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Stress at work: Factors associated with cognitive disorganisation among private sector professionals

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Abstract

This study explores psychological and psychological variables associated with perceived stress at work. A total of 100 international participants consented to donating a hair sample and completing a work-related stress survey. Logistic regression was used to investigate associations with low/high cognitive disorganisation using data collected from hair cortisol analysis and self-report questionnaires. High cognitive disorganisation scores were associated with high cardiopulmonary and anger scores. Low perceived self-efficacy was associated with high cognitive disorganisation. An association was found between low cortisol and low perceived self-efficacy. The relationship between high cognitive disorganisation and low self-efficacy endorses previous claims linking performance to perceived high self-efficacy.

Keywords

cognitive processing, cortisol, experience, stress, well-being

Introduction

Over recent years, there have been increasing reports about stress and its impact on psychological and physical health. The UK Health and Safety Executive (HSE) estimates the costs to society of work-related stress to be approximately £4 billion each year and has identified six areas of work that can have a negative impact on employee health: (1) demands (workload and work environment); (2) control over work; (3) support provided by the organisation, line management and others; (4) role clarity; (5) change management and communication; and (6) relationships and conflict management (HSE, 2011).

The European Commission (2010) has reported that among professionals with work-related ill health, 'stress, depression or anxiety' is reported as the most serious health problem by 14 per cent. The European Survey of Enterprises on New and Emerging Risks (ESENER, 2010) has found that 79 per cent of European managers are concerned about stress in their workplaces. According to the Labour Force Survey (LFS) in 2016, 37 per cent of all work-related ill health cases and 45 per cent of all working days lost due to ill health were attributed to stress, with particular emphasis

placed on pressure of work and deadlines, overwhelming responsibility and a lack of managerial support.

In recent years, a number of studies have highlighted a relationship between the work environment and employee well-being (Podsakoff et al., 2007; Skakon et al., 2010). Consequences of stress and poor well-being are cited as including lost revenues caused by decreased job satisfaction, employee withdrawal and high error rate (Kerr et al., 2009). From both an employer and an employee perspective, the impact of stress is far-reaching and exacerbated by recent economic difficulties. However, while ESENER reports that over 40 per cent of European managers consider that stress is difficult to manage, less than 30 per cent of organisations in Europe have procedures for dealing with workplace stress.

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Over the last two decades, stress has been explored from different perspectives. Psychologists and social cognitive theorists have propounded self-efficacy (defined as ‘people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives’; Bandura, 1995: 2) as an important means of boosting motivation and performance (Wood et al., 1990). Bandura (1995) has also ascertained that self-efficacy improves with a positive state of mind but is lowered with despondency. Notions of self-efficacy are constructed on past experiences of performance and individual constructs of these past experiences in turn influence future expressions of self-efficacy (Bandura, 1986). Past self-efficacy studies have confirmed the need to understand the cognitive and motivational factors involved in determining success and dealing with a range of complex organisational issues (Wood and Bandura, 1989).

Much attention has also been paid to the body’s physiological response to stress. There are two separate stress pathways: (1) the sympathetic adrenal medullary (SAM) pathway which releases adrenaline and noradrenaline and (2) the hypothalamus–pituitary–adrenal (HPA) axis. The HPA axis drives the production of cortisol, a glucocorticoid hormone that facilitates catecholamine activity and serves to enable glucose metabolism, suppresses inflammatory responses and maintains homeostasis via a negative feedback loop. Chronic exposure to stress may be observed when homeostasis is altered, driving elevated cortisol levels that are not reduced via the normal negative feedback. Increased cortisol levels as a measure of hyperactivity of the HPA axis have been observed in situations of perceived inefficacy, stress and high job strain (Rydstedt et al., 2008; Steptoe et al., 2000).

Both hyperactivity and hypoactivity of the HPA axis have been observed in patient populations with psychiatric disorders such as depression and anxiety (Olf et al., 2006; Vreeburg et al., 2010) or panic disorder (De Kloet et al., 2005). Both attenuated and elevated cortisol levels may therefore be strong indicators of diminished well-being and may act as a mediator for prolonged exposure to chronic stress and cortisol secretion (Ouellet-Morin et al., 2011). Diminishing cortisol responses may suggest an adaptation of the HPA axis to stress as a protective means of preventing excessive cortisol levels from suppressing immune function (Gunnar and Vazquez, 2001; Ozeki et al., 2010; Raison and Miller, 2003). Common physical symptoms of stress have also been well documented. These include cardiopulmonary, upper respiratory, gastrointestinal disturbances and sympathetic arousal.

