^2(3) = 63.87$, $p < .001$). Random intercept model of safety participation at work was tested with self-report alerting and Attention Network Test alerting error rates as predictors (Table 16). Neither forms of alerting attention assessment were associated with safety participation, although self-reported alerting was trending on significant ($B = 0.81$, $p < .10$). Hypothesis 4.2 was fully supported for the reaction times model and safety participation, but not for the error rates model

For the outcome of safety compliance using self-reported orienting attention and orienting reaction times on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 160.11$; $\chi^2(3) = 59.81$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report orienting and Attention Network Test alerting reaction times performance as predictors (Table 17). Self-report orienting attention, not orienting performance on the Attention Network Test, was a significant predictor of informant-report safety compliance. Higher self-ratings of orienting attention were associated with higher informant-ratings of safety compliance ($B = 1.17$, $p < .05$).

Table 17

Orienting Attention and Safety Performance Model Summaries (N = 40)

	Safety compliance		Safety participation	
Parameters	*B*	*SE*	*B*	*SE*
Reaction times Model				
Intercept	12.98	2.44***	12.12	2.78***
Timepoint	0.01	0.18	-0.13	0.19
Self-report orienting	1.17	0.52*	1.17	0.58[a]
ANT orienting	0.010	0.013	0.013	0.015
Error rates Model				
Intercept	13.92	2.46***	14.01	2.73***
Timepoint	-0.03	0.18	-0.17	0.19
Self-report orienting	1.06	0.55[a]	0.86	0.60
ANT orienting	0.04	0.12	0.13	0.13

Note: * $p < .05$; *** $p < .001$; [a] $.05 < p < .10$; Attention Network Test (ANT)

For the outcome of safety compliance using self-reported orienting attention and orienting error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data (-2LL = 156.01; $\chi^2(3) = 63.91$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report orienting and Attention Network Test alerting error rates performance as predictors (Table 17). Neither forms of orienting attention assessment were associated with safety compliance, although self-reported orienting was trending ($B = 1.06$, $.05 < p < .10$). Hypothesis 4.3 was supported for orienting attention using the reaction times and safety compliance, but not the error rates model.

For the outcome of safety participation using self-reported orienting attention and orienting reaction times on the Attention Network Test attention predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 171.26$; $\chi^2(3) = 59.67$, $p < .001$). Random intercept model of safety participation at work was tested with self-report orienting and Attention Network Test orienting reaction times performance as predictors (Table 17). Neither forms of orienting attention assessment were associated with safety participation, but self-report orienting attention was trending ($B = 1.17$, $p < .10$).

For the outcome of safety participation using self-reported orienting attention and orienting error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 166.74$; $\chi^2(3) = 64.19$, $p < .001$). Random intercept model of safety participation at work was tested with self-report orienting and Attention Network Test orienting error rates performance as predictors (Table 17). Neither forms of orienting attention assessment were associated with safety participation. Hypothesis 4.3 was not supported for orienting attention using the reaction times and error rates models and safety participation.

For the outcome of safety compliance using self-reported executive control attention and executive control error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL$ = 158.95; $\chi^2(3) = 60.97$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report executive control and Attention Network Test executive control reaction times performance as predictors (Table 18). Self-report executive control attention, not executive control reaction times performance on the Attention Network Test, was a significant predictor of informant-report safety compliance. Higher self-ratings of executive control attention were associated with higher informant-ratings of safety compliance ($B = 1.30$, $p < .01$).

Table 18

Executive Control Attention and Safety Performance Model Summaries (N = 40)

	Safety compliance		Safety participation	
Parameters	*B*	*SE*	*B*	*SE*
Reaction times Model				
Intercept	13.31	2.15***	14.63	2.67***
Timepoint	-0.001	0.16	-0.16	0.16
Self-report executive control	1.30	0.43**	1.15	0.52*
ANT executive control	-0.006	0.012	-0.023	0.01
Error rates Model				
Intercept	12.65	1.87	12.47	2.38
Timepoint	-0.0003	0.16	-0.12	0.17
Self-report executive control	1.32	0.42*	1.19	0.52*
ANT executive control	-0.02	0.06	-0.010	0.08

Note: * $p < .05$; ** $p < .01$; *** $p < .001$; Attention Network Test (ANT)

For the outcome of safety compliance using self-reported executive control attention and executive control error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 155.84$; $\chi^2(3) = 64.08$, $p < .001$). Random intercept model of safety compliance at work was tested with self-report executive control and Attention Network Test executive control reaction times performance as predictors (Table 18). Self-report executive control attention, not executive control reaction times performance on the Attention Network Test, was a significant predictor of informant-report safety compliance. Higher self-ratings of executive control attention were associated with higher informant-ratings of safety compliance ($B = 1.32$, $p < .05$). Hypothesis 4.4 was fully supported for executive control attention using the reaction times and error rates models and safety compliance.

For the outcome of safety participation using self-reported executive control attention and executive control reaction times on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 169.38$; $\chi^2(3) = 61.55$, $p < .001$). Random intercept model of safety participation at work was tested with self-report executive control and Attention Network Test executive control performance as predictors (Table 18). Self-report executive control attention, not executive control reaction times performance on the Attention Network Test, was a significant predictor of informant-report safety participation. Higher self-ratings of executive control attention were associated with higher informant-ratings of safety participation ($B = 1.15$, $p < .05$).

For the outcome of safety participation using self-reported executive control attention and executive control error rates on the Attention Network Test as predictors, the -2 restricted log likelihood value for the random intercept model indicated that the random intercept model was a better fit to the data ($-2LL = 168.17$; $\chi^2(3) = 62.76$, $p < .001$). Random intercept model of safety participation at work was tested with self-report executive control and Attention Network Test executive control error rates performance as predictors (Table 18). Self-report executive control attention, not executive control error rates performance on the Attention Network Test, was a significant predictor of informant-report safety participation. Higher self-ratings of executive control attention were associated with higher informant-ratings of safety participation ($B = 1.19$, $p < .05$). Hypothesis 4.4 was fully supported for executive control attention using the reaction times and error rates models and safety participation.

Study 4 Discussion

Higher self-report alerting and executive control predicted higher informant's report of the same type of attention, which suggested that informants' reports were better predicted by the self-reported Workplace Attention Trifactor Scale than Attention Network Test-based attention. Most importantly, higher self-reported orienting attention and executive control predicted informants reports of safety compliance, and higher self-reported alerting and executive control predicted informants reports of safety participation, which suggested that informants' reports of safety performance can be predicted by the self-reported Workplace Attention Trifactor Scale. The self-reported ratings of executive control were consistently better predictors than the reaction times and the error rates on the Attention Network Test.

According to the classification of human failures, inattention is the cause of slips and lapses and incompliance is the cause of purposeful safety violations (Rasmussen, 1983; Reason, 1990), yet, Study 4 revealed that self-reported attention predicted informant-reported safety compliance and participation. However, if the Workplace Attention Trifactor Scale is truly capturing individuals' metacognition, then Study 4's finding did not undermine the classification of human failures, but instead further demonstrate the importance of attention for safety performance by showing that knowledge of own attentional abilities can influence the motivation to exhibit safety behaviours. In addition, workers with an attentional bias towards safety cues (i.e., implicit attentional focus on safety-related words on a Stroop test) show more safety compliance and participation (Xu et al., 2014), which suggests that both explicit and implicit perceptual processing could enhance motivation to exhibit safety behaviours.

