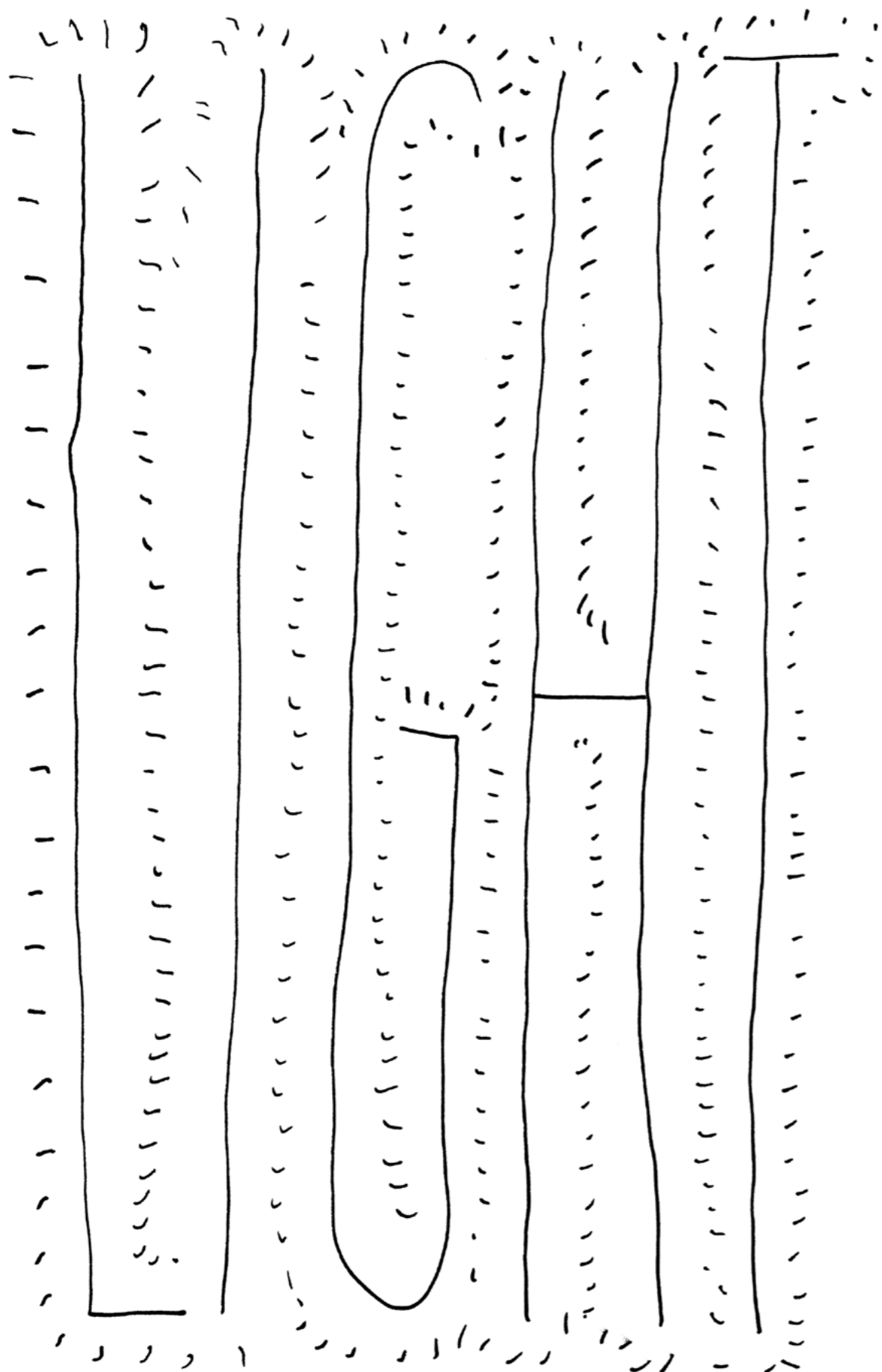


DA

DAYLIGHT & ARCHITECTURE MAGAZINE
VELUX GROUP AUTUMN 2014 ISSUE 22 10 EURO
SLEEP, WORK, LIVE





VELUX EDITORIAL

SLEEP, WORK, LIVE – HEALTHY LIVING AROUND THE CLOCK

Our health and well-being are essential parameters to the quality of our lives. But we spend an excessive amount of time inside buildings – and the air that we breathe and the daylight we are exposed to have a great impact on those parameters.

In recent years, much of the debate on sustainable architecture – and the public discourse on sustainability as a whole – has focussed on energy, CO₂ emissions and the efficient use of material resources. These are all vitally important issues for our survival on this planet; but they are only three of a whole spectrum of issues facing us as human beings living in the built environment. Because health and well-being are paramount to all of us, the primary goal for sustainable homes and urban areas should be to preserve those precious benefits for the people who live in them.

This issue of D/A is a call to everyone – building owners, engineers, architects and other professionals working with the built environment – to be aware of and alert to the interlocked factors and mutual dependencies of health and contact with nature, and its material and immaterial resources. A virtuous circle becomes apparent: the more people interact with nature in their everyday lives, the healthier they are likely to become; and the more sensitised they are likely to be to the protection of nature and its resources. 'Nature' includes not only flora and fauna. Just as important for our survival are the air that we breathe, the daylight that is being shed on our skin, and the time rhythms of nature that we depend upon, however hard we try to deny them in our modern, 24-hour society.

In the first two articles in this magazine, Peter Buchanan and Jakob Schoof outline the challenges of reintroducing nature into our lives, and explain how the different levels of contact with nature interact with each other. The third article presents an in-depth analysis of what human beings need for healthy sleep, work and life and the knock-on impli-

cations to genuine attempts to design health into our future cities, homes, schools and office buildings.

In the last article, we present recommendations for healthy homes. This compilation is the outcome of five workshops that have brought together interdisciplinary teams of international experts who seldom meet and discuss across the boundaries of their own fields of expertise. The workshops were initiated and organised by the VELUX Group in 2012 and 2013 as part of our continuous search for – and research in – sustainable living in buildings.

The VELUX Group is committed to tackling the challenges of climate change, limited energy resources and the basic need for human health and well-being inside buildings – and we strive to supply products and solutions that support this commitment. This magazine is our contribution to the discussion on the future development of sustainable architecture. It is our hope that this development will be qualified by the realisation that sustainable building is not only about preserving natural resources far away in time and space, but, in a very immediate sense, about human health and well-being.

Enjoy the read!

The VELUX Group

D/A

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SYNCHRONISING WITH NATURE

Sustainable architecture so far has mainly aimed at making buildings 'less bad' in terms of emissions and harm to the environment. This narrow mindset must be overcome, argues Peter Buchanan. In his article, he calls for a new wave of sustainable building design aimed at doing 'more good', particularly as regards the physiological health and psychological well-being of the inhabitants.

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FORWARDS TO NATURE

We can only truly care about what we know and what we experience in our everyday lives. Based on this premise, Jakob Schoof explores some of the most promising strategies to reconnect our lives and our built environment to nature. These operate in four distinct ways: the physical, the sensory, the way we use vital resources, and the temporal.

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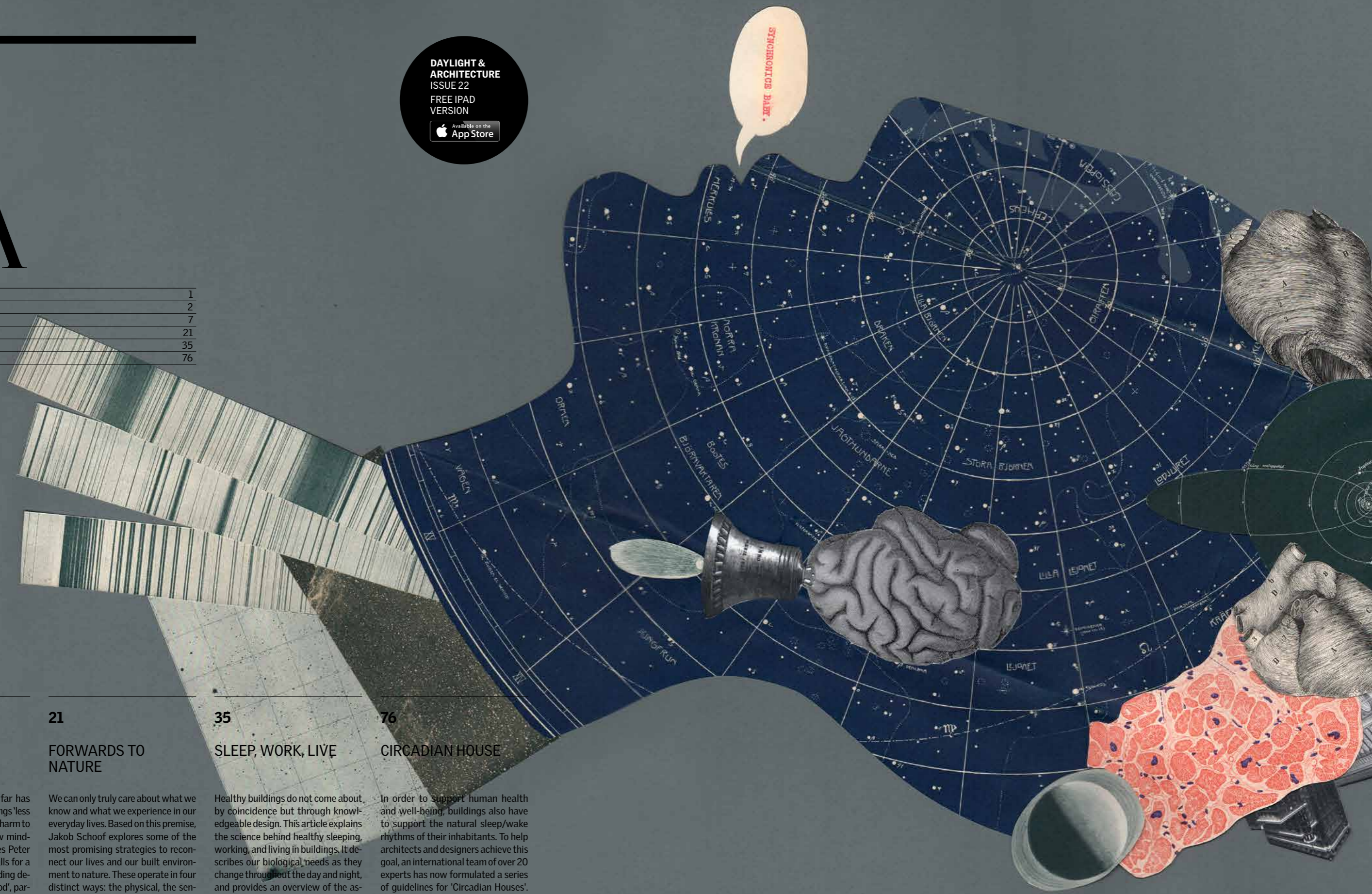
SLEEP, WORK, LIVE

Healthy buildings do not come about by coincidence but through knowledgeable design. This article explains the science behind healthy sleeping, working, and living in buildings. It describes our biological needs as they change throughout the day and night, and provides an overview of the aspects that need to be considered if buildings and cities are to become truly beneficial for human beings.

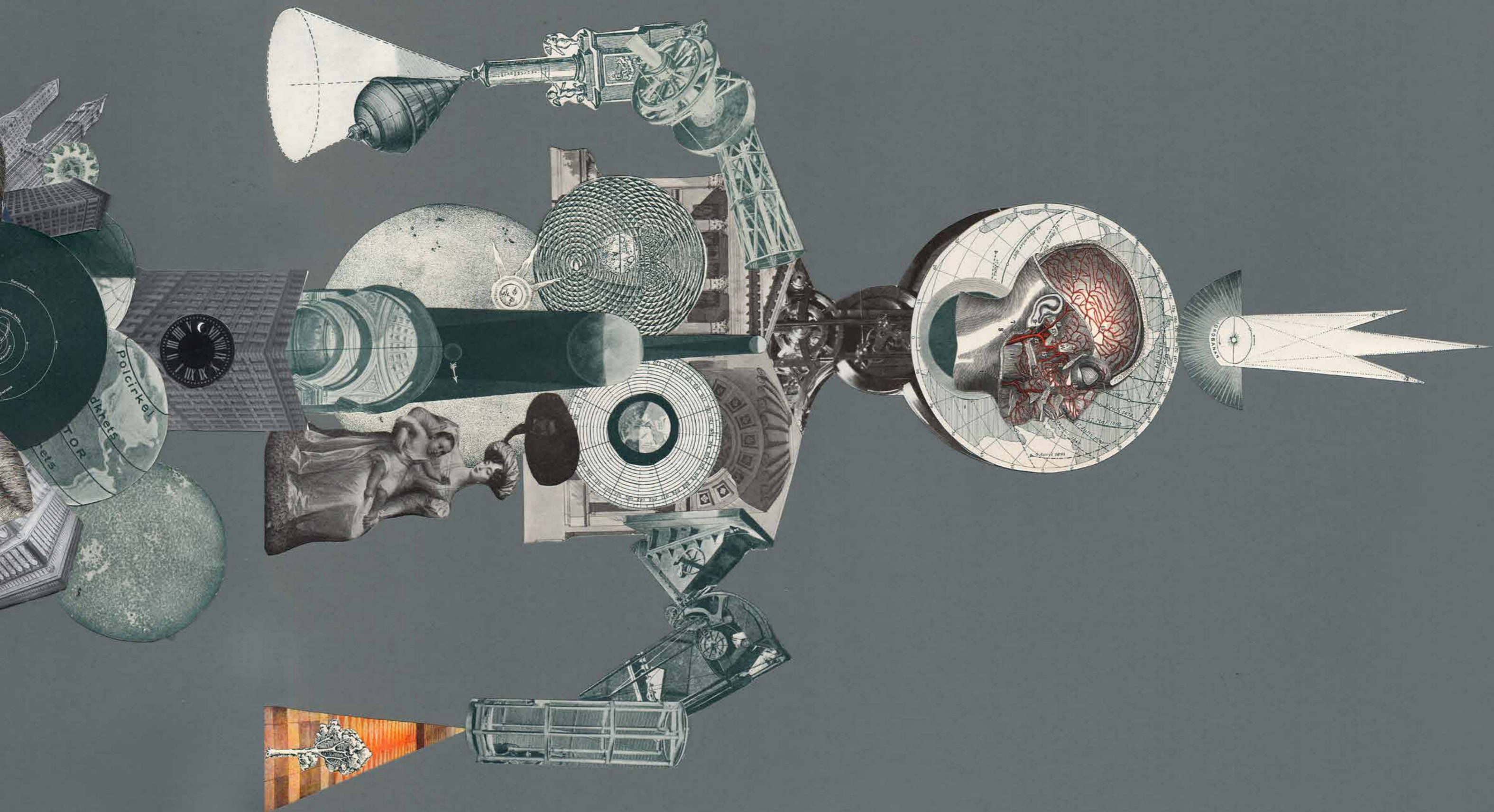
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CIRCADIAN HOUSE

In order to support human health and well-being, buildings also have to support the natural sleep/wake rhythms of their inhabitants. To help architects and designers achieve this goal, an international team of over 20 experts has now formulated a series of guidelines for 'Circadian Houses'. Amongst other things, these constitute a call for more variety in the spaces we inhabit - both in terms of lighting conditions, temperatures and noise levels.



Jesper Waldersten (born 1969) is one of the most popular Swedish artists. For many years, his – often satirical – illustrations have regularly appeared in Sweden's leading newspaper, Dagens Nyheter, as well as in several magazines in his home country. Jesper Waldersten has also worked as an art director and book illustrator. In 2011, his book *Waldersten 365* was awarded the Swedish Book Arts Award. With his inimitable style, in which he mixes words, photos, music and draughtsmanship, Jesper Waldersten creates images in which nothing is static, nothing is obvious. The result is unpredictable and usually unsettling; yet his sharp humour and ingenious wordplay always conceal a depth of seriousness.



- A little bit more to the right please!



SYN- CHRO- NISING WITH NATURE

By Peter Buchanan

Over time we have progressively removed ourselves from and denied our dependencies upon the natural world, and moved out of sync with its rhythms. Science, which facilitated this, is now proving that the consequences harm us as well as the biosphere. For our health, and the happiness that reinforces it, we need to reconnect and live in greater harmony with nature in all its richly sustaining aspects by bringing these into the city and its buildings in as many ways as possible, while also increasing its sense of urbanity.

For the nomadic tribespeople we were for nearly all our time here, the natural world was home; it gave birth to and sustained us, provided food and medicine immediately to hand, and so was celebrated with due gratitude and reverence.

Until recently we lived in intimate engagement with a world of endless variety and nuance, surrounded by the multi-sensorial stimulus of nature's profligate diversity of species collaborating in complexly interdependent ecosystems. Moreover, all these responded each moment and in myriad ways to nature's shifting cycles and weather patterns. These range from the sensual stimulus of leaves rustling audibly in the breeze to create dancing patterns of dappled light, or the subtly choreographed sequence of animals and birds drinking and splashing in murmuring streams, to the health-affirming coordination of our various individual biological cycles with those of the day and season. Today we need reminding of the paradise we have largely exiled ourselves from and, to an even greater extent, have co-evolved with and, for most of human history, thrived in and been an intrinsic part of.

For the nomadic tribespeople we were for nearly all our time here, the natural world was home; it gave birth to and sustained us, provided food and medicine immediately to hand, and so was celebrated with due gratitude and reverence. But with agriculture and permanent settlement we wrested from this larger world a contracted and bounded home, and defended ourselves against the incursions of nature that we progressively sought to conquer and control. With passing time, we saw ourselves as increasingly separate from the natural world that, in the last few centuries, has been considered primarily as mere material resource to be exploited. We have become deadened to, and even deny, our multiple webs of dependency on it, so tolerating the ravaging of the biosphere, as supercharged by colonialism, industrialisation, technological hubris, reductionist science and extractive multinational corporatism.

HOMOGENISING AND UNHEALTHY IMPACTS OF MODERNITY

Modernity brought great gifts, but we now confront its toxic downsides. Besides those mentioned, these include a mania for standardisation and the resulting homogenisation and narrowing of sensual experience – the antithesis of nature's generously diverse profligacy. In architecture this resulted in standardised building components and everywhere the same dumb boxes aloofly disregarding their settings. Comfort standards too are defined as steady

ideal conditions – of temperature, light levels and so on – so annihilating the sensual joys of ever-varying stimuli. Contrast a traditional building with a contemporary one. The former's forecourt might greet us with a fountain, celebrating dependency on the precious resource of water, and a surrounding arcade offers sun or shade to move between with time of day and season. Then inside, the hearth's dancing flames mark the home's social and sacred focus, while beyond, on a breeze-wafted terrace, you can enjoy the setting sun on which all life depends. Today water, heat and cool air are ducted in, offering no sense of their origins to curb careless consumption.

We have long known we are ravaging the planet; now we increasingly realise the extent to which the same forces harm our health too. The first wave of green design cut energy consumption – and so emissions; while increasing the use of renewable resources for energy and materials to somewhat lessen negative environmental impacts. Called sustainable design, it was merely less unsustainable, worthy but insufficiently inspiring to be eagerly and widely adopted.

Besides protecting the planet, the emerging next wave of green design extends concern to protecting people, to improving physical and mental health and the intimate engagement with nature that enhances these. Scientific studies are proving what should, from an evolutionary perspective, be obvious common-sense, that the natural environment we evolved with provides multiple health benefits. (Meanwhile politicians and corporations argue, as excuses for resisting change, that such proof is not yet conclusive. In future our narrowly rationalist modern mind-set and reductionist science will be recognised as inculcated stupidity.)

This essay explores some of this second wave of green measures. Like the first, it promises considerable benefits, yet is merely another step towards true sustainability which must entail more comprehensive and inspiring cultural changes than considered here. Suffice it to say that these will extend the emerging ethos, which informed earlier waves of green design of opening up to, enjoying and drawing upon the natural world and the rich variety of ambient phenomena we evolved with.

...the vastness of cities, ringed off from countryside by sprawl, now isolates urban dwellers from nature. Even the countryside is not nature but agribusiness monoculture poisoned by pesticides, so that wildlife and biodiversity have retreated to suburban gardens.

INCREASING THE PRESENCE OF NATURE IN CITIES
There are myriad rationalisations for separating ourselves (or liberating ourselves as we mistakenly saw it) from nature and denying our manifold dependencies upon it. Particularly influential are the emphasis on the narrowly objective and measurable, and the utilitarian ethos, that still underpin much science, technology and economics. Postmodern critiques, phenomenology and so on brought counterbalancing currents, but the modern mind-set still dominates thinking about architecture and the city. The latter continues to be largely seen as an engine of productivity, with parks and recreation merely for distracting release and amusement, rather than as the crucible of culture, consciousness and the continuing evolution of humankind.

More prosaically, the vastness of cities, ringed off from countryside by sprawl, now isolates urban dwellers from nature. Even the countryside is not nature but agribusiness monoculture poisoned by pesticides, so that wildlife and biodiversity have retreated to suburban gardens. (In the UK, official guidelines encourage gardens hospitable to wildlife using low maintenance indigenous plants.) Children today lack the easy access to woods and wilds enjoyed by earlier generations, a problem compounded by paranoid parents prohibiting children (with some justification) from wandering freely for fear of traffic and dangerous strangers. Numerous studies show children spend diminishing time outdoors, depriving them of intimate engagement with nature and physical adventure (both essential to their development), leading to 'nature deficit disorder'¹ and health problems.

