NEUROMANAGEMENT

People and Organizations

Edited by Michela Balconi

LED Edizioni Universitarie di Lettere Economia Diritto

IrcCAN
International Research Center for Cognitive Applied Neuroscience

ISSN 2724-3540
ISBN 978-88-7916-952-3

LED Edizioni Universitarie di Lettere Economia Diritto
Via Cervignano 4 - 20137 Milano
https://www.lededizioni.com
https://www.ledonline.it/neuropsychologicaltrends/

Printed by Logo

Index

M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
ISBN 978-88-7916-952-3 - https://www.ledonline.it/IrcCAN-Cognitive-applied-neuroscience/

How to manage stress at the workplace: neuroscientific applications

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DOI: https://dx.doi.org/10.7359/952-2020-bal5 michela.balconi@unicatt.it

1. The framework of stress at the workplace

Historically, stress has been defined as an aspecific response of the organism to any form of exogenous or endogenous stimulus that, due to its duration or intensity, is capable of triggering adaptation mechanisms to face the stimulus and restore homeostasis (Selye, 1975). Despite this definition could be criticized as too simplistic, since it leaves out the contextual factors and appraisal mechanisms (Matthews et al., 2017), it contains the assumption that stress can be considered a basic adaptation reaction to a positive or negative event.

Stress responses are essential for triggering the organism and for addressing an event or situation appropriately. In this way, stress encourages a controlled reaction in which the individual feels to have sufficient skills and resources to respond to the context's demands and initiates a productive problem-solving process. On the other hand, when the action of the stressor agent is too severe and lasts for long, such processes of physiological adaptation begin to fail, homeostatic regulatory mechanisms become less efficient, and the stress response becomes dysfunctional (Dhabhar, 2014). Therefore, extremely low, and extremely high stress levels are linked to a drop in cognitive performance and the lack of adaptive responses, while optimal levels of performance are settled in the middle of the stress curve.

Intense and chronic exposure to severe stressors may have relevant clinical implications, however, the same sequence of physiological and psychological events occurs

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even when people experience common stressors, such as competitions and examinations/tests (Saleh et al., 2017), with relevant effects on self-perception, performance, and well-being.

But what about stress and workplace? When at the workplace, stress could affect all workers but especially professionals occupying managerial positions. In fact, mainly managers and top-level professionals are engaged in demanding tasks connoted by heavy cognitive load and require outstanding cognitive resources. They are therefore exposed to extremely high pressure to attain a good outcome and are characterized by high responsibilities and considerable workload. Overall, the high level of stress experienced by managers is substantially influenced by all those aspects (Mohr & Wolfram, 2010; Schieman & Glavin, 2016).

Despite the attention given to the issue of workplace stress, systematic research on the impact of stress on managers is currently limited. However, the actual literature quite consistently emphasizes the negative impact of occupational stress on the mood of managers, on their perceived health and performance efficacy (Schieman & Glavin, 2016).

Interestingly, the empirical study on managerial stress by Cavanaugh and colleagues (2000) differentiated self-report stress into challenge stress and hindrance stress. Challenge stress was defined as "self-reported work stress associated with challenging job demands". Hindrance stress was defined as "job demands or work circumstances that involve excessive or undesirable constraints that interfere with or hinder an individual's ability to achieve valued goals". This study showed support for the proposition that self-reported stress shows a different relationship to work outcomes, such as job satisfaction and job search behavior, depending on an individual's appraisal and whether the stressor represents a positive challenge or a negative obstacle to deal with.

Accordingly, nowadays the impact of managers' stress level on their success and performance at the workplace, on workers well-being and on the productivity of the company is a hot topic in organizations and management research, along with studies on successful ways to handle the stress load managers are exposed to and its implications (Balconi et al., 2017; Crivelli & Balconi, 2017; Little et al., 2007).

As previously mentioned, a high level of chronic stress can become dysfunctional, as it can alter mental abilities, wear out cognitive resources and worsen performance (Chrousos, 2009). Research on stress management within job contexts in the last few years therefore strongly suggests that occupational stress can:

- increase cardiovascular risk and directly alter the neural regulation of cardiovascular activity (Backé et al., 2012);
- alter the functionality of endocrine and immune systems, thus increasing individual susceptibility to various diseases (Chandola et al., 2010);
- affect autonomic responsivity and regulation, with heightened heart rate (HR) and blood pressure and reduced vagal tone (i.e. reduction of the ability of the

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parasympathetic system to downregulate autonomic arousal associated, e.g., to chronic distress) not only at work but even during leisure time (Lucini et al., 2007);
- more generally, affect the quality of life and psychological well-being because of interpersonal conflicts and work-to home interference (Schieman & Glavin, 2016).

