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Nedenstående artikkel er skrevet av to dyktige medlemmer i NEHF, Knut Inge Fostervold og Thor Husby. Den ble lagt fram på NES konferansen i Stockholm i august. Den er en del av et større arbeid med en ny publikasjon om "Lys i læringsmiljø".

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Lighting quality in learning environments: premises for new guidelines

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New schools and rehabilitation of old schools represents huge investments. This paper discusses premises for good lighting quality in learning environments and stresses the importance of understanding human capabilities and limitations as evolutionary adaptations. The paper point toward that vision must be considered as work and that poor lighting has consequences although they may not be visible at first glance. Vision is viewed as an interplay of sub-processes that are emphasised differently depending on the task. Finally the paper discusses the importance of correct perception and that both psychological and physiological factors may contribute to the end result.

Keywords: Evolutionary adaptations, lighting guidelines, learning environment, schools

1 Introduction

In Norway, as in most other countries, huge investments are made each year on new school buildings and rehabilitation of old schools. According to the Primary and Lower Secondary Education Act (LovData, 2002) all pupils in Norway have the right to a good physical and psychosocial environment that promotes health, well-being and learning. Facing this challenging goal, one should expect the politicians, educational experts, and school authorities to use evidence based knowledge from the field of ergonomics in their effort to design school buildings, that comply with the intentions of the legislation. Generally, this seems not to be the case. A major problem is that empirical knowledge about how architecture, both interior and exterior, affects learning and the learning environment seem to be relatively sparse and not very well known among the decisive and granting authorities. Instead, plans and decisions often seem to be based on a combination of economical concerns, pedagogical ideology, architectural trends, and individual conviction.

Although, proper lighting unquestionably is a prerequisite for much learning, lighting is not an exemption in this regard. From research, it is well known that light not only influences vision, but also affects neuropsychological factors such as circadian rhythms and mood (e.g., Figueiro et al., 2011, Küller et al., 2006). However, the transfer of this knowledge to learning environments and classroom design seems limited. Looking at guides for the design of learning environments, the importance of proper lighting is often referred to by superficial statements like: "Learning areas infused with natural light, for example, provide an environment that is easy and pleasurable to work in." (JISC, 2006). In other cases the guidelines boils down to a question of the right amount of lux.

In a way, the current situation is understandable but not unavoidable. The learning environment is complex, with crisscrossing agendas struggling for attention. At first sight, the ergonomics of lighting does not seem to ease the complexity significantly. Although current guidelines often are both clear and concise, they do not seem to address the most important question; how do you light learning environments to sustain learning.

Initiated by The Norwegian Lighting Institute a project was launched to overcome the current lack of knowledge. The aim was to develop updated guidelines for lighting in learning environments that should help school authorities and entrepreneurs to implement lighting systems that improves the learning environment and satisfies the needs of pupils and teachers.

2 Premises for the guideline

Human vision is based on light emitted by the sun. Over millennia, our interaction with daylight has moulded the visual system. It is however not only the human eye that has been adapted to daylight, also in other areas we find anatomical adaptations to this totally dominating light source. Daylight is therefore the benchmark for any lit environment. However, acknowledging that artificial lighting is a virtue of necessity, at least in our part of world, lighting must be understood as any combination of daylight and artificial light.

The purpose of lighting requirements is to ensure that installed lighting systems provide high quality lighting. To achieve this aim a variety of factors should be taken into account. This could be factors such as: functionality, aesthetics, universal design, health and well being, technological and economical efficiency, and energy and environmental load. The approach should be evidence based and reflect best practise within the field. In order to do so, it is vital to understand that evolutionary adaptations have generated both capabilities and limitations

embedded in the human visual system, which may affect our reactions when encountering other light sources.

3 Light, vision, and the learning environment.

Learning environments are understood as any environment that is specially designed or modified for learning purposes and include all age groups from kindergarten to college and universities.