Modern urban life has brought epidemics of 'diseases of civilisation'² that can be ameliorated by the introduction of nature, particularly trees and planting. People are more inclined to walk or cycle (reducing obesity, diabetes, hypertension and other cardiac problems) if streets are pleasantly shaded and sheltered by trees. These also absorb pollutants like CO₂, NO₂ and ozone, and help precipitate particulates, cleaning and refreshing the air to offset diseases like asthma (although contributing to pollen allergies).

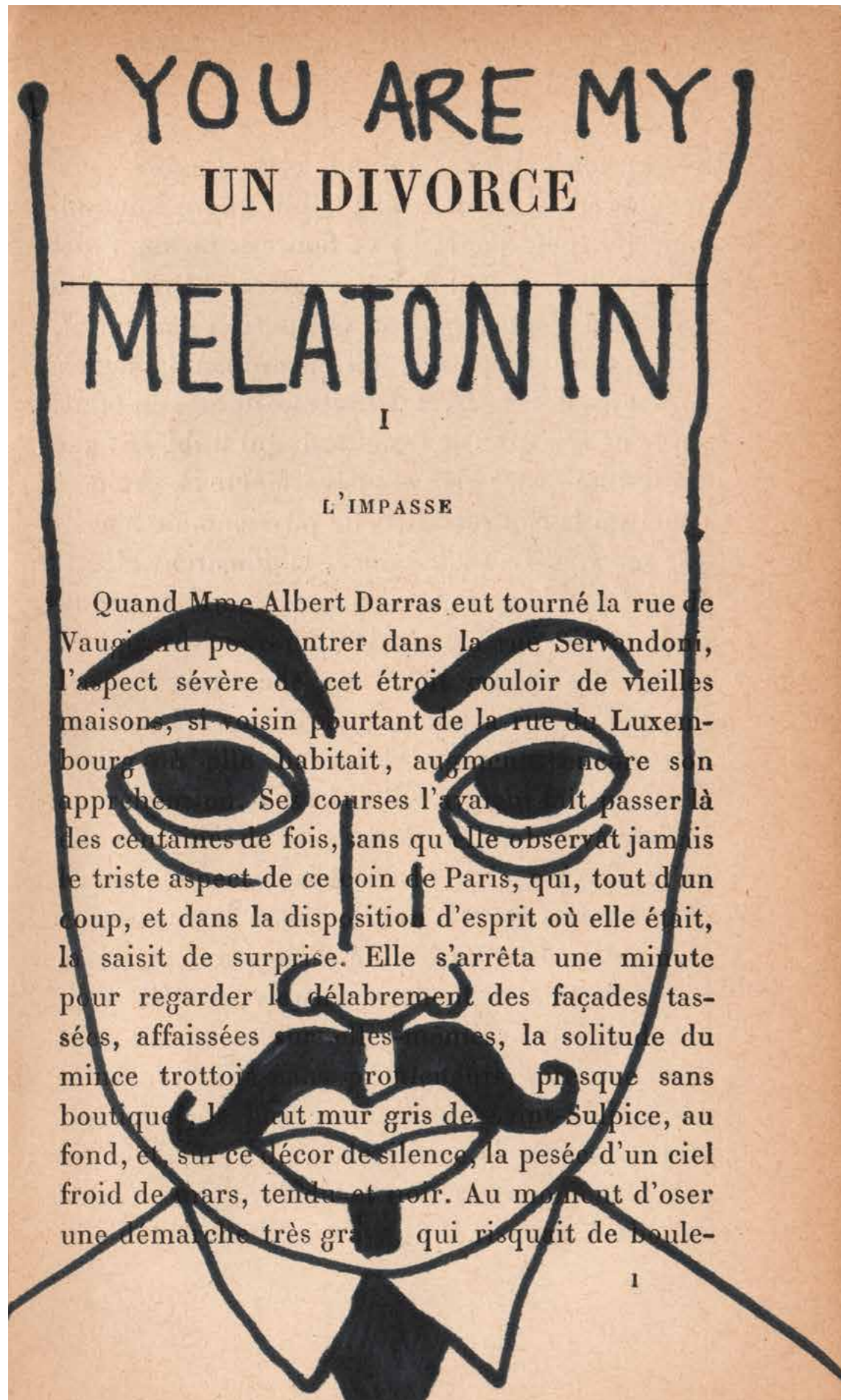
To enhance health – and reduce energy consumption and global warming – urban designers advocate 'compact' cities of dense mixed-use neighbourhoods suited to walking and cycling along shady streets,

with quieter traffic-free greenways for walking to school, jogging and so on. These are also corridors for wildlife, some of which must migrate as food plants and suitable climatic conditions move with climate change.

Scientific studies also prove that the soothing presence of trees and plants – and the birds, butterflies and other wildlife they attract – dissipates stress (proved by reductions in cortisol, heart rate and blood pressure³), which compromises immune systems and contributes to almost all diseases. For instance, patients in hospital wards with verdant outlook heal quicker than those without natural outlook. Indoor plants bring similar benefits, especially for those looking after them.⁴ There is even evidence of reduced violence in verdant areas – perhaps reflecting their greater affluence, although planting has reputedly brought peaceable behaviour to non-affluent areas. (Elsewhere, people remove planting as potential hiding places for criminal types.) Other studies show that planted streets, and particularly easily accessible green spaces removed from traffic, encourage social interaction and multi-family play, bringing social and health benefits, including alleviating stress. This tallies with the widespread adoption of the successful *woonerf* concept of slowing traffic and mixing it with pedestrians in paved and planted multi-use access to residential complexes.

Dark impervious surfaces of streets, parking lots and modern flat roofs contribute to the 'urban heat island' effect whereby temperatures rise several degrees above those of the surrounding countryside. Many cities are becoming almost unbearably hot in summer (especially for people without air-conditioning, which further raises temperatures outdoors), causing fatalities amongst the elderly. Planting, including on roofs, offsets this with cooling shade (and screening windows and roof lights from direct sun), by absorbing heat through photosynthesis and with transpiration-induced up-currents of air sucking in fresher air.

The same hard surfaces, and sun-baked soil, cause rapid run off of rainwater and flooding. Planting prevents this by keeping shaded soil permeable to absorb water and allow slow runoff, while roots guide rainwater into the earth and its aquifers. Recent UK research shows a single row of trees can prevent rainwater rushing down slopes.⁵ Grassy swales are



Illuminance in offices, factories and schools (where away from natural light) is often only 300 lux and seldom more than 400–500 lux, which results in serious underexposure to light for many people

increasingly prevalent landscape features, slowing runoff and downstream flooding. And there is a movement, still more discussed than acted upon, to clean, open up and landscape the banks of rivers buried under cities to become visual and leisure amenity, and to temper summer heat.

All these measure resonate with and complement those of current and increasingly influential international movements. These include various forms of urban agriculture ranging from using empty land and roofs for food production (vegetables and grain, fowl and fish), and the deep satisfactions (including a sense of meaning) gained from participating in such enterprises, to ‘urban farms’ offering city children a chance to encounter and tend farm animals and to till, sow and harvest. Originating in Italy is the Slow City (Città Slow) movement dedicated to making urban life more convivial and less stressful by such activities as planting streets and adjacent spaces to be more hospitable to lingering and socialising, and celebrating local customs and cuisine to enhance the character and enjoyment of cities. Spreading rapidly within and out from the UK is the Transition Town movement, committed to making urban areas more resilient so as to better resist future challenges by being more self-sufficient and socially vibrant. Its many strategies range from planting streets with fruit and nut trees, increasing the interdependency of towns and surrounding country (including farmers’ markets for local produce) and letting the younger and less well-off share the gardens of the elderly and/or more affluent. More limited in its focus, but still significant in countering nature deficit disorder, is the ‘forest school’ movement, originating in Germany and spreading elsewhere, in which pre- and early school children study and are active outdoors in woodland settings.

Yet no measures described above should be mistaken as endorsements of the currently influential academic fad for ‘landscape urbanism’, now taught as a specific discipline in some architectural schools and manifesting in designs of academic practitioners currently garnering publicity. Offered in antithesis to the generic urban typologies of New Urbanism,⁶ the attention given to local topography and ecology is obvious good sense. Many designs, though, seem to prioritise surface water management above all else, resulting in networks of elongated, wiggly parks or

greenways that offer alternative pedestrian circulation to the street system. This would be laudable if the street system were not handled in a similar way, so rendering all locations within these interwoven networks as much the same, essentially homogenising what should be a richly varied public realm and annihilating true urbanity, choice and social intensity. Thus even large urban areas with tall buildings end up no more urban than a gigantic golf estate.⁷ Instead, we should seek to simultaneously increase both the presence of nature and the sense of urbanity, which need not be mutually exclusive, to facilitate a wide range of activities and experiences, along with the benefits to the health of people and planet.

CONNECTING INTERIORS TO AMBIENT CONDITIONS OUTSIDE

The impulse to increase the presence of nature in the outdoor spaces of the city is complemented by that of reconnecting building interiors with the natural world outside – which brings benefits beyond maximising natural light and ventilation for energy efficiency. For us today, the most pathological form of modern architecture (once admired as the epitome of narrowly defined efficiency and suave corporate cool) is the freestanding, air-conditioned, tinted glass enclosed box that ignores context, culture and climate. Apart from not shaping a legible public realm by framing urban space, the abstractly-gridded facades further annihilate any sense of place – aptly reflecting the abstract disengagement of the global corporations they house from their deleterious planetary impacts. Occupants sealed within might as well be under the sea or on a planet with a poisonous atmosphere rather than on the paradisaical planet these energy guzzlers are destroying. Yet the truly toxic conditions are inside, with chemicals off-gassed from finishes and furniture, recycled germ-laden stale air and an unhealthy narrow spectrum and low levels of light – the latter partly a consequence of seeking efficiency and economies in energy consumed in the necessary artificial lighting and air-conditioning. Illuminance in offices, factories and schools (where away from natural light) is often only 300 lux and seldom more than 400–500 lux, which results in serious underexposure to light for many people, as the average office worker spends up to 90% of his time indoors. In contrast to this,

Particularly significant is bright light in the morning, confirming the old idea that bedrooms and breakfast rooms should face east to facilitate alertness in the mornings.

even an overcast day in northern Europe has 10,000 lux, and a bright sunny day up to 100,000 lux. Although excessive solar radiation has its downsides (it may cause skin cancer), it is only outdoors that sunlight will deliver the dose of UVB radiation that we require for vitamin D synthesis. Medical studies show we are starved of the health benefits of natural light and that vitamin D deficiency contributes to many diseases besides rickets – including cancer (colon, breast and prostate), hypertension and heart disease, osteoporosis and autoimmune disorders.⁸ Moreover, low light levels strongly correspond with depression, a modern epidemic resulting in massive loss of workdays.

Constant light levels are a problem too in that they tire the eyes that are relaxed by continual changes in focus and light intensity – hence working on computers is wearying and deleterious to eyesight. Slowly fluctuating light levels – commonly delivered by daylight – relax the eyes and provide the subtle pleasure of varying sensory stimulus denied by constant, supposedly ideal, conditions of light, temperature and ventilation. Even before energy costs and global warming provoked rethinking notions of constant, ideal conditions, a nineteen-sixties Swedish study exposed the fallacies of such assumptions. This proved the obvious – that in winter, when warmly dressed, people feel more comfortable inside at lower temperatures than in summer, when lightly clad. It took two decades for service engineers to take notice, but recognising this seemingly minor issue and allowing temperatures to fluctuate through the year brings huge energy and cost savings. Variations in temperatures considered acceptable proves even more beneficial in naturally-ventilated spaces where occupants control their own conditions. A post-occupancy survey of Foster's Commerzbank tower in Frankfurt found people sitting happily before open windows at much warmer and cooler temperatures than expected, so much of the building is naturally ventilated for more of the year than anticipated during design.

Although prestige office buildings are increasingly naturally lit and ventilated for much of the day and year, some building types, such as art galleries, require more stable and controlled conditions, at least where the fragile artworks are located. Even here, huge energy savings can be made by keeping

conditions stable only in the bottom three metres of the galleries, while the air rises slowly to high ceilings and roof lights, under which temperatures fluctuate widely – a strategy used by Renzo Piano and Arup at the Beyeler Foundation outside Basle. Furthermore, the fluctuations of 'living' natural light not only relax the eye, eliminating the tiredness many experience in artificially lit galleries, but subtly animate the artworks, further enhancing our enjoyment.

More responsive to conditions outside are the large transparent- or translucent-roofed spaces found in many contemporary buildings, such as atria in offices. Besides contributing to the social conviviality and identity of the building, they can considerably improve energy efficiency, particularly when occupied by each user for only short periods, when less than ideal temperatures are tolerable. With careful design of the roof lights and reflective side walls, spaces overlooking these are often brighter lit than those along sun-shaded exterior walls.⁹ And with temperatures intermediate between those outside and interiors, they act as thermal buffers. Designing the lighting and sun-shading, ventilation and temperature controls of such spaces has almost become a specialisation in itself. Besides creating an internal microclimate, designers seek to enhance experience of the space by making aspects of this microclimate sensually perceptible in the movement of sun, slight temperature variations through the day and even awareness of the convection currents that are intrinsic to the ventilation system – so giving a semi-outdoors feeling in enriching contrast to the building's other spaces.

CHRONOBIOLOGY, CIRCADIAN RHYTHMS AND RECONNECTING WITH NATURE'S RHYTHMS

Another scientific field bound to impact architecture, particularly how it is lit, and provoke rethinking of our lifestyles, is chronobiology. This studies the cyclic temporal rhythms of organisms as they respond to larger cycles, such as those of the sun and moon. The most important of these are the circadian rhythms that govern the 24-hour cycles of nearly all organisms and, with humans, include lowering body temperature and blood pressure during the night and raising these and cortisol levels (to increase alertness) in the early hours prior to waking. The body has many biological clocks distributed

HUMAN NEEDS!

EAT

DRINK

SLEEP

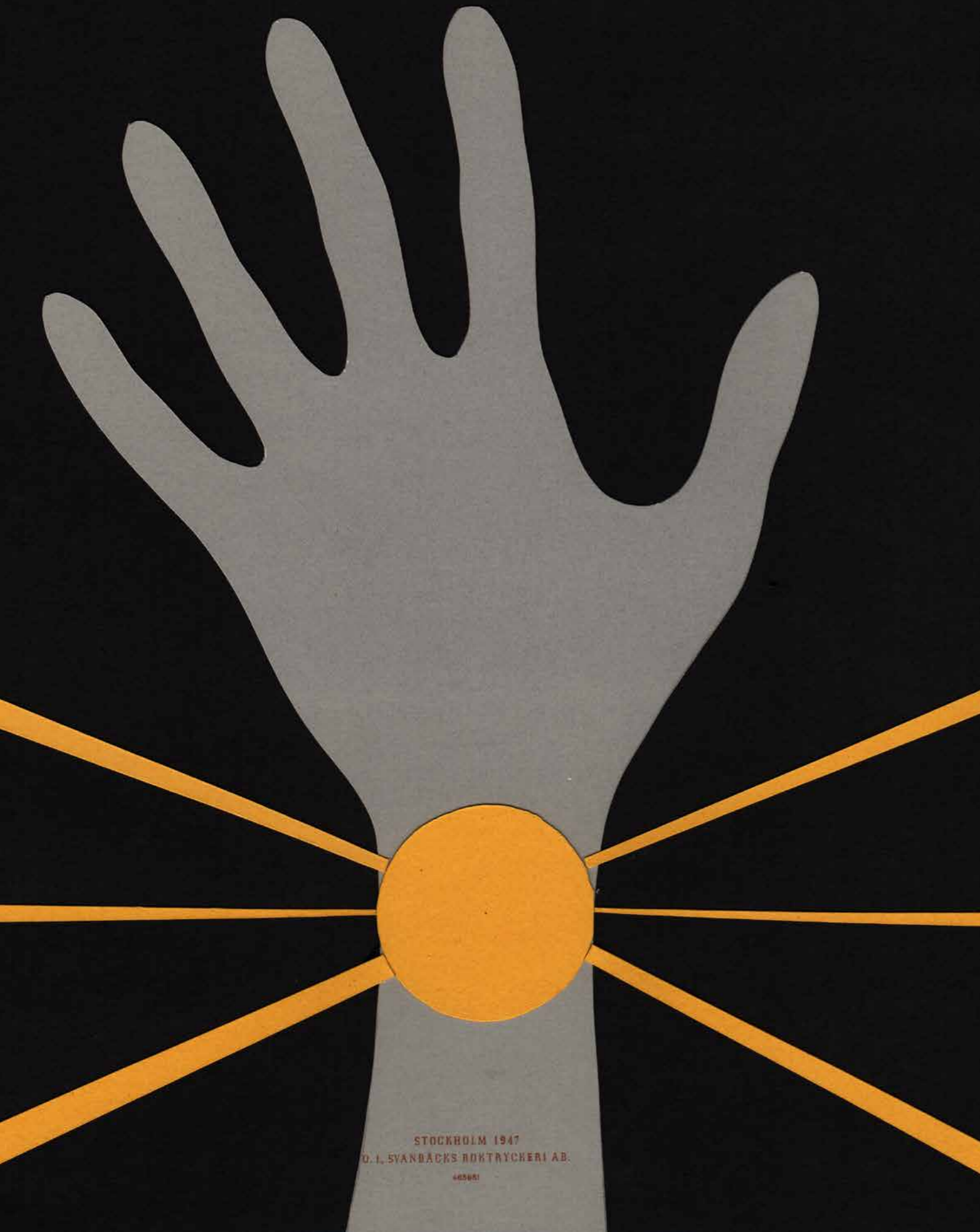
LOVE

SHARE

ROLL OVER

SIT!





By denying, or attempting to transcend, our innate connections to nature and not synchronising our lives to its cycles, we might have gained much in a material sense; but we have also lost much of what is magical about this miraculous world...

through it, but the master clock controlling all others is in the suprachiasmatic nucleus (SCN) in the brain. This influences the downstream rhythms of glands in the brain such as the pineal that adjusts melatonin, which effects our sleep cycle, and the pituitary, which influences the release of cortisol by the adrenal glands, as well as other body clocks controlling a wide range of organic functions.

Without external stimulus, the periodicity of the circadian rhythms of most people would be somewhat longer than 24 hours. But the incidence of bright light detected by photoreceptors that are not part of the visual system (and which are active in many of the blind), fine-tunes these cycles, adjusting them somewhat to the seasons and re-synchronising them with local conditions after changing time zones through flying. Particularly significant is bright light in the morning, confirming the old idea that bedrooms and breakfast rooms should face east to facilitate alertness in the mornings. For similar reasons, classrooms and workplaces might, in the future, be flooded with bright light as the day begins. When the sun is high on cloudless days, natural light acquires a blue tinge that suppresses the presence of melatonin and keeps us alert. Then in the evening the warm light of sunset and light sources with a warm colour temperature prepare us for sleep, and warm firelight even makes us drowsy.

These natural cycles are disturbed in the modern 24-hour city in which, rather than being freed from nature's cycles by electric light, we tend to insufficiently acknowledge the role of circadian rhythms and their responses to light. Many people are deprived of sleep and time spent in outdoors in bright natural light, which should be at least 30 minutes a day. Hence their circadian rhythms may not be fully synchronised with the solar day, contributing to chronic stress, depression and seasonal affective disorder (SAD). Artificial light levels are typically not bright enough to reset circadian rhythms. Studies show that particularly those who habitually work night shifts never fully reset their circadian rhythms and demonstrate diminished alertness and productivity and greater proneness to mistakes and accidents. Worst of all are conditions in intensive care units where constant low levels of light inhibit healing of patients and the alertness of medical staff, despite ample evidence that bright light speeds recovery.

Contributing to sleep problems is the blue-tinged light computers and televisions emit, which suppresses the production of melatonin that helps us fall asleep. Although medical advice is to switch these off some hours before bedtime, many are now semi-addicted to their use. Some specialists now propose that we design artificial lighting to change in intensity and colour balance through the day to best suit human physiology and the activities then taking place. Lighting control systems that allow for this already exist, but are still relatively costly and, for the most part, do not deliver the illuminance levels required for circadian entrainment. How much better, surely, to simply admit more liberally the natural light that already does this, and more, so well. Then, instead of sleeping in one long stretch (a new phenomenon historically), we might return to sleeping in two stretches interrupted by a waking period for reading and other activities. Indeed, sleep may once again be distributed more intermittently with daytime naps – a habit now encouraged by some leading US corporations to benefit creativity and productivity. Cubicles for napping might become regular features of workplace design.¹⁰

Not respecting our circadian rhythms and living out of sync with the natural world is again being proven to have deleterious physical and mental health effects beyond diminished work performance. Besides, as with the definition of standard ideal conditions, the desire to minimise the difference between day and night is another homogenising effect – as is our general lack of appreciation of the importance of the colour of light. We have lost the cosy closeness to each other brought by warm fire or candle light when winding down for sleep and dreams; it made a perfect time for storytelling, fantasy and shared intimacies – all of them psychologically enriching. And in contrast to this inward turning dynamic, light pollution outside obliterating the stars has robbed us of the expansive dynamic that draws our psyches out in wonderment into the vastness of the cosmos. By denying, or attempting to transcend, our innate connections to nature and not synchronising our lives to its cycles, we might have gained much in a material sense; but we have also lost much of what is magical about this miraculous world as well as of what would make us the healthier and happier humans we know, deep down, we are meant to be.



