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## The Integral Role of Physical and Cognitive Ergonomics for Workplace Performance and Wellbeing

A Comprehensive Review of Research-Based Approaches

# Abstract

The modern workplace is evolving quickly as trends towards employee wellbeing and productivity are prioritized [1]. Assessing workers' health, comfort, and performance requires investigating the physical and cognitive ergonomics shaping their work environments.

This manuscript explores the diverse applications of physical and cognitive ergonomics by reviewing extensive research. The primary goal is to provide a holistic understanding of how physical and cognitive ergonomics impact the workplace. Evidence-based recommendations are discussed to improve both fields of ergonomics, developing workplace environments that promote employee wellbeing, efficiency, and innovation.



# Purpose

The goal of this white paper is to highlight the complexities of physical and cognitive ergonomics in work environments and offer solutions for improvement. Individual and interconnected influences are examined to determine how they impact employee wellbeing and performance. This white paper surveys peer-reviewed studies in existing research to provide evidence-based suggestions for workplace renovation. The connections outlined in this review serve as a helpful resource to employers, workplace designers, and policymakers who desire to nourish and improve the holistic health of workforces..



## Introduction

The post-pandemic modern workplace is brimming with unprecedented transformations, technological advancements, alternative work arrangements, and diverse job roles. A thorough assessment of physical and cognitive ergonomics is necessary to prioritise the wellbeing and productivity of employees in these ever-changing environments.

# Defining Physical and Cognitive Ergonomics



The term itself, stemming from the Greek „ergon“ (work) and „nomoi“ (natural laws), encapsulates the quest to align work environments with human capabilities and limitations.

Historically, the emergence of ergonomics paralleled industrial advances, intensifying with the computerisation of workplaces in the late 20th century. In contemporary settings, ergonomics has transcended physical workplace adjustments, encompassing cognitive and organisational elements to address the complex needs of the modern workforce.

Physical ergonomics is concerned with the physical design of workspaces, focusing on accommodating the physiological needs and skills of individuals. Physical ergonomics pertains to the ways in which the human body interacts with tools and tasks. Healthy physical ergonomics include measures to prevent injuries, support posture, streamline manual tasks, reduce human error, and reduce harmful repetitive movements. Overall, physical ergonomics aims to increase productivity with tools, machinery, room design, and workers' wellbeing and satisfaction [2].

In contrast, cognitive ergonomics seeks to optimise mental processes, striving to nurture a workplace that engages cognitive functions and minimises mental fatigue. Cognitive Ergonomics focuses on

how brain function impacts the quality of worker performance as well as the mind's ability to process information and data. Relevant cognitive ergonomic markers include information processing, accidents and errors, decision making, interaction between humans and tools or machinery, mental workload, emotional distress, satisfaction, efficiency of design, and worker training.

Physical and cognitive ergonomics within the workplace have a significant impact on worker's wellbeing and quality of productivity [3]. Physical and cognitive ergonomics do not operate independent of each other, as the mind affects the body, and the body affects the mind [4]. Though deeply interconnected, these topics can still be discussed individually.

## Unique Workplace, Unique Needs

Each workplace and their workers have special ergonomic needs. Every workspace requires different design and consideration, depending on the function of the business and the tasks of the workers. The scope of this white paper will focus mainly on office workspaces.

In 2019 alone, employers nation-wide spent an average of \$3.6 million on workplace wellness programs [5]. Research also revealed that “employees who are satisfied with their work environments are 16% more productive, 18% more likely to stay, and 30% more attracted to their company over competitors” [6].

No matter what field of work is being studied, a better environment equals better quality of work and satisfaction of workers. It is therefore understandable why employers are increasingly willing to invest in achieving optimal ergonomic designs for their businesses



# Physical Ergonomics and Workspace Design

Evaluation of workspace design is critical for the foundations of physical ergonomics in the workplace. It considers employee privacy, the arrangement of limited open spaces, worker autonomy to personalise their own workspace, designated rest and break areas, and more.