3.1 Vision is work

The main purpose of any lighting system is to provide sufficient light, with sufficient quality, to facilitate goal directed behaviour without unnecessary strain. In other words, the lighting quality should be good enough to enable the person to accomplish the visual task at hand, without the visual work itself causing any significant strain. The distinction between the visual task and visual work is done to emphasize that both concepts can be understood and examined independently, even though we generally do not experience it that way. The visual task is linked to objects in space, and refers to the tasks/activities that people use their visual system to perform. Visual work is associated with individuals and refers to the effort, physically and mentally, a person must exercise in order to carry out a visual task.

In educational contexts, as for most other goal directed activities, lighting is usually linked to productivity. We want to achieve something more than just to see. We want to orient ourselves efficiently, we want to develop good social relationships, and not least, we want to achieve the best possible learning outcomes. It is well known that inappropriate and inferior tools and work processes can lead to lower productivity, both in terms of reduced quantity and quality. There is no reason to believe that this does not apply to the relationship between human effort and learning outcome.

3.2 Vision: interplay of sub-processes.

What we usually understand as vision is in fact composed of several sub-processes or specific visual capabilities. Each process can be understood separately although they affect each other mutually. It is the sum of the different processes that gives us our visual experience. The primary goal for the visual system is to provide us with the most appropriate experience of the three-dimensional world around us, while this experience at the same time is adapted to the purpose of the activity being performed. The demands placed upon the visual system when enjoying ball-games inside a gymnasium is, for example, quite different from the demands required when reading.

Depending on the visual task at hand, different amounts of these processes are emphasised. To maintain optimal visual functionality over time, the visual system needs to adapt quickly to upcoming visual demands by readjustments of the relationship between the different processes. Malfunctions in one of the processes will indisputably affect the adaptability and thereby the functionality of the whole system, with reduced visual quality and productivity as a result. A well-designed lighting system must therefore take into account the sub-processes that are most important for the activities to be undertaken in a specific area.

To present a complete list of such sub-processes or visual capabilities is beyond the scope of this paper, but a list of some important capabilities, found in Fostervold and Ankrum (2008, pp. 74), is cited in table 1.

Table 1 Normal vision involves more than just "seeing", as noted in these definitions

Visual acuity	Seeing fine details.
Near vision	Seeing close objects.
Distance vision	Seeing far objects, such as blackboard.
Eye-hand coordination	Moving eyes and hands simultaneously so they work together quickly and accurately.
Focusing or accommodation	Maintaining clear vision at different distances
Peripheral vision	"seeing objects outside of the central area of vision
Color vision	Distinguishing Colors

4 Discussion

As mentioned previously, poor lighting often increase visual work load, which may lead to reduced functionality and productivity. A lighting system properly adjusted to the activities that take place in the lighted area will, in a timely manner, facilitate visual work and make it easier to perceive the world, and what happens around us. Usually, this will make it easier to carry out activities, which means that they can be completed faster and with higher quality. This may increase the feeling of cooping, a factor we know have a positive effect on learning and motivation for learning. Well-designed lighting may therefore, in addition to reducing the visual work load, also contain a stimulating effect. The learning outcome from tuition is thus not simply a result of how well the lighting system fits the visual work needed to accomplish a given assignment, but is also affected by the overall room lighting quality. In the same way a good lighting plan must satisfy architectural and financial requirements, the lighting plan should also support important factors in the learning environment, such as health, job satisfaction, pro-social behaviour and group affiliation of the individual.

4.1 Poor lighting has consequences

Humans have a vast capability to adapt, and in daily life we ostensibly tolerate very well deviations from optimum viewing conditions. However, adaptations have a limit. If the lighting quality is too poor, it will no longer be possible to perform the task. In other lighting conditions, individuals may manage to maintain their visual work. The task is performed, but with negative consequences for the user.