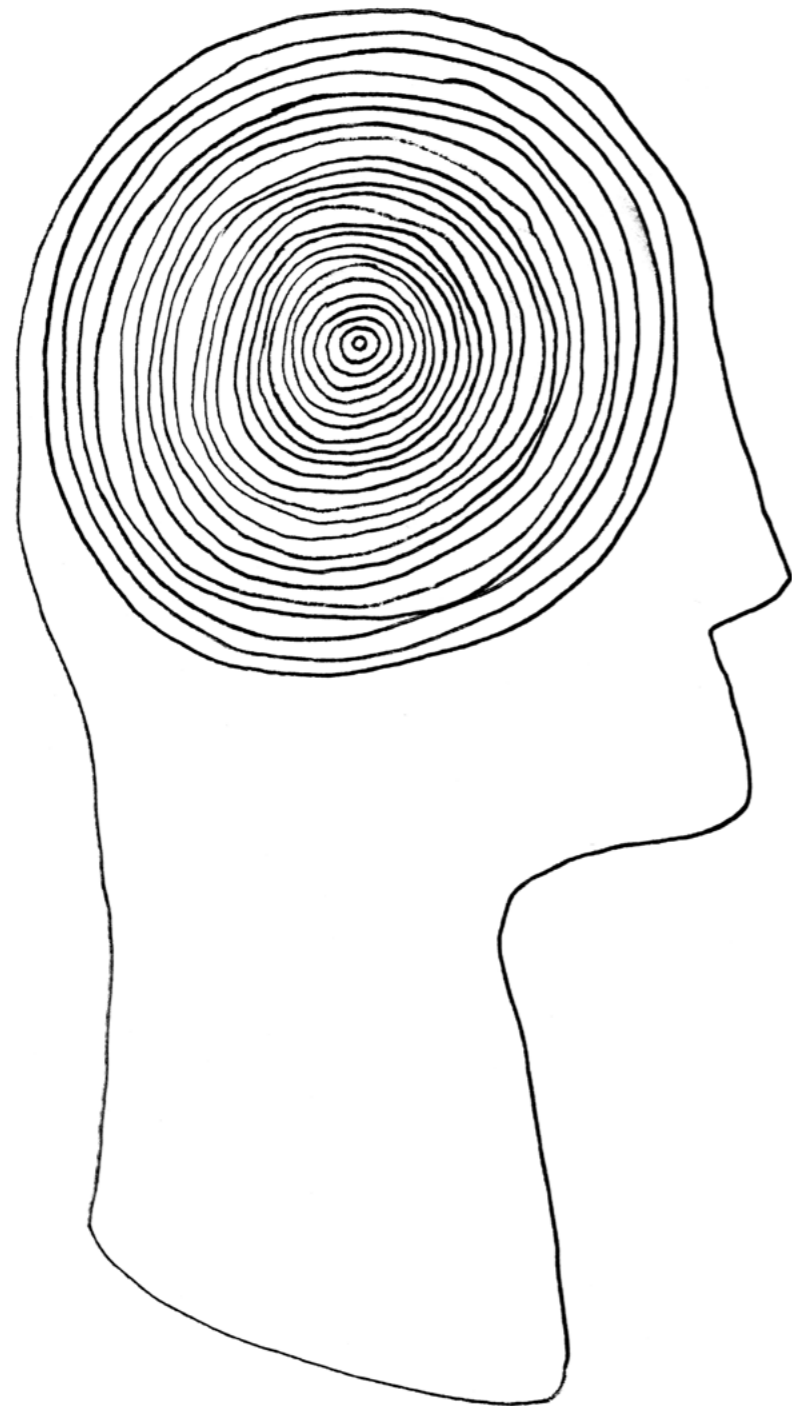
Peter Buchanan graduated in 1968 and worked as architect and urban designer before joining *The Architectural Review* in 1979, becoming Deputy Editor in 1982. A freelance since 1992, he curated the travelling exhibitions *Renzo Piano Building Workshop: Selected Projects* and *Ten Shades of Green* for The Architectural League of New York and has published copiously in journals from many countries, most recently the 12-essay series 'The Big Rethink' in *The Architectural Review*. His many books include the five volumes of *Renzo Piano Building Workshop: Complete Works* (Phaidon Press) and *Ten Shades of Green* (WW Norton).

Notes

Apart from other references, two books proved invaluable sources for this article, providing much more information than those footnoted below. The books are *Biophilic Design: the Theory, Science and Practice of Bringing Buildings to Life* by Stephen R Kellert, Judith Heerwagen and Martin Mador, John Wiley & Sons, 2008 and *Go Wild*, by John R Ratey MD and Richard Manning, Little Brown, New York, 2014

1. *Last Child in the Woods: saving our children from nature-deficit disorder*, by Richard Louv, Algonquin Books, 2006
2. For an illuminating discussion of diseases of civilisation – a concept that dates back to lectures in the 1840s by Stanislas Tanchou, a French physician who had served Napoleon's army – see the chapter 'What Ails Us' in *Go Wild*, by John R Ratey MD and Richard Manning, Little Brown, New York, 2014
3. See chapter on Biophilia in *Go Wild*. The same chapter tells of Japanese studies showing that a walk in the woods can raise the immune system's killer cell count by 40 per cent and that areas with a high proportion of forests have reduced cancer rates.
4. See Chapter 6 of *Biophilic Design*, 'Biophilic Theory and Research for Healthcare Design' by Roger S Ulrich
5. *Drowning in Money* by George Monbiot, The Guardian, 14 January, 2014
6. Much less pernicious than landscape urbanism, although not endorsed fully either.
7. For more on landscape urbanism, see *The Landscape Urbanism Reader* edited by Charles Waldheim, Princeton Architectural Press, 2006. An excellent compilation of New Urbanist counter-attack is *Landscape Urbanism and its Discontents: dissimulating the sustainable city*, edited by Andres Duany and Emily Talen, New Society Publishers, 2013
8. See chapter on biophilia in *Go Wild*.
9. As at One Finsbury Square by Arup Associates in the Broadgate development, London
10. For more on circadian rhythms, sleeping and so on see *Light, Health and Well-Being: Implications from Chronobiology for Architectural Design* by Anna Wirz-Justice and Colin Fournier in *Design & Health Scientific Review*, January 2010 and the chapter *Bodies at Rest* in *Go Wild*.

rhythm of life
on my mind.



DISCOURSE FORWARDS TO NATURE

In surveys and polls, climate protection and preservation of the environment are repeatedly referred to as important issues. But the successes achieved up to now are relatively modest. This will not change until people arrive at the insight that it is ourselves that are the main concern, not kilowatt hours and tons of carbon. Nature is not something that needs protection far removed from civilisation; it is the basis of all our lives, right here and now. It must therefore be rendered visible and noticeable in our cities again. This not only applies to flora and fauna but also to more intangible natural phenomena such as the air that we breathe, the light that we let into our homes and even the rhythms of nature that still affect us in the 24-hour society.

By Jakob Schoof

What is nature worth to us? Until ten years ago, it would only have been possible to answer this question in a philosophical sense. Since then, however, hundreds of economists, biologists, geographers and climate researchers have been trying to express the answer in more concrete form. In the Millennium Ecosystem Assessment of the United Nations,¹ published in 2005, they undertook the first attempt to systematically make a record of all the resources and services that nature provides us with. Under the heading Ecosystems and Human Well-Being, the report provided a compelling account of how much we depend on nature – materially and for our health as well as culturally and spiritually.

In the public discussion of the report, there was a lot of talk about nature as the supplier of food, raw materials and medically effective substances. In contrast, there was hardly any discussion of nature's less tangible services – in other words, of how important urban parks are for people's physical and mental well-being, of how much we need clean air to breathe and daylight to regulate our circadian rhythm.

All of this highlights people's understanding of nature today. On the one hand, stressed-out city dwellers instinctively know the value of direct contact with nature. Any real-estate listing demonstrates this; houses in garden cities or directly next to parks and green spaces

command the very highest prices, as do city penthouses offering maximum daylight, spectacular views and large all-round roof terraces.

On the other hand, these priorities are often forgotten when people decide about issues that do not directly affect their personal living environment. In such cases, urban density or low energy consumption are often paraded as objectives to which everything else supposedly has to be subordinated – in cases of doubt, even the well-being of the inhabitants. Abstract mathematical variables frequently replace good judgement and healthy common sense.

This ignorance ought to be overcome. We don't just need nature as a supplier of food, raw materials and other resources that can be assigned a price. Nor is nature a self-enclosed entity outside our civilisation that we ought to protect for its own sake; it is the basis of our existence in a very direct way – particularly in the world's cities, which will soon accommodate three quarters of the global population. If we really want to preserve nature – and therefore our entire civilisation, which is, after, all dependent on it – we have to make it visible in everyday life. In his book *The Nature Principle*, the journalist Richard Louv writes, "We cannot protect something we do not love, we cannot love what we do not know, and we cannot know what we do not see. Or hear. Or sense."²

“We cannot protect something we do not love, we cannot love what we do not know, and we cannot know what we do not see. Or hear. Or sense.”

Richard Louv in *The Nature Principle*

URBAN NATURE IN THE 21ST CENTURY

At this point, a basic question must first be clarified: how to define ‘nature’ in an era in which virtually no place on Earth remains untouched by Man, and in which over half (and soon three-quarters) of humankind live in urban areas? The structure of our settlement areas has practically been inverted in the last 200 years – from individual villages and towns in the landscape to a continuous carpet of habitation in which isolated patches of green have been allowed to remain. The duality of ‘town versus country’ has thus lost its original meaning. In her book entitled *The Granite Garden* in 1984, the US professor of architecture Anne Whiston Spirn wrote, “Nature is a continuum, with wilderness at one pole and the city at the other”, and, “... nature in the city is far more than trees and gardens, and weeds in sidewalk cracks and vacant lots. It is the air we breathe, the earth we stand on, the water we drink and excrete, and the organisms with which we share our habitat”.³

It is not only our understanding of nature that has undergone major change in recent decades. The health benefits of contact with nature are also known much more thoroughly today than they were in the 1970s. The social ecologist Stephen R. Kellert summarises the essential findings of research as follows:

- Contact with nature – both physical and visual – can promote the healing of illnesses.
- Contact with nature enhances mental capacity, increases the ability to concentrate and improves the memory.
- Contact with nature is important for the mental and sensorial development of children.
- Offices with a lot of daylight and natural ventilation result in higher productivity, less stress and greater motivation of employees.
- A large proportion of green areas and well-designed open-air spaces in cities increases the subjectively felt quality of life and social cohesion in the surrounding districts.⁴

In Kellert’s view, the positive effects that nature exerts on us have a profound evolutionary basis: in the course of millions of years, humankind has adapted itself to a life in nature, and human beings feel most at home where they can see and hear nature as well as smell, feel and taste it. Accordingly, ‘contact with nature’ means nothing other than that the nature within us makes connections with the nature that surrounds us.

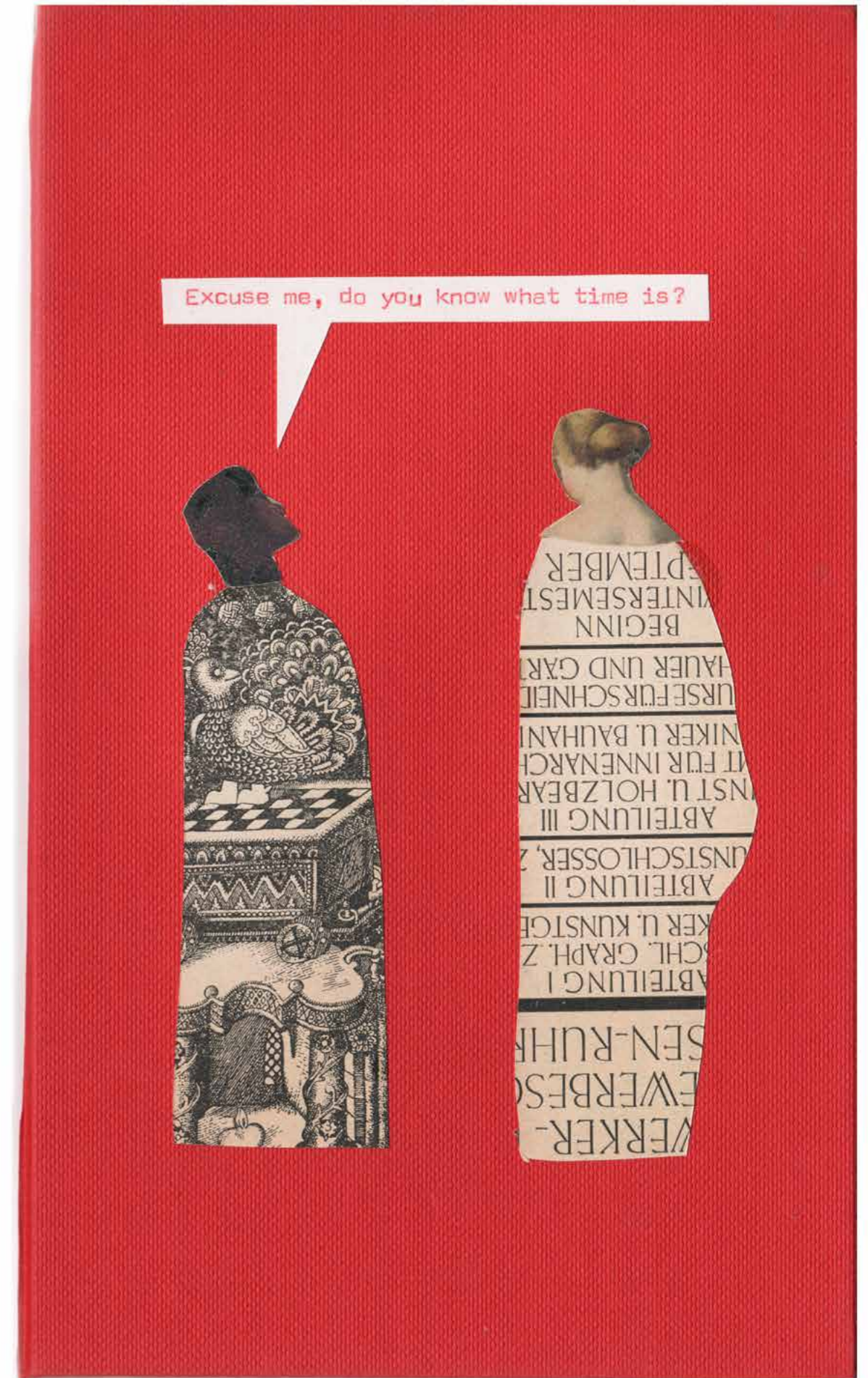
In view of the knowledge gained, it is surprising how often city and nature are still regarded as opposites whenever people have to make decisions on the future of our urban areas. Anne Whiston Spirn sees this attitude as one of the main reasons for today’s environmental problems: “The belief that the city is an entity apart from nature and even antithetical to it ... has aggravated and even created many of the city’s environmental problems”.⁵

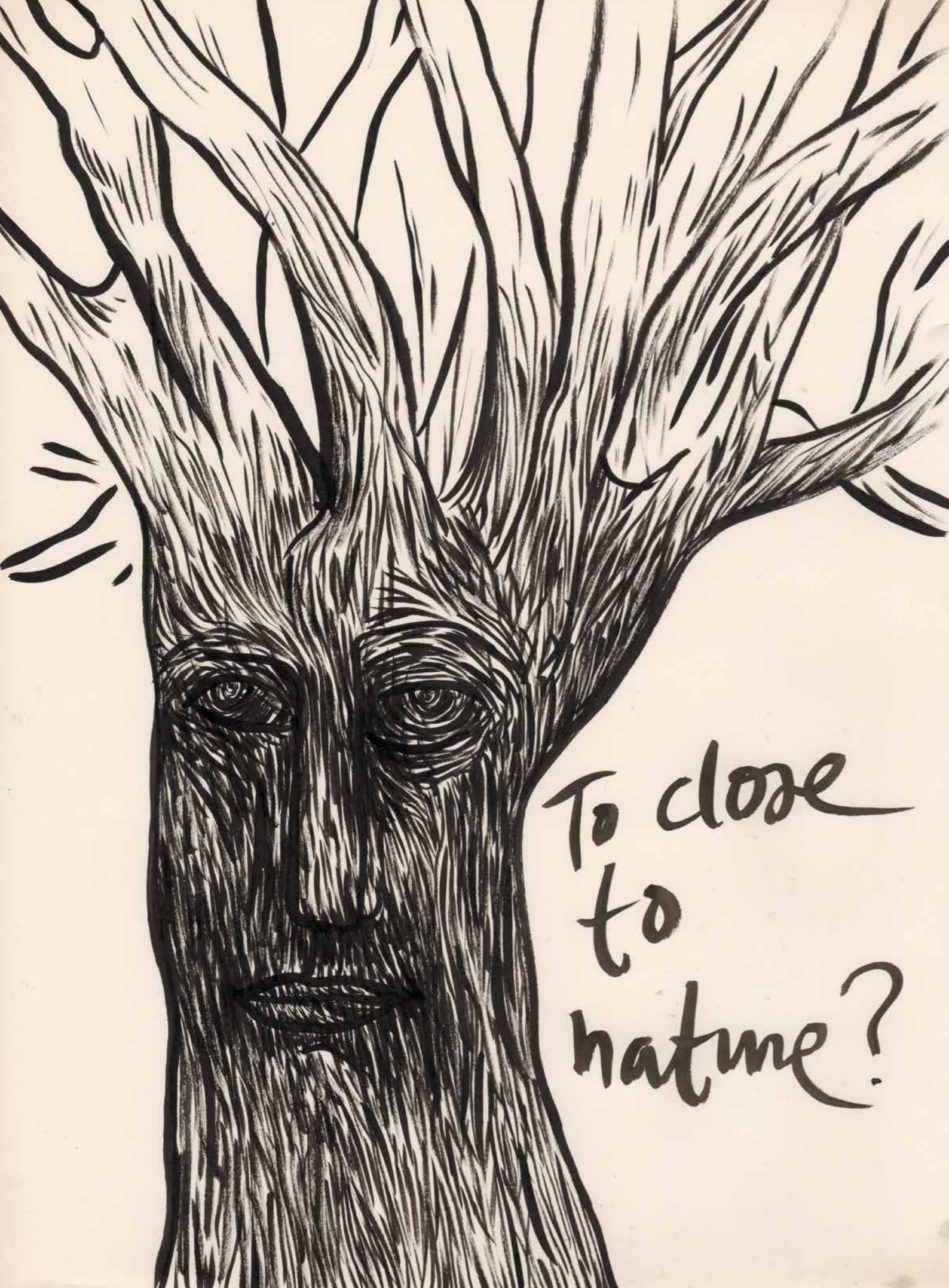
THE FOUR WAYS TO NATURE

In order to understand the reciprocity between nature and human health, it is worthwhile taking a closer look at four ways in which our inner nature connects to nature outside ourselves. Between these ways, there are numerous points of contact and all four are equally relevant for healthy living in the city.

Our first way of gaining access to nature is of a spatial kind. The fact that physical immersion in nature is good for body and soul was recognised by the urban politicians and landscape architects of the 19th century who created the first large city parks as places for mental recuperation and physical exercise. Up to today, there has been little change in the basic functions of urban parks or in their popularity. According to Enrique Peñalosa, the former mayor of Bogota, parks are “essential to the physical and emotional health of a city”.⁶

The evolution of urban gardens has been a more changeful one. In the 20th century, they developed from being places of food production to serving as places of relaxation and recreation for stressed employees. Today, however, the garden





... In its new, often communal form, urban gardening satisfies many needs that traditional parks leave unfulfilled. Users of communal gardens become actively involved in the design of their urban environment. They contribute to biodiversity in the city and, in the process, give first-hand experience of ecological interrelationships.

is being rediscovered as a source of self-sufficiency. What's more, in its new, often communal form, urban gardening satisfies many needs that traditional parks leave unfulfilled. Users of communal gardens become actively involved in the design of their urban environment. They contribute to biodiversity in the city and, in the process, give first-hand experience of ecological interrelationships.

On the whole, non-material motives clearly predominate urban gardening.⁷ The quantitative aspect of food production is much less significant. Even if all the buildings in New York had roof gardens, only 2% of the city's food needs would be covered by them. This was calculated by microbiologist Dickson Despommier, regarded as the inventor of 'vertical farming', together with his students.⁸

PERCEIVING NATURE WITH ALL THE SENSES

Our second way of gaining access to nature is via sensory perception. The visual and acoustic perception of natural phenomena can have a calming effect, counteract fatigue and even help to cure illnesses – both outside and inside buildings. In 1984, the behavioural scientist Roger S. Ulrich showed that if patients have a free view of nature from their window they need considerably less pain medication after a heart operation than when they can only see bare brick walls.⁹

In later studies, Ulrich proved that looking at nature lowers blood pressure and reduces muscle tension in just a few minutes – and considerably more effectively than looking at a busy road or a shopping centre.