The cost of stress to the body’s physiology is linked to psychological and cognitive indicators of stress. Studies indicate an association between hair cortisol concentration (HCC) and stress-related disorders or psychiatric conditions and support its use as a reliable biomarker of chronic stress (Wosu et al., 2013).

The first systematic review of the body of research of hair cortisol, stress and mental health (Staufenbiel et al., 2013) has highlighted elevated cortisol levels as a common factor in psychopathologies that also indicate cognitive decline. This systematic review (Staufenbiel et al., 2013) has also pointed to the need for deeper investigation into the relationship between hair cortisol and cognitive processes. The hippocampus, the area of the brain associated with cognition and memory (Sapolsky, 1992, 2000), is a major target for glucocorticoids in the brain as it plays an important role in regulating the HPA axis. Sustained exposure to glucocorticoids has been linked to selective atrophy of the hippocampus (Sapolsky, 2000). The pre-frontal cortex, which is involved in executive functioning and emotional regulation, is also susceptible to cortisol secretion. Impaired memory and executive function have been noted in patients with depression and anxiety disorders (Castaneda et al., 2008; Hinkelmann et al., 2009). Cognitive disorganisation has been observed with failures in hippocampal and pre-frontal circuits to interpret and segregate information (Olypher et al., 2006).

More recently, attention has been given to observing structural changes to the amygdala, the area of the brain involved in fear and anxiety, as a result of prolonged exposure to stress (Lau et al., 2017). This supports findings that stress leads to changes in the brain’s neurocircuitry, with particular regard to the amygdala and pre-frontal region (Mah et al., 2016). Cognitive deficiency and chronic stress have also been linked to impaired cognitive functioning and decline (Aggarwal et al., 2014) and even degenerative disorders such as dementia (Mah et al., 2016; Wilson et al., 2007).

Although it is clear from the growing body of evidence across multiple disciplines that there are serious risks posed by stress on psychological, physiological and physical health, there are still limited data within healthy populations.

Following an emerging trend in self-reported memory loss and cognitive failure among private sector professionals, this study considered demographic, employment characteristics, self-rated health, physiological and psychological factors associated with cognitive disorganisation. This study was the first study that aimed to target a healthy working population across a number of private sector industries (e.g. aviation, consumer products, education, electronics, finance, gaming, insurance, media, security, shipping and technology) and assess factors associated with cognitive disorganisation. Since assessments of stressors are largely subjective, specific coping strategies or moderators are varied and individual dependent. However, different coping styles have been seen to affect HPA axis reactivity (Binder and Holsboer, 2012). This study therefore focused on a population of healthy professionals – their perceptions of their psychological well-being, including perceived self-efficacy, together with their physiological well-being using different stress measures and HCC as the biomarker of HPA axis activation – and the impact of both psychological and physiological measures (as well as additional demographics) on

self-reported episodes of cognitive disorganisation. In addition to considering elevated cortisol levels, this study also examined any attenuated cortisol levels as a possible indication of blunted activity of the HPA axis. Attenuated cortisol levels are an indicator of increased receptivity of the hippocampus, with a possible resultant negative impact on cognitive functioning.

Method

Participants

A convenience sample of participants from private sector organisations in several countries were invited to take part in the study. A total of 100 international participants (64 females, 36 males; with a mean age of 40.6 years and standard deviation of 8.5 years) volunteered to take part in the study. Recruitment was from six different locations including New York, Oslo, Geneva, London, Oxford and Guildford over a period of 9 months in 2013. A sample size of 100 was considered reasonable for this kind of study and appropriate to carry out logistic regression (Long, 1997). The participants were selected in line with one of the researcher's international work commitments. Each location offered similarities in terms of professional experience within the private sector, such as working hours, travel obligations and responsibilities. Any differences observed were due to nationality, industry sector or work type, such as lawyer versus accountant.

All participants were employed at the time of the study. The participants were invited via senior executives who had been carefully briefed by one of the researchers. A letter and summary of the research was also sent to participants explaining the purpose and scope of the research, and this was followed up with a briefing note and explanation of next steps.