Our resources, both physical and mental are limited. If we use much of our resources on the visual work itself, a lesser amount of resources are inevitably available for other processes. Things take longer, errors occur, and the quality of the performed work task is reduced. This is a general principle and applies to both information processing and physical labor. To counteract this limitation, evolution has developed our ability to automate behaviour. Automated behaviour requires a minimum of mental resources, which means that we can use the most of our resources for other purposes.

A good example is reading. To begin with, the child uses most of its resources on the reading process itself. As reading is becoming automated, resources are released making it possible for the child to concentrate on understanding the content of what has been read. If the lighting conditions are poor, a disproportionate part of the resources must be allocated to processing the visual work itself. This could affect the appropriation of the reading process and delay automation.

Under good lighting conditions, much visual work consists of automated behavior. This implies that we can allocate most of our resources to the visual task. If there are deviations from optimal conditions, adaptations are usually needed. Unfortunately, even small

adaptations may lead to reduced quality of the automated behaviour. Over time this can lead to negative consequences, not only in terms of reduced concentration, but also in terms of reduced well-being and health. Depending on individual capabilities, such strains may lead to decreased learning outcome. To ensure an optimal result of the learning process, it is consequently essential that the individual's capabilities can be allotted to the visual- or learning task and not to the visual work itself.

4.2 Psychological factors

Although still under debate, most psychosocial conditions do not seem to be influenced directly by luminous settings. However, light and the distribution of light may still play an important role indirectly, through psychological processes. The knowledge concerning such relationships is still relatively sparse. However, some empirical evidence is present, especially from research areas nearby. Studying lighting in office environments, Veitch et al. (2010) have, for example, presented an empirical model that shows an indirect link between the luminous condition and mood. The relationship is mediated through individual lighting appraisal and the perception of room appearance. Mood is regarded an important factor in the psychosocial work environment. The model also identifies a link between mood and health, with low mood related to a greater degree of health problems.

Through satisfaction with the environment, room appearance and mood also seem to affect job satisfaction and organizational commitment. A high degree of organizational commitment is in the model negatively related to intent to turnover. Employees with low levels of job involvement express in other words, a greater desire to quit their current job. In the school context, this is particularly important at the upper secondary school level, since a high group affiliation have shown to predict lower intention to quit school (e.g., Studsrød & Bru, 2011). Despite the fact that this model has been developed in relation to office work, there is no reason to believe that situation should be very different in schools. However, the presented model (Veitch et al., 2010) should not be interpreted as definitive. Such models will always be dependent on the factors included in the model. It is therefore quite possible that other factors have equally, if not greater, importance in schools than those included in this model.

4.3 Physiological factors

Other factors are more closely related to neurological conditions and physiological processes. Some of these are regulatory mechanisms, like dark adaptation and the pupillary light reflex. In most cases these mechanisms increase our adaptability to the environment. In lighting research, especially the effect of the pupillary light reflex has gained attention. High adaptation luminance constricts the pupil and reduces the amount of light that enters the eye. The consequence is enhanced visual acuity and reduced glare. Improved visual acuity is obviously an important factor in the learning environment, due to reduced visual work load. Claims have been made that both daylight and artificial lighting with a spectral distribution close to daylight will enhance visual acuity even further. However, the empirical basis for these claims is often somewhat vague and reviews of the field have not been able to attain clear conclusions (e.g., Wu & Ng, 2003, McColl & Veitch, 2001).

An example more connected to neurological conditions is the relationship between light, the perception of wakefulness, and the production of the sleep hormone Melatonin. Melatonin is produced in the epiphysis (glandula pinealis) and it is well known that the presence of Melatonin is related to the feeling of drowsiness. It is also known that light entering the eye demise the production of Melatonin and that this process is related to the excretion of Cortisol and our sense of being awake and feel well rested (e.g., Zisapel, 2006). Recent research

results suggest that increased levels of ambient lighting in classrooms may affect the production of melatonin and the excretion of cortisol and that this may affect student achievement in a positive direction (Goven & Laike, 2010).