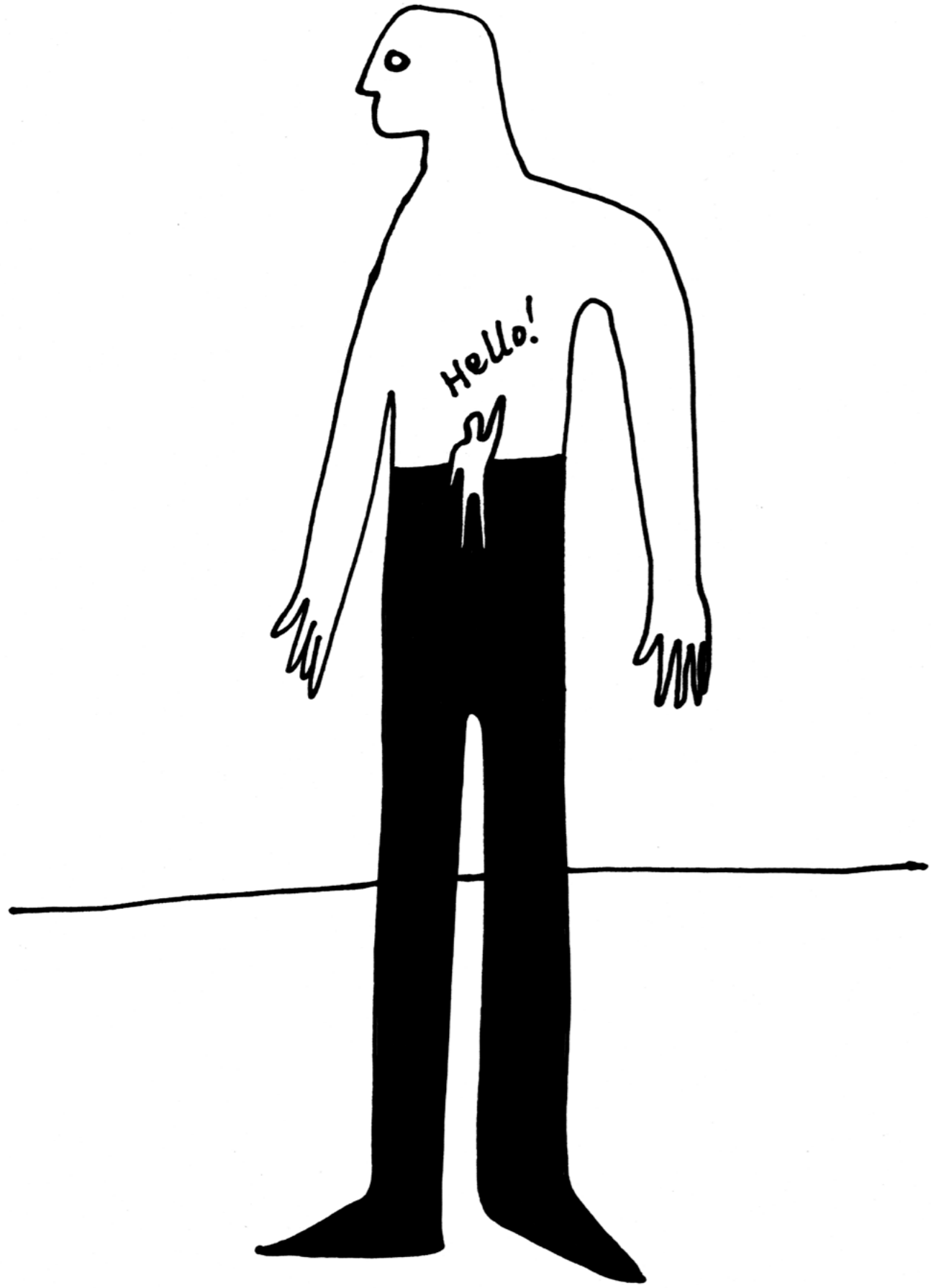
The development of our sensory perception is also fostered by contact with nature. This evidently does not just apply to the conventional five senses. In his book *The Nature Principle*, Richard Louv writes about an investigation among US soldiers, whereby two groups of people demonstrated an especially pronounced 'sixth sense' for hazardous situations; those who spent a lot of their free time hunting outdoors and those who had grown up in very problematic city districts with a high crime rate.¹⁰

One insight in the discussion relating to the perception of nature is central; nature does not consist of sensory stimuli alone, and it is exactly this that distinguishes it from the numbing flood of signals with which electronic media compete for our attention. Nature is also the silence without which we would be unable to hear the rain outside rattling on the window. And it is the darkness that is needed in order to see the stars at night – an experience that, due to light pollution, has almost become impossible in many of the world's large cities.

VITAL RESOURCES

Our third level of contact with nature concerns the resources we need in order to live. A person can survive for up to three months without solid food but only a few minutes without breathing. And although we can do without light for somewhat longer, it would be a life devoid of sensory stimuli which, in the long term, would be at the expense of our spiritual and mental health.

The mistaken notions of past generations of planners with regard to the lighting and ventilation of buildings have already been described extensively elsewhere – not least in Peter Buchanan's article in this issue of *Daylight/Architecture*. They were based on the false assumption that the way in which light and



As early as 1967, a survey of American office workers showed that 96% of them preferred working in daylight rather than under artificial light. In general, employees who worked next to windows said they had greater work satisfaction than those who sat a long way away from the facade.

air entered buildings was irrelevant. This development culminated in the fully air-conditioned office buildings and windowless classrooms of the 1950s and '70s, an era that the British daylight expert Nick Baker has christened the "fluorescent dark ages".¹¹

Many mistakes could have been avoided if the people actually affected by all this had been listened to – regarding the selection of light sources among other things. As early as 1967, a survey of American office workers showed that 96% of them preferred working in daylight rather than under artificial light. In general, employees who worked next to windows said they had greater work satisfaction than those who sat a long way away from the facade.¹²

Similar results have since been reproduced in hundreds, if not thousands of user questionnaires. In the meantime, scientists have also drawn up a long list of the benefits of daylight. Daylight and views through windows provide us with information about the world outside. Bright light is regarded as an important stimulant, capable of alleviating winter depression. People need daylight (or more precisely, the UVB radiation that comes with it and which can only be found outdoors or in rooms equipped with special glazing) for vitamin D synthesis. Above all, however, we need the regular alternation of light and darkness in order to regulate our circadian rhythm. Bluish light in the morning has shown itself to be a highly effective stimulant – in other words, exactly what nature has been providing us with for millions of years free of charge. In contrast, blue light in the evening and night hours is comparatively harmful; this is exactly what we in the electronic media society are increasingly surrounding ourselves with in the form of TV and computer screens.

FOLLOWING THE RHYTHM OF NATURE

This takes us to a fourth level of our relationship with nature, a level that many people do not immediately recognise as such: the temporal. As noted above, we need bright light during the day and

darkness at night for a healthy circadian rhythm. Nature provides us with both – but only as long as we allow it to, i.e. by spending sufficient time outdoors during the day and avoiding too much electric light at night.

In order to live according to the rhythms of nature, however, individual good intentions are hardly sufficient. The reason is that apart from one's personal temporal rhythm and that of nature, a third temporal level comes into play: that of the society in which we live. Societies can live at very different speeds, as the US psychologist Robert Levine discovered.¹³ A flourishing economy, a high degree of international networking, a large number of inhabitants, a cool climate and an individualistic cultural orientation were found by Levine to be the most important accelerating factors. In recent decades, nearly all of these factors have been constantly enhanced, with the result that the speed of living is continuously increasing in industrialised societies. This is shown by many everyday details such as the speed of talking. Political scientist Ulf Torgensen analysed speeches in Norwegian's parliament and found that it has increased by almost 50% since the middle of the 20th century.¹⁴

Social change, economic growth and the advances of technology all reinforce each other in the acceleration of human life. Human beings are not only driven by technological acceleration – but they are, at the same time, its instigators and drivers. A faster life promises a great many benefits; above all in terms of economics and – at least for many people – of quality of life. Anyone who is faster than his competitors in a capitalist economy attains certain market advantages. And although the contemporary workforce enjoys an unprecedented amount of leisure time, this has hardly eased the self-imposed time pressures. People have been quite inventive at 'filling' their spare time with new activities. For example, the number of 'friends' that the average person has to stay in touch with has probably increased tenfold since the advent of Internet-based social networks.

“People are and will remain creatures of nature in spite of their abundance of prostheses [...] Yet nature knows a large number of other temporal qualities apart from speed.”

Karlheinz Geißler in *Eine kleine Geschichte der Zeit*

However, it is easily forgotten that not all processes can be accelerated. Above all, nature in us and around us resists technically- and socially-driven acceleration in the sense being discussed. Disturbed circadian rhythms are merely a symptom of this. “People are and will remain creatures of nature in spite of their abundance of prostheses”, says the philosopher Karlheinz Geißler. “Yet nature knows a large number of other temporal qualities apart from speed.”¹⁵

But how can more room be made for this temporal variety in our society? Many people have now developed individual deceleration strategies – such as reducing their work time, retreating to a monastery for a week, and much more. On the collective level as well, there are 'niches' of slowness in many areas of life that elude the laws of the marketplace. Cultural and religious rituals, for example, are difficult to accelerate. And in many countries – even highly industrialised ones –, there are sub-cultures that live according to their own, slower temporal rhythms.¹⁶

In the view of sociologist Hartmut Rosa, patches of still water in the raging current of acceleration are to be found everywhere where people enter into 'relationships of resonance'. What he means by this are relationships with other people or with nature that do not obey the logic of target achievement and efficiency but are sufficient unto themselves – and, precisely because of this, achieve an intensity that enriches people's lives.

PATHS INTO THE FUTURE

The circle thus closes and a self-reinforcing logic becomes apparent; we achieve

a healthy relationship with nature wherever we actively practice it. This, in turn, must be encouraged socially and culturally, and through the shaping of our built environment. In this context, some promising strategic approaches can be identified:

- Synthesis instead of optimisation. The best ideas are those that initiate broadly conceived changes on a social, ecological and economic level. Urban gardening is a good example of this. A second is the 'Città slow' movement, to which over 100 communities in Europe now belong. The aim of the movement is not simply to slow urban life down – 'slow', in this context, signifies much more, namely everything that leads to a better quality of life, greater social cohesion, hospitality towards strangers, better education, transparency in local politics, a good infrastructure and a healthy environment.¹⁷
- From action to knowledge. People retain around ten per cent of what they read. But they remember up to 90 per cent of what they actually do themselves¹⁸. Today, we 'know' more about climate change and changes in nature than ever before but are nevertheless more uncertain than ever as to what exactly to do about it. The reason is that this knowledge is mostly abstract and not anchored in our lived experience. It is time to listen to our intuition more, to simply try things out and, in this way, learn through doing. Many grass-roots movements of recent years – such as the international Transition Towns movement – pursue this strategy. Rob Hopkins, initiator of the first 'Transition Town' in Totnes, UK, says: “It's about unleashing potential ... And you don't do that by trying to depress everyone into action. It's about feeling part of something historic, something timely...”¹⁹
- Appreciating that which is different. “Those who envisage creating heaven on earth ... will only succeed in making hell”, wrote the great philosopher Karl Popper.²⁰ What seems to be an

“We can truly care for nature and ourselves only if we see ourselves and nature as inseparable, only if we love ourselves as a part of nature, only if we believe that human beings have a right to the gifts of nature, undestroyed.”

Richard Louv in *The Nature Principle*

ingenious idea to one person will be fundamentally rejected by another. Variety enhances the quality of life and is, at times, important for survival – whether it is in the form of biodiversity, relates to daylight and indoor climate in buildings or concerns social temporal rhythms. And real variety can only arise where a variety of opinions, strategies and initiatives are permitted.

- Learning to do nothing. Not everything has to be planned and built. Especially in empty spaces in the city and in our time schedules, biological and temporal niches can occur in which a new kind of relationship between people and nature flourishes. Densification has its limits as we have seen – this applies to urban design as much as to our individual appointment calendars.
- Creating financial incentives. Why do our health systems spend billions on medicines every year but provide very little (if any) incentive to support a health-promoting approach to the design of hospitals, kindergartens, office buildings and houses? We have long known what works here: a lot of daylight, fresh air through windows and views of the outside, plus a moderate degree of temperature variation indoors. Anyone who creates specific incentives in this regard could reduce the national spending budget by billions.
- Putting people at the centre of things. Environmental protection is doomed to fail if it only focuses on CO₂ emissions and other abstract key data. Instead, it is ultimately about ourselves, as Richard Louv says, “We can truly care for nature and ourselves only if we see ourselves and nature as inseparable, only if we love ourselves as a part of nature, only if we believe that human beings have a right to the gifts of nature, undestroyed.”²¹

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DON'T
BADMOUTH
THE
SUN!





SLEEP WORK LIVE

Healthy living around the clock

Over the last three decades, scientific research has produced an increasing amount of knowledge on what human beings require for healthy living in both indoor and outdoor spaces. Taken together, this evidence constitutes a wake-up call to all those involved in the construction industry. Will it be possible to 'design' health into the places where we live, work, and play? Can we, by doing so, create the living conditions for people to flourish around the clock and regardless of their age?

The following pages summarise some of the most important scientific findings and aspects that need to be considered for healthy sleeping, working, and spending our free time in buildings and outdoor spaces. The findings and quotes are structured according to the cycle of the day, and divided up into three sections that coincide with the three main phases of our everyday activities: sleeping, working and living. Each of the three sections starts with the human body and the processes taking place inside it, as these are the basis for any meaningful, health-related urban and building design.

I WANT
A CAVE
IN MY
BED.

SLEEP

On average, people reach their deepest sleep between 2 a.m. and 3 a.m., coinciding with the highest concentration of the sleep hormone melatonin in the blood. The brain is decomposing the waste toxins that have been accumulated by concentrated thinking during daytime, and the bowels shut down for the night. For those still awake, attention levels are lowest, which makes industrial accidents a particular risk at night shifts.

Blood pressure is also much lower than during the day, whereas the production of growth hormones increases. The body temperature reaches its lowest point around 4:30 a.m. as much of the body's energy is diverted to other activities such as skin repair. From about 5 a.m. onwards, melatonin levels start to drop as the body approaches wake-up time.

THE INTERNAL AND THE EXTERNAL CLOCK

Almost all organisms on Earth have been attuned to the diurnal cycles of day and night by evolution. Man is no exception. Distributed throughout our body cells, we have many millions of internal 'clocks' that regulate functions such as gene expression, digestion, body temperature, performance levels and, most importantly, our sleep/wake rhythm. As a consequence, all of these mechanisms follow (roughly) a 24-hour rhythm in healthy human beings.

To synchronise all of these body clocks – which scientists call peripheral circadian oscillators – our brain has a built-in master clock, the suprachiasmatic nucleus (SCN), which is located in the hypothalamus. The SCN synchronises with the peripheral oscillators by means of neural signals and hormones. The most important of these are the stress hormone cortisol and the sleep hormone melatonin.

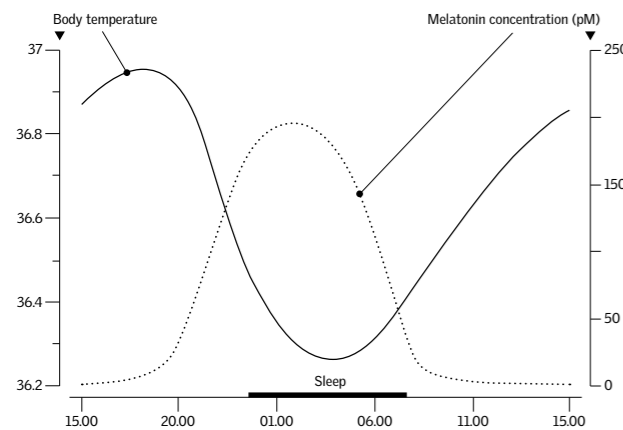
According to chronobiologist Till Roenneberg, the main purpose of the internal clocks is to create a representation of the time rhythms in the world outside in our organism. To be accurate however, this representation crucially depends on external clues, among which the most important by far is light.

Experiments in the 1960s and 1970s have shown that when people are isolated from all external clues (e.g. by living in windowless bunkers and not wearing watches), their 'internal day' is, on average, slightly longer than 24 hours. It is thus only through regular exposure to light and darkness that our body can be fully kept 'in sync' with the 24-hour rhythm of the world outside.

Around the last turn of the century, scientists finally discovered the mechanism by which this synchronisation works. A special light receptor in our retina is activated by light and then sends a neural signal to the SCN, which passes it in turn on to the other 'clocks' distributed throughout our body.

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Graphical representation of the melatonin (dotted line) and core body temperature (solid line) rhythm of a 24-hour period. The time of sleep is indicated by the grey area.

CHRONOTYPES: OF OWLS AND LARKS

When left to their own devices, not all people live according to the same rhythm. Some of us seem to have faster body clocks, and some slower ones. Chronobiologists call the speed at which our internal clock works 'chronotype'.

These individual differences are the reason why some of us have a reputation of being night owls whereas others are considered larks, who are up with the first rays of light in the morning. Within a given population, the chronotypes show an almost normal distribution, with slightly more late than early chronotypes but rather few extremes. The chronotype of a person can be determined relatively easily, by calculating the middle of night sleep (e.g. 3 a.m. for someone sleeping from 11 p.m. to 7 a.m.) on a free day on which sleep is not prematurely interrupted by an alarm clock.

Our chronotype is mainly genetically

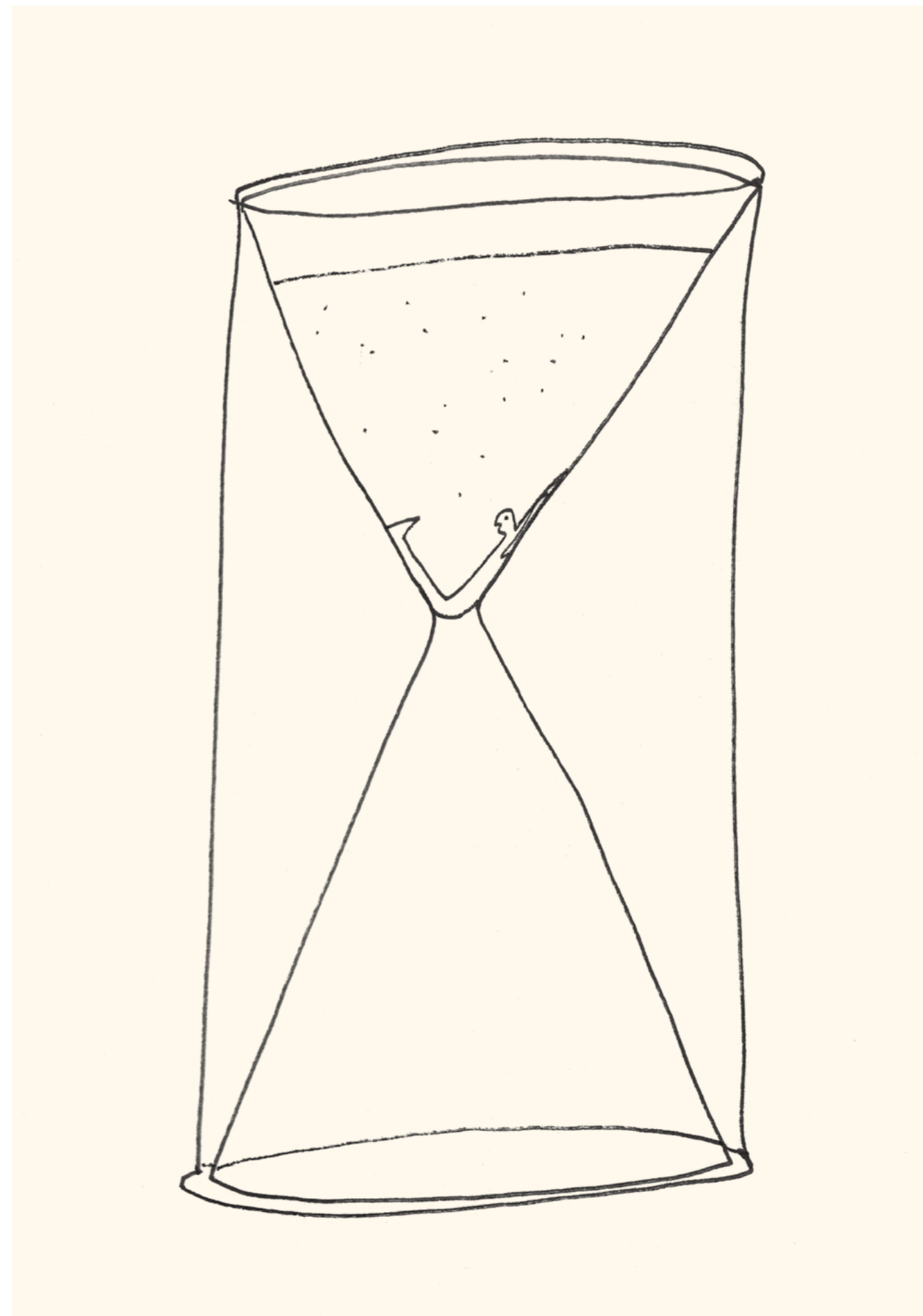
predetermined, but it also varies with age, gender and even the place we live. In an evaluation of tens of thousands of Internet-based questionnaires, researchers from the University of Munich found that the further east within a time zone people live, the earlier in the day they tend to rise and go to bed again. This has nothing to do with culture but is an overwhelming proof of the importance of daylight for circadian entrainment. People in Spain, for example, have a reputation for staying up late and getting up late – the main reason for this being that, as Spain is located in the westernmost part of the Central European Time (CET) zone, the sun rises and sets extremely late (if measured according to CET rather than solar time).