Exclusion criteria were adults suffering from Cushing's syndrome, the effects of which include elevated cortisol levels. One participant was excluded due to steroid therapy. Bald adults and those with shaved heads were excluded from the study due to an inability to collect hair samples for later hair cortisol analysis.

Ethical approval was sought and secured from the University of West London University (Reference: CRSEC25). All completed questionnaires were stored in a locked cabinet. All participants were fully debriefed and directed to relevant policies and services (such as Occupational Health) if they felt they wanted to discuss personal issues which may have arisen from the study. Participants were also invited to contact the researchers if they wished for clarification about seeking support about stress.

Data collection

Data collection comprised a self-report questionnaire and hair cortisol extraction.

Self-report questionnaires. Participants were asked to complete a questionnaire that assessed their demographics (e.g. gender, age, ethnicity, marital status and whether they had children), employment characteristics (e.g. length of time employed by current employer, time spent travelling on behalf of work, line management responsibilities, number of sick days over the last year) and health status (e.g. description of general physical and mental health, medications taken, exercise, amount of sleep per night, current smoking status, whether drank alcohol).

The survey also sought to capture participants' experiences of stress and mental well-being. The *Calgary Symptoms of Stress Inventory (C-SOSI)* (Carlson and Thomas, 2007) is a 56-item scale with 8 subscales of 6–9 items which seek to capture physiological, behavioural and cognitive components of participants' stress responses. The subscales are named: *Sympathetic Arousal, Neurological/Gastrointestinal Symptoms, Upper Respiratory Symptoms, Anger, Cardiopulmonary Arousal, Depression, Anger and Cognitive Disorganisation*. Finally, self-efficacy was measured by the *New General Self-Efficacy Scale* (Chen et al., 2001). The term 'stress' was not used in the survey itself in order to reduce distress and any preconceptions or negative associations which may have added a priming effect to the study.

Hair cortisol extraction. For the purpose of this study, cortisol analysis offered by HCC, being less affected by context or time of day than saliva or urine samples (Stalder et al., 2012; Stalder and Kirschbaum, 2012), offered a more stable and retrospective assessment of cortisol secretion. HCC also enabled the easy transport of samples across different geographic boundaries.

At the same time as the questionnaire was completed participants were asked for scalp hair of between 1 and 6 cm in length. The hair samples were collected from participants using the hair collection protocol described by Stalder et al. (2012). A comb was used to separate two to three strands of hair at the back of the head approximately 2 cm below the cranial bone. The hair strands were cut closely to the scalp using sterile scissors from the posterior vertex area of the head, which has been shown to have the lowest coefficient of variation. The strands of hair were placed in the centre of a small piece of aluminium foil which had been marked using a permanent marker to show which end of the sample was the cut end (and closest to the scalp). The hair samples that were too long for the foil were trimmed at the end that was furthest from the scalp. The foil was folded about 1 in over the top scalp end of the strand and then carefully folded over the hair sample – left to right – and then 1 in from the bottom. Care was taken not to fold the hair sample. A paper clip was placed over the foil at the scalp end of the sample. A participant label was placed on the foil which was then placed in a Ziploc bag. Each bag was stored in a dark, dry location until shipping.

The samples were analysed for cortisol concentration in methanol extracts using a radioimmunoassay by the Salimetrics Laboratory in Cambridge. The tubes were labelled and the hair was cut into a specified length and weighed in tubes. The hair samples were washed in isopropanol. Isopropanol was added to tube, which was shaken for 3 minutes and then removed. This was repeated once. The hair was left to dry completely at room temperature which took a minimum of 48 hours, after which grinding media was added to the tubes and the samples were ground to a fine powder using a FastPrep®-24 Instrument. Methanol was added to the tubes which were incubated for 24 hours at room temperature. The sample was centrifuged and clear methanol transferred to a new tube. The samples were loaded into a Scanvac vacuum centrifuge to dry down clear methanol. Once dried, the samples were stored in a -80°C freezer until the day of assay. Before assaying, the samples were reconstituted with assay diluent.

Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 22.0. The categorical variables were collapsed into two groups in order to maximise the number in some of the categories. In order to investigate low/high values, and because the majority were positively skewed and not considered strictly continuous, the continuous/ordinal variables were also divided into two groups using the median value as the cut-off to obtain approximately equal proportions in each group where possible. The total cognitive disorganisation outcome variable score was categorised into two groups where low was considered to be less than 11 and high was considered to be at least 11.