5 Conclusion

In most modern societies children and adolescents spend much of their time awake in buildings and environments that could be categorized as learning environments. On this ground it is worrying to witness the lack of ergonomic knowledge in the design of learning environments. It is perhaps even more disappointing that even when knowledge exists, it is very seldom, or only unsystematically, used in the planning process of new schools or when rehabilitating old school buildings. Lighting is no exception.

The ergonomics of lighting is multifaceted. Chances in one factor affect other factors. If each factor is adjusted in isolation, even adjustments according to best practise, may not provide an optimal net result. If we want to design lighting systems that sustain learning we need to understand the human capabilities and limitations that interact with the environment in learning situations. In this paper some of these capabilities and limitations have been discussed with regard to lighting and learning. Although the present discussion by no means is comprehensive it should provide a basis for the development of a new set of guidelines for lighting in learning environments. The next step that needs to be addressed is how such guidelines can be incorporated in the planning process of school building projects, both when new schools are build and when old schools are rehabilitated.

The goal of ergonomics is to understand the capabilities and limitations of people and to design environments that correspond. The result we are aiming for is to improve productivity, both quantitatively and qualitatively, while at the same time improving health and well-being. The aim for our children's learning environments should be no less.

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Støy og åpne kontorlandskap

Over halvparten av arbeidstagerne som jobber i åpne landskap er misfornøyde med at samtaler foregår i "offentligheten" på kontoret, skriver The New York Times, som viser til undersøkelser Berkley-forskere har gjort blant 65 000 personer i Nord-Amerika, Europa, Afrika og Australia.

For ikke å bli forstyrret av kolleger, velger mange å ta på seg høretelefoner og høre på musikk eller radio på jobben. I New York Times kaller en kontoransatt høretelefonene for de nye kontorveggene.

Kontordesignere har begynt å ta tak i problemet med støy i kontorlandskap, og en av de nye tjenestene som er kommet på markedet er lydmaskering av kontorer.

En spesialtilpasset lyd pumpes da ut i rommet. Den lyder etter sigende som et vindpust eller en vifte, og er satt sammen slik at den maskerer stemmestøy. Dette skal blant annet føre til at du ikke hører samtaler klart når de finner sted på litt avstand. Kilde: Ledelse Ukeavisen 25. mai

Dr. Jack Lewis, en forsker på nervesystemet, forklarte i et program på BBC i fjor at effekten av åpne kontorlandskap har ikke blitt slik man hadde forutsett. Tanken bak var at folk skulle kunne bevege seg og kommunisere fritt, hvilket skulle gi mer kreativ tenkning og problem løsning. Men det fungerer ikke slik; "Hvis du akkurat har fordypet deg i noe og en telefon ringer i bakgrunnen ødelegger det konsentrasjonen din. Selv om du ikke merker det nødvendigvis, så responderer hjernen på dette og blir distrahert."

I fjor gjorde University College London en spørreundersøkelse hvor 20 000 kontorarbeidere ble spurt om hvor fornøyd de var med sitt åpne kontorlandskap. De fant at 56% klaget på mangel på privatliv, 55% på dårlig temperatur, og 60% på støy.

I 2009 ble en studie gjort i Australia som viste at kontorarbeidere i åpne landskap fikk høyere blodtrykk og førte til stress, influensa og utmattelse.

Kommentar:

NEHF har ved flere anledninger tatt opp spørsmål omkring hvordan fysisk arbeidsmiljø påvirker arbeidsprosesser i kontorsektoren. Det finnes i dag ganske mye forskning på hvordan kontorlandskapet påvirker arbeidstakerne og de tingene som diskuteres mest er nettopp effekter av lav støy. Ønsker du å vite mer om dette kan du kontakte NEHF.

Ergonomi på arbeidsplass blir enda viktigere i fremtiden i Irland

En stor økning i arbeidstakere med muskel og skjelett plager er forventet i Irland frem mot 2020 i følge forskning publisert av The Institute of Public Health (IPH) i Irland.