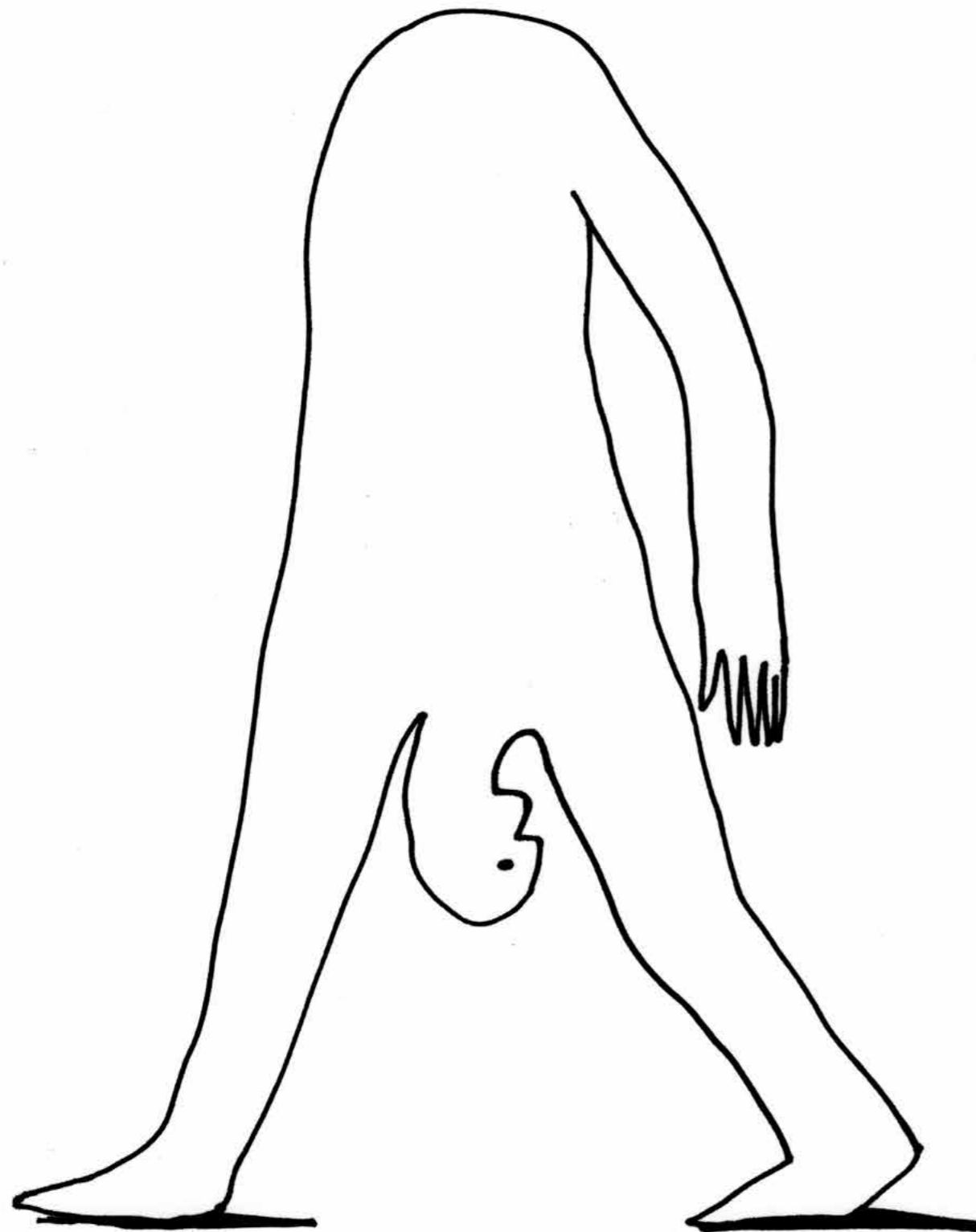
Whereas children are usually relatively early chronotypes, our 'circadian programme' progressively delays until it reaches a peak of lateness around the age of 21 (1.5 years earlier in women than in men). From that age, our chronotypes become progressively earlier again.

One consequence of this is that early school (and university) hours are rather counterproductive for adolescents and young adults. Their relative lateness (and, in consequence, drowsiness in the morning) is not a consequence of lack of discipline but a natural phenomenon that ought to be respected in scheduling lessons.

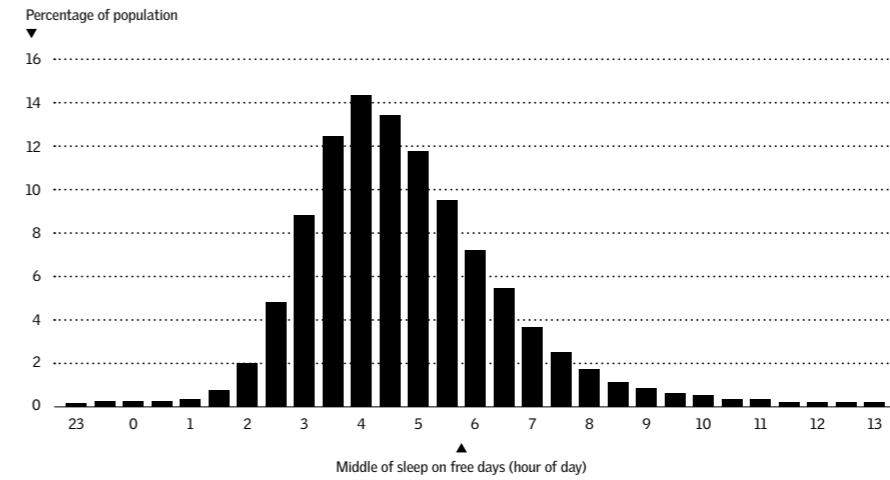
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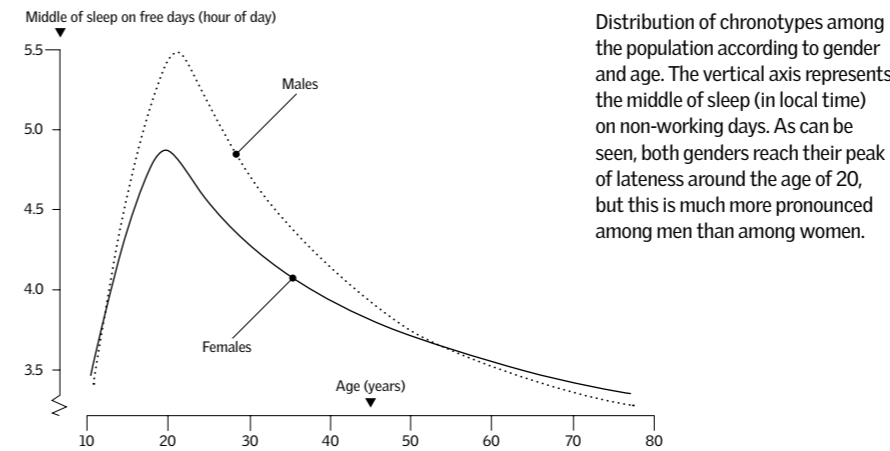




S O C I A L J E T L A G



Distribution of chronotypes in the Central European population, as represented by the middle of sleep (in local time) on a non-working day (horizontal axis in the diagram).



Distribution of chronotypes among the population according to gender and age. The vertical axis represents the middle of sleep (in local time) on non-working days. As can be seen, both genders reach their peak of lateness around the age of 20, but this is much more pronounced among men than among women.

SLEEP DISRUPTIONS AND SOCIAL JETLAG

Sleepy students at schools are just one symptom of a phenomenon that chronobiologist Till Roenneberg has termed 'social jet lag'. It occurs when people's circadian rhythms get out of phase with the daily schedules they are forced to keep. Social jet lag can be measured by comparing the timing of sleep on work days with that on free days. For most of the population, the middle of sleep on work days is 1-2 hours earlier than on free days. However, extremely late chronotypes (for example, young adults) can accumulate up to five hours of social jet lag. This has similar consequences as flying from Europe to New York every Friday night and coming back on Sunday night. In some respects, it is even worse. Normal jet lag, which is experienced after transcontinental flights, has the advantage that our internal clock can adapt to it within a few days. Social jet lag, by contrast, is chronic

because we always stay within the same day/night rhythm.

A key reason for the prevalence of social jet lag in industrialised societies is lack of daylight, which causes people's internal clocks to run later and later. But working times in our society are still largely the same as in the early industrial age.

The influence of daylight on our circadian system also results in annual variations of social jet lag. It is greater in winter than in summer because our internal clock tends to run later during the dark season. The situation tends to improve in spring as days become longer, but only to be disrupted again by the start of daylight savings time. This temporal shift means that many people - who just adapted to the increase in day length - once again have to get up while it is still dark outside. Thus they experience a lack of daylight precisely when they most need it - in the mornings. According to chronobiologists, it takes our internal clock up to four weeks to adapt to the one-hour shift - and some late chronotypes never fully adapt.

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WHAT ARE 'NATURAL' SLEEP PATTERNS?

Our internal clock systematically tracks the shifting dawn and dusk times over the year. This would suggest that, in preindustrial times, people used to sleep longer in winter than in summer – but they didn't. Instead, as historian Roger Ekirch has found out, it was quite normal for people to sleep in two four-hour 'chunks' at night and to lie awake – or even to get up – for an hour and a half during the middle of the night. This habit started to dwindle from the late 17TH century onwards – a development that Ekirch attributes to improvements in artificial lighting and a surge of coffee houses, which were sometimes open all night. Furthermore, the

early industrial age with its long working hours (sometimes as much as 15 hours per day) gradually forced the working population into a more 'efficient', compact eight-hour sleep at night.

None-the-less, it still seems that pre-industrial sleep patterns have remained alive in many of us who tend to wake up in the middle of night and then find it hard to fall asleep again for one or two hours. According to chronobiologists, this is rather normal and nothing to worry about. "Many people wake up at night and panic," says Russell Foster, a professor of circadian neuroscience at Oxford. "I tell them that what they are experiencing is a throwback to the bi-modal sleep pattern."

Source

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Milan 2007, p. 4 ff.

“A harmony exists between the timing of our pre-programmed clock and the local, solar light-dark pattern no matter where we are on the planet.”

DISRUPTED SLEEP PATTERNS AND THEIR CONSEQUENCES

Around 85% of the working population need an alarm clock to get up during the week, and, according to an estimate by Till Roenneberg, only 7% of us get sufficient sleep on work days. This has wide-ranging consequences, as social jet lag and lack of sleep affect both our work performance as well as our subjective well-being and our objective health. Social jet lag has been shown to cause insomnia, digestive and metabolic problems (which may in turn lead to diabetes, obesity, and high blood pressure) and daytime drowsiness. In 2007, scientists at the World Health Organization's International Agency for Research on Cancer in Lyon even concluded that "shift-work that involves circadian disruption is probably carcinogenic to humans".

Another study showed that people who suffer from insomnia are more likely than others to develop depressions a few

years later. Strong links have also been found between social jet lag and smoking. Among people who experience no social jet lag, the percentage of smokers is at around 10%, whereas it rises to 60% among individuals whose sleep time differs four hours or more between work and free days.

According to estimates, between 16% and 30% of the working population suffer from insomnia. Poor sleep at night has been linked to lower job performance, a higher risk of work accidents and difficulties in making decisions at work. Furthermore, insomnia is one of the best predictors of absenteeism from work. According to one study, the monthly sick absence rate of insomniacs was 1.4 times higher than that of healthy sleepers.

The economic costs associated with insomnia are thus considerable. According to some estimates, they amounted to approximately US \$100 billion per year in the US in 1990. The lion's share of this is attributed to accidents, loss of productivity and absenteeism related to insomnia.

Sources

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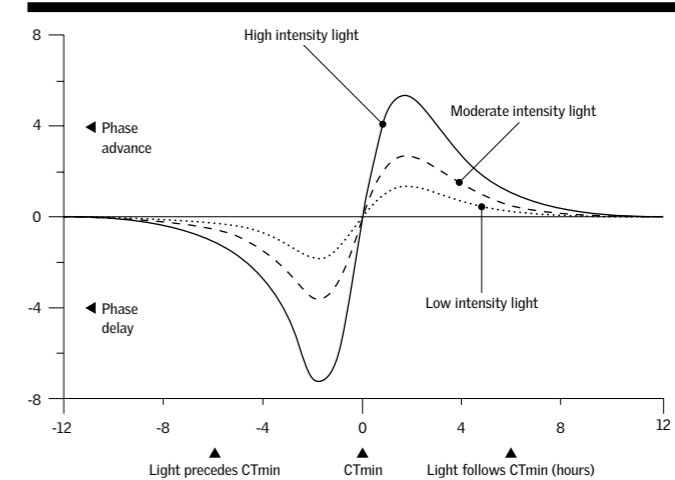


**MAY
DUGH
T!**



“In many situations, our biology and our society appear to be in serious opposition, and the damaging consequences to our health under these circumstances are increasingly recognised.”

Russell G. Foster and Till Roenneberg in: *Human Responses to the Geophysical Daily, Annual and Lunar Cycles*. *Current Biology* 18, 2008



Human phase response curves for three different intensities of light, with CTmin representing the time of night when the body temperature is at its minimum (usually, between 4 a.m. and 5 a.m.) As can be seen, light of any intensity will be at its most effective in advancing our internal clock in the early morning, whereas it achieves its greatest phase-delaying effect in the hours after midnight.

PROVISIONS FOR HEALTHY SLEEPING

Healthy sleeping occurs at night but starts during the day. In simple terms, each person should have sufficient light during activity periods, and darkness during rest and sleep periods over a regular 24-hour cycle. ‘Healthy darkness’ at night, in particular, is an absolute prerequisite for healthy sleeping as our circadian system is much more sensitive to light at night than during the day. Even lighting levels of 300–500 lux or less (which would have no effect whatsoever during the day) may disrupt our sleep/wake cycles during the night.

Particular care should be taken with watching TV or using computers late at night in this respect. TV and computer screens do not emit huge quantities of light, but their light has a particularly high proportion of blue wavelengths. And blue light in particular has been found to be the most powerful trigger of

melatonin suppression (and thus arousal) in the human body.

Just as important as night-time darkness is exposure to bright light in the mornings, when our internal clock is still relatively sensitive to it (much more so, for example, than at noon or in the afternoon). In general, whereas light in the evening will shift our internal clock backwards (i.e. make it run later), light in the morning will shift our diurnal rhythms forward. This is a welcome thing, as average chronotypes would otherwise follow a rhythm that is somewhat slower than 24 hours per day, and thus start to accumulate social jet lag.

Sources:

REA, Mark S.: *More than Vision*. In: *More than Vision*. Milan 2007, p. 4 ff.
 WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chronobiology for architectural design*. In: *World Health Design*, January 2010
 LACK, L. C.; WRIGHT, H. R.: *Chronobiology of sleep in humans*. In: *Cellular and Molecular Life Sciences* 64, 2007

“Collectively the daily, seasonal, lunar and tidal geophysical cycles regulate much of the temporal biology of life on Earth. The increasing isolation of human societies from these geophysical cycles, as a result of improved living conditions, high-quality nutrition and 24/7 working practices, have led many to believe that human biology functions independently of them. Yet recent studies have highlighted the dominant role that our circadian clock plays in the organisation of 24 hour patterns of behaviour and physiology.”

LIGHT AND TEMPERATURES IN THE BEDROOM

An appropriate light signal during the day (and particularly in the morning) and darkness at night are critical to maintaining key aspects of our overall health.

Bedrooms (particularly those for adolescents and young adults, who have a delayed biological clock and often find it hard to get up in the mornings) should thus be oriented east towards the morning sun and have generous windows that are equipped with roller shades or “black-out” curtains that will eliminate any light from entering the room at night.

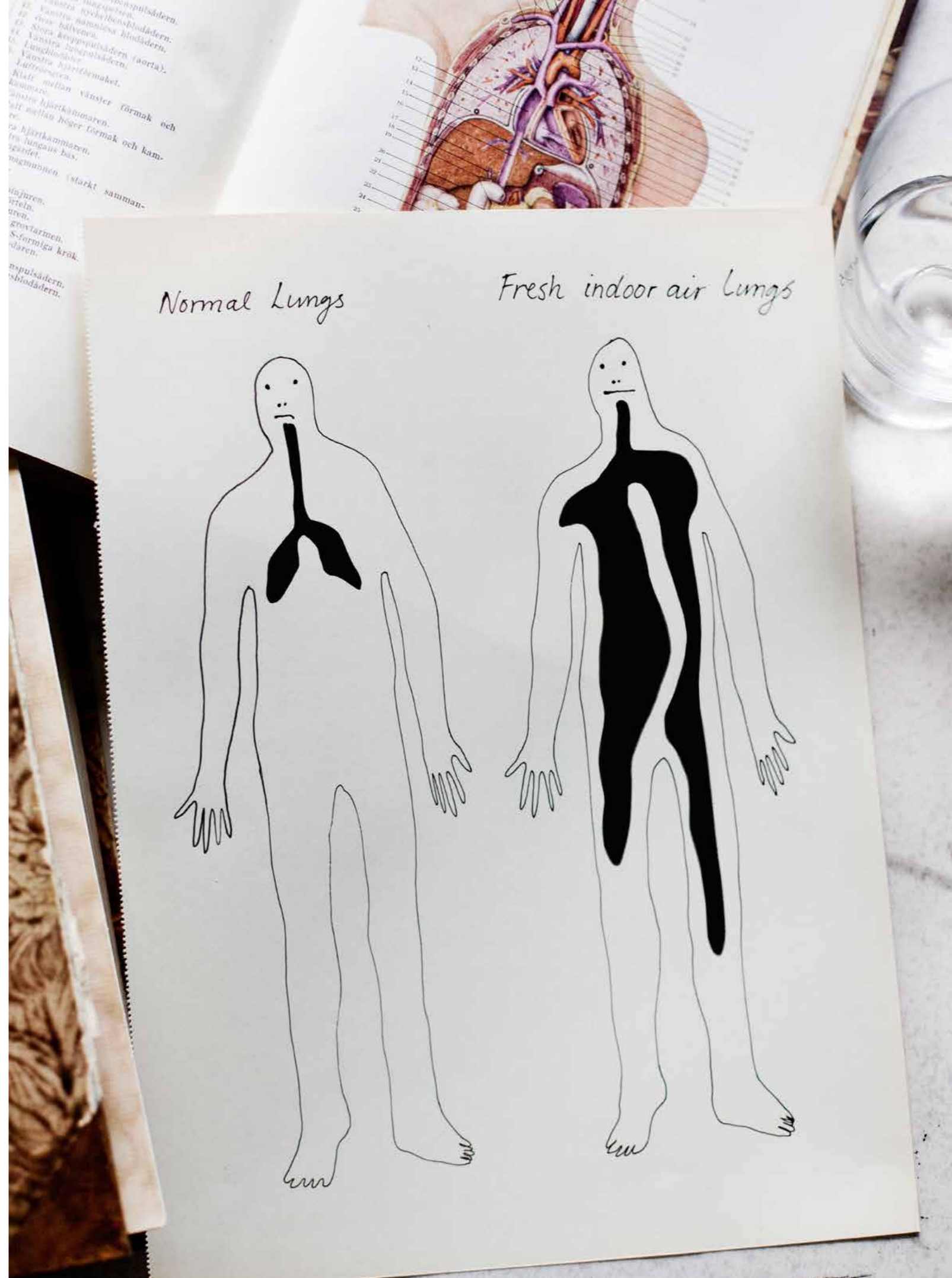
Artificial light sources, both within public and private spaces, should be designed and placed so they minimise the amount of light pollution at night. Uncontrolled ‘spillover’ from electric light sources – be they street lamps shining through windows or the individual partner’s bed-lamp on the other side of the room – can be a significant cause of sleep disruption.