A sufficient level of attention may be necessary for the exhibition of good safety behaviours. For example, safety compliance is the adherence to safety protocols and policies (Neal et al., 2000) and overt orienting assessed by the Workplace Attention Trifactor Scale referred to exhibiting the correct and timely focus of attention on important cues. Orienting attention might be relevant for safety compliance if the important cues were safety-related. Safety participation is the willingness to go above and beyond the job description and engage in safety behaviours that are extra-role (Neal et al., 2000). Alerting attention could be useful for safety participation because a good general awareness of the work environment might be necessary in order to find opportunities to engage in extra-role behaviours without compromising the in-role behaviours. Sustained alerting and vigilance throughout the work day might also facilitate safety participation because of the resource of wakefulness; workers who are not experiencing fatigue could channel that energy to perform safety behaviours that are not necessarily expected of them. Executive control assessed by the Workplace Attention Trifactor Scale referred to filtering out conflicting cues that competed for attention. A workplace might have conflicting and misleading information that could insinuate a non-adaptive approach to safety, which would require executive control to refocus on the appropriate policy and procedures to maintain safety compliance. Executive control might also be useful for safety participation because it could enable the individual to see opportunities for displaying extra-role behaviours that would not compromise the continuous maintenance of in-role safety requirements.

The relationship between self-reported and performance-based attention on self-reported and informant-reported incidents and injuries remained inconclusive because there were no incidents and injuries experienced by participants and their informants in Study 4, however, the lack of data did not mean that there is no relationship between attention and incident and injuries outcomes. In fact, I would expect the Workplace Attention Trifactor Scale to predict incidents and injuries because slips and lapses often happens with individuals who are fully compliance yet not completely aware of their true attentional capacities (Norman, 1981; Reason, 1990).

Executive control performance on the Attention Network Test predicted informants outcomes of attention, but the directionality of the relationship was different than expected. Larger differences in the reaction times of the incongruent and congruent conditions on the Attention Network Tests were associated with better informant-reported executive control scores. It might be because longer reaction times did not necessarily reflect the lack of executive control attention capacity. To illustrate, impulsivity as a personality trait is indirectly associated with incidents through unsafe behaviours (Beus, Dhanani, & McCord, 2015). Therefore, individuals who took the time to evaluate the situation in the face of conflicting and distracting information might be exhibiting adaptive safety behaviours rather than risky choices. In fact, decrease in speed is typically the trade-off for increase in accuracy in individuals who are engaging in their executive control processes to monitor and catch their own errors (Robertson et al., 1997). To support this, the model that examined the effect of executive control error rates on informant-reported scores did not show a significant negative relationship, which suggested that accuracy mattered in the interpretation of the executive control finding.

There were significant positive correlations between the error rates of alerting and orienting portion of the Attention Network Test, and orienting and executive control portion of the Attention Network Test. Interestingly, in this study there were significant correlations between the three attention networks reaction times from the Attention Network Test, yet these correlations were negative. Faster reaction times on the alerting domain were associated with slower reaction times on the orienting domain, and faster reaction times on the orienting domain were associated with slower reaction times on the executive control domain. In MacLeod et al.'s (2010) meta-analysis about the psychometrics property of the Attention Network Test, he reported a significant positive correlation between the alerting and orienting reaction times using data from 15 datasets, although the magnitude of the relationship was small ($r_{\text{weighted}} = .06$). However, MacLeod et al. (2010) stated that using difference scores to calculate the network effects is problematic and tend to lead to low reliabilities. Therefore, the method of obtaining network efficiency scores on the Attention Network Test is a limitation to the study.

A couple more limitations to Study 4 should be noted. First, the placement of the Attention Network Test was moved from after work (Study 3) to before work in Study 4 to assess the extent of attentional capacities right before individuals go to work rather than the depleted of them at the end of work, yet, the self-report of attention and the attention performance task were not temporally aligned. To rule out the effects of timing in Study 4's research design, the Attention Network Test should ideally be administered in the beginning and the end of a work shift to be able to properly complement the self-report of attentional capacities at work. However, administration of the 20-minute cognitive task twice a day over a daily diary study might cause test fatigue and increase attrition rate. Second, even though the length of recall was reduced from three months to daily in Study 4, the Workplace Attention Trifactor Scale could still be susceptible to retrospective bias in participants and their informants. Third, informant-reports might be subjected to selection bias, since the participants were able to choose their informants, they may opt to choose colleagues who they had not injured. Although effort had been made to counteract this by ensuring anonymity of responses, choice of informant could still be a possible confound to the study. Lastly, informants reported on the participants' attentional capacities prior to reporting on their safety performance. Therefore, completing the two assessments back to back may have introduced interference; the judgement of their attention might had inadvertently influenced the judgement of their safety performance.

General Discussion

In summary, the purpose of this dissertation was to integrate past work on occupational safety with relatively more recent advances in cognitive psychology. A self-report measure of attention capacity was developed based on Petersen and Posner's (2012) cognitive psychology conceptualization of the three attention networks. The 12-item Workplace Attention Trifactor Scale captured self-reports of alerting, overt orienting, and executive control of attention. The alerting network referred to attentional capacities at work that had to do with general wakefulness and preparedness to react to stimulus. The overt orienting network referred to attentional capacities at work that had to do with physical alignment of attention to the source of the stimulus. The executive control network referred to attentional capacities at work that had to do with resolving conflicting stimuli that competed for attention (i.e., switching or focusing attention to the more important stimulus or the correct stimulus). Item development was informed by the definitions of the content domains and also by Reason's (1990) work on attention slips and lapses. The Workplace Attention Trifactor Scale showed good construct validity; scores on the measure were indirectly associated with reports of incidents and injuries through work-related cognitive failures of attention. The measurement also showed good test-retest reliability over three months, which implied that the measure tapped into attentional capacities that were trait-like.

When the Workplace Attention Trifactor Scale was compared to the performance on the Attention Network Test, scores on the self-report and the reaction times on the cognitive task did not significantly correlate, which suggested that the aspects of attention that the self-reported Workplace Attention Trifactor Scale captured were not the same as what was measured by the Attention Network Test. In predicting informants reports of attention and safety performance, the self-reported measure was a better predictor than the cognitive task, although the effects varied across different attentional domains. Alerting attention was a significant predictor of informant-reported alerting while alerting performance on the Attention Network Test was not. Executive control attention self-reported and on the tasks were both significant predictor of informant-reported executive control, however the relationship between task performance and informant-ratings were counterintuitive; longer reaction times were rated to have better executive control of attention. It may be because the longer the time spent on deliberating conflicting and distracting information did not necessarily mean less executive control capacity. Most importantly, self-reported alerting, orienting, and executive control predicted informant-reported safety compliance and participation rather than performance on the Attention Network Test. Self-reported executive control was the predictor that was consistently better at predicting safety performances above and beyond reaction times and error rates on the Attention Network Test.