Organisasjonen sier at et større fokus på å forhindre risk faktorer og på å forbedre arbeidstakeres livsstil blir viktig. Forsknings analytiker Steve Barron sier at et større fokus på ergonomi på arbeidsplassene trengs.

De forventer en 15% økning i pasienter med ryggproblemer fra 2010 til 2020. De forventer i samme periode en 30% økning i pasienter diagnostisert med leddgikt, og en 29% økning i pasienter med osteo arthrose. Dette vil få store konsekvenser for helsevesen og økonomi i Irland. Kilde www.irishhealth.com

Ingen Overraskelse for Ergonomer

En studie publisert 13. August :

The effectiveness of a chair intervention in the workplace to reduce musculoskeletal symptoms. A systematic review Sjan-Mari S Van Niekerk, Quinette QA Louw **and** Susan S Hillier

Viser noe som ikke akkurat kommer som en bombe på Ergonomer,-

Bakgrunn:

Å sitte lenge i statiske stillinger har vært assosiert med muskel og skjelett dysfunksjon. For kontorarbeidere har intervensjon ofte vært å se på arbeidsbord og stol. Stoler som kan forhindre for mye slitasje på det nevromuskulære system kan hjelpe mot muskel og skjelett smerter og ubehag. Den vanligste intervensjonen er å justere sete høyde og dybde for å matche målene (anthropometrics) til brukeren. Særlig p.g.a det nåværende økonomiske klima vil arbeidsgivere ha bevis for at disse ergonomiske gjennomgangene på arbeidsplassene har noe for seg. Denne

studien evaluerte bevis for hvor effektivt justeringer av stoler er for å redusere muskel og skjelett symptomer på jobb.

Metode:

Pubmed, Cinahl, Pedro, ProQuest, SCOPUS and PhysioFocus ble brukt som search.

Konklusjon:

Alle studiene viste at det ble en reduksjon i selv rapporterte muskel og skjelett smerter etter at stolene hadde blitt justert for å passe bruker.

The New York Times

So Many Gadgets, So Many Aches

By PHYLLIS KORKKI

Published: September 10, 2012

LOOK around, they're everywhere: hunched shoulders, angled necks and wrists, hands twisted like claws. As people harness their bodies to use more electronic devices in more places, they may unknowingly be putting themselves at a greater risk of injury.

Things were much simpler 20 years ago, when employees worked mainly on desktop computers that could be adjusted for maximum comfort. Now people have added laptops,

smartphones and tablets to their arsenals, and they're using — or perhaps misusing — them at work, at home and in trains, planes, hotels and coffeehouses.

Visit any airport waiting area, said Alan Hedge, an ergonomics professor at Cornell, and you can see people using their laptops in awkward and contorted positions. Too much of this activity is bound to take a physical toll.

By positioning themselves improperly, people are at greater risk of eye strain, tendinitis and carpal tunnel syndrome, to name just a few ailments. Repetitive actions that lead to overuse of muscles and tendons can inflame them, causing pain in the hands, shoulders, neck and back.

Laptops are adding to these problems because "they do not meet any of the ergonomic requirements for a computer system," Professor Hedge said. The keyboard and the screen are connected, so if you place the keyboard at the ideal position for typing, the screen won't be at the best distance for viewing, he said. Docking stations that provide an extra keyboard or monitor can help solve this problem.

Another lurking danger is touch screens, Professor Hedge said. Keys that move up and down provide more of a cushion for the fingers, whereas the drumming of fingers against screens is harsher and can lead to soreness. For that reason, he said, a tablet should not be used heavily for typing.

And think of our poor thumbs, which have been pressed into a level of service they were never meant to provide. Thumbs are more vulnerable than fingers because they have two bones instead of three, Professor Hedge said.

"If you want to get injured, do a lot of texting," he added (and that includes the chance that you will collide with something while walking or driving).

