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THE INFLUENCE OF SATISFACTION WITH THE PHYSICAL WORK ENVIRONMENT ON SAFE WORK BEHAVIOUR AND COGNITIVE FAILURE

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Research article

Abstract: This research looked at workers' satisfaction with the work environment, cognitive failures and safe work behaviour. Results indicated that safe work behaviour was positively related to workers' satisfaction with their physical work environment and negatively related to cognitive failures. There was also a negative relationship between satisfaction with the physical work environment and cognitive failures. This paper contributes to a further understanding of how organisations can enhance safe work behaviour with a view to reducing occupational injuries and safety-related incidents by understanding the influence that satisfaction with the physical work environment has on workers.

Keywords: Mindfulness; physical work environment; human factors; safe work; cognitive failures.

Introduction

Industrial psychology's early beginnings in the 1920's were predominately "related to the study of boredom, fatigue … and the best uses of the human as a machine and focused on the study of what environmental conditions enables this machine to operate most efficaciously" (Herzberg, 1968). The Hawthorne studies (1924-1932) indeed probed the "effects of change in the physical environment on the human machine" (Herzber, 1968). Research examining how the physical work environment contributes to human work behaviour is still evolving. Today human factors practitioners continue to examine the role of the work environment with expanded understandings, particularly around human error and organisational influences on safe work behaviour.

Since those earlier times, a whole realm of research and indeed occupations have developed with the focus on addressing the person and environment interactions including Organisational Psychology, Human Factors and Environmental Psychology all of which are interested in how humans interact and relate to their environment. More recently behavioural based safety programs have acknowledged the role that certain operational and environmental conditions have in influencing psychological states within humans and their corresponding behaviours (Geller, 2001; Yeow and Goomas, 2014; Jasiulewicz-Kaczmarek, et al., 2015).

Given that a great number of the population spend a significant amount of their waking hours at work it is of interest to continue to conduct and report on applied research around understanding how the physical work environment either assists or prohibits individual mental functioning. Increases in the examination of safety occurrence contributing factors have highlighted the requirement for organisational involvement and commitment towards improving work environments with a view to creating both safer workplaces and work process improvements (Limborg, 2001; Hedlund et al., 2016).

The understanding by the modern socio-technical theory that people are a requirement within the work environment for their discretionary and decision-making abilities continues to drive understanding of safety performance to another level (Hollnagel, 2014a). This level includes the acceptance that the workplace and its related human factors can either enhance or reduce one's cognitive functioning and that this functioning can subsequently enhance or reduce individual safety behaviour.

Materials and methods

Various industry workers were recruited through contacts at their workplaces and came from both the Gold Coast and northern New South Wales areas in Australia for this study. This research was part of a larger study by this author into individual Mindfulness and Workplace Safety and the study

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was conducted under an ethics approval program approved by the University of South Australia, Human Research Ethics Committee. Subjects were advised of the rationale for the research and all signed a consent form prior to taking part. Participants were predominately tradespeople (49%) with the balance being managers (25%), professionals (11%), clerks (11%) and para-professionals (4%). There were 58 males and 32 females, with ages ranging from 15 to 61+ years with the majority of participants reporting that they were between 41-50 years (28%). A total of 90 surveys (N = 90) were included for statistical analysis with 2 surveys having a large number of questions not completed and removed from the study.

All participants completed a package of self report measures and a bio-data questionnaire which asked them to indicate gender, age bracket, type of employment, type of industry and occupational group.

The Physical Work Environment

The environment in which one works has long been recognised as having an impact on work performance and work behaviours with numerous studies in social and environmental psychology examining the role that the physical workplace environment has on the behaviour and attitude of individuals (Oldham and Fried, 1987).

Genaidy and Karwowski (2003) have proposed that there are both work demands (draining energy) and work energises (giving energy) within a work environment. Enabling an understanding of how different elements and facets of the physical work environment impacts on individual performance has been the development of various measures.