Contributions of current research: Theory and practice

The series of four studies in this dissertation contributed to the research of assessing attention at work and understanding how attention impacts workplace safety in three main ways. First, it determined that individuals were aware that they have three different types of attention at work. Second, these attentional capacities were perceived to be different from performance-based measurement of attention. Last, these attentional capacities were demonstrated to be linked to safety outcomes such as incidents, injuries, safety compliance, and safety participation.

Three types of work-related attention. This dissertation corroborated past studies of attention and occupation safety with the cognitive understanding of different types of attention. The research on sustained attention (Robertson et al., 1997), selective attention (Gopher & Kahneman, 1971), and attention switching are comparable to the alerting, orienting, and executive control networks of attention (Petersen & Posner, 2012). Furthermore, the cognitive understanding of these networks is that they are functionally distinct, meaning that the capacity for sustained attention, selective attention, and attention switching may be enhance or depleted by different factors at work (Petersen & Posner, 2012). For example, the test-retest reliability of the self-reported scores of the Workplace Attention Trifactor Scale indicated that while all three attention networks appeared to be stable over a period of three months, the overt orienting domain was the most stable, then alerting, and finally executive control (although the reliabilities were not different on a significance level). This implied that individuals perceived their ability to filter out conflicting cues to be more likely to change over time compared to their vigilance and focal responsiveness. On a daily level, the data from the Attention Network Test suggested that the performance-based executive control of attention is the most stable over the course of the day, with alerting and orienting abilities changing as the day goes on (Fan et al., 2001; 2002).

The Workplace Attention Trifactor Scale offers a multifaceted perspective on attention compared to existing attention-related error scales (Attention-related Cognitive Errors Scale and the attention portion of the Work-related Cognitive Failure Questionnaire). Existing error scales frame their items based on slips, lapses, and mistakes, while the Workplace Attention Trifactor Scale items assess the capability to perform a work-related responsibility that requires attention. Also, knowing that there are three distinct types of attention at work can further the understanding of the attentional requirements of risky work tasks. Task analyses uncovering to what extent are these three types of attention used for certain jobs can lead to job redesign or accommodations that will help improve safety of workers by minimizing the risk of human errors.

Self-perceived attention versus cognitive performance of attention. Although based on the same theoretical framework of the three attention network (Petersen & Posner, 2012), the self-report Workplace Attention Trifactor Scale and the Attention Network Test appeared to be tapping into different types of alerting, orienting, and executive control of attention. Study 3 discussion pointed out nuance differences between the content domain definitions of the Workplace Attention Trifactor Scale, the actual items themselves, and the conditions on the Attention Network Test that could had contributed to the lack of convergent validity. The alerting items referenced general vigilance (tonic alerting), and did not reference responsiveness after a warning cue (phasic alerting). The orienting domain of the Workplace Attention Trifactor Scale assessed overt orienting behaviours such as explicit movement of the body towards stimuli of interest and not covert orienting behaviours such as internal orientation of the senses towards stimuli of interest. Executive control items concerned the ability to deal with conflicting cues on the self-report measure, even though the calculation of the efficiency of the executive control Attention Network Test involves both incongruent and congruent conditions.

As well, there are variations of the Attention Network Test that build on overcoming the limitations of the original and these variates may show convergent validity to the Workplace Attention Trifactor Scale. In the original Attention Network Test, the alerting attention portion only assesses phasic attention, rather than tonic and phasic, the type of orienting attention captured only pertains to one sense (i.e., sight) rather than multiple senses, and that the 100% validity of the spatial cue incorporates exogenous factors into the assessment of orienting effects (Ishigami & Klein, 2009). Variations of the original include the Attention Network Test-Vigilance (Roca, Castro, López-Ramón, & Lupiáñez, 2011), which has a separate calculation for tonic attention, and the Modified Attention Network Test (Callejas, Lupianez, Funes, & Tudela, 2005), which uses sound as a warning cue for visual stimuli and has spatial cues that are valid 50% of the time.

Alternatively, aside from the measurement issues, self-report and performance-based attention may be theoretically incomparable. The relative test-retest reliabilities of the three attention domains on the Workplace Attention Trifactor Scale and the Attention Network Test were different in magnitude (although not different at a significance level). The self-reported measure's most stable domain being orienting, alerting, and then executive control, and the most stable attention network on the cognitive task being executive control, orienting, and then alerting (Fan et al., 2001; 2002). Low reliability is not necessarily a psychometric issue, since it may indicate that the nature of alerting attention assessed by the Attention Network Test had high within-subject variability on a daily basis, and executive control assessed by the Workplace Attention Trifactor Scale had high within-subject variability over a longer length of time. This suggested that the Attention Network Test may be assessing state-like attentional capacities while the Workplace Attention Trifactor Scale may be assessing trait-like or state-like attentional capacities depending on the framing of the self-recall. The Workplace Attention Trifactor Scale may also be assessing individuals' metacognition rather than their true attention abilities. As a brief 12-item scale, the Workplace Attention Trifactor Scale can be used for assessing three types of work-related attention on a daily or longer term basis. In can be used to supplement or in place of the Attention Network Test when appropriate (i.e., examining metacognition, recall of attention over longer time periods). The self-reported measure can also be utilized in organizations to further workers' understanding and awareness of their three types of attention capacities, either through assessment and feedback purposes, or with training and learning.

Attention's link to safety outcomes. Although the relationships between self-reported and performance-based attention on incidents and injuries remain to be investigated, self-reported alerting attention was considered to be important for safety participation, self-reported orienting attention for safety compliance, and self-reported executive control attention for both types of safety performance outcomes. Aforementioned, the Workplace Attention Trifactor Scale may reflect metacognition, and that knowledge and awareness of one's attention capacities determines the anticipated effort of behaviours and actions, and the decision to execute them. Self-reported attention may be a better predictor of safety behaviours than performance-based attention because metacognition encapsulate an element of motivation for behaviours. The Workplace Attention Trifactor Scale, particularly the executive control attention, shows promise in predicting informant-ratings of safety performance, which would contribute to the overall safety climate at work. Furthermore, all three components of workplace attention potentially have indirect effects on incidents and injuries through human errors, although this relationship has to be tested with the correct research design (i.e., a longitudinal study).

With further development, the Workplace Attention Trifactor Scale may be used as an assessment for outcomes of interests pertaining to readiness to perform. The measure can be used to identify certain work conditions in which facilitate the three types of attention. At this stage of research, the Workplace Attention Trifactor Scale is not ethically suitable for prediction purposes, and should not be used as a screening tool during recruitment. With further development, the Workplace Attention Trifactor Scale may be turned into a screening tool for readiness to perform risky job tasks, although organizations must uphold their due diligence in accommodating workers who may score low on the measure. The Workplace Attention Trifactor Scale must never be used to assign blame during an accident investigation.

This does not rule out the notion that cognitive attentional performance is important; it just highlights the gaps in knowledge that must be addressed prior to utilizing a cognitive task such as the Attention Network Test in a field setting. The Attention Network Test is meant to be administered with full attention and effort, and the test environment is meant to be void of distraction. Therefore, the test at this stage may be too ‘pure’ of a measurement to be used in assessing practical attentional capacities or predicting behaviours in a real-life setting, which is filled with innate distractors.