Worker's wellbeing is significantly affected by the layout and design of their environments. Research confirms that specialised office furniture from companies like Interstuhl, that provide adjustable-height desks/ seating and appropriate lighting to reduce eye strain, noise control to prevent auditory disruptions, and temperature regulation to ensure comfort can improve comfort while decreasing the chances of developing musculoskeletal disorders (MSDs) [7]. It's worth noting that the proliferation of mobile devices and the shift towards flexible work arrangements necessitate ergonomic solutions that extend beyond the traditional office.



## Seating Ergonomics

A comfortable, posture-minded ergonomic task chair is a necessary element within physical ergonomics. Ergonomic task chairs that cater for a long duration of seating with adjustable armrests, seat depth, and lumbar support enable individuals to maintain a neutral spine position, mitigating the likelihood of developing (MSDs).

It is generally accepted that one should have their feet planted firmly on the floor while seated with their knees bent at a 90-degree angle. Arms should also rest at a 90-degree angle while the head, shoulders and pelvis are all in alignment. Adjustable lumbar supports can also be positioned to ensure the correct curvature of the spine.

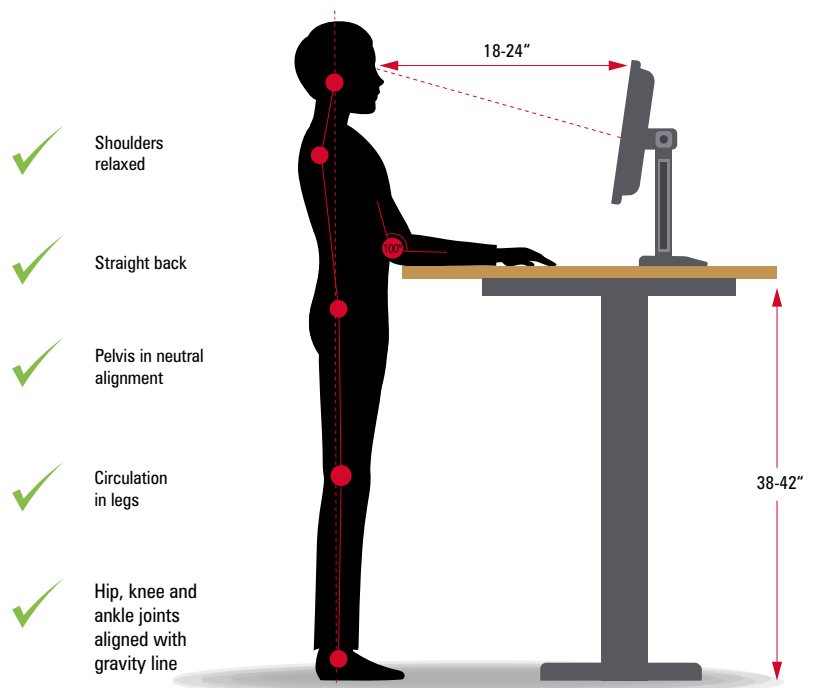
Active sitting should also be considered and refers to seating options that promote movement and posture changes to counteract the negative effects of prolonged sitting. Unlike traditional static office chairs, active sitting chairs are designed to allow and even encourage a range of motions such as tilting, swaying, and bouncing. These dynamic movements can lead to increased muscle activity, improved circulation, and enhanced spinal health. Active sitting is a response to growing evidence that sedentary lifestyles, particularly extended periods of sitting, are associated with increased risks for several health issues, including obesity, diabetes, cardiovascular disease, and lower back pain. A strong focus on the chair is often the most pragmatic action because altering the work surface may be limited by physical space constraints and an adjustable work surface is not always economically viable. [8]. For more information on practical task seating options seek professional advice for Interstuhl.



## Adjustable Standing Desks

Prolonged sitting is associated with musculoskeletal pain disorders. Adjustable standing desks are a popular choice for office environments, as they have been shown to minimise sedentary consequences while increasing the physical activity of employees. One study observed that call center employees who received a standing desk showed increased productivity than the seated control group [3].