One of the most widely used measures for this purpose is the Physical Work Environment Satisfaction Questionnaire (PWESQ) and empirical research using this measure has enabled many distinctions to be drawn. The PWESQ is used for gaining a detailed understanding of the effects of the physical work environment and measures satisfaction on five distinct factors being (1) Environmental Design, (2) Facilities, (3) Work Organisation, (4) Equipment and Tools and (5) Health and Safety. The survey has been closely related to job satisfaction, organisational commitment and intent to turnover (Verhaegen, 1979, Carlopio, 1996). Carlopio (1986) suggests that if lower order hygiene factors at work are not provided task performance will also be affected regardless of higher order motivation factors (Herzberg, 1968; Whitehill, 1976).

Cognitive Failures

Many organisations who focus on improving safety strive for both reliability in processes of cognition, as much as processes of production (Weick, Sutcliffe and Obstfeld 1999). Cognitive-based mistakes on simple tasks that a person should normally be capable of completing without error have been termed Cognitive Failures (Martin, 1983). Cognitive failures often occur under conditions of boredom, worry and divided attention (Robertson et al, 1997).

Positive associations have been found with individuals with a high rate of boredom proneness (Branton, 1970), attention deficit (Nadeau, 1995) and cognitive failures (Larson and Merritt, 1991; Wallace and Vodanovich, 2003) with the suggestion that these individuals also experience more frequent accidents (Wallace et al., 2002). The link between cognitive failures and negative safety performance, particularly workplace accidents, appears to now be well established (Allahyari et al., 2014; Wallace and Chen, 2005; Wallace and Vodanovich, 2003).

Inspired in part by James Reason's work (Cheyne et al., 2006) the Cognitive Failures Questionnaire (Broadbent et al., 1982) was developed and is used to assess a person's likelihood of committing an error (Wallace et al., 2002). There is some empirical evidence that the questionnaire is related to a behavioural measure of sustained attention (Robertson et al, 1997; Smallwood et al., 2004) and correlates with overt behavioural measures of attention (Robertson et al., 1997; Tipper and Baylis, 1987).

Cognitive failures have been associated with automobile accidents (Larson et at, 1997; Larson and Merritt, 1991), aircraft piloting errors involving turning off the wrong engine and plotting the wrong course using a compass (Reason, 1977, 1997) and social traits of self-consciousness and anxiety (Houston, 1989) and the Big Five personality dispositions with a positive correlation for Neuroticism and a negative correlation with Extraversion (Klockner and Hicks, 2015).

Various research using the Cognitive Failures Questionnaire (CFQ) has now associated CFQ scores with lack of concentration and a less stable emotional pattern (Klockner and Hicks 2015; Matthews, Coyle and Craig, 1990). Cognitive failures can be defined in terms of slips of action and with lapses of attention or vigilance and the CFQ can be viewed as a self-report measure of one's tendency to both experience accidents and errors and explain multiple causes of accidents and errors (Wallace et al., 2002). Cognitive failures have been attributed

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to an inability to attend to a task (distractibility) or to errors in task execution (blunders) and other behavioural and personality traits such as boredom proneness (Kass et al., 2001) and attention deficit (Shaw and Giambra, 1993).

What has been identified is that several personal and environmental factors are strongly associated with cognitive errors. These factors include the inability to attend to a task (Distraction), errors in task execution (Blunders) and overload of short-term memory incurring memory failures and forgetfulness (Memory). Research suggests that distraction and memory failure is directly linked to poor attention and lapses of attention (Wallace et al., 2002). Human error in the work environment is often associated with cognitive fallibility from both high cognitive demands such as distraction and competition for attention to low cognitive demands including boredom, repetition and lack of encouragement to think and use one's cognitive skills.

Researchers have acknowledged that individual cognitive style is a concept which has been recognised as another variable in work performance. Findings have suggested that work environments may be responsible for forcing people to work in a way which may be less effective than it could be if differences in cognitive styles are not recognised in ways of structuring work and making demands within the work environment. (Kirton and McCarthy, 1988; Goodenough, 1985; Robertson, 1985; Robey and Taggart, 1981).