Limitations

Over the course of four studies, I attempted to correct for the methodological limitations of each study in the one after it. Some of the limitations I was able to addressed (i.e., Study 2: common method bias, long timeframe of recall; Study 3: common method bias, placement of the Attention Network Test). Some of them I was not able to but I clearly explained how these limitations could had affected the results (i.e., Study 1: lack of cognitive psychology subject matter experts for q-sort, grammatical mistakes in items; Study 2: depicting mediations using cross sectional data; Study 3: distance from the participants’ eyes to the computer screen).

Several limitations from the last study, Study 4, should be considered in the interpretation of the overall findings of this dissertation. First, although studying attention as a daily state is important, using incidents and injuries as an outcome of interest in daily diary studies proved to be unfruitful since these incidents tend to be rare. Even gathering more data and recruiting more participants cannot guarantee that there would be incident and injury data to examine. Expanding the recall of injuries over a longer time period may capture more incidents, but the issue of retrospective recall would then come into consideration. Furthermore, since the Attention Network Test research suggested that the three networks may have high intra-individual variability, using a lengthier recall period may not capture the changes in attention capacities. An appropriate compromise of recall length between incidents and injuries and attention is needed.

Second, the method of calculating attention network scores using difference scores is accepted by cognitive researchers, but that does not acknowledge that it is mathematically problematic. Aside from low reliabilities (MacLeod et al., 2010), other issues with using differences scores include conceptual ambiguity, ambiguity in results, and oversimplification of the relationship between predictors and outcomes (Edwards, 1995). Differences scores assume that each condition contributes equally to the composite score, and is conceptually ambiguous because the relative contributions of the conditions are unknown (Edwards, 1994). Different scores could result in negative values, and the signs and magnitude of these negative values can be hard to interpret in relation to outcomes (Edwards, 1995). Finally, using difference scores oversimplifies a multivariate relationship into a univariate model (Edwards, 1995). Calculating attention network efficiency with difference scores is a contrast in the way self-reported composite scores are computed.

Another limitation is with the generalizability of the data from the four studies. By using snowball sampling for Study 1, 2, and 3, the sample may not be representative of the population since the survey was accessible to individuals from my personal network, and to individuals who frequently visited the volunteer section of Kijiji and the research participation section of Reddit. Also, with the inclusion of cognitive testing for Study 3 and 4, recruitment was more difficult since the investment in time had increased. The use of the Inquisit 4 Web program (Draine, 2015) allowed for web-wide recruitment and eliminated the need to come into the university laboratory spaces, however, the technicality of downloading the program might had deterred the older generation which were not as technology savvy. Finally, aside from Study 3, I chose to focus on collecting data from a non-white collar sample to increase the likelihood of significant findings since the exposure to hazards at work are presumed to be relatively high in the non-white collar group compared to the white collar group. These different forms of recruitment, study design, and inclusion criteria might have affected the generalizability of the dissertation findings outside of the current samples.

Finally, the last limitation is that the attention checks in the surveys from Study 1 and 2 filtered out inattentive responses, therefore the Workplace Attention Trifactor Scale was developed based on the ideals from attentive individuals on what workplace attention is. The factor structure might not be replicated with inattentive individuals, either due to the lack of validity in their responses, or that they might not perceive attention to be tri-factor. Using the attentive individuals for construct validity testing also narrowed the range on the responses, thus the tests of significances were more conservative than if the inattentive individuals were included as well.

Future directions

This dissertation only scratched the surface of questions to explore with the three attention networks and workplace safety. I believe the most pressing question right now is how a self-reported attention measure relates to performance on a cognitive attention test. Although only the Attention Network Test was used in the current dissertation, there are many different variation of the test being used in cognitive psychology. Future studies can compare different types of attention network tests with self-reported attention (Attention Network Test-Vigilance; Roca et al., 2011; Modified Attention Network Test; Callejas et al., 2005), or even with cognitive attention tasks other than the Attention Network Test. For example, the psychomotor vigilance test had been validated to be a good cognitive measurement of tonic alertness (Dinges & Powell, 1985). The psychomotor vigilance test is sensitive to attention deficits from sleep loss and circadian rhythm misalignment and is not susceptible to learning effects over repeated administration (Balkin et al., 2004). The test is considered to be a probed-performance fitness-for-duty test, as it probes the individual to sustain attention and respond quickly to visual or auditory stimulus (Basner & Dinges, 2011), and it would be comparable to the self-reported alerting on the Workplace Attention Trifactor Scale.

This dissertation highlights the nuance difference in framing attention-related items positively and negatively. Just as how slight framing of items can reflect different constructs (i.e., attention capacities versus attentional slips and lapses), different way of portraying cognitive performance data may reflect different aspects of attentional performance. Aside from differences in mean reaction times and total error, there are mean reaction times and total error counts within each of the six conditions (no cue, double cue, center cue, spatial cue, incongruent flankers, congruent flankers; Fan et al., 2001). Also, the worst performance rule perspective could be used as a performance outcome on the attention network test. The worst performance rule is based on the idea that the poorest performed trial on these cognitive tests is fundamentally a slip in performance and not an unintentional outlier, thus the worst reaction times is more closely related to lapses rather than the fastest or the average reaction times (Coyle, 2003). Lapses of slow responses result in the reaction times distribution to have an increase in the tail of the upper end of the distribution. Therefore, the study of attentional performance may be more appropriately captured by examining the variability in scores or looking at methods of capturing extreme scores such as fitting an ex-Gaussian function to the distribution (West, 2001). In fact, looking at variability and extreme scores is analogous to how incidents happen at work; most of the time employees are careful (mean scores), but it is due to those rare instances when they are not paying attention that incidents occur (extreme cases, variability in scores).

Now that attention is demonstrated to be important for safety behaviours, the next step is to build a nomological net and determine the important precursors to the three types of attention at work. Exploring individual daily and chronic lifestyle factors (i.e., sleep) and organizational-related factors (i.e., workload) allows for education and best practices to maintain an adequate level of attention necessary to prevent workplace incidents. Extending the nomological net of attention to predict other work-related constructs, such as creativity and productivity, can be fruitful as well.

As well, future research should determine if individuals hold accurate metacognition or self-awareness about their attention, since mental models of one's cognitive knowledge and ability may be flawed, especially if there is poor or no feedback and monitoring to build awareness (Brehmer, 1980). Individuals tend to think highly of their accuracy in abilities, even when that knowledge is not accurate (Bjork, 1999), so it is possible that the Workplace Attention Trifactor Scale is an overestimation of the self's abilities. Thus, exploring the importance of developing and maintaining an accurate mental model attention, perhaps through self-awareness (e.g., working memory training, mindfulness training, situation awareness exercises, supervisory/peer feedback) is an exciting future direction.