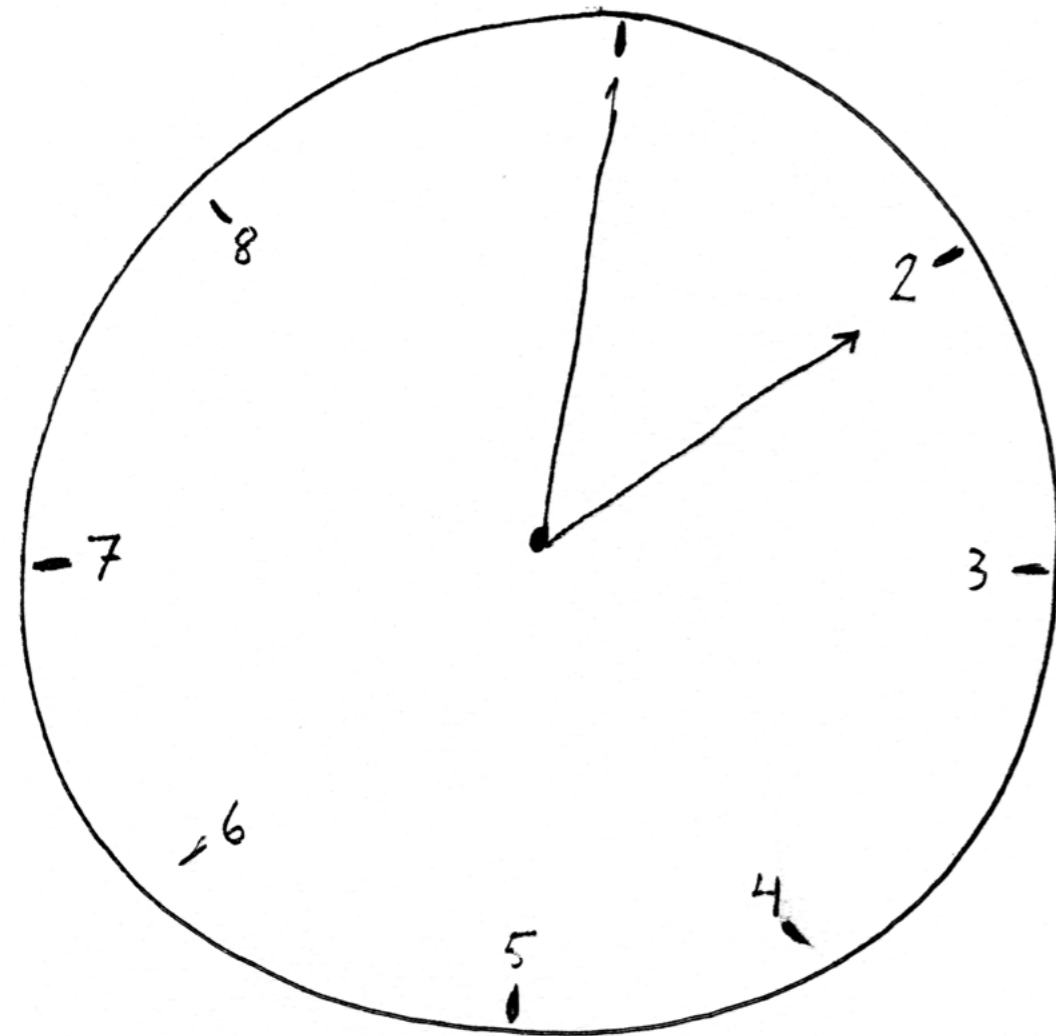
Alongside the exposure to light, temperatures in the bedroom are another determining factor for sleep quality. Research suggests that a lower room temperature (as low as 16°C) during sleep than when awake is preferred. This has to do with thermal insulation of duvets and blankets that in most cases overcompensate for the reduced activity level during the sleep. The maximum temperature in a bedroom should therefore be several degrees lower than in other rooms, and a light duvet and light night dress should be used during warm periods.

Sources:

- Circadian House – Principles and Guidelines for Healthy Homes*, VELUX, Hørsholm/Denmark 2013
- WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chrono-biology for architectural design*. In: World Health Design, January 2010

← Russell G. Foster and Till Roenneberg in: Human Responses to the Geophysical Daily, Annual and Lunar Cycles. Current Biology 18, 2008





The Stress O'Clock

WORK

Between 6 and 9 a.m., the production of the sleep hormone melatonin in the body stops, and melatonin levels drop to barely detectable levels during the day. It is a good time to get up but also a period of vulnerability: blood vessels are stiffer and more rigid, the blood is thicker and the blood pressure increases sharply. Thus people with heart problems are most at risk of suffering a heart attack in the morning, and it is a poor time to do physical exercise.

Later in the morning, between 9 and 11 a.m., the stress hormone cortisol reaches its natural peak, giving our minds a boost of alertness. For this reason people tend to be most productive at work in the mid-morning and studies show that short-term memory is at its best.

From noon to about 2:30 in the afternoon, the exact opposite is the case: gastric activity reaches its peak after lunch, absorbing much of our bodily energy. At the same time, our hormone system switches to siesta mode, and alertness dips. Early afternoons are a bad time to drink alcohol, as this can make us even more drowsy than at other times of the day.

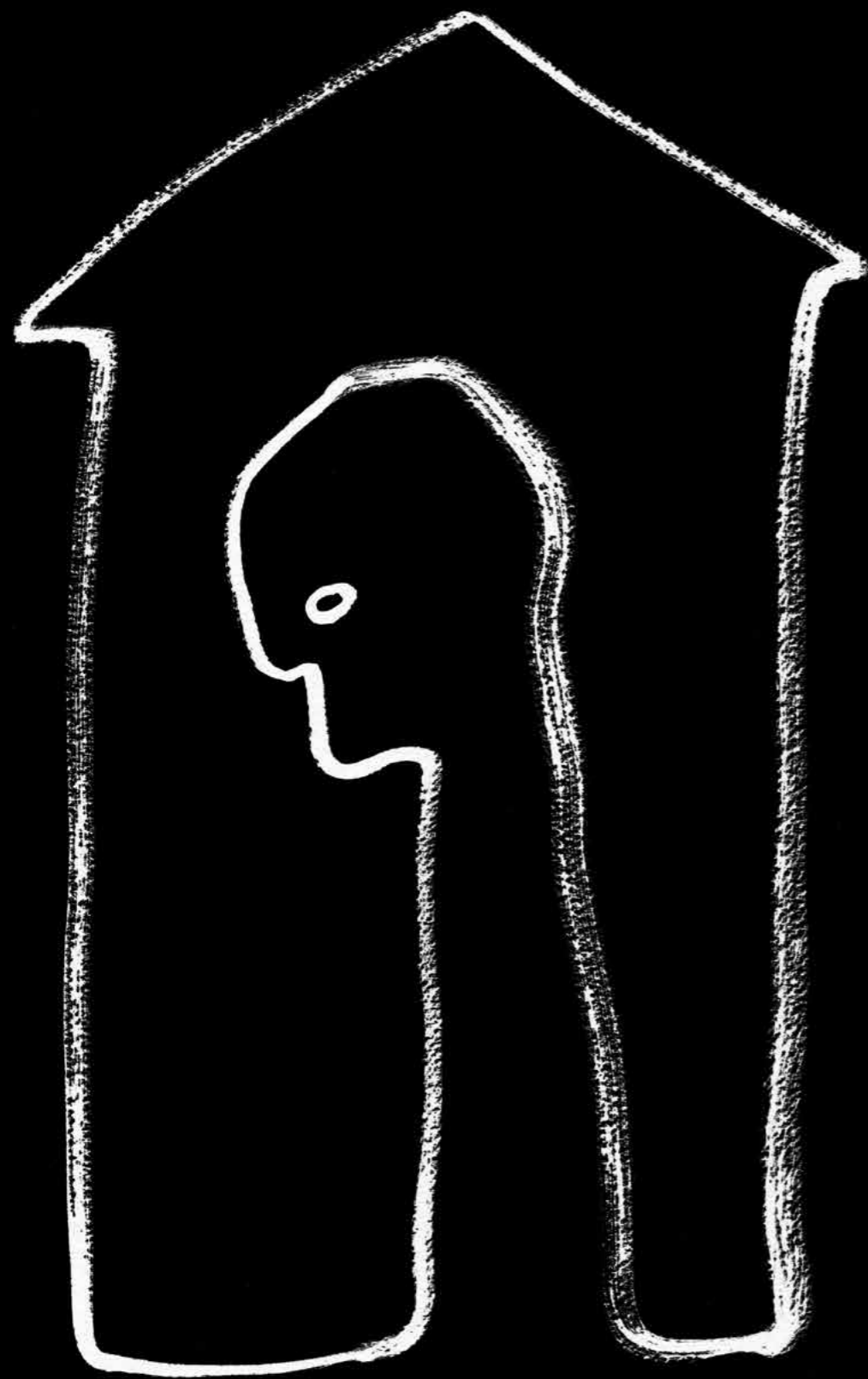
HOW MUCH LIGHT DO WE NEED?

There is no simple, unambiguous answer to this question, as our circadian system functions according to a very different set of rules than the visual system. Circadian entrainment (i.e. the effect of light on the body clock) is a function of illuminance, spectral composition of light, as well as time of day and duration of the exposure. During daytime, the lighting levels of 300–500 lux that are typically found at workplaces, may result in good visual conditions but represent near darkness to the circadian system. White light only achieves its full effect on melatonin suppression at lighting levels above 1,000 lux. In a paper published in 2003, US lighting expert Mark S. Rea writes, “Significantly, modern deep-core offices with limited access to daylight and typical energy-saving electric lighting levels may provide inadequate stimulation to the circadian system, particularly during winter

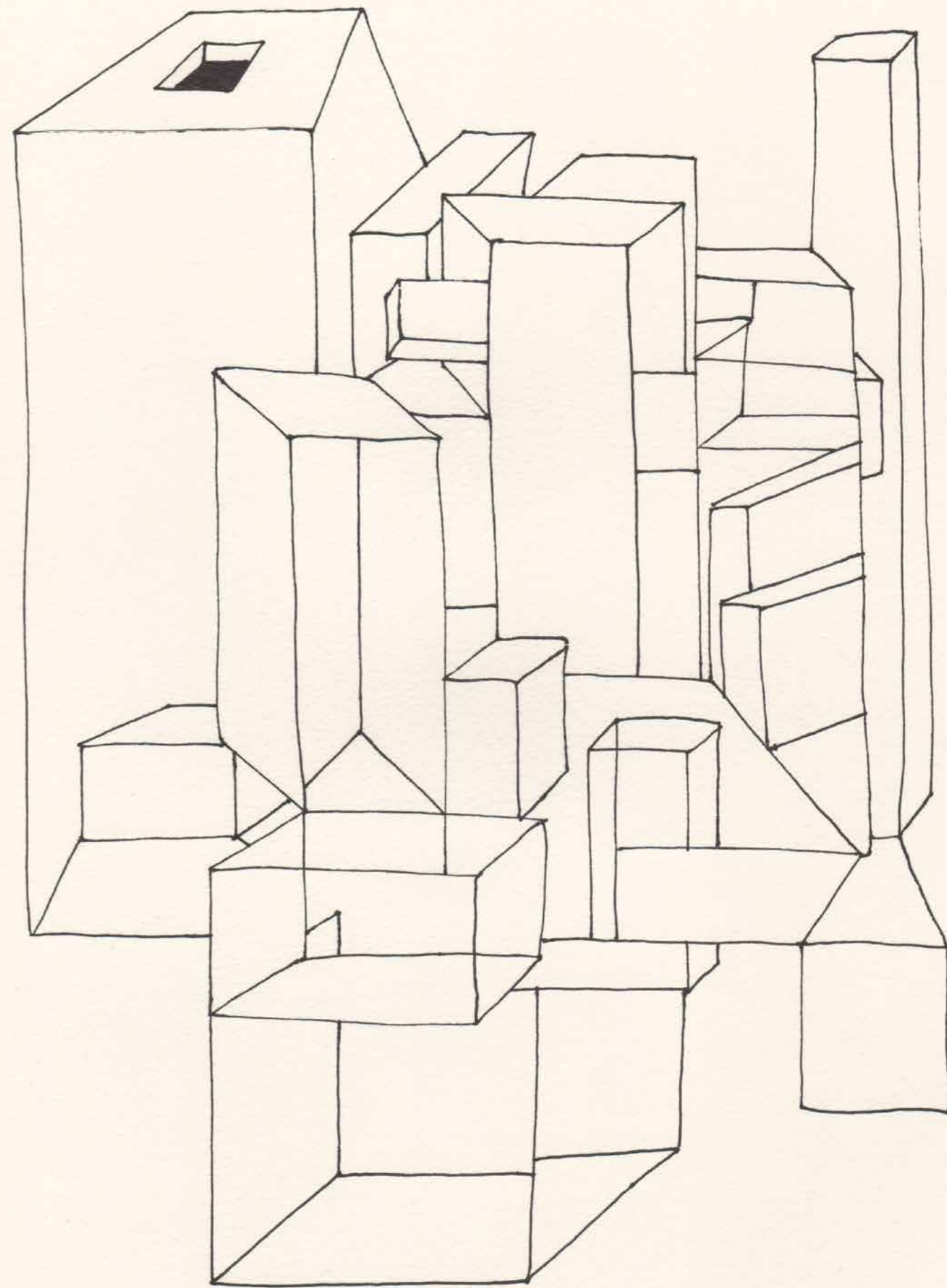
months when access to daylight is minimal. Approximately 10% of the population experiences some degree of seasonal depression in northern latitudes during the winter, and this may be a direct result of limited exposure to light brighter than found in modern buildings”.

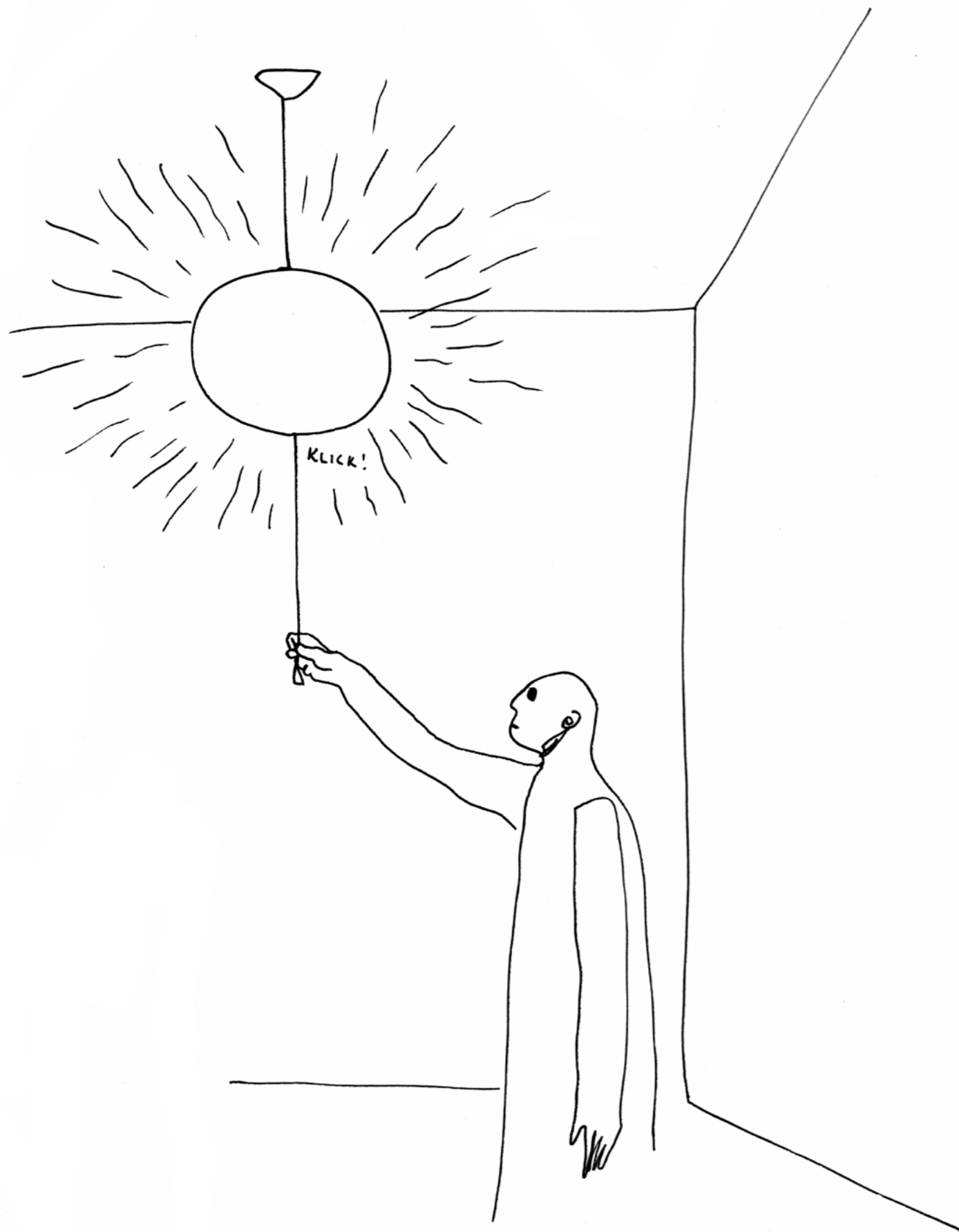
Sources:

WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chronobiology for architectural design*. In: World Health Design, January 2010
 REA, Mark S.: *More than Vision*. In: *More than Vision*. Milan 2007, p. 4 ff.



The house is a
skin.





“The amount of light, its spectral composition, spatial distribution, timing and duration needed for vision is so different from that needed for circadian functioning, that generalizations about ‘good lighting’ will have to be assessed by two very different sets of criteria in the future.”

Mark S. Rea in: *Light – Much more than Vision*, July 2003. See www.lichtundgesundheit.de/cyberlux/?p=856

WHAT KIND OF LIGHT AND WHERE DO WE NEED IT?

Two other marked differences between the visual and the circadian system concern the spectral sensitivity of the system and the location where light is required. What counts for our circadian system is the illuminance level at the eye, not on the desk top. This makes quite a difference, as vertical surfaces (such as the eye) in a room often receive more daylight from windows than horizontal ones (such as the desktop). For artificial light from ceiling-mounted or suspended luminaires, the opposite is true, and in many situations, an electric illumination of 500 lux at the work plane may only result in 100 to 200 lux at eye level.

Furthermore, whereas at daytime our visual system is most sensitive to green and yellow light, the circadian system reaches its peak in the blue range of wavelengths. Monochromatic green/yellow light at 555 nanometers (nm) will only

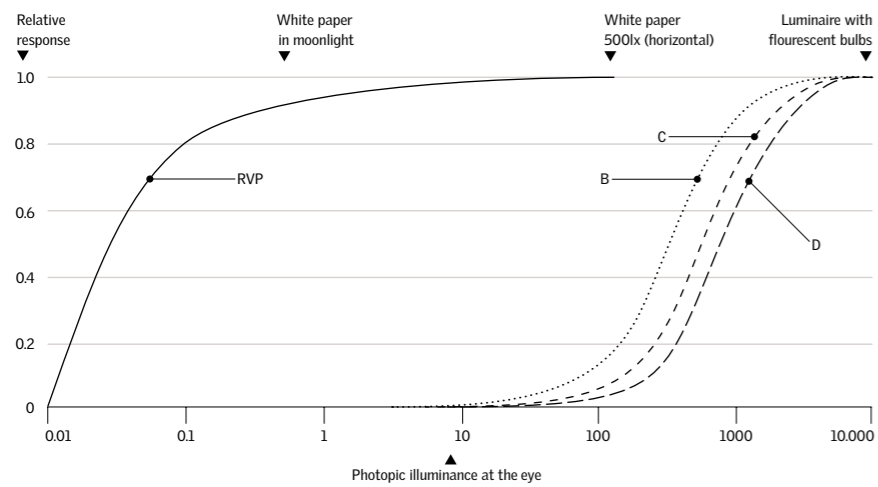
have around 10% of the effect on our circadian system that monochromatic blue light at 450 nm has.

Daylight, in particular, contains a high proportion of short-wave (blue) light and is thus very effective at stimulating the circadian system. Theoretically, even if a light bulb could be constructed that achieved the same illuminance levels as daylight, the latter would still be 2.2 times more effective than the incandescent source for the circadian system. Compared to a 3,000K fluorescent lamp, daylight is even 2.8 times more effective.

Sources:

WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chronobiology for architectural design*. In: *World Health Design*, January 2010

REA, Mark S.: *More than Vision*. In: *More than Vision*. Milan 2007, p. 4 ff.



The illuminances needed for effective circadian entrainment are much higher than those required for visual performance. This is illustrated by the diagram, which compares the relative sensitivity to light by the human visual system (RVP), and the sensitivity of our circadian system to fluorescent light with three different colour temperatures (one hour exposure to B = 6,500 K, C = 4,100 K and D = 3,000 K respectively).

WHEN DO WE NEED IT – AND FOR HOW LONG?

The majority of people will benefit from bright light in the morning to keep us on a regular 24-hour schedule. Light stimulation in the early morning will ‘phase advance’ our body’s master clock, whereas bright light in the late evening will ‘phase delay’ it, causing us to wake up later the next morning. During the middle of the day, light appears to have little effect on the phase of the clock but some researchers claim that it reinforces circadian entrainment, i.e. it helps us to stay on track in terms of time rhythms.

Alongside the timing of light exposure, its duration is also crucial. Being exposed to bright light for as little as 10 minutes

may already have a short-term effect on melatonin suppression in the body, but in order to maintain a healthy sleep/wake cycle in the long term, a longer duration is necessary. Recommendations regarding the minimum exposure to bright light (e.g. daylight) per day vary in the range of 30 minutes to 2 hours per day.