Furthermore, sustained stress exposure also has implications for neural activity and the effectiveness of cognitive systems involved in attention regulation (Ptak, 2012). Sustained stress-related hyperactivation related then influences neural and cognitive functioning by affecting the ability to properly implement cognitive processes (such as executive, attentive, decision-making and memory processes), but also self-monitoring and affective regulation skills (Arnsten, 2015; Girotti et al., 2018).

Given these premises, it seems of major importance to train the ability to capitalize on the initial stress-related increase of psychophysiological reactivity while preventing dysfunctional consequences via proper stress management techniques (Subhani et al., 2018). This would help promote subjective well-being and optimize the effectiveness of neural, cognitive, and behavioral reactions to stressful events or situations (including common environmental stressors which characterize and influence social and working life).

According to Le Fevre and colleagues (2006), stress management interventions (SMIs) can be classified as primary (i.e. those that aim to deal with the source(s) of stress in the workplace (stressors), and focus at the organizational, or group level), secondary (i.e. those that focus at the individual stress level of the employee), or tertiary (i.e. those that aim to address or ameliorate already existing stress signs and symptoms in individual organizational members) (Quick et al., 1998). Primary interventions include active organization development, support groups, or a combination of the two; while secondary interventions encompass somatic approaches, relaxation techniques, biofeedback and cognitive exercise, meditation and visualization, psychotherapy, or a multimodal combination of the above approaches.

Below, major attention will be given to some secondary SMIs, and the potential of integrating neuroscientific tools will be specifically highlighted. The key aspect driving secondary SMIs is that it is unlikely to completely delete stressors inherent in the job and organization, so it is better to concentrate on the organizational members' reactions to stress and ways to cope with such stressors. These assumptions fit well with the idea that individuals can react positively or negatively to environmental pressures and demands based on their appraisal of the event and the methods they adopt to cope with stressors (Le Fevre et al., 2006).

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2. Interventions for stress management: from mental training to neurotechnology applied in the company

In this section, current empirical methods and techniques borrowed from the neuroscientific field and applied to professionals for secondary SMIs will be described. Particular attention will be given to interventions combining multiple techniques, such as mindfulness-based interventions supported by neurofeedback wearable devices, since they demonstrated to be promising tools for supporting efficient stress management.

2.1 Mindfulness-based interventions

Relaxation techniques, cognitive-behavioural psychological training, and meditation practices can be considered as the most widespread intervention protocols designed to empower stress management skills in the workplace (Richardson & Rothstein, 2008). Mainly these techniques try to prevent health risks and reduced performance by mitigating the negative influence of exposure to stressors.

In particular, the latter, mindfulness-based interventions (MBI) have been considered useful for coping with stress-related problems, since they have been shown to successfully alleviate stress and associated consequences in various clinical and non-clinical contexts (Creswell, 2017). By taking into account the ample literature on physiological and neural correlates of mindfulness practice, not strictly related to neuromanagement, it is generally and consistently suggested that such form of mental training could be associated with significant modulation of physiological markers of stress. Also, when used in organizations and work environments to manage occupational stress, MBI showed an interesting potential, as reported in various reviews on the topic (Janssen et al., 2018; Ravalier et al., 2016).

Despite actual outcomes and methodological limitations of such approaches are still debated (e.g., work-related outcomes and effects for longer-term, follow-up; Jamieson & Tuckey, 2017; Vonderlin et al., 2020) and also negative results have been reported (Bartlett et al., 2019), MBI for employees were shown to effectively reduce stress, burnout, mental distress, and somatic complaints, while improving mindfulness, wellbeing, compassion and job satisfaction (Vonderlin et al., 2020).

2.2 Wearable devices technologies

Recently, well-designed app-based wearable devices have been identified as a plausible option to manage occupational stress. More specifically, wearable device technologies may facilitate self-awareness processes due to their ability to collect real-time physiological measures, as an indicator of stress, and cue individuals in real-time at moments when they should take action (Patel et al., 2015). These systems hold at least three main advantage for SMIs: i) they act as a reminder of SMI, ii) they monitor change over time thus boosting

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motivation to engage in the training, to keep practice and to reach new progress, iii) they can notify the worker during the moment of stress helping the person to apply stress management strategies more consistently and to interrupt a potential maladaptive stress response.