Conclusions

A self-reported measurement of work-related attention capacities was developed and validated in the current dissertation. The 12-item Workplace Attention Trifactor Scale was created from the conceptual integration of two streams of psychological research: James Reason's (1990) occupational safety work on human errors, and Posner and Petersen's (2012) cognitive psychology work on the three attention networks. Exploratory and confirmatory factor analyses demonstrated the Workplace Attention Trifactor Scale had three attentional domains: alerting attention referred to the vigilance and sustained wakefulness during working hours, orienting attention referred to the prompt and accurate alignment of attention to the source of the stimuli, and executive control of attention referred to adaptive resolution of conflicting or competing stimuli. The Workplace Attention Trifactor Scale showed good test-retest reliability with the orienting domain being the most stable, then alerting, and then executive control. Self-reports on the Workplace Attention Trifactor Scale was compared to performance scores on the Attention Network Test, a cognitive task that test for the efficiency of the three attention networks. The lack of convergent validity between the two forms of measurement suggested that the two measurements were capturing different aspects of attention; the cognitive task may be tapping into 'true' attentional capacities while the self-reported measure may be tapping into metacognition, the knowledge and awareness of ones' attentional capacities. In a field setting, scores the Workplace Attention Trifactor Scale (particularly executive control), rather than the performance on the Attention Network Test, were predictive of informant-reported safety compliance and participation. The three types of self-reported attention had indirect relationships with incidents and injuries through work-related cognitive failures of attention. The possibilities for occupational safety research and practice is promising.

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Appendix A
Q-sort Instructions

Developing a Workplace Inattention Scale Study (REB 15-329)

Hi everyone! Thanks in advance for participating in the Q-sort for my dissertation project. I am working on developing a scale for attention in the workplace based on Posner's theorization of the three attentional networks. Here is the definition of the three networks as my content domains:

Alerting network:
Attentional capacities at work that has to do with general wakefulness and preparedness to react to stimulus.

Orienting network:
Attentional capacities at work that has to do with aligning your attention the the source of the stimulus and filtering out irrelevant *details. This can be physical (e.g., moving your eyes) or mental (e.g., focusing on someone's voice while ignoring other chatter in the background).

Executive control network:
Attentional capacities at work that has to do with resolving conflicting* stimuli that are competing for your attention. This involves switching or focusing attention to the more important stimulus or the correct stimulus.

*Just a note, "irrelevant" and "conflicting" have different meanings. Irrelevant stimulus are unrelated to your primary task at hand, while conflicting stimulus may be related but are not the most adaptive.

	Networks			
	Alerting	Orienting	Executive control	Comments:
I found myself looking in the wrong direction when my name was called				
I was able to focus on work despite distractions				
I remained vigilant at work				

I responded quickly when my name was called				
I was able to multitask effectively at work				
I was overwhelmed when I had to multitask at work				
I was able to prioritize the work tasks that required my immediate attention				
I found it hard to stay alert at the end of my work shift				
I was caught off-guard by surprises at work				
I was easily flustered by conflicting details at work				
I went with my immediate instinct when confronted with choices				
I maintained focus on my work tasks				
I got confused with irrelevant details at work				
It took a lot of effort to capture my attention at work				
I reacted promptly when things at work come up unexpectedly				
I found it difficult to work through interruptions				
I was aware of the things that went on in my working environment				
I was easily confused by conflicting details at work				

I was easily overwhelmed by conflicting details at work				
I disregarded things irrelevant to my work				
I did not feel present at work				
I was able to sustained my attention over long work tasks				
I fixated on irrelevant details at work				
My ears were quick to pick up on noises that required my attention				
I found myself zoning out at work				
I identified misleading details at work				
I worked through confusing task effectively				
I was slow to react to unexpected things at work				
I had difficulty maintaining my vigilance at work				
I was able to switch between work tasks effectively				
I maintain attention on my work responsibilities				
I found myself fixated on minor work tasks				
I behaved impulsively at work when confronted with choices				

I had difficulty focusing on my work tasks				
I noticed important details in my work environment				
I switched attention effectively from one task to another				
I had difficulty switching my attention from one task to another at work				
I stayed alert during work				
I was easily distracted from my job at hand				
I overlooked important details in my work tasks				
I was affected by interruptions in the workplace				
I missed important details that should have been brought to my attention				
I was slow to react to things that required my attention at work				
I was quick to respond to important work-related details				
I handle conflicting details effectively at work				
I was able to ignore distractions at work				
I got confused when working on things that required my attention				
I filtered out irrelevant information at work				

I had difficulty controlling my attention at work				
I was overwhelmed with irrelevant details at work				
My eyes were quick to pick up on details in my working environment				
When someone called my name, I directed my attention to them				
My working environment was a blur to me				
I was easily frustrated by conflicting details at work				
I worked without being affected by interruptions				
I stayed attentive at work				
I was able to focus on work despite interruptions				
I turn my head towards where my attention is expected				
I was aware of my surroundings at work				
I felt like there was too much going on in my working environment				

Appendix B
Study 1 Online Advertisement

Developing a Workplace Inattention Scale Study (REB 15-329)

Conscientiousness is the best personality precursor to successful job performance. Are you curious to know where you stand on that trait as well as other traits of your personality? Would you like to contribute to psychological research? Would you like the chance to win a $50 VISA gift card?

I am a Ph.D. student researcher at Saint Mary's University, Halifax, Canada. For my dissertation, I am developing a measure of inattention at work. We are seeking participants who are 19 or older, currently employed in an organization for at least 3 months, and are working in a **non white-collar position** ('white collar' refers to workers who perform professional, managerial, or administrative work, typically in an office or cubicle).

In exchange for your full completion of my survey, you will receive instant personalized feedback in the survey on your basic five aspects of personality (conscientiousness, agreeableness, openness to experience, neuroticism, and extraversion), evidence-based tips for increasing your conscientiousness, and a draw token for a $50 VISA gift card. The survey will take around 15-20 minutes to complete. Your participation is voluntary, and your responses will be anonymous and confidential. Your personality report will be only shared with you.

If interested, please click on the link to take you to online study and the informed consent form. If you have any questions about the study, please contact the principal investigator Jennifer Wong at jhkwong2@gmail.com

Survey Link: https://smuniversity.qualtrics.com/SE/?SID=SV_bf6SjzTQxEGh97T

All research involving human participants have been approved by the Saint Mary's University Research Ethics Board (REB 15-329).

Appendix C
Study 1 Qualtrics Questionnaire

Age:

Gender: Male Female

Ethnicity:
- Caucasian
- African-American
- Hispanic
- Middle Eastern
- First Nation
- Asian and Pacific Islander
- South/Southeast Asian
- Other — Specify: ________________

Highest level of completed education:
- Less than grade 12
- Grade 12
- College
- Bachelor
- Master or Professional Degree
- Doctoral

Is your job position considered to be:
- White collar (relating to the work done or the people who work in an office, for example, lawyer)
- Blue collar (relating to manual work or workers, particularly in industry, for example, plumber)
- Grey collar (refer to occupations that incorporate some of the elements of both blue- and white-collar, for example, farming, fishing, forestry, engineering)
- Pink collar (relating to work traditionally associated with women or the service industry, for example, flight attendant, nurse, hairdresser)

What job industry do you work in?

What is your job title?

How long have you been working in this position in the industry?