Percentages were first calculated to describe the sample characteristics given the categorical nature of the recoded variables. Two-by-two cross-tabulations and chi-square tests were then used to investigate the associations between the demographics, employment characteristics, self-reported health status and psychological scoring/measurements with the low/high cognitive disorganisation outcome variable. Logistic regression was then used to investigate the factors associated with low/high cognitive disorganisation. Given the sample size and the need to minimise the number of independent variables and missing data, as well as issues around multiple significance testing, only the four variables that were found to be highly significantly associated with low/high cognitive disorganisation in the chi-square tests ($p < 0.01$) were included in the regression.

Results

Table 1 presents the demographics, employment characteristics, self-reported health status and psychological scoring/measurements for the sample. It shows that

Table 1. Demographics, employment characteristics, self-reported health status and psychological scoring/measurements from sample of 100 private sector workers from New York, Oslo, Geneva, London, Oxford and Guildford, 2013.

Variable	Valid % (n) ^a
<i>Demographics</i>	
Gender	
Female	64.0 (64)
Male	36.0 (36)
Age (years)	
<42	49.4 (40)
42+	50.6 (41)
Ethnicity	
White	84.0 (84)
Other	16.0 (16)
Union status	
Married/cohabiting/civil partner	66.3 (65)
Single/divorced/other	33.7 (33)
Has children	
No	44.4 (44)
Yes	55.6 (55)
<i>Employment characteristics</i>	
Length of time employed by current employer (months)	
<64	49.5 (49)
64+	50.5 (50)
Time per month on average spent travelling on behalf of work (hours)	
<36	49.4 (43)
36+	50.6 (44)
Line management responsibility	
No	47.0 (47)
Yes	53.0 (53)
Number of days sickness over the last year	
No sick days	37.4 (37)
Sick days	62.6 (62)
<i>Self-reported health status</i>	
Description of general physical health	
Excellent/good	69.0 (69)
Satisfactory/poor	31.0 (31)
Description of general mental health	
Excellent/good	78.0 (78)
Satisfactory/poor	22.0 (22)
Medications taken	
No	67.3 (66)
Yes	32.7 (32)
Exercise regularly	
Yes	77.0 (77)
No	23.0 (23)
Amount of sleep per night on a typical night (hours)	
7+	70.1 (68)
<7	29.9 (29)
Currently smoke cigarettes	
Non-smoker	82.8 (82)
Smoker	17.2 (17)
Drink alcohol	
No	10.1 (10)
Yes	89.9 (89)

(Continued)

Table 1. (Continued)

Variable	Valid % (n) ^a
<i>Psychological scoring/measurements^b</i>	
Total Calgary Symptoms of Stress Inventory (C-SOSI) sympathetic arousal score	
<20	46.5 (46)
20+	53.5 (53)
Total C-SOSI neuro gastrointestinal score	
<10	48.9 (46)
10+	51.1 (48)
Total C-SOSI upper respiratory score	
<12	39.4 (37)
12+	60.6 (57)
Total C-SOSI cardiopulmonary score	
<9	49.0 (48)
9+	51.0 (50)
Total C-SOSI depression score	
<12	49.0 (47)
12+	51.0 (49)
Total C-SOSI anger score	
<12	41.2 (40)
12+	58.8 (57)
Total C-SOSI cognitive disorganisation score	
<11	49.0 (49)
11+	51.0 (51)
Total self-efficacy score	
<16	40.8 (40)
16+	59.2 (58)
Cortisol concentration level (pg/mg)	
<6.7269	49.5 (49)
6.7269+	50.5 (50)

^an varies due to the different number of responses.

^bHigher scores indicated increased frequency of experiencing symptoms for psychological scoring and self-efficacy score, whereas lower scores indicated increased perceptions of self-efficacy.

nearly two-thirds of the sample were female with just over half aged 42 years and above. The vast majority of the sample were White, two-thirds were currently in a union and just over half of the sample had children. The median length of time with the current employer was just over 5 years and the median number of hours per month spent travelling related to work (including commuting) was 36 hours. Just over half of the sample had line management responsibilities and nearly two-thirds reported a sick day in the past year.