Safe Working

Within the safety research arena, the workplace environment has received significant recognition in the role that environmental factors contribute towards occupational health and safety (hazard identification, dangerous goods, housekeeping etc). Studies continue to confirm a strong correlation between accidents rates and the work environment and support the proposition that the better the situation the lower the accident rate (Varonen and Mattila, 2002). A long list of environmental and workplace conditions such as noise, heat, dust, chemicals, physical workload, tools and equipment and hazards have been directly linked to workplace injuries and illnesses (DeJoy et al., 2004; Baker et al., 1992; Levy and Wegman, 1995).

The study of a person's thoughts or cognition has also been recognised as having a considerable contribution to safety and induced accidents (Broadbent et al, 1982; Åberg and Rimmöe, 1998; Strater, 2005) and has been widely studied in relation to a variety of aspects including equipment design, situational awareness, decision making and human error. Researchers continue to examine different features of the individual with a view to understanding their safe work behaviour with these studies previously focusing on a variety of individual aspects including perceptions (James and James, 1989), work behaviour (Janicak, 1996; D'Amato and Zijlstra, 2008) risk-taking (Harrell, 1995, Zuckerman, 1971, Horvath and Zuckerman, 1993) aspect of personality (Hansen, 1989; Borofsky and Smith, 1993; Arthur and Graziano, 1996) and cognitions (Michon, 1985).

D'Amato and Zijlstra (2008) have identified that "individual characteristics of employees and the notion of cognitive regulation within situations have a prominent place and … both these aspects are determinants of work behaviour". In safety-focused research understanding individuals in their work environments is a key function for the prevention of work behaviours which result in workplace incidents.

Safety researchers have for some time now recognised that occupational accidents are no longer to be attributed to either technical (organisational) causes or person (individual causes) but are now seen as an interaction of both technical and person sequences as contributing factors within complex socio-technical systems. They also suggest however that "technical and social components of a system … interact with human thought processes and attitudes to influence outcomes" (Brown et al., 2000).

Previous studies that comprised causal prediction of safe work behaviour through mental models of safety (Brown et al., 2000; Prussia et al., 2003) and prediction of accidents and industrial mishaps through cognitive failures (Wallace and Vodanovich, 2003) were examined along with the role that satisfaction with the physical work environment plays in contributing to safety (Carlopio, 1996). Technical and social factors within the workplace have been identified as being constructs which operator through employees and ultimately influence both safety efficacy and cavalier attitudes leading to both safe and unsafe behaviour (Brown, Willis and Prussia, 2000).

The challenge for all organisations has been how to create an environment that is conducive to simultaneously maximising human potential, quality and workplace health and safety (Abdallah et al, 2004).

Hypothesis

Based on a review of the research in this area it was proposed that where an individual is satisfied with their physical work environment they will have fewer cognitive failures and therefore fewer safety incidents within that work environment. Therefore the following hypotheses were explored:

Hypothesis 1. Individual satisfaction with the physical work environment will be positively related to an individual's level of safe work behaviour.

Hypothesis 2. Individual satisfaction with the physical work environment will be negatively related to cognitive failures.

Hypothesis 3. Cognitive failures will be negatively related to an individual's safe work behaviour.

Instruments

The Cognitive Failures Questionnaire

The Cognitive Failures Questionnaire (CFQ) (Broadbent et al., 1982) assess a person's likelihood of committing an error in the completion of everyday tasks and measures the frequency of lapses in the three areas of perception, memory and motor function (Wallace et al., 2002). The 25 items are each rated on a five-point Likert scale from 0 (never) to 4 (very often). The CFQ measures four distinct factors being Memory, Distraction, Blunders and Names. An example item is "Do you daydream when you ought to be listening to something?"

The Physical Work Environment Satisfaction Questionnaire

The Physical Work Environment Satisfaction Questionnaire (PWESQ) was developed by James Carlopio in 1986 and was based on a human factors-ergonomic conceptualization and typically considers design of the physical environment (lighting, air quality and work surfaces), plant facilities (toilets, recreation and eating facilities, cleanliness and pleasantness and size), work and system characteristics (work pace and information availability), equipment design (task performance and materials) and health and safety (training, hazard exposure and control) (Carlopio, 1996). The survey is used for gaining detailed understanding of the effects of the physical work environment on attitudes and behaviour. The role that understanding the effect of the physical work environment has on task performance is emphasised as is the use of the construct for workplace health and safety improvements. The 37 questions asks participants to ranked on a five-point Likert scale from 1 (very dissatisfied) to 5 (very satisfied) how satisfied they are with their work environment. The questionnaire measures satisfaction on the five distinct factors of Environmental Design, Facilities, Work Organisation, Equipment and Tools and Health and Safety.