This light dose need not be delivered all at once, however. A study showed that six ‘pulses’ of bright light (9,500 lux at eye level), each lasting 15 minutes and distributed throughout the day, had the same phase-shifting effect as one continuous, 6.5-hour exposure to the same lighting level. This finding highlights the importance of taking regular breaks during the work day and spending them outdoors whenever possible.

Sources:

WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chronobiology for architectural design*. In: World Health Design, January 2010
 REA, Mark S.: *More than Vision*. In: More than Vision. Milan 2007, p. 4 ff.

HOW MUCH LIGHT DO WE GET?

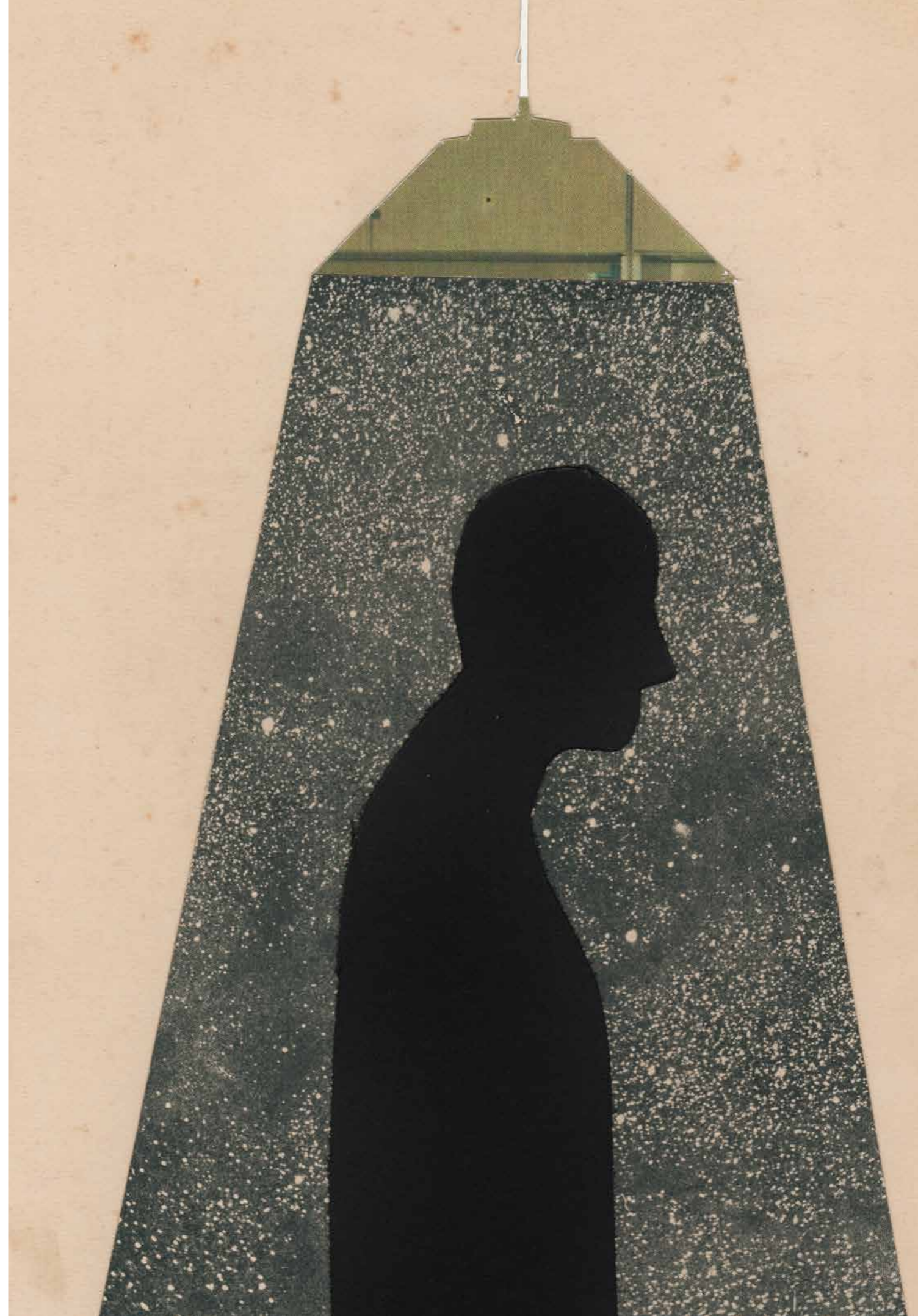
The daily light exposure among people in modern industrialized nations is much less influenced by latitude and climate than one may think – and it is, in most cases, way too low. Chronobiologist Till Roenneberg reports that on working days, the average workforce spends a mere 15 minutes outdoors during daytime. This figure is based on self-reports from several thousand persons in online questionnaires. Long-time measurements with photometers show somewhat higher, but still alarmingly low, figures. According to several studies from the US, people’s average daily exposure to >1000 lux is between 100 and 150 min-

utes in summer but only 25 to 80 minutes in winter. Even in southern California, wintertime light exposures are quite low. Given the fact that most of us spend 90% of our time indoors on average, this result is hardly surprising.

The problem is that even though we receive too little light, this does not seem to be bothersome to us. People intuitively judge lighting levels in terms of visual comfort – and indeed our visual system may be perfectly at ease with indoor lighting levels as low as 300 lux. Indeed, in one experiment in which office workers were given free reign over lighting conditions in their office, 60% of all participants selected values below 500 lux, and none chose a lighting level that came anywhere near having a circadian effect.

Sources:

ROENNEBERG, Till: *Was ist der wahre Preis des Weckers?* In: Ernst Peter Fischer, Klaus Wiegandt (eds.): Dimensionen der Zeit, Frankfurt 2012, p. 116 ff.
 REINHART, Christoph: *Daylighting Handbook, Vol. 1 “Fundamentals”*. Cambridge/Mass. 2014
 WIRZ-JUSTICE, Anna; FOURNIER, Colin: *Light, Health and Wellbeing: Implications from chronobiology for architectural design*. In: World Health Design, January 2010
 VEITCH, Jennifer: *The physiological and psychological effects of windows, daylight and view at home*. Presentation at the 4th VELUX Daylight Symposium, Lausanne 2011



MODERN VIEW W



THE IMPORTANCE OF VIEWS

Offices and classrooms alike benefit from ample and pleasant views that include vegetation or human activity and objects in the distance. Studies with over 8,000 pupils in Californian schools have shown that such views measurably support better outcomes of student learning. In 1990, a survey of over 2000 employees in two buildings at the US Department of Energy also identified 10–20 per cent lower sick building symptoms among employees who had views of windows from their work place.

Other, more recent research has found that not only the presence of windows but also the content of views is crucial. In a laboratory experiment conducted in 1991, behavioural scientist Roger S. Ulrich measured the effect that viewing different scenes on a videotape had on stress symptoms (such as blood pressure, heart activity and muscle tension) after a stressful event. He found that those students who were shown a natural scene displayed the most significant drop in heart rates, blood pressure and muscle tension within only three to five minutes. Viewing urban scenes (such as a shopping mall or a trafficked road) had a much smaller effect on stress recovery. Interestingly, such outcomes were already predicted by the landscape architect Frederick Law

Olmsted – who created Central Park in New York – as early as 1865, when he argued for providing urban citizens with views to nature, reasoning that this would be effective in recovery from stresses associated with urban life.

Probably the most radical view on this topic was taken by environmental scientist Rachel Kaplan, who, from her own research, concluded that a window view with only ‘built’ elements does not foster any psychological benefits and is equivalent to having no window view at all. On the other hand, according to Kaplan, a view with even a few elements of nature makes great differences in worker ratings of satisfaction with their job, life and overall health.

In contrast to this, daylighting expert Jennifer Veitch argues that views to nature may not always be feasible in buildings, and therefore calls for more research on whether equally restorative ‘substitutes’ for nature views can be created in urban settings. In other words, can window views to urban sceneries be made ‘attractive’ enough that office workers will consider them restorative and beneficial for their well-being? And what kinds of window views will qualify for this? These are important questions that researchers and designers will have to answer in the years to come.

NORTH, SOUTH, EAST OR WEST?

In office buildings, an east/west orientation of rooms is often preferred by occupants as both sides receive direct daylight at certain times of the day. However, on both west and east facades, sunlight entering at low angles often leads to a ‘blinds down, lights on’ situation.

In terms of visual and thermal comfort, north/south oriented buildings are therefore a better option. In an average Central European office building, south-facing offices have a 3× lower occurrence of overheating (indoor temperatures > 28°C) than east-facing and west-facing ones. As a consequence, window-to-wall ratios (and thus daylight levels) can be

higher in north-facing and south-facing offices while overheating is still limited to acceptable levels.

In schools, there is a trade-off between daylighting levels and protection from overheating. Students need a boost of bright light in the morning to readjust their circadian rhythm, but overheating from excessive solar irradiation needs to be avoided. Natural ventilation in the morning can be an effective means to ensure this. Furthermore, east and south facing windows should be equipped with effective shading systems, and the control over the shading given to the teacher, not the central building management system alone.

Sources:

- FARLEY, Kelly M. J.; VEITCH, Jennifer Ann: *A Room with a View: A Review of the Effects of Windows on Work and Well-Being*. National Research Council of Canada, Ottawa 2001
- VEITCH, Jennifer A.; GALASIU, Anca D.: *The Physiological and Psychological Effects of Windows, Daylight, and View at Home: Review and Research Agenda*. National Research Council of Canada, Ottawa 2012
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Sources:

- HAUSLADEN, Gerhard; de SALDANHA, Michael; LIEDL, Petra: *ClimaSkin*. Munich 2006
- LOFTNESS, Vivian; SNYDER, Megan: *Where Windows Become Doors*. In: Stephen Kellert/Judith Heerwagen (eds.): *Biophilic Design*, 2008, p. 119 ff.
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A SHADY WORKPLACE

Shading devices are an integral part of any daylighting concept. For buildings located at moderate latitudes, all facades (including north-facing ones, as even diffuse radiation entering north-facing windows can lead to glare and overheating) should be equipped with adjustable blinds, and the occupants given individual control over these. External blinds provide a roughly 10x better protection against overheating than internal ones¹. Internal blinds should therefore only be used for (additional) glare control.

Blinds should be designed in a way as to interfere as little as possible with views outside when they are closed. In early summer mornings and late summer evenings, when workplaces are unoccupied, closing the blinds altogether is a good way to keep unwanted solar radiation from entering the spaces, and thus prevent overheating.

Notes:

1. Assumption: south-facing office in an office building in Central Europe; window-to-wall ratio: 70%

Sources:

REINHART, Christoph: *Daylighting Handbook Vol. 1*, Cambridge/Mass., 2014
HAUSLADEN, Gerhard; de SALDANHA, Michael; LIEDL, Petra: *ClimaSkin*. Munich 2006

THE BENEFITS OF NATURAL VENTILATION

The superiority of natural ventilation over air-conditioning in terms of health has been shown in a large number of studies. On average, air-conditioned rooms had a 30% to 200% higher prevalence of SBS (sick building syndrome) symptoms. Even in most buildings with simple mechanical ventilation with or without humidification, SBS symptoms were more frequent than in buildings that relied on natural ventilation or exhaust ventilation only.

Furthermore, research in the 1990s has shown that people have a much greater capacity to adapt to changing temperatures in naturally-ventilated buildings than in air-conditioned ones. This involves both physiological mechanisms (e.g. through genetic adaptation and acclimatisation), and psychological ones. In naturally ventilated buildings, for example, people have lower expectations regarding temperature stability. Furthermore, they will more easily accept fluctuations in indoor temperatures as long as they are provided with a means of temperature control – even if they do not actively use it.

In the meantime, the so-called ‘adaptive model’ of thermal comfort has therefore been incorporated into the most important standards of indoor comfort. Studies have shown that the adoption of this model in the design of buildings and technical installations can lead to significant energy savings.

According to the model, optimum indoor temperatures in summer vary both by region (they are higher in warmer climates) and according to the medium-term development of outdoor temperatures in a given location. During hot periods with median outdoor temperatures of 30°C, even indoor temperatures as high as 28°C may thus be considered comfortable.

Sources:

SEPPÄNEN, Olli; FISK, William J.: *Relationship of SBS symptoms and ventilation system type in office buildings*, 2002
BRAGER, Gail; de DEAR, Richard: *Climate, Comfort & Natural Ventilation: A new adaptive comfort standard for ASHRAE Standard 55*, 2001
PANATINESCU, Tudor Mihai: *Indoor climate – the adaptive approach to thermal comfort*. BSc dissertation at VIA University College, Aarhus 2013

HOW MUCH FRESH AIR DO WE NEED?

If CO₂ levels in the indoor air are to remain below 1,000 ppm, a fresh air supply of at least 25 m³/h per person is needed. To ensure good air quality, however (which, according to the standard EN 15251 (category II) is equivalent to max. 800 ppm of CO₂), a substantially larger ventilation rate is required.

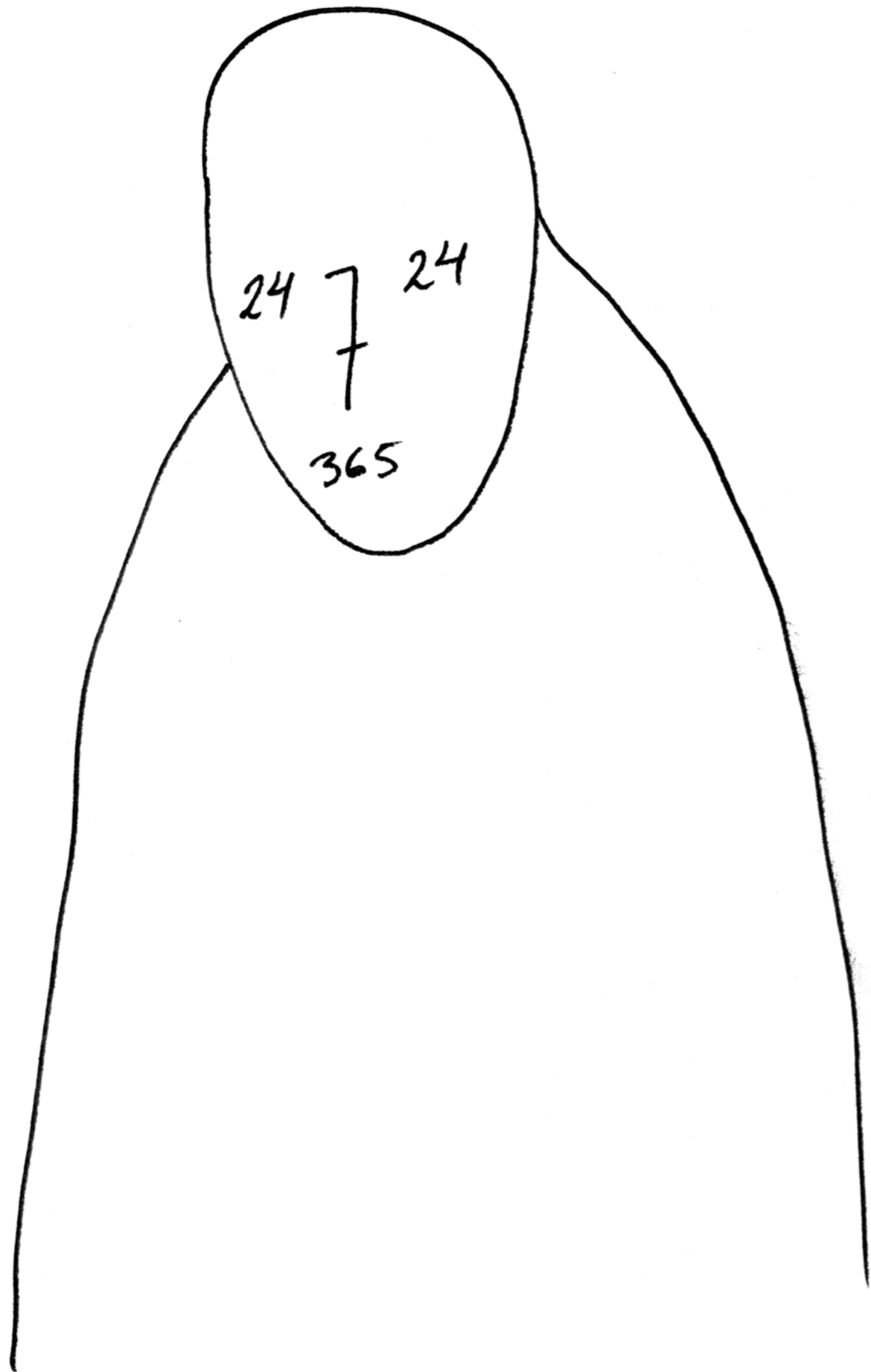
User evaluations in buildings underline the benefits of having plenty of fresh air at the workplace. Calculations by Fisk et al., which were based on field data, show that doubling the ventilation rate from 36 m³/h/person to 72 m³/h/person may reduce sick leave in offices due to infectious diseases by around 30%. The same ventilation increase has also been predicted to raise the performance of office workers by 1% to 1.5%. This may sound insignificant but if we consider that, in many cases, over 80% of the entire business costs related to an office building are spent on salaries, higher ventilation rates may indeed be an economically attractive option.

Sources:

EN 13779: *Ventilation for non-residential buildings*, 2007
EN 15251: *Input Parameters for Indoor Climate in the Design and Evaluation of the Energy Efficiency of Buildings*
FISK, William J.; SEPPÄNEN, Olli: *Some Quantitative Relations between Indoor Environmental Quality and Work Performance or Health*. Lawrence Berkeley National Laboratory, 2006
FISK, William J.; SEPPÄNEN, Olli; FAULKNER, David; HUANG, Joe: *Economic Benefits of an Economizer System: Energy Savings and Reduced Sick Leave*, Lawrence Berkeley National Laboratory, 2004

Since we don't have any natural light in this office. You have to act shadow.





“Although indoor lighting (between 50–300 lux) is perfectly adequate for the visual system, it is near darkness for the circadian system. The human species evolved to function with more than one hour of daylight per 24 hours – but now in industrialised nations we appear to receive too little light during the day and too much light at night.”

Anna Wirz-Justice, Colin Fournier in: *Light, Health and Well-being: Implications from chronobiology for architectural design*. World Health Design, January 2010

THE GREAT OUTDOORS

Outdoor spaces around offices and schools are vital for human health in general, and for the physical and cognitive development of children in particular.

With sidelighting through windows alone, most offices and classrooms will rarely achieve the lighting levels above 1000 lux that are needed for effective circadian entrainment. Moreover, UVB radiation (which is vital for human beings in order to synthesise vitamin D in the body) is largely filtered out by window glazing.

Therefore both the work or learning schedules, as well as the building itself, should invite users to step outside at regular intervals. This behaviour can be supported by providing balconies and roof terraces, and by locating the building in a walkable neighbourhood, with green areas nearby. For inclement weather, well-lit breakout spaces (e.g. in atria) will be another antidote to the widespread lack of daylight.

Outdoor areas around educational buildings can also be vital resources for children’s cognitive, physical and social development. In 2006, a Danish study

found that outdoor kindergartens were better than indoor ones at stimulating children’s creativity. Furthermore, periodical exposure to pollutants in small and non-harmful doses, particularly as a child, will decrease the risk of developing allergies at a later stage in life. For this reason, outdoor areas around kindergartens and schools should contain as many natural features as possible. Apart from providing a healthy pollutant exposure, they also offer a much greater wealth of sensory experience than man-made materials and structures alone.

Last but not least, a diverse system of natural settings on school grounds can offer great opportunities for learning, especially for students whose style is not well adapted to indoor environments, such as children with ADD (attention deficit disorder).