Have you received occupational safety training at your job? If yes, please specify:

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to your day-to-day work performance in the past three months by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
I was aware of my surroundings at work	1	2	3	4	5
I was quick to respond to important work-related details	1	2	3	4	5
I reacted promptly when things at work came up unexpectedly	1	2	3	4	5
I responded quickly when my name was called	1	2	3	4	5
When someone called my name, I directed my attention to them	1	2	3	4	5
I turn my head towards where my attention is expected	1	2	3	4	5
My ears were quick to pick up on noises that required my attention	1	2	3	4	5
My eyes were quick to pick up on important details in my work	1	2	3	4	5
I disregarded things irrelevant to my work	1	2	3	4	5

I filtered out irrelevant information at work	1	2	3	4	5
I noticed important details in my work environment	1	2	3	4	5
I maintained attention on my work responsibilities	1	2	3	4	5
I remained vigilant at work	1	2	3	4	5
I maintained focus on my work tasks	1	2	3	4	5
I stayed attentive at work	1	2	3	4	5
I stayed alert during work	1	2	3	4	5
I was able to sustain my attention over long work tasks	1	2	3	4	5
I was aware of the things that went on in my working environment	1	2	3	4	5
I identified misguiding information at work	1	2	3	4	5
I identified misleading details at work	1	2	3	4	5
I was able to multitask effectively at work	1	2	3	4	5

I was able to focus on work despite interruptions	1	2	3	4	5
I switched attention effectively from one task to another	1	2	3	4	5
I was able to switch between work tasks effectively	1	2	3	4	5
I handled conflicting details effectively at work	1	2	3	4	5
I was able to focus on work despite distractions	1	2	3	4	5
I worked through confusing tasks effectively	1	2	3	4	5
I was able to prioritize the work tasks that required my immediate attention	1	2	3	4	5
I worked without being affected by interruptions	1	2	3	4	5
I was able to ignore distractions at work	1	2	3	4	5

Work-related Cognitive Failure Questionnaire (Wallace & Chen, 2005)

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things happened to you in the past three months at work. Please select the appropriate number.

	Very often	Quite often	Occasion - ally	Very rarely	Never
Failed to notice postings or notices on the facilities bulletin board(s) or e-mail system.	5	4	3	2	1
Did not fully listen to instruction.	5	4	3	2	1
Day-dreamed when you ought to be listening to somebody.	5	4	3	2	1
Did not focus your full attention on work activities.	5	4	3	2	1
Were easily distracted by co-workers.	5	4	3	2	1

Attention-related Cognitive Errors Scale (Cheyne, Carriere, & Smilek, 2006)

Please rate the frequency to which the following sentence relates to your day-to-day activity in the past three months by selecting the appropriate number.

	Very often	Quite often	Occasion - ally	Very rarely	Never
I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge).	5	4	3	2	1
When reading I find that I have read several paragraphs without being able to recall what I read.	5	4	3	2	1

I have misplaced frequently used objects, such as keys, pens, glasses, etc.	5	4	3	2	1
I have found myself wearing mismatched socks or other apparel.	5	4	3	2	1
I have gone into a room to get something, got distracted, and left without what I went there for.	5	4	3	2	1
I fail to see what I am looking for even though I am looking right at it.	5	4	3	2	1
I begin one task and get distracted into doing something else.	5	4	3	2	1
I have absent-mindedly mixed up targets of my action (e.g., pouring or putting something into the wrong container).	5	4	3	2	1
I make mistakes because I am doing one thing and thinking about another.	5	4	3	2	1
I have gone to the fridge to get one thing (e.g., milk) and taken something else (e.g., juice).	5	4	3	2	1
I have to go back to check whether I have done something or not (e.g., turning out lights, locking doors).	5	4	3	2	1
I go into a room to do one thing (e.g., brush my teeth) and end up doing something else (e.g., brush my hair).	5	4	3	2	1

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents you have caused in the past three months that delayed operations at work.

Please indicate how many workplace major incidents you have caused in the past three months that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries you have experienced yourself/caused to others in the past three months that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries you have experienced yourself/caused to others in the past three months that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about your safety performance at work. Please rate the extent that you agree with the statements about your safety performance **in the past three months.**

	Very often	Quite often	Occasion - ally	Very rarely	Never
I promote the safety program within the organization	5	4	3	2	1
I put in extra effort to improve the safety of the workplace	5	4	3	2	1
I help my co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
I voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
I use all the necessary safety equipment to do my job	5	4	3	2	1

I use the correct safety procedures for carrying out my job	5	4	3	2	1
I ensure the highest levels of safety when I carry out my job	5	4	3	2	1
I carry out my work in a safe manner	5	4	3	2	1

Appendix D
Study 2 Qualtrics Questionnaire

Age:

Gender: Male Female

Ethnicity:

- Caucasian
- African-American
- Hispanic
- Middle Eastern
- First Nation
- Asian and Pacific Islander
- South/Southeast Asian
- Other — Specify: ________________

Highest level of completed education:

- Less than grade 12
- Grade 12
- College
- Bachelor
- Master or Professional Degree
- Doctoral

Is your job position considered to be:

- White collar (relating to the work done or the people who work in an office, for example, lawyer)
- Blue collar (relating to manual work or workers, particularly in industry, for example, plumber)
- Grey collar (refer to occupations that incorporate some of the elements of both blue- and white-collar, for example, farming, fishing, forestry, engineering)
- Pink collar (relating to work traditionally associated with women or the service industry, for example, flight attendant, nurse, hairdresser)

What job industry do you work in?

What is your job title?

How long have you been working in this position in the industry?

Have you received occupational safety training at your job? If yes, please specify:

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to your day-to-day work performance in the past three months by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
I was able to sustain my attention over long work tasks	1	2	3	4	5
I maintained attention on my work responsibilities	1	2	3	4	5
I remained vigilant at work	1	2	3	4	5
I stayed attentive at work	1	2	3	4	5
My ears were quick to pick up on noises that required my attention	1	2	3	4	5
I responded quickly when my name was called	1	2	3	4	5
My eyes were quick to pick up on important details in my work	1	2	3	4	5
I turn my head towards where my attention is expected	1	2	3	4	5
I worked through confusing tasks effectively	1	2	3	4	5

I handled conflicting details effectively at work	1	2	3	4	5
I was able to multitask effectively at work	1	2	3	4	5
I was able to prioritize the work tasks that required my immediate attention	1	2	3	4	5

Work-related Cognitive Failure Questionnaire (Wallace & Chen, 2005)

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things happened to you in the past three months at work. Please select the appropriate number.

	Very often	Quite often	Occasion - ally	Very rarely	Never
Failed to notice postings or notices on the facilities bulletin board(s) or e-mail system.	5	4	3	2	1
Did not fully listen to instruction.	5	4	3	2	1
Day-dreamed when you ought to be listening to somebody.	5	4	3	2	1
Did not focus your full attention on work activities.	5	4	3	2	1
Were easily distracted by co-workers.	5	4	3	2	1

Attention-related Cognitive Errors Scale (Cheyne, Carriere, & Smilek, 2006)

Please rate the frequency to which the following sentence relates to your day-to-day activity in the past three months by selecting the appropriate number.