Texting has led to an increase in a condition known as De Quervain's tenosynovitis, where the tendons become so inflamed that it becomes painful to move your thumb, affecting your ability to hold things, Professor Hedge said.

These days, you can be texting your boss one minute and a friend the next. And this greater mingling of work and personal life is placing more stress on the body. It can also make it harder to pinpoint what is causing a new physical problem.

Adding a device or routine can tip the scales toward an injury, said Carol Stuart-Buttle of Stuart-Buttle Ergonomics in Philadelphia. She gave the example of a client who recently began typing on a propped-up tablet computer at home. That placed extra strain on her wrists so that typing at work — never a problem before — suddenly became painful.

To trace a pain's origins, you may need to become a detective in your own life. As you seek to lessen or prevent pain, she said, look for any repetitive and sustained activity in all the devices you use.

Don't discount psychological factors, she added. Mental stress can cause you to tense your muscles, aggravating any existing physical stress.

If you can, consult an ergonomics expert at your company to arrange the best possible setup for your devices at both work and home, along with a discussion of best practices. And notify your employer or consult a doctor if you experience pain or vision problems.

Ms. Stuart-Buttle says a common health issue is vision impairment stemming from a monitor being placed at the wrong distance from the eyes. And she often finds problems like tendinitis because people aren't supporting their arms when they use a mouse, causing a tighter grip and increasing muscle tension.

IF you are hunched over while working, something is wrong, she said. Look for the things that are pulling you forward and fix them. Sit back in your chair, support your feet if needed and make sure your arms are relaxed as you type. Check that the screen is close enough so that you can see clearly without strain, enlarging the type size if necessary.

Be aware of these factors and try to approximate them as much as possible when you aren't at your primary workstation.

As you work, "match the technology to the task you want to perform," Professor Hedge said. "If what you're doing is a lot of typing, you need a keyboard," he added. "Don't try to type 'War and Peace' with your thumbs."

The simplest and most well-worn piece of advice is one that people too often forget to follow: take a break. Separating yourself from your machines gives your muscles, and your mind, a rest that they richly deserve.

Ryggsmerter, ny norsk studie:

De som går på ski og ror har ikke mer vondt I ryggen enn oss andre.

(Reuters, 21. Sept. 2012)

Profesjonelle roere og ski entusiaster har ikke mer vondt i ryggen enn resten av folket, på tross av at de legger stadig belastning på ryggene sine. Dette viser en ny norsk studie som har blitt lagt merke til internasjonalt.

Elite sportsutøvere i andre sporter slik som gymnastikk og wrestling har derimot vist seg å ha en høyere sjanse for å få vondt i korsrygg. Roere og skigåere må ikke bøye seg langt bakover, men de må bøye og rette opp ryggene sine, om og om igjen.

"De utsetter ryggene sine for monotone bevegelser i årevis" sa ledende forkser Ida Stange Foss, på Idrettshøyskolen i Oslo, hvis studie ble publisert i the American Journal of Sports Medicine.

Alikevel fant ikke Foss sitt team at profesjonelle roere eller skiutøvere har mer vondt i ryggen enn de som sitter og ser på sport på tv.

Av de 415 tidligere roerne og langrennskiløperne som deltok i studien sa 56% at de ikke hadde hatt noe vondt i ryggen det siste året. Til sammenligning hadde 53% av kontrollgruppe som ikke hadde drevet med sport samme svar.

"Dette er en viktig og positiv beskjed til sportsutøvere" sa Foss i en email til Reuters.

Andre studier i dette feltet viser at det som gir størst fare for ryggsmerter er de som er ekstreme...ekstrem trening eller ekstrem sofasitting er ikke lurt, da har man høyere risk for å få problemer med ryggen.

Et annet interessant poeng fra Foss sin studie viser at langrenskiløpere får mer vondt når de går klassisk enn freestyle.

Den gyldne middelvei...