However, around 70 per cent reported their general health and mental health as excellent/good but a third reported taking medications. Over three-quarters of respondents reported exercising regularly and 70 per cent reported getting at least 7 hours sleep on a typical night. While the majority reported drinking alcohol, only 17 per cent reported currently smoking cigarettes. With regard to the C-SOSI, the median total cardiopulmonary score was the lowest (9), whereas the total sympathetic arousal score

was the highest (20). The median for the total self-efficacy scale was 16 with the scale decreasing with greater self-efficacy. The median cortisol concentration was 6.7 pg/mg.

Noting the caveat of multiple significance testing, four variables were highly significantly associated with the outcome variable ($p < 0.01$) in the chi-square tests (not shown) and so were entered into a logistic regression – low/high cardiopulmonary score, low/high depression score, low/high anger score and low/high self-efficacy score.

Table 2 presents the findings from this logistic regression which explained close to 40 per cent of the variance in the data. Those with a high total cardiopulmonary score of at least 9 were four times as likely to have high cognitive disorganisation compared to those with a low cardiopulmonary score of less than 9 ($p < 0.01$). Similarly, those with a high total anger score of at least 12 were three times as likely to have high cognitive disorganisation than those with a low score of less than 12 ($p < 0.05$). In contrast, individuals with a high self-efficacy score of at least 16 (indicating lower perceived self-efficacy) were four times as likely to have high cognitive disorganisation than those with a lower self-efficacy score (indicating higher perceived self-efficacy ($p < 0.01$)). That is, lower perceived self-efficacy was associated with higher cognitive disorganisation. However, low/high depression score was not significantly associated with low/high cognitive disorganisation when adjusting for cardiopulmonary, anger and self-efficacy.

Discussion and conclusion

This study highlighted several significant associations between cognitive disorganisation and a number of psychological variables. Strong associations were found between high cognitive disorganisation scores and high cardiopulmonary and anger scores, while the high cardiopulmonary and anger scores suggest sympathetic nervous system activation and possible accompanying emotions of frustration. High self-efficacy scores (pointing to low perceived self-efficacy) was also strongly associated high cognitive disorganisation. The significant relationship between high cognitive disorganisation and low self-efficacy endorses previous claims linking high self-efficacy to improved performance (Lai and Chen, 2012).

Although a direct relationship between low/high cortisol and low/high cognitive disorganisation was not observed, there was an association between low/high self-efficacy and low/high cortisol, as Figure 1 suggests. Previous studies, as mentioned in the introduction, have highlighted both elevated cortisol levels as a common factor in psychopathologies that indicate cognitive decline and also blunted cortisol levels as an indicator of prolonged exposure to chronic stress. This study's findings therefore may signal an early adaptation of the HPA axis via the negative feedback loop.

Table 2. Odds ratios with 95 per cent confidence intervals (CI) and p -values from logistic regression of Calgary Symptoms of Stress Inventory (C-SOSI) high total cognitive disorganisation score of at least 11 among 92 private sector workers from New York, Oslo, Geneva, London, Oxford and Guildford, 2013.

Variable ^a	Odds ratio	Lower bound for 95% CI	Upper bound for 95% CI	p -value
Total C-SOSI cardiopulmonary score				
<9	RC	RC	RC	RC
9+	4.232	1.473	12.157	0.007
Total C-SOSI depression score				
<12	RC	RC	RC	RC
12+	1.691	0.581	4.927	0.335
Total C-SOSI anger score				
<12	RC	RC	RC	RC
12+	3.268	1.105	9.669	0.032
Total self-efficacy score				
<16	RC	RC	RC	RC
16+	4.490	1.541	13.081	0.006

RC: reference category.

Nagelkerke R^2 of 0.389.

^aHigher scores indicated increased frequency of experiencing symptoms for psychological scoring except for self-efficacy score where lower scores indicated increased perceptions of self-efficacy.