It's worth noting that a one-size solution doesn't fit all and that standardisation of desk widths and heights comes with its own challenges. Consider a variety of desk configurations and allow employees to choose the configuration that best suits their needs for greater individual adaptability and support.



## Lighting Considerations

Office lighting has a powerful effect on the wellbeing of workers. Natural light is directly linked to improved mood and increased alertness. Poor lighting conditions have been linked to visual discomfort, dry eyes, blurry vision, and headaches. In one study, workers were provided with adjustable LED task lights. They reported significantly less discomfort, eye fatigue, and poor posture. They also had a more positive perception of job content [9].

Integrating windows, skylights, and adjustable artificial lighting has a positive effect on circadian rhythms, reduces eye strain, and contributes to overall wellbeing.



## Temperature and Ventilation

Optimal temperatures and ventilation systems are essential for employee comfort and productivity in the workplace. Research reveals that temperatures between 68-75.2 degrees Fahrenheit (20°-24° Centigrade), combined with appropriate ventilation, contribute to a more comfortable and focused work environment [10]. However, getting the right balance can prove difficult as age and sex also play a role in the subjective individual requirements that naturally fluctuate.



# Movement and Breaks



Essential to healthy physical ergonomics is regular movement and breaks throughout the workday as sitting for extended time periods is linked with obesity; insulin resistance, which may lead to diabetes; cardiovascular disease; and cancer [11]. Providing break rooms with comfortable seating, encouraging short breaks every hour with walking for 2 minutes all help balance sedentary behaviour, improving wellbeing and lowering the risk of cardiovascular disease.

One study led a group of healthcare workers through a whole body stretching (WBS) routine, 3 times a week for 6 weeks. Compared to the control group, who only received education, the WBS group reported significantly less musculoskeletal pain and fatigue and were able to do a variety of physical tasks with less effort [12].

In today's technologically dependent world eye strain is a cause for concern as screen time increases across the world. To avoid eye strain and its accompanying symptoms apply the 20-20-20 rule and shift one's gaze from the computer screen every 20 minutes to a distance of 20 meters for 20 seconds.





## Other Tools for Physical Ergonomics in the Workplace

There are many other physical ergonomic tools that can be introduced into the office workplace: specialised computer keyboards and mice, comfortable headphones, blue light blocking computer glasses, adjustable laptop stands, curved monitor screens, seat cushions, document holders, anti-fatigue mats, footrests, and more.

The positioning of these tools is also vital to prevent overextension and awkward postures. The optimal monitor height is at or slightly below eye level and arms distance away reducing neck flexion and associated neck pain. The layout of input devices should promote a natural and relaxed position for the arms and hands, as evidenced by reduced incidence rates of carpal tunnel syndrome and other repetitive strain injuries (RSIs) when such ergonomic principles are applied.

## Cognitive Ergonomics Defined

The International Ergonomics Association defines cognitive ergonomics as “mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system” [13].

Cognitive ergonomics can also be defined as “the mental effort and resources required to perform a specific task or activity. It is a measure of how demanding a particular cognitive task is on a person’s brain” [14]. Cognitive ergonomics impact the mind, which in turn impacts the quality of work and goals of workers.

The vast field of cognitive ergonomics considers human reliability, mental workload, decision-making, skill performance, human-computer interaction, training, physical pain and demands, work stress, attention, memory, and learning.





## Workspace Design for Cognitive Ergonomics

Designing workspaces for optimal cognitive ergonomic impact includes decreasing cognitive strain, disruptions, interruptions, and information overload. It is also important to provide clearly organised information and instructions to minimise cognitive load. Other helpful tactics are to assign a variety of tasks, minimise multi-tasking, encourage autonomy, offer advanced training, and create opportunities for teamwork [3].

## Reducing Cognitive Load

Understanding cognitive workload is essential for enhancing employee productivity and performance. Excessive cognitive workloads can result in fatigue, stress, and decreased productivity [15] [16]. A balanced workload can be achieved by assigning tasks with reasonable complexity, providing sufficient resources, and offering training programs.

