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Insider threats and thermal stress in the working environment

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Abstract. The human body can be compared to a heat engine where nutrients represent the input energy. This paper describes an interdisciplinary effort to explore the energy fluctuations of the human body in a broad context, including working conditions, nutrition, and psychological traits, with the ultimate goal to prevent counterproductive behaviour. Analogous to the material world, we argue that improper ambient temperature causes temporary and residual stress in humans, which facilitates two categories of insider threats that apply to both blue- and white-collar workers. We then propose several measures to adapt working conditions in order to minimize insider threats.

1. Introduction

Insider threats are employees that own legitimate access to organizational assets who use that access, whether maliciously or accidentally, to cause harm to their employer. The prevalence of cyber-attacks attributed to insider threats has grown in the past years. The deficit between the occurrence of an attack and its detection, along with the increasing cost of a breach, indicates that the current methods for detecting insider threats are inadequate. Because security professionals must manage not only technological and functional processes but also the human nature, an interdisciplinary approach is needed where aspects that influence human behavior, such as working environment and underlying psychological traits are considered.

In section 2, insider threats were categorized into three types based on malicious intent. Two categories, disgruntled employees and inadvertent insiders, were identified as being subject to be affected by working conditions. The effects of thermal stress on inadvertence and disgruntlement are analyzed in the next two sections. Several research papers regarding thermal stress and working conditions were reviewed for this purpose. Psychological and thermodynamic views on the brain mechanism were particularly revealing in the investigation process.

White-collar workers are individuals who perform professional, managerial, or administrative tasks. White-collar work is usually conducted in an office. Blue-collar workers refer to individuals whose profession requires them to perform a large volume of manual labor. Both categories, in the context of thermal stress, are subject to counterproductive behaviors. We put forward the idea that temporary thermal stress causes inadvertence, and continuous thermal stress leads to disgruntlement. Considering the findings, we argue that working conditions should be specially adapted in order to reduce insider threats.

Although white-collar workers are more likely to cause expensive breaches, inadvertent mistakes caused by blue-collar workers can cause injuries. In this sense, we argue that an organization should prioritize its strategy to protect the workers.

In the end, we proposed a series of guidelines that can be used to mitigate insider threats. The proposed measures can also reduce counterproductive behavior and, at the same time, improve the wellbeing of the employees.

2. Insider threats

Insider threats are employees with authorized access to the assets of an organization that cause harm to the business, whether unintentionally or for malicious purposes. Insider white-collar employees are accounted for roughly one-third of the data breaches in 2019 [1]. A recent analysis of the taxonomies used in this field [2] has identified the malicious intent as a differentiator between the different types of insider threat. In Fig. 1. we can observe an intentional-based general taxonomy of insider threats. Disgruntled employees, workers who are dissatisfied with their job, were identified as a category that transitions from the non-intentional to the planned action of malicious activity. The increasing expenses associated with an insider violation [3] and a growing time to detect such events [4] suggest that the present techniques for managing such threats are ineffective. For this study, only the first two insider threat categories are of interest since this work addresses the impact of the working environment conditions. For a purposeful malicious actor that wants to cause harm to an organization, the working environment would be irrelevant.

Unintentional blue-collar workers are subject to workplace accidents that cause business disruptions [5]. Disgruntlement, in this case, manifest itself into counterproductive behaviour that impacts productivity. We argue that identifying the facilitating causes for inadvertent insiders and the leading causes of disgruntlement might prove useful not only for reducing insider threats but also for proactively encourage good productive behaviour among workers.

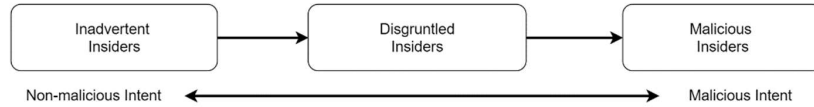


Fig. 1. General insider threats taxonomy based on malicious intent

Disgruntled employees are initially honourable workers who end up causing harm through organized acts against an organization. According to [6], the study and exploration of treason acts within companies have explained the elements and actions that lead to the perpetrating of unlawful acts by trusted workers. Negative emotions produce emotional stressors that can lead to counterproductive work performance and, ultimately, to major criminal acts, as can be observed in Fig. 3. Although our work addresses professional stressors, some personal stressors can also be addressed in a real context since developments in an individual's intimate life can represent a source of stress. For example, an adequate work-life balance can be a factor influenceable by the employer.

Considering the fact that disgruntled employees were loyal at the time of hiring, psychological studies have revealed a form of gradual degeneration of some personality traits. There are correlations between agreeableness and loyalty [7], and changes in extraversion were correlated with work satisfaction [8].