By using elementary features of wearable devices (i.e. heart rate sensors, app notifications, and haptic vibrations) in combination with cognitive and physiological experimental processes, Fallon and colleagues (2018) proposed to reduce stress and increase attention in employees (p. 229-239). However, it has been argued that these devices act as facilitators and not drivers of health behavior change (Patel et al., 2015). To date, solid evidence of efficacy is needed, since we found no empirical studies on stress body monitoring devices deployed to a sizable population in a work environment.

On the contrary, the most advanced body-and-brain sensing wearable devices providing real-time feedback to the individual on its body and mental state were shown to be able to promote the reduction of stress levels, with remarkable practical advantages for managers and employees (Balconi & Crivelli, 2019), and will be described in the following paragraphs.

2.3 Body sensing biofeedback systems

Biofeedback (BF) could provide an accessible, low-cost, and easy-to-use system for applying stress interventions at the workplace. De Witte and colleagues (2019) collected preliminary promising evidence in the use of BF system to improve physiological (i.e., electromyography, temperature, cortisol, and heart-rate variability, HRV) and psychological (self-report job stress scale) indicators of stress in healthy working adults (Kotozaki et al., 2014; Murphy, 1984; Sutarto et al., 2012).

On the other hand, recently Brinkmann and colleagues (2020) compared heart rate variability-biofeedback (HRV-BF) training with MBI since both interventions have been empirically shown to reduce stress in the work context. The study was conducted on 69 employees of the same organization, equally divided in three groups HRV-BF and MBI (performing a 6-week training) and the control group (CG). Findings suggest an overall reduction in stress for all groups. Participants with higher baseline stress levels might benefit more from mindfulness and biofeedback-based stress reduction interventions indistinctively. Given the relatively small sample size and the application of BF targeted HRV only, these results should be interpreted with caution and they do not constitute the definitive answer about the effectiveness of BF in the workplace.

Indeed, a recent meta-analysis from Goessl and colleagues (2017) affirmed the efficacy of HRV-BF with wearable devices on self-reported stress in clinical and non-clinical contexts. Whereas Munafò and colleagues (2016) previously showed that five weekly 45 minute sessions of a respiratory sinus arrhythmia (RSA) BF intervention has a positive impact on sixteen managers with high-level work responsibilities. Specifically, after the training, managers in both groups (BF and controls) reported reduced heart rate at

M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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rest, lower anxiety levels, and improvement in health-related quality of life. More importantly, managers in the RSA-BF group showed increased vagal control (as indexed by increased RSA), decreased sympathetic arousal (as indexed by reduced skin conductance and systolic blood pressure) and lower emotional interferences, compared to managers in the control group (Munafò et al., 2016).

2.4 Brain sensing neurofeedback systems

Recently, novel approaches that integrate mental training practices with wearable brain-sensing devices showed their improved potential for the improvement of cognitive skills needed for promoting efficient stress management (Balconi et al., 2017; Balconi & Crivelli, 2019; Bhayee et al., 2016; Crivelli et al., 2019).

In particular, Balconi and colleagues (2017) examined the conscious and unconscious mechanisms of MBI supported by a NF wearable device, in emotion regulation and stress management. They showed how MBI can be suitable in regulating affective responses to external stimuli and stressful events, enhancing the ability to handle implicit negative emotions. More recently, this integrated training protocol was tested for the empowerment of stress management skills and neurocognitive efficiency in highly stressful professional contexts, with people who occupy positions characterized by very high levels of responsibilities and top management duties (Crivelli et al., 2019).

This study can be conceived as an attempt to tackle the psychophysiological consequences of occupational stress at the top management organization level. At the end of the 2-weeks intensive NF training, it was possible to observe two main sets of particularly interesting results for stress management. Firstly, regarding self-report psychological measures, a significant decrease in stress, anxiety, anger, and mental fatigue was found; secondly, an increase of electrophysiological markers of relaxation and improved physiological markers of equanimity and effective recovery from stress response was detected (Balconi et al., 2018).

Regarding psychological and self-report outcomes, perceived stress, situational anxiety and reported levels of anger, and mental fatigue were lowered. This suggests that the protocol could provide evident opportunity and practical implications for the individual, but also for the organization's welfare. Indeed, it is now widely recognized that management staff's stress has negative impacts not only on their working and interpersonal life but also on the well-being of collaborators, team productivity and the effectiveness of organizations (Little et al., 2007).