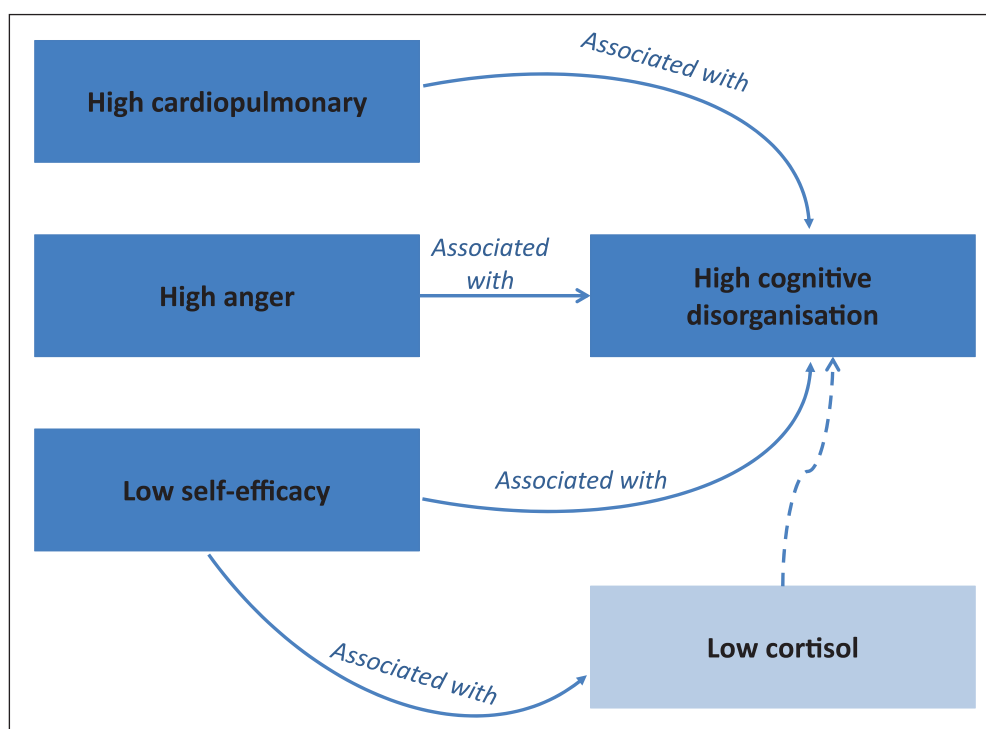


Figure 1. Diagram suggesting potential pathways between variables.

The significance of these relationships suggests that, even in a healthy population, there are both subjective and objective indications of chronic stress and possible early signs of hippocampal changes. Moreover, although cognitive disorganisation has been observed in this context as an outcome variable, it may itself suggest early signs of hippocampal changes.

These findings underline the significant role of thinking patterns and state of mind on visceral factors. Mere perception of what is stressful may thus result in activation of the body's stress response which in turn may cause cognitive impairment.

This study therefore seeks to bridge the divide between the two disciplines of social and biological psychology and

reinforce the view that human physiology and psychology are affected by both environmental influences and by personal constructs of reality. The fact that this study's findings showed highly significant relationships, even in a healthy rather than a clinical population with no definite diagnosis or reports of psychopathology, is of particular interest.

A number of potential limitations of this study need to be mentioned. Since this was a new study, the scope may have been a little too broad and further studies may wish to focus on specific predictions or associations. The convenience sample may have increased the homogeneity of the participant population which, although it was taken from different geographic locations, was nevertheless similar in type namely private sector employees. It is also worth noting that those participants who volunteered may have also recognised in themselves some issues with dealing with stress resulting in the intense responses highlighted in the findings. A random sample may have provided a more balanced view.

The absence of a direct significant relationship between low/high cortisol and low/high cognitive disorganisation is worthy of mention. This may be explained by a lack of sensitivity and specificity in the cognitive disorganisation measure and possibly in the HCC method of cortisol extraction. Future research studies may provide more insight into the relationship between HCC and cognitive disorganisation, particularly with a view to examining blunted cortisol as a measure of hippocampal adaptation and possible atrophy.

This study was the first of its kind to consider HCC data within a healthy sub-clinical population and its findings support previous links made between self-efficacy and impaired performance. The study therefore represents an important step in determining and possibly pre-empting any factors that could potentially lead to more serious cognitive decline.

Since impairments to cognitive functionality are located largely in the hippocampal and pre-frontal areas of the brain, implications are raised for future biopsychosocial research into stress in the workplace. It is hoped that greater awareness of psychoneuroendocrinological factors of well-being at work and possible correlates with the demands of the working environment may lead to improved coping mechanisms and targeted interventions to delay or reverse adverse neurological responses. Additionally, the findings from this study will be an important precursor to further research into hippocampal structure and volume, perhaps even delaying neurodegenerative diseases in the long term.

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