In the following sections, we will analyse the two types of insider threats in the context of thermal stress. We argue that short- and long-term human body exposure is similar to the thermal stress exposure applied to materials. Thermal fatigue is the progressive deterioration and ultimate cracking of material by alternate heating and cooling during which free thermal expansion is partially or completely restrained. In the human field temporary heat stress leads to protective physiological adaptation [9] which requires an amount of energy that is diverted from the other vital systems. Similar to the material word, long-term exposure is part of a series of professional stressors that “crack” the human causing counterproductive behavior. In buildings, long term exposure has traditionally been addressed by air cooling systems. According to a recent study [10], women perform better on cognitive tasks in warmer working environments, while men perform better in colder ones. These gender differences, along with the trending campaigns regarding gender diversity among the workforce, will lead to improper ambient temperature in the working environment. In the next two sections, we will analyze the relationship between the two identified insider threats and thermal stress.

3. Temporary thermal stress and inadvertence

The human body maintains a core body temperature of 37°C. The physical activity process creates metabolic heat inside the body, which needs to be transferred to the environment to avoid a dangerous build-up of core body temperature. This balance is regulated by several factors, such as air temperature, humidity, clothing, and the amount of heat produced by the body [11]. Thermal stress represents a situation where an employee is exposed to a combination of such factors that cause a thermic regulation response from the body.

The human brain can be considered a thermodynamic system that processes information. The two cognitive models proposed to model the human mind, and its cognitive processes were consequently a thermodynamic one and an information-based one. According to [12], both cognitive models of the brain guide the behaviour in the same direction when an individual is exposed to a given situation that requires a solution. The brain uses the energy provided by the body to further provide the necessary computation for an individual to perform an action. The primary function of energy in the brain is to fuel neural signalling and information processing. Moreover, the design and operation of the brain's computational architecture are constrained by the energy supply [13].

The body input energy is provided by nutrition and the surrounding oxygen and is used in the following ways:

- Brain activity
- Basal metabolism (energy to keep a human alive at rest)
- Digestion
- Physical activity
- Stored energy for later use
- Energy lost in waste

According to [14], the adult brain accounts for 20% of the body's total glucose utilization and 20% of oxygen consumption. Although it comprises only 2% of the body mass, it demands a lot of energy to function compared to other organs and produces intense heat [15]. In addition, computational processes inside the brain are sensitive to fluctuations in temperature [16]. Consequently, metabolism requires additional energy in order to lower brain temperature. Emerging research supports the hypothesis that brain computation is affected by the energy flow inside the body and the idea that Consciousness represents a physical process that is caused by the organization of energy in the brain was put forward [13]. Past research also suggested the existence of a direct connection between brain energy and Consciousness [17]. By studying the gradual suppression of the behavioral response to outer stimulus from alertness to deep unconsciousness, the study uncovered a corresponding decrease in energy consumption. Consequently, it was argued that conscientiousness requires a high global metabolism [17]. Past psychological research [18] has positively correlated conscientiousness and attention. Consequently, a low conscientiousness level denotes a low capacity to maintain attention. There is a consensus that humans are most vulnerable to phishing attacks during lunch break and in the early afternoon. This can be explained by a drop in conscientiousness that is in line with the increased energy need for the digestion process. Similarly, we can anticipate a drop in attention levels due to an increased energy need to compensate for the ambient temperature as we can observe in Fig. 2.

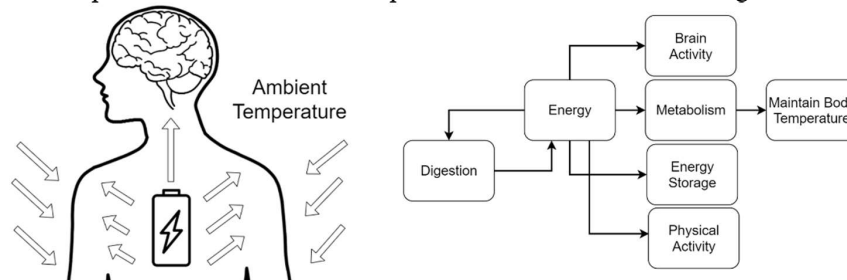


Fig. 2. Energy flow in the context of thermal stress

4. Long-term exposure to thermal stress and disgruntlement

Disgruntled employees are initially honest. INSA [6] has assessed the mind of the malicious insiders and revealed some progressive aspects related to betrayal. In Fig. 3. we can observe that personal and professional stress factors influence human behaviour to the point of committing major malicious acts. While white-collar workers commit crimes such as financial frauds, blue-collar workers are subject to violence [19]. Abnormal working conditions are stressful to humans, and the human body responds to extreme temperatures by manufacturing stress hormones such as adrenaline, a hormone that is associated with violence.