	Very often	Quite often	Occasion - ally	Very rarely	Never
I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge).	5	4	3	2	1
When reading I find that I have read several paragraphs without being able to recall what I read.	5	4	3	2	1
I have misplaced frequently used objects, such as keys, pens, glasses, etc.	5	4	3	2	1
I have found myself wearing mismatched socks or other apparel.	5	4	3	2	1
I have gone into a room to get something, got distracted, and left without what I went there for.	5	4	3	2	1
I fail to see what I am looking for even though I am looking right at it.	5	4	3	2	1
I begin one task and get distracted into doing something else.	5	4	3	2	1
I have absent-mindedly mixed up targets of my action (e.g., pouring or putting something into the wrong container).	5	4	3	2	1

I make mistakes because I am doing one thing and thinking about another.	5	4	3	2	1
I have gone to the fridge to get one thing (e.g., milk) and taken something else (e.g., juice).	5	4	3	2	1
I have to go back to check whether I have done something or not (e.g., turning out lights, locking doors).	5	4	3	2	1
I go into a room to do one thing (e.g., brush my teeth) and end up doing something else (e.g., brush my hair).	5	4	3	2	1

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents you have caused in the past three months that delayed operations at work.

Please indicate how many workplace major incidents you have caused in the past three months that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries you have experienced yourself/caused to others in the past three months that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries you have experienced yourself/caused to others in the past three months that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about your safety performance at work. Please rate the extent that you agree with the statements about your safety performance in the past three months.

	Very often	Quite often	Occasion - ally	Very rarely	Never
I promote the safety program within the organization	5	4	3	2	1
I put in extra effort to improve the safety of the workplace	5	4	3	2	1
I help my co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
I voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
I use all the necessary safety equipment to do my job	5	4	3	2	1
I use the correct safety procedures for carrying out my job	5	4	3	2	1
I ensure the highest levels of safety when I carry out my job	5	4	3	2	1
I carry out my work in a safe manner	5	4	3	2	1

Appendix E
Study 3 Email Recruitment Script (Test-retest Reliability)

Hello,

Thank you for participating in the
survey *Developing the Workplace Inattention Scale* (SMU REB# 15-329) in December 2015. Unfortunately you did not win the draw but I want to thank you again for participating in my study. It has been an important contribution to my dissertation.

I am now conducting a follow-up study looking at how stable workplace attentional capacities are over time. I am looking for volunteers who participated in the first study to provide a bit more data and fill out an online survey. The survey takes about 15 minutes and in return for your response **you will receive a draw token for another $50 VISA draw**.

Please respond to this email if you are interested in participating in the follow-up study so I can send you the survey link.

Thank you again for helping out my doctoral research!

Jennifer Wong, M.Sc.
Ph.D. Candidate
Industrial-Organizational Psychology

Saint Mary's University
Halifax, Nova Scotia, Canada

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CERTIFICATION

The Saint Mary's University Research Ethics Board has approved this research. If you have any questions or concerns about ethical matters or would like to discuss your rights as a research participant, you may contact the Chair of the Research Ethics Board at ethics@smu.ca or (902) 420-5728.

Appendix F
Study 3 Qualtrics Questionnaire (Test-retest Reliability)

Have you switched jobs since the last time you taken this survey?

IF NO ↓

IF YES:

What job industry do you work in?

What is your job title?

How long have you been working in this new position in the industry?

Is your job position considered to be:
- White collar (relating to the work done or the people who work in an office, for example, lawyer)
- Blue collar (relating to manual work or workers, particularly in industry, for example, plumber)
- Grey collar (refer to occupations that incorporate some of the elements of both blue- and white-collar, for example, farming, fishing, forestry, engineering)
- Pink collar (relating to work traditionally associated with women or the service industry, for example, flight attendant, nurse, hairdresser)

Have you received new occupational safety training at your job? If yes, please specify:

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to your day-to-day work performance in the past three months by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
I was able to sustain my attention over long work tasks	1	2	3	4	5
I maintained attention on my work responsibilities	1	2	3	4	5

I remained vigilant at work	1	2	3	4	5
I stayed attentive at work	1	2	3	4	5
My ears were quick to pick up on noises that required my attention	1	2	3	4	5
I responded quickly when my name was called	1	2	3	4	5
My eyes were quick to pick up on important details in my work	1	2	3	4	5
I turn my head towards where my attention is expected	1	2	3	4	5
I worked through confusing tasks effectively	1	2	3	4	5
I handled conflicting details effectively at work	1	2	3	4	5
I was able to multitask effectively at work	1	2	3	4	5
I was able to prioritize the work tasks that required my immediate attention	1	2	3	4	5

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents you have caused in the past three months that delayed operations at work.

Please indicate how many workplace major incidents you have caused in the past three months that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries you have experienced yourself/caused to others in the past three months that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries you have experienced yourself/caused to others in the past three months that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about your safety performance at work. Please rate the extent that you agree with the statements about your safety performance in the past three months.

	Very often	Quite often	Occasion - ally	Very rarely	Never
I promote the safety program within the organization	5	4	3	2	1
I put in extra effort to improve the safety of the workplace	5	4	3	2	1
I help my co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
I voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
I use all the necessary safety equipment to do my job	5	4	3	2	1
I use the correct safety procedures for carrying out my job	5	4	3	2	1

I ensure the highest levels of safety when I carry out my job	5	4	3	2	1
I carry out my work in a safe manner	5	4	3	2	1

Appendix G
Study 3 Advertisement Ad (Convergent Validity)

Cognitive Attention and Safety Performance Study (REB 16-029)

I am a Ph.D. student researcher at Saint Mary's University, Halifax, Canada studying occupational health psychology. I developed a self-report measure of inattention at work for my dissertation. Currently, I am seeking participants to help comparing my self-reported measure with a cognitive attention task. I am looking for individuals who are:

• 19 or older
• currently employed
• have access to a computer (desktop or laptop). This is a requirement for downloading the cognitive tasks

In exchange for your full completion of my survey, you have the option to receive personalized feedback on your awareness of your attentional capacity (a comparison of your self-reported scores and your cognitive performance) and a draw token for a $100 VISA gift card. The study will take around 45 minutes to complete. Your participation is voluntary, and your responses will be anonymous and confidential. Your feedback report will be only shared with you. If interested, please click on the link to take you to online study and the informed consent form.

Survey Link (https://smuniversity.qualtrics.com/SE/?SID=SV_72IKhAF0akRAjZP)

All research involving human participants have been approved by the Saint Mary's University Research Ethics Board (REB 16-029). If you have any questions about the study, please contact the principal investigator Jennifer Wong at jhkwong2@gmail.com

Appendix H
Study 3 Qualtrics Questionnaire (Convergent Validity)

Age:

Gender: Male Female

Ethnicity:

- Caucasian
- African-American
- Hispanic
- Middle Eastern
- First Nation
- Asian and Pacific Islander
- South/Southeast Asian
- Other — Specify: ________________

Highest level of completed education:

- Less than grade 12
- Grade 12
- College
- Bachelor
- Master or Professional Degree
- Doctoral

Is your job position considered to be:

- White collar (relating to the work done or the people who work in an office, for example, lawyer)
- Blue collar (relating to manual work or workers, particularly in industry, for example, plumber)
- Grey collar (refer to occupations that incorporate some of the elements of both blue- and white-collar, for example, farming, fishing, forestry, engineering)
- Pink collar (relating to work traditionally associated with women or the service industry, for example, flight attendant, nurse, hairdresser)

What job industry do you work in?

What is your job title?

How long have you been working in this position in the industry?