Examples of cognitive workload support include implementing quiet hours, in which phone calls, visitors, and emails are temporarily suspended at times during the workday [3].

Reducing information overload, disruptions and interruptions allow workers to concentrate and stay on task. One study showed that limiting email checking to just 3 times a day increased the productivity of employees. In addition, it was shown that asking multiple questions at one time, as opposed to interrupting throughout the day, reduced information overload and stress [3].

Another method of reducing cognitive load is providing the employee with autonomy to choose the work setting that is appropriate to the task at hand. For example, when an employee requires complete focus and interruption an enclosed individual setting would be desirable to accomplish this task.



## Technology Integration and Challenges

Friendly interfaces in technology are pivotal to cognitive ergonomics. Providing employees with efficient software and ergonomic hardware can increase workflow and alleviate cognitive strain. However, even reliable technology and machinery experience breakdowns, which impacts worker wellbeing.

It is vital that workers have a sense of autonomy in their work environments. Machine and technology breakdowns are stressful, given that these tools are necessary to complete tasks. Workers report frustration and irritation following system or component failures. The consequences of these system failures create time delays, requiring overtime, and exertion of additional physical and mental effort, leading to exhaustion [18]. One such example would be connecting to meeting room technology which is rarely a seamless process. Ensuring that there is a strong IT team on-site to support such matters makes a difference to workers' cognitive loads.

Furthermore, cultivating a strong sense of autonomy is challenging when employees experience breakdowns that are inherently out of human control. To mitigate technology mishaps, companies can limit overtime, increase overtime wages, hire more staff to shoulder the workload, and have expert repair services on-site to minimise downtime due to malfunctions. The rise of the four-day work week is a natural reaction to a highly overworked and stimulated workforce.



# Group Dynamics and Cognitive Diversity



Creating positive group dynamics and pleasant fellowship improves group communication and increases motivation to work. Positive social contribution increases work performance and worker commitment to their company [19].

Conversely, emotionally toxic workplace environments drive employees away and reduce wellbeing and productivity. Dissatisfied workers are also likely to spread their discontent to other employees, draining the morale of a toxic culture even lower. This creates a cascade of unhappy, quitting workers and a high turn-over rate [20].

Research has shown that teams high in diversity produce more innovative solutions and better problem-solving skills [21]. Building a cognitively diverse population of employees helps to ensure a rich reward for both employer and employee. Diverse perspectives are indispensable to workplaces, contributing to a supportive, intellectually stimulating environment.



# Training, Development, and Information Organisation



The office is uniquely positioned to support training and development which is integral to cognitive ergonomics. Clear instructions and thorough, continuous training make tasks feel more manageable and are difficult to administer in a decentralized remote world. This helps to reduce mistakes, improve reaction speeds, and shorten learning curves [22]. Companies should invest in frequent training and development programs and environments to keep their staff engaged and up to date on best practices. Employees then have more opportunities to sharpen their skillset and become an in-demand worker. Learning is stifled by distance so by providing purposeful spaces in the office to support this activity you will naturally improve job satisfaction while also shaping adaptable and resilient workers [23].

Cognitive ergonomics relies heavily on optimal information organisation. Providing clear and intuitive information systems, reducing distractions, and offering sufficient storage solutions help a work environment remain focused and organised [24].



## Biophilic Office Design for Cognitive Ergonomics

Research shows that incorporating live plants in workplaces creates a positive biophilic (nature-connected) environment. Natural environments capture a person's involuntary attention, subconsciously supporting the recovery of mental fatigue, attention span, and cognitive capacities. Natural environments also have positive impacts on blood pressure regulation, heart rate, cortisol levels, and mood states. Biophilic design in offices is associated with the perception of more pleasant work environments as well as improvements in workers' health, wellbeing, productivity, and performance [25].

## Physical Design and Cognitive Ergonomics

Physical design of workspaces impacts cognitive ergonomics of workers. One study asserts that employee satisfaction is linked to office design, considering aspects such as interior decor, level of openness in floor plan, subdivision of space, seclusive space, number and diversity of workspaces, and accessibility of the building [26].