Several papers [11][5][20] have analysed the changes in productivity and the incidence of accidents related to continuous thermal stress conditions. According to [20], humans work slower when exposed to either indoors or outdoors raised ambient temperatures.

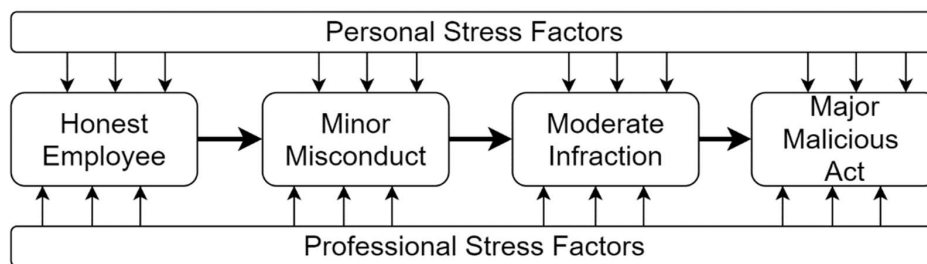


Fig. 3. Disgruntled insider evolution

A recent study on the effects of heat stress on productivity [21] has revealed that extreme heat during labour creates professional health risks. Heat stress limits a worker's physical capacities and abilities, work volume, and productivity. According to the study, temperatures above 24–26°C are correlated with reduced labour productivity, and temperatures over 33–34°C reduce 50 percent of a workers' capacity.

The physical effects of the continuous exposure to extreme heat levels can be fatal, one form being the heatstroke. Although employees in all sectors are affected, specific professions are particularly dangerous because they require more substantial effort and/or take place outside. Before-mentioned jobs are typically encountered in farming, construction, garbage collection, transport, and tourism. Manufacturing workers in production facilities are also in danger if heat levels are not suitably managed. At high-temperature levels, mental fatigue appears and affects even basic office activities.

Beyond the 38–40.6°C threshold of temperature, the body's physiological control mechanisms are no longer capable of sustaining the body temperature at a healthy functioning level. As a consequence, there is a heightened danger of discomfort, deficiencies in bodily functions, heat-related sicknesses, organ deterioration, loss of consciousness, and, finally, death [21]. Apart from personal factors, we can anticipate that improper working conditions can quickly materialize to occupational stress factors and lead to disgruntlement.

5. Insider threat mitigation guidelines

Considering the aspects identified in the previous sections, we identified several mitigation measures that can be strategically applied in an organizational environment to minimize the impact of insider threats.

Let's consider a pragmatic approach. A first separation between white- and blue-collar workers should be performed at the start of the assessment. An organization that employs both types of workers must identify the associated vulnerabilities and calculate the risk impact for both categories. Based on the risk tolerance, strategic investments must be directed in order to mitigate the risk. Since white-collar insider attacks are usually more expensive it's more likely that they will be prioritized. An obvious solution regarding the ambient working environment would be to find an optimal temperature for the human body to perform its cognitive processes efficiently. A recent study regarding gender differences

and cognitive performance [10] revealed that this is not necessarily easy to achieve, especially in the present context of workforce gender diversification trend. A mixed-gender office population will cause heat-related professional stressors in the office (the “thermostat war” between genders). Since gender needs for cognitive productivity are ambient-temperature dependent, we envision that a “politically incorrect” separation of the two genders inside the office, using adapted climate zones, would enable the full potential of cognitive functions among workers.

Additionally, we propose that a psychological assessment should be performed periodically over the employees in order to determine their conscientiousness, agreeableness and extraversion levels. A low level of conscientiousness will favor mistakes, especially if the person works in improper temperature settings. Several items must be considered in order to prevent inadvertence:

- Conscientiousness level
- Nutrition
- Amount of stress associated with work
- Ambient temperature

For example, a white-collar employee with a low conscientiousness level will need a suitable temperature for its gender, proper nutrition, and a reasonable amount of stress associated with work to behave optimally and use its full cognitive capacity. For blue-collar workers that work outside or in large facilities where temperature cannot be controlled, the hiring company should take into consideration additional measures to enhance the wellbeing of the worker and maximize productivity while reducing injuries. We argue that ethical issues should be at the forefront of an organization’s operations, and the life and wellbeing of workers should be placed before profit.

Changes in the agreeableness and extraversion levels indicate disgruntlement. By proactively identifying disgruntlement through its symptoms, decisional factors can correct the circumstances leading to it, thus mitigating insider threats.

6. Conclusions

Insider threats represent one of the most prevalent organizational problems, and technical solutions have shown their limitations in addressing them. In this context, it becomes evident that an interdisciplinary approach would be more suitable for treating these types of threats.

Ambient temperature represents just one of the professional stress factors that need to be considered when assessing the occupational risk hazard. Work conditions that are optimized for cognitive capacity add benefits to employee productivity and, at the same time, reduce the risk associated with insider threats. In addition to ambient temperature, psychological, nutritional, and organizational factors should also be considered in the quest to mitigate insider threats.