Moreover, a significant increase of vagal tone, as measured by greater HRV both during a resting condition and during exposure to a cognitive stressor, was observed on cardiovascular measures of managers' autonomic profiles. HRV is considered to be an insightful autonomic measure reflecting the effect of stressors on a person, but also a reliable metric showing the capacity of physiological coping skills with practical consequences for assessment and intervention on stress management in different contexts

M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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(Subhani et al., 2018). HRV values increase indicates that the intense MBI with NF was able to promote effective psychophysiological reactivity and homeostatic mechanisms with observable effects even on physiological stress response markers. Besides, it is worth noting that the modulation of vagal tone was observed even at rest, which indicates that the competencies that were trained by constant practice might have partly been transferred also to the functioning of daily life, besides acute stress situations. Considering the extensive literature on the relationship between occupational stress and cardiovascular disease, this last point might be especially important for supporting the effectiveness of this practice (Backé et al., 2012; Collins et al., 2005; Eller et al., 2011).

Overall, the pattern of training outcomes depicts a broad positive scenario and seems to outline a general increase in participants' well-being. Taken into consideration the promising outcomes and the limited duration of the overall protocol (2 weeks) and of daily practices (of increasing duration), this training could be a potentially valuable tool especially for people whose professional position imposes time limitations and elevated job duties, thus increasing the risk of drop-out from traditional stress management programs.

2.5 VR based interventions

There are a growing interest and body of evidence supporting the efficacy of Virtual Reality (VR) treatments for stress and anxiety, however to date only one review has looked specifically into the use of VR for this purpose in the workplace (Naylor et al., 2020).

Between the wide variety of study designs and techniques confirming the general indication that the VR interventions can reduce stress, only four empirical studies specifically explored VR application at the workplace (Ahmaniemi et al., 2017; Straßmann et al., 2019; Thoondee & Oikonomou, 2017; Yin et al., 2019). These studies adopted both subjective and objective outcome measures and reported higher relaxation effects and lower stress levels in participants. Participants responded favorably to the idea of using VR for relaxation and time break stress management: in the VR condition, they were immersed in the scene and were effectively distracted from work-related thoughts and duties (Ahmaniemi et al., 2017; Thoondee & Oikonomou, 2017). More specifically, Straßmann (2019) reported less negative mental state after the relaxation phase, no feeling of simulator sickness, and flagged how important was for the participants that the intervention was adaptable to user choice. Finally, Yin and colleagues (2019) discussed the importance of biophilic and natural VR design to decrease stress and enhance creativity.

Despite this evidence, there is a gap in the current literature on the topic of VR use to cope with workplace stress. Therefore, areas for future studies mainly concern the standardization of scientific protocols with the full methodological and statistical procedure, and the adoption of robust randomized controlled trial design including an objective measure (such as HR, HRV, or neural indices) to examine the stress reduction at the workplace through VR interventions.

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3. Conclusion and remarks

Without claiming to be exhaustive, in the previous section some of the main neuroscientific interventions for stress management employed in the workplace context have been described. Introducing effective and intensive training devised to enable and optimize the stress management skills of professionals at risk, with the support of wearable technologies, may help containing health-related complications due to stress. It also lowers potential costs for the company and improves the physical and psychological well-being of the workforce, with limited investment in standard welfare interventions.

Despite the potential of the application of these tools, there are still limited opportunities in the application of SMIs at the workplace and we acknowledge that current evidence will profit from more and innovative research applied in the company.

It would be of high interest to collect outcome data on two other relevant aspects, that are i) work-related variables, such as company climate, working experience, and productivity from participants' collaborators; and ii) notable protective factors, such as high level of job satisfaction, elevated earnings, job autonomy, non-routine work and schedule control (Mühlhaus & Bouwmeester, 2016). Future studies would benefit from the inclusion of these supplementary dimensions relating to the productivity, the competitiveness and environment of managers and companies for at least two reasons: i) to paint a clearer picture of the effect that a training customized for top organization positions might have at group and company levels, and ii) to better estimate related potential economical, other than psychological, advantages.

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M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
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M. Balconi (ed.), *Neuromanagement: People and Organizations*, Milano, LED, 2020
ISBN 978-88-7916-952-3 - https://www.ledonline.it/IrcCAN-Cognitive-applied-neuroscience/