Have you received occupational safety training at your job? If yes, please specify:

The following sections you need to complete at the end of a work day, since these questions and tasks are meant to assess your state after work. Please bookmark this page until you are ready to continue. Using the same computer will ensure you to be at the same spot in the study.

What type of work shift did you work today?
- Morning
- Afternoon
- Evening
- Overnight

How long has it been since the end of your shift today?

Create a personalized ID to be used to identify your performance on the cognitive tests
Last 2 letters of your last name
Last 2 digits of your year of birth
Last 2 letters of your mother's maiden name

Click on the following link to go the cognitive testing. Please follow the instructions for downloading the cognitive tasks. Use this personalized ID when the program prompts for your ID.

http://research.millisecond.com/jhkwong2/batchJuly.web

Once you are done the cognitive portion of the study, it will direct you back to this page. Click next to continue with the study.

DIRECTED TO MILLISECOND WEBSITE TO DOWNLOAD INQUISIT 4 WEB AND THEN BACK TO QUALTRICS

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to your day-to-day work performance today by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
I was able to sustain my attention over long work tasks	1	2	3	4	5

I maintained attention on my work responsibilities	1	2	3	4	5
I remained vigilant at work	1	2	3	4	5
I stayed attentive at work	1	2	3	4	5
My ears were quick to pick up on noises that required my attention	1	2	3	4	5
I responded quickly when my name was called	1	2	3	4	5
My eyes were quick to pick up on important details in my work	1	2	3	4	5
I turn my head towards where my attention is expected	1	2	3	4	5
I worked through confusing tasks effectively	1	2	3	4	5
I handled conflicting details effectively at work	1	2	3	4	5
I was able to multitask effectively at work	1	2	3	4	5
I was able to prioritize the work tasks that required my immediate attention	1	2	3	4	5

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents you have caused today that delayed operations at work.

Please indicate how many workplace major incidents you have caused today that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries you have experienced yourself/caused to others today that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries you have experienced yourself/caused to others today that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about your safety performance at work. Please rate the extent that you agree with the statements about your safety performance today.

	Very often	Quite often	Occasion - ally	Very rarely	Never
I promote the safety program within the organization	5	4	3	2	1
I put in extra effort to improve the safety of the workplace	5	4	3	2	1
I help my co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
I voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
I use all the necessary safety equipment to do my job	5	4	3	2	1

I use the correct safety procedures for carrying out my job	5	4	3	2	1
I ensure the highest levels of safety when I carry out my job	5	4	3	2	1
I carry out my work in a safe manner	5	4	3	2	1

Appendix I
Study 4 Qualtrics Demographics Questionnaire

Age:

Gender: Male Female

Ethnicity:

- Caucasian
- African-American
- Hispanic
- Middle Eastern
- First Nation
- Asian and Pacific Islander
- South/Southeast Asian
- Other — Specify: ________________

Highest level of completed education:

- Less than grade 12
- Grade 12
- College
- Bachelor
- Master or Professional Degree
- Doctoral

What job industry do you work in?

What is your job title?

How long have you been working in this position in the industry?

Have you received occupational safety training at your job? If yes, please specify:

Appendix J
Study 4 Qualtrics Daily Questionnaire

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to your work performance today by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
I was able to sustain my attention over long work tasks	1	2	3	4	5
I maintained attention on my work responsibilities	1	2	3	4	5
I remained vigilant at work	1	2	3	4	5
I stayed attentive at work	1	2	3	4	5
My ears were quick to pick up on noises that required my attention	1	2	3	4	5
I responded quickly when my name was called	1	2	3	4	5
My eyes were quick to pick up on important details in my work	1	2	3	4	5
I turn my head towards where my attention is expected	1	2	3	4	5
I worked through confusing tasks effectively	1	2	3	4	5

I handled conflicting details effectively at work	1	2	3	4	5
I was able to multitask effectively at work	1	2	3	4	5
I was able to prioritize the work tasks that required my immediate attention	1	2	3	4	5

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents you have caused today that delayed operations at work.

Please indicate how many workplace major incidents you have caused today that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries you have experienced yourself/caused to others today that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries you have experienced yourself/caused to others today that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about your safety performance at work. Please rate the extent that you agree with the statements about your safety performance today.

	Very often	Quite often	Occasion-ally	Very rarely	Ne ver
I promote the safety program within the organization	5	4	3	2	1
I put in extra effort to improve the safety of the workplace	5	4	3	2	1

I help my co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
I voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
I use all the necessary safety equipment to do my job	5	4	3	2	1
I use the correct safety procedures for carrying out my job	5	4	3	2	1
I ensure the highest levels of safety when I carry out my job	5	4	3	2	1
I carry out my work in a safe manner	5	4	3	2	1

Appendix K
Study 4 Qualtrics Daily Informant Questionnaire

Workplace Attention Trifactor Scale (Wong & Kelloway, 2016)

Please rate the frequency to which the following sentence relates to [PARTICIPANT'S NAME] work performance today by selecting the appropriate number.

	Never	Rarely	Sometimes	Often	All the times
He/she was able to sustain his/her attention over long work tasks	1	2	3	4	5
He/she maintained attention on his/her work responsibilities	1	2	3	4	5
He/she remained vigilant at work	1	2	3	4	5
He/she stayed attentive at work	1	2	3	4	5
His/her ears were quick to pick up on noises that required his/her attention	1	2	3	4	5
He/she responded quickly when his/her name was called	1	2	3	4	5
His/her eyes were quick to pick up on important details in his/her work	1	2	3	4	5
He/she turn his/her head towards where his/her attention is expected	1	2	3	4	5

He/she worked through confusing tasks effectively	1	2	3	4	5
He/she handled conflicting details effectively at work	1	2	3	4	5
He/she was able to multitask effectively at work	1	2	3	4	5
He/she was able to prioritize the work tasks that required his/her immediate attention	1	2	3	4	5

Minor and major incidents and injuries (Wallace & Vodanovich, 2003)

Please indicate how many workplace minor incidents he/she caused today that delayed operations at work.

Please indicate how many workplace major incidents he/she caused today that halted operations at work (e.g., damaged work equipment).

Please indicate how many workplace minor injuries he/she caused to others today that did not require medical attention beyond first aid (e.g., cuts, bruises).

Please indicate how many workplace major injuries he/she caused to others today that require medical attention beyond first aid.

Safety compliance and participation (Neal, Griffin, & Hart, 2000)

Below are statements about [PARTICIPANT'S NAME] safety performance at work. Please rate the extent that you agree with the statements about his/her safety performance today.

	Very often	Quite often	Occasion - ally	Very rarely	Never
He/she promote the safety program within the organization	5	4	3	2	1
He/she put in extra effort to improve the safety of the workplace	5	4	3	2	1
He/she help his/her co-workers when they are working under risky or hazardous conditions	5	4	3	2	1
He/she voluntarily carry out tasks or activities that help to improve workplace safety	5	4	3	2	1
He/she use all the necessary safety equipment to do his/her job	5	4	3	2	1
He/she use the correct safety procedures for carrying out his/her job	5	4	3	2	1
He/she ensure the highest levels of safety when he/she carry out his/her job	5	4	3	2	1
He/she carry out his/her work in a safe manner	5	4	3	2	1