Safe Work Behaviour

Following on from the work on safe work behaviours and the link to workplace accidents by Brown et al. (2000) and Prussia et al. (2003) this research was also interested in looking at the perceptions and mental modes of safety behaviour from the workers point of view in relation to their safe work behaviour. Brown et al. have operationalised safe (or unsafe) work behaviour questions as a safety measure due to counts of safety incidents inclined to have relativity low occurrence (as evidenced in this study) and around certain flaws associated with definitions and perceptions of what comprises a safety incident or accident. The measure of safe work behaviour is therefore operationalised in this study by a safety behaviour question and also one question asking the number of safety incidents over the last 12 months to give both sets of information.

Participants were asked the question "About what percentage of the time do you follow safe work practices for the jobs that you do?" Possible responses ranged from 0% to 100%, in 10% increments.

Data Analysis

Analyses of individual responses were conducted using a correlation analysis between the three self-reported individual difference factors (safety behaviour, CFQ and PWESQ). Data were analysed using a standard statistical package, SPSS software.

Results and discussion

Tab. 1 shows a correlation matrix between the individual differences measures of safe work behaviour, cognitive failures and satisfaction with the physical work environment.

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Tab. 1. Correlation Matrix: Safe Work Behaviour with Cognitive Failures and Satisfaction with the Physical Work Environment (N = 90)

Individual Measures	Cognitive Failures Questionnaire					Physical Work Environment Satisfaction Questionnaire					
	MEM	DIST	BLUN	NAM	CFTOT	ENV	FAC	WKOR	EandT	HandS	PWETOT
Safe Work Behaviour	-.104	-.231**	-.241**	-.124*	-.226**	.258*	.461**	.232*	.287**	.408**	.378**

Note. Parametric 2-tailed test. MEM = memory; DIST = distraction; BLUN = blunders; NAM = names; CFTOT = cognitive failures total; ENV = environmental design; FAC = facilities; WKOR = work organisation; EandT = equipment and tools; HandS = health and safety; PWETOT = physical work environment total. **p ≤ .01; * p ≤ .05.

Tab. 2 shows a correlation matrix for the 4 factors of the Cognitive Failures Questionnaire and the 5 factors of the Physical Work Satisfaction Questionnaire.

Tab. 2. Correlation matrix: Cognitive Failures with Physical Work Environment (N = 90)

	Physical Work Environment Satisfaction Questionnaire					
Cognitive Failures Questionnaire	ENV	FAC	WKOR	EandT	HandS	PWETOT
MEM	-.321**	-.297**	-.377**	-.219**	-.316**	-.355**
DIST	-.465**	-.524**	-.524**	-.553**	-.451**	-.575**
BLUN	-.378**	-.453**	-.441**	-.375**	-.437**	-.476**
NAM	-.288*	-.260**	-.514**	-.482**	-.326**	-.415**
CFQTOT	-.456**	-494**	-.563**	-.456**	-.507**	-.566**

Note. Parametric 2-tailed test. MEM = memory; DIST = distraction; BLUN = blunders; NAM = names; CFTOT = cognitive failures total; ENV = environmental design; FAC = facilities; WKOR = work organisation; EandT = equipment and tools; HandS = health and safety; PWETOT = physical work environment total. **p ≤ .01; * p ≤ .05

Tests of Hypothesis Results

Hypothesis 1 addressed the relationship between an individual's satisfaction with the physical work environment and their safety behaviour. In support of hypothesis 1 a significant positive correlation was found between self-reported satisfaction with the physical work environment and safe work behaviours ($r = .378$, $p < 0.01$, two-tailed). Results, therefore, demonstrated that individuals who reported that they were satisfied with their work physical environment a higher percentage of the time also reported higher levels of safe work behaviour.