For white-collar workers, the financial losses associated with an insider attack are particularly high. Low conscientious people should be especially protected since they are prone to make mistakes. For identifying disgruntled employees, we put forward a strategy that requires the monitoring of changes in agreeableness and extraversion levels in time. The degradation of these two personality traits should raise alerts regarding the stress level on the mental state of an employee.

The wellbeing of the human person is an essential part of a business. Ambient temperature plays a role in attention and in the ability to solve problems. By nurturing a healthy attention level among employees, mistakes are minimized.

Political correctness can discourage novelty and innovation. Since studies have revealed gender differences in (temperature-dependant) cognitive abilities, adequate measures should take into consideration these studies regardless of the controversies that could follow.

An interdisciplinary approach to research brings together concepts and ideas across various disciplinary boundaries. We envision that further combined study in fields such as thermodynamics, social psychology, cognitive science, and neuroscience might prove useful in optimizing human activity not only for increased productivity but for the betterment of society.

References

- [1] Widup S et al. 2019 Verizon Data Breach Investigations Report p. 5
- [2] Homoliak I et. al. 2018 Insight into Insiders and IT: A survey of insider threat taxonomies, analysis, modeling, and countermeasures, *ACM Computing Surveys* DOI: 10.1145/3303771
- [3] Ponemon Institute 2020 Cost of Insider Threats: Global Report IBM Security pp. 3-4
- [4] Verizon Research Lab 2019 Insider Threat Report p. 6
- [5] Page L and Sheppard S 2019 Heat Stress: Ambient Temperature and Workplace Accidents in the US *Department of Economics Working Papers 2019-05*, Williams College
- [6] Intelligence and National Security Alliance 2017 Assessing the mind of the malicious insider *INSA, Security Policy Reform Council Insider Threat Subcommittee*
- [7] Smith T 2012 The Personality Trait Predictors of Brand Loyalty *Academy of Business Research, The University of the West Indies Vol. III*, 6-21
- [8] Scollon C and Diener E 2006 Love, Work, and Changes in Extraversion and Neuroticism Over Time *Journal of Personality and Social Psychology Vol. 91, No. 6*, pp. 1152–1165
- [9] Parsons K 2014 Human thermal environment: The effects of hot, moderate and cold temperatures on human health, comfort and performance, 3rd ed.; *CRC Press: New York, NY, USA*.
- [10] Chang T and Kajackaite A 2019 Battle for the thermostat: Gender and the effect of temperature on cognitive performance DOI: 10.1371/journal.pone.0216362
- [11] Kjellstrom T et. al. 2009 Workplace heat stress, health and productivity an increasing challenge for low and middle-income countries during climate change *Global Health Action 2009*. DOI: 10.3402/gha.v2i0.2047
- [12] Collell G and Fauquet J 2015 Brain activity and cognition: a connection from thermodynamics and information theory *Frontiers in Psychology* DOI: 10.3389/fpsyg.2015.00818
- [13] Pepperell R 2018 Consciousness as a Physical Process Caused by the Organization of Energy in the Brain *Hypothesis and Theory* DOI: 10.3389/fpsyg.2018.02091
- [14] Purdon A et. al. 2002 Energy Consumption by Phospholipid Metabolism in Mammalian Brain *Neurochem Res* 27, 1641–1647 DOI:10.1023/A:1021635027211
- [15] Howarth C, Gleeson P. and Attwell D 2012 Updated energy budgets for neural computation in the neocortex and cerebellum *J. Cereb. Blood Flow Metab* DOI: 10.1038/jcbfm.2012.35
- [16] Kiyatkin E 2010 Brain temperature homeostasis: physiological fluctuations and pathological shifts. *Front. Biosci.* 15, 73–92 DOI: 10.2741/3608
- [17] Shulman R 2013 Brain Imaging: What It Can (and Cannot) Tell Us About Consciousness. *Oxford: Oxford University Press*. DOI: 10.1093/acprof:oso/9780199838721.001.0001
- [18] Marchetti G 2012 Against the view that consciousness and attention are fully dissociable *Frontiers in Psychology, Consciousness Research* DOI: 10.3389/fpsyg.2012.00036
- [19] Simister J and Cooper C 2005 Thermal stress in the U.S.A.: Effects on Violence and on Employee Behaviour *Stress and Health* 21: 3–15 (2005) DOI: 10.1002/smi.1029
- [20] Dear K 2018 Modelling Productivity Loss from Heat Stress *Atmosphere* DOI:10.3390/atmos9070286
- [21] International Labour Organization 2019 Working on a warmer planet: The impact of heat stress on labour productivity and decent work