At times office design negatively impacts worker satisfaction. Research shows that an open-space concept was criticised by workers, who expressed that "stations" created polarisation between different employee groups. This fostered a sense of exclusion, as groups reflected territorial behaviours in popular work zones. An open-concept floor plan without zones for specific work to be completed contributes to a sense of lack of belonging or being "lost in space". Personal settings were highly coveted for the privacy they offered [27].

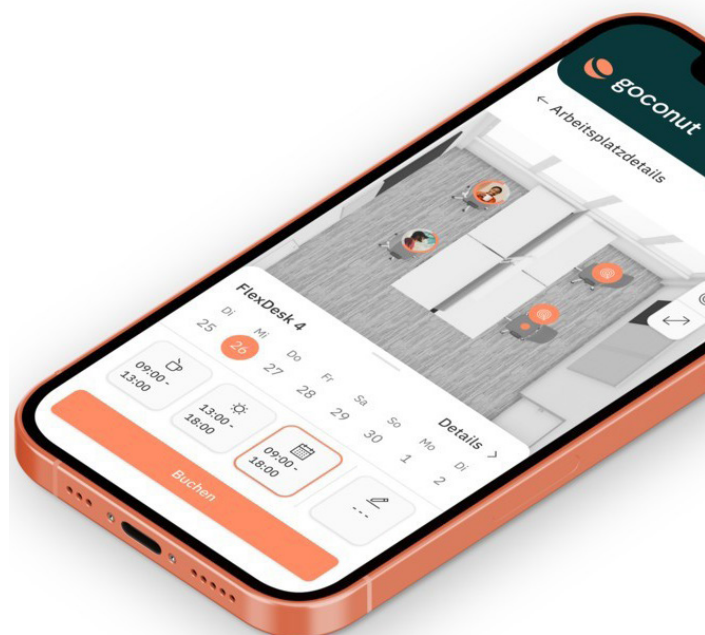
Brunia et al. [28] suggested that the main differences between the best and worst flexible offices concern employee satisfaction with the interior design, level of openness, subdivision of space, number and diversity of workspaces.





## Integrating Physical and Cognitive Ergonomics in the Workplace

The nature of physical and cognitive ergonomics is holistic and interconnected. Balanced implementation of proven strategies is essential for creating an optimised work environment. The relationship between physical and mental wellbeing requires an integrated approach to achieve holistic workplace design, policies, and practices that support the health, wellbeing, and performance of employees [28]. When considering workplace change, it's always recommended to reach out to experts like Interstuhl for updates in the latest thinking and processes.





# What do we learn from this?



The modern workplace is undergoing powerful changes as society implements healthy elements of physical and cognitive ergonomics. A purposefully designed, physical and cognitive ergonomic-focused environment benefits employee's wellbeing. At the same time, it also contributes to increased productivity, innovation, and job satisfaction as studies show. Strategies to improve physical ergonomics in the workplace include provision of posture-supportive seating, adjustable standing desks, natural lighting, personal LED lighting, proper temperature and ventilation, incorporation of breaks, movement and stretching, and providing various hardware tools like ergonomic computer keyboards, blue-light blocking glasses, and curved monitor screens.

To implement strategies that improve cognitive ergonomics in the workplace, employers should reduce cognitive load, minimise disruptions and interruptions, provide organised information and instructions, assign a variety of tasks, decrease mul-

ti-tasking, optimise technology interfaces, minimise technology breakdown, encourage worker autonomy, offer frequent training, and create opportunities for enjoyable teamwork and fellowship. Physical design considerations for cognitive ergonomics include incorporating live plants and biophilic elements, choosing pleasant interior décor, carefully considering design that promotes worker privacy, and avoiding certain open-concept layouts that promote feelings of exclusion and isolation amongst workers.

By approaching these evidence-based recommendations with a holistic mindset, organisations can cultivate work environments that are adaptable while safeguarding the health of their most valuable asset: their workforce.

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