Supporting hypothesis 2 there was a significant negative relationship ($r = -566$, $p < 0.01$, two-tailed) between an individual's satisfaction with the physical work environment and their cognitive failures as reflected by their total scores on the PWESQ and the CFQ. Thus an individual who has a higher level of satisfaction with their physical work environment can be seen to score lower in the area of cognitive failures with all four factors of the CFQ (distraction, blunders, memory and names) being negatively related to all factors of the PWESQ (equipment design, facilities, work organisation, equipment and tools and health and safety).

Hypothesis 3 addressed the relationship between cognitive failures and safe work behaviour. In support of this hypothesis, there was a significant negative relationship ($r = -226$, $p < 0.05$, two-tailed) between an individual's cognitive failures and their safe work behaviour. Results, therefore, demonstrated that individuals who reported that they were working safely a higher percentage of the time also reported a lower level of cognitive failure. All four factors of cognitive failures (memory, distraction, blunders and names) were negatively related to safe work behaviour.

Discussion

In the safety accident/incident context, it is acknowledged that even minor disruptions in the basic cognitive processes of attention can have numerous and far-reaching consequences (Carriere et al., 2007). Widely recognised and understood is the human error role in the accidental chain of events and "it is necessary to consider the internal mental decision functions which are required in a task

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and the related internal psychological mechanisms which are involved in error" (Leplat and Rasmussen, 1984).

This research was interested in reviewing the link between the physical work environment and its impact on aspects of workplace safety. Results have demonstrated that individual's satisfaction with the physical work environment is significantly positively related to an individual's self-reported level of safe work behaviour. Safe work behaviour then can be enhanced with a focus on ensuring that aspects of the physical work environment including design of the physical environment (lighting, air quality and work surfaces), plant facilities (toilets, recreation and eating facilities, cleanliness and pleasantness and size), work and system characteristics (work pace and information availability), equipment design (task performance and materials) and health and safety (training, hazard exposure and control) are all taken into account as human factor issues in workplace health and safety efforts.

Satisfaction with the physical work environment and cognitive failures were found to be significantly negatively related, meaning that the greater the level of individual satisfaction with one's physical work environment the less cognitive failures are encountered. Cognitive functioning can, therefore, be enhanced where workers are less concerned about the work environment and feel that they can perform their work in an environment which supports their work needs.

D'Amato and Zijlstra (2008) have identified that "individual characteristics of employees and the notion of cognitive regulation within situations have a prominent place and … both these aspects are determinants of work behaviour". Cognitive failures were found to be significantly negatively related to an individual's safe work behaviour with workers reporting that their safe work behaviour is associated with having less cognitive failures in the form of the frequency of lapses of perception, memory and motor function. Overall by enhancing worker's satisfaction with their work environment safe work behaviour may be enhanced and workers may experience less cognitive issues in completing daily work tasks.

Conclusion

Human Factors practitioners are inherently interested in the interaction between people and their physical environment. The long-held view is that human work performance is enhanced where the physical work environment supports a human's social and technical needs. The safety science study presented here has attempted to provide further empirical evidence and understanding of how the physical work environment can have an impact on safe work behaviour through employee satisfaction with their work environment. It has found that higher levels of satisfaction with the physical work environment points towards lower levels of cognitive failures and can lead to enhancements in the performance of safe work behaviour.

Organisations' should, therefore, consider how the physical work environment is impacting on an individual's propensity to stay safe in the workplace and how the manifestation of cognitive failures from dissatisfaction with the physical work environment can have a role to play in safe work outcomes.

In safety-focused research, understanding individuals in their work environments is a key function for the prevention of work behaviours which result in workplace incidents. The idea continues to be supported that improvements in safety will come from understanding and enhance how people function within their environment (human factors) and recognising that things go well because people make sensible adjustments according to the demands of the everyday work as done (rather than work as imagined) as proposed by Hollnagel's (2014b) the Safety II theory.

The importance of understanding that the work environment influences an individual's actions and thoughts to either contribute to or distract from safety is undoubtedly not a new concept for most human factors practitioners. However, research which continues to explore and discuss various aspects of an individual safety-related behaviour and cognitive functioning within the work environment can only contribute to the promotion, practice and need for the human factor perspective of the work environment.

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