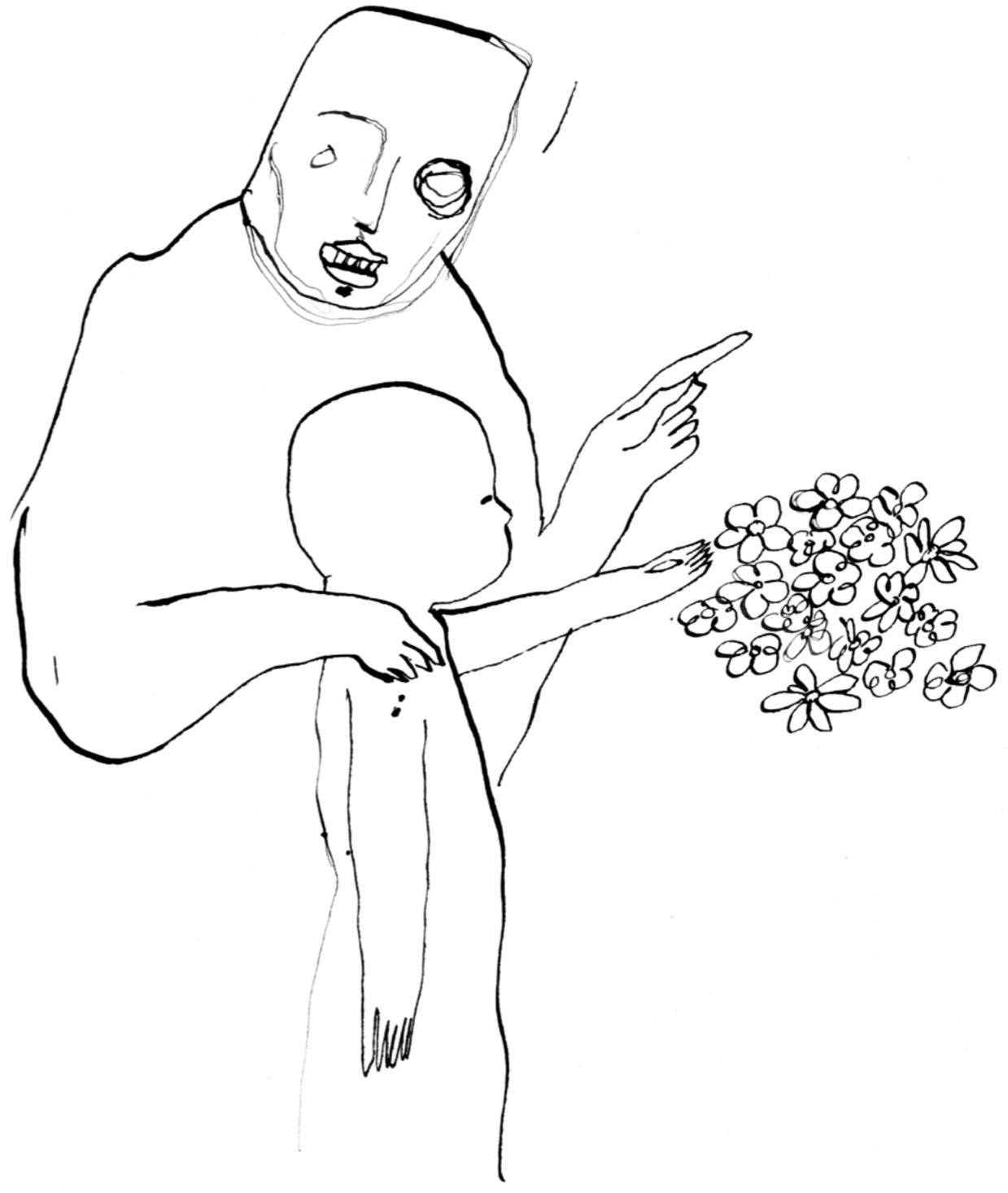
And not only for these. School gardens in particular allow a didactic encounter with nature. Here students are not only given the possibility to learn the skills needed in gardening work but also get a first-hand experience of ecological principles, the cycle of seasons and what constitutes a healthy diet.

Sources:

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- MOORE, Robin C.; MARCUS, Clare Cooper: *Healthy Planet, Healthy Children: Designing Nature into the Daily Spaces of Childhood*. In: Kellert/Heerwagen(eds.): *Biophilic Design*. Hoboken 2008, p. 153ff.
- VEITCH, Jennifer; GALASIU, Anca: *The Physiological and Psychological Effects of Windows, Daylight, and View at Home: Review and Research Agenda*. National Research Council of Canada, Ottawa 2012



Be carefull.
Those things can
really cut you bad!
lets go inside instead.





LIVE

Mid-afternoons are an excellent time to do physical exercise. Around 3:30 p.m., reaction times are fastest, and body temperature increases throughout the afternoon like a natural warm-up. The cardiovascular system is at its most efficient around 5 p.m., and muscles are 6% stronger than at their lowest point of the day.

Between 6 and 7 p.m., both blood pressure and body temperature reach their daily peak, and people have been shown to be particularly good at intuitive thinking in the early evenings. At the same time, the liver is particularly good at dealing with alcohol around dinnertime.

From about 9 p.m. onwards, melatonin secretion in the body starts and sleepiness sets in. The core body temperature drops, making people yearn to slip under the duvet. At the same time, gastric activity decreases, so late evenings are a poor time to have big meals. Watching TV late at night is not a terribly good idea either, as the blue light emitted by TV sets may result in a level of arousal that is counterproductive to good sleep.

PLACES TO LIVE

Ideally, the building site for a house or apartment building should be located in an area with good outdoor air quality and plenty of daylight and sunlight, and with limited outdoor noise levels. Other aspects to be considered are prevailing winds and the amount of night-time light pollution.

Above all, however, access to green outdoor areas is consistently ranked a top priority by prospective home-buyers when making choices about where to live. This preference is supported by research studies, which have shown that people living closer to green spaces have better health profiles than those living farther away. Other, consistent benefits of living in close contact with nature are improved mood and reduced stress levels.

By means of evapotranspiration, plants in cities counteract the so-called 'urban heat island' effect, which, as the

2003 heat wave in Central Europe has shown, can be health-threatening, particularly for elderly people in hot summers. By comparison, the effect of plants on air quality is somewhat more ambiguous. On one hand, vegetation may reduce levels of gaseous pollutants (such as nitrogen oxides) and particulate matter in the outdoor air, but only by a few percentage points and, according to some studies, even less. (Having said this, trees may be an effective barrier against the local dispersion of such pollutants because they impede air movement in streets and other outdoor spaces).

On the other hand, plants themselves can be a significant source of air pollution. Trees release hydrocarbons, which may function as precursors of ozone and secondary organic aerosols. This is one of the reasons why high ozone levels in summer not only occur in urban areas but, with a time delay, in areas outside the city as well.

Furthermore, many trees and plants release pollen, aggravating allergies – so

that all those who are allergic to pollen will benefit from living in urban areas where there are few trees. Similarly, wetlands adjacent to streams, waterways and bodies of water, as well as to forests with their shady and moisture-rich atmosphere are commonly ridden with mould spores. For people who are allergic to mould and mildew, such places are not suitable places to live.

Sources:

Circadian House - Principles and Guidelines for Healthy Homes. VELUX, Hørsholm/Denmark, 2013

OVERATH, Christine: *Quality management for healthy indoor spaces.* In: DETAIL Green 2-2012, p. 55ff.

HARTIG, Terry; MITCHELL, Richard; de VRIES, Sierp; FRUMKIN, Howard: *Nature and Health. Annual Review of Public Health 35,* 2014, p. 207 ff.

“Perhaps we should be aiming for a higher level of experiential quality in our environments, where ‘pleasantness’ rather than ‘neutrality’ are the goals. Can thermal qualities be used in a more purposeful way to add to the richness of our indoor environments? Can we create spaces that are more than neutral, where people can find “thermal delight”, where they can interact with their environments, and be refreshed and stimulated by them?”

Gail Brager, Richard de Dear in: *Climate, Comfort & Natural Ventilation: A new adaptive comfort standard for ASHRAE Standard 55, 2001*

VIEWS AND WELL-BEING

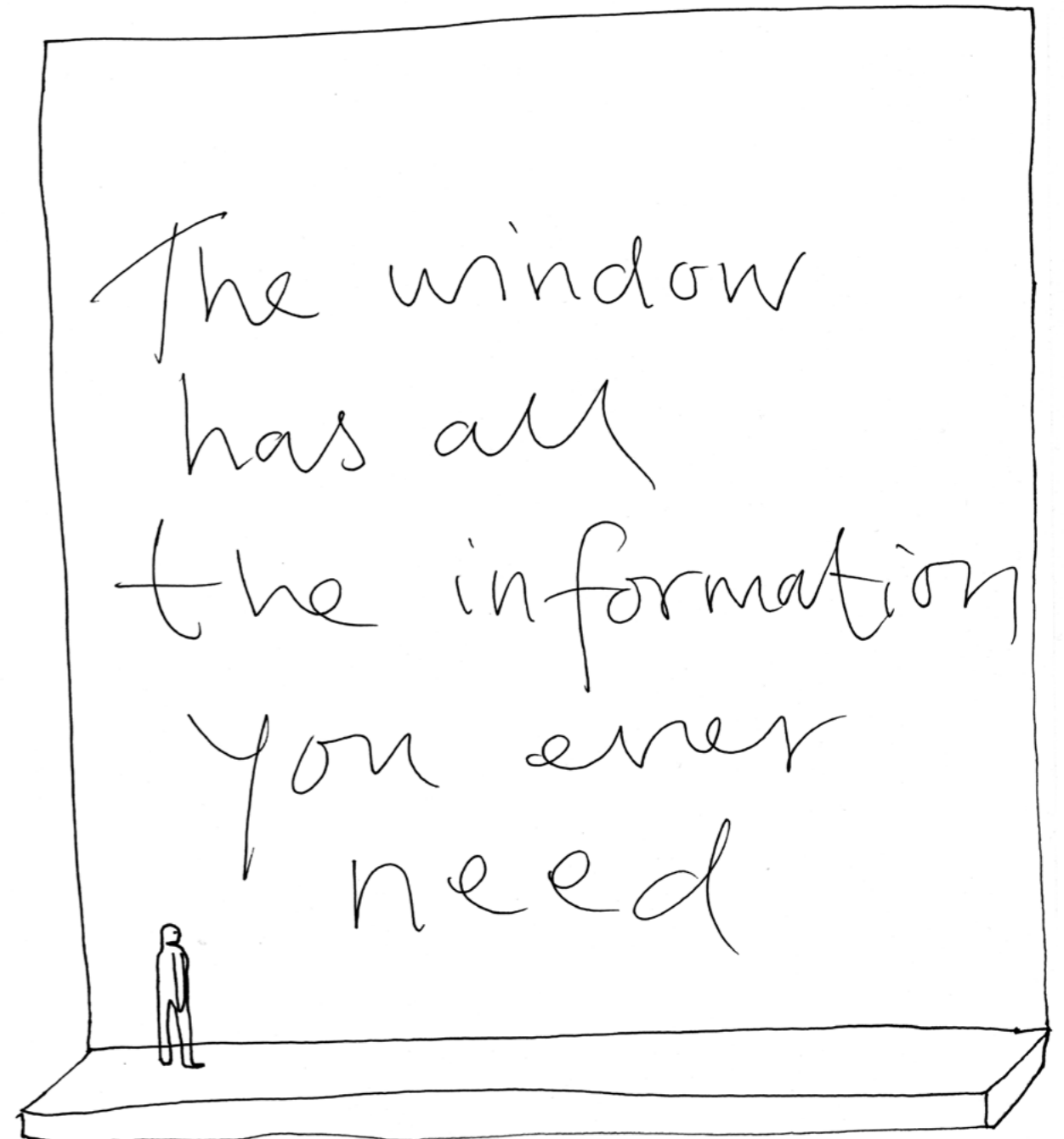
Just as in offices and schools, views of the outdoors significantly influence people’s well-being at home. This includes both psychological and physiological effects. In surveys among apartment residents, those who had views to nature from their windows consistently reported better well-being and, particularly, higher satisfaction with their homes than those without nature views. In a study among elderly women in a retirement centre, Joyce Tang and Robert Brown found that residents who had views to nature from their windows also had lower blood pressure and heart rate than those who had views of the built environment or no windows at all.

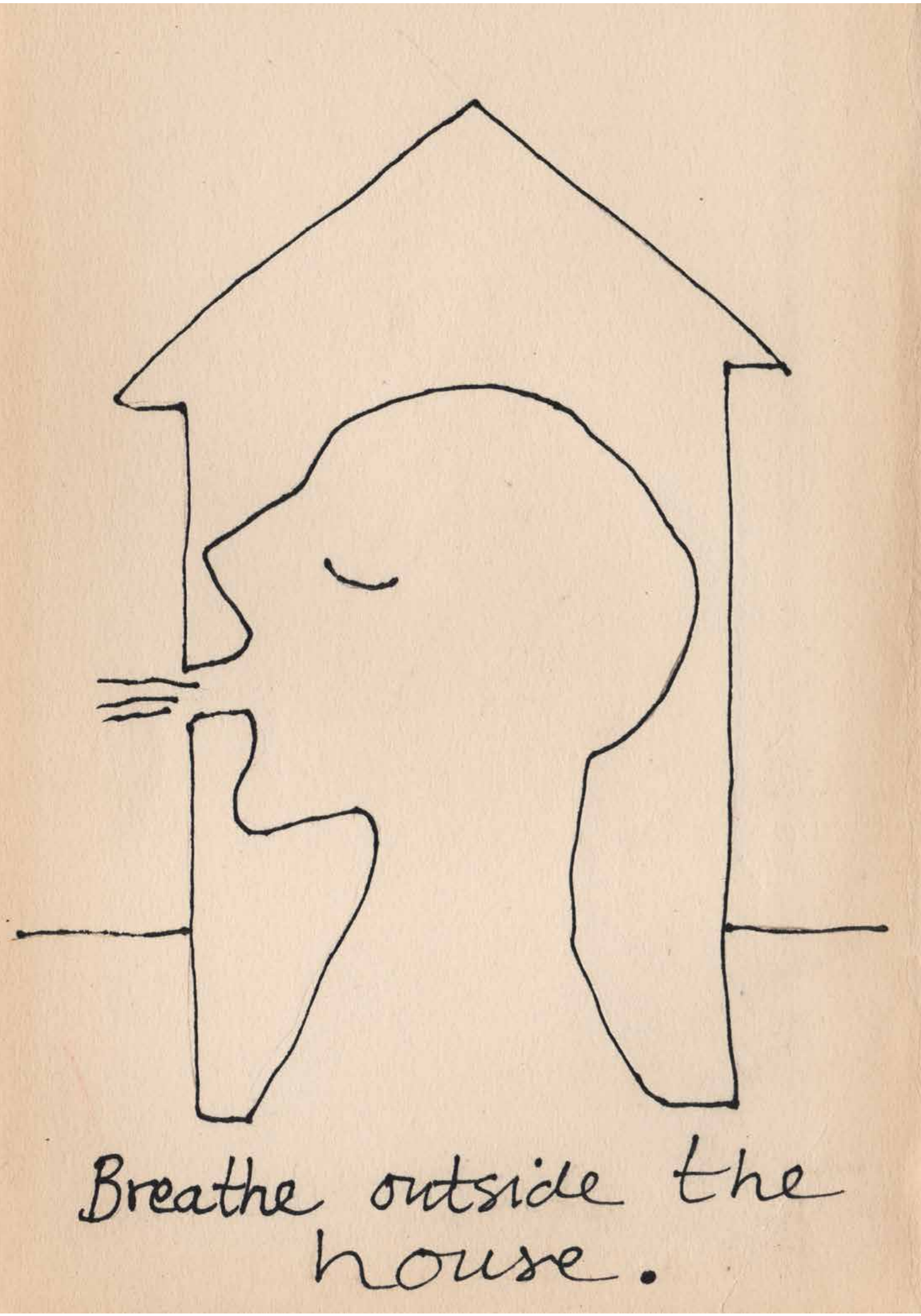
Similarly beneficial effects have been found among children, and these in turn translate into better cognitive functioning and ability to concentrate. In a 2000 study aptly entitled *At Home with Nature*, the

architect and psychologist Nancy M. Wells conducted an enquiry among parents in a social housing estate before and after moving to other apartments that offered more views of green spaces from the windows. The results were clear: four months after the move, the parents reported significantly fewer symptoms of attention deficit disorder (ADD) among their children than before moving to the new apartments. In a similar study, Andrea Taylor et al. assessed the self-discipline of 169 boys and girls living in inner-city high-rise buildings and compared these with the amount of ‘greenery’ that the test persons were able to see from their windows. For girls, there was a significant correlation between ‘natural’ content of view and better self-discipline, while for boys, no relationship between the two factors could be found. The authors concluded: “These findings suggest that, for girls, green space immediately outside the home can help them lead more effective, self-disciplined lives. For boys, perhaps more distant green spaces are equally important.”

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HEALTHY LIGHT AT HOME

During daytime, private homes and apartments should provide opportunities for exposure to high daylight levels at eye level, in a range between 1,000 lux and around 5,000 lux. High intensity boosts of light are particularly needed in the morning for circadian entrainment.

Overall, the traditional distribution of rooms in houses (with bedrooms facing east and living rooms facing south and west) is rather beneficial in this respect. Distributing windows in multiple external walls and in the roof, rather than placing them with only one orientation, will considerably improve the daylight supply in a room. In a recent study, John Mardaljevic et al. analysed the daylight levels in a typical residential home with or without skylights by means of computer simulations. They conclude: "Given the

evident limitations in delivering significant amounts of daylight from vertical windows more than a few metres into a deep-plan space, it is plausible that residential dwellings and low-rise buildings with some form of top-lighting (e.g. skylights) have a greater potential to achieve the daylight illuminance levels at the eye required for non-visual effects." This was reinforced by the simulations, which showed that the illuminance levels at the eye (which matter for circadian entrainment) were both higher and more evenly distributed throughout the space in the case with roof windows than without.

Furthermore, the type of glazing also matters, as daylight with minimal spectral filtering should be delivered to indoor spaces in order to ensure effective circadian regulation. In this respect, care should be taken with solar protective glazing and window films to ensure they do not alter the spectral composition of the light.

“What would our lives be like if our days and nights were immersed in nature as they are in technology? How can each of us help create that life-enhancing world, not only in a hypothetical future, but right now, for our families and for ourselves?”

Richard Louv in: *The Nature Principle*.
Chapel Hill, 2011, p. 3

THE AIR THAT WE BREATHE

Opening windows brings in fresh outdoor air and provides contact to the outside as well as a rapid improvement of indoor air quality. Airings should therefore be part of the daily cycle. They serve mainly two purposes: to lower CO₂ levels and to remove excess moisture, i.e. water vapour, from the indoor air.

An average 4-person household produces 5–10 kilogrammes of water vapour every day. The most significant sources of humidity are showers, baths, cooking, as well as clothes washing and drying. Peoples' activities make a significant contribution, too: during heavy work, a person emits as much as 175 g of water vapour per hour.

To keep CO₂ concentrations in the indoor air at acceptable levels, a four-person

Sources:

Circadian House - Principles and Guidelines for Healthy Homes. VELUX, Hørsholm/Denmark, 2013

MARDALJEVIC, John; ANDERSEN, Marilyne; ROY, Nicolas; CHRISTOFFERSEN, Jens: *Daylighting, Artificial Lighting and Non-Visual Effects Study for a Residential Building*. VELUX, Hørsholm/Denmark 2012

household requires some 2,000–3,000 m³ of fresh air per day. This is roughly equivalent to one full air exchange every two hours.

The amount of fresh air needed also depends on the individual activity. While sleeping, people need around 20 m³ of fresh air per hour. When doing household work (such as cooking or cleaning), these amounts rise to approximately 60–70 m³ per person per hour.

Sources:

Circadian House - Principles and Guidelines for Healthy Homes, VELUX, Hørsholm/Denmark 2013

Energie Tirol: Energiesparen durch richtiges Lüften. Innsbruck 2001

OVERATH, Christine: *Quality management for healthy indoor spaces*. In: DETAIL Green 2-2012, p. 55ff.

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TACKLING INDOOR AIR QUALITY AT THE ROOT

Generally, indoor air is more contaminated with pollutants than outdoor air. The most effective way to reduce the associated health risks is not increased ventilation, but eliminating indoor emission sources in the first place.

Indoor air pollutants (which, in many cases, cannot be sensed by humans) can be present in both building materials and consumer products, but are also generated by everyday habits such as smoking or cooking. Indeed, the kitchen can be the most affected room in the house due to the pollutants (particles, NO_x, etc.) emitted from the stove and oven when cooking. The most effective means of reducing pollutant exposure is by using an efficient cooking hood. Kitchens that can be closed off (at least temporarily) from their surroundings are also beneficial as they prevent cooking-related particles from spreading throughout the house.

All interior materials emit chemicals to the indoor air and it is important to

choose low-emission products that do not emit substances at hazardous levels. In general, the closer a material is to a surface on the inside, the greater the probability that it will release its toxins into the indoor air. Thus special attention is advisable regarding surface treatments and coatings. Furthermore, the mutual 'compatibility' of the individual materials also matters. In some cases, chemical reactions between otherwise harmless products may generate toxic substances that were originally not present in the construction. Specifying entire systems (e.g. a floor build-up or roof build-up) that have been tested for emissions may be a good way to circumvent this problem.

Apart from building materials, furniture, electrical appliances and even toys can also lead to deterioration of the indoor air. These are usually brought in by the occupants over time, and rooms will have different uses over the years. Therefore, the design of the house (and especially of the ventilation system) must be robust towards such changes, and provide enough extra capacity for higher air exchange rates.

Sources:

OVERATH, Christine: *Quality management for healthy indoor spaces*. In: *DETAIL Green* 2-2012, p. 55ff.

Circadian House - Principles and Guidelines for Healthy Homes, VELUX, Hørsholm/Denmark 2013

TEMPERATURES AT HOME: VARIATION IS KEY

Preferably, indoor temperature should vary over the course of the day, in parallel with the outdoor temperature. The indoor temperature should – with limitations – also follow the seasons, with minimum levels during the winter and maximum levels in summer.

Overheating can normally be avoided by the use of solar shading and natural ventilation through windows – particularly if efficient ventilation strategies such as cross ventilation or stack ventilation are applied. Bedrooms are particularly sensitive to overheating and should therefore be located on the cold side of the house, i.e. facing north or (even better, as this will increase daylight supply in the mornings) east.

As long as overheating is avoided, solar gains should be welcomed as they provide spatial variation of temperature in the rooms with local warm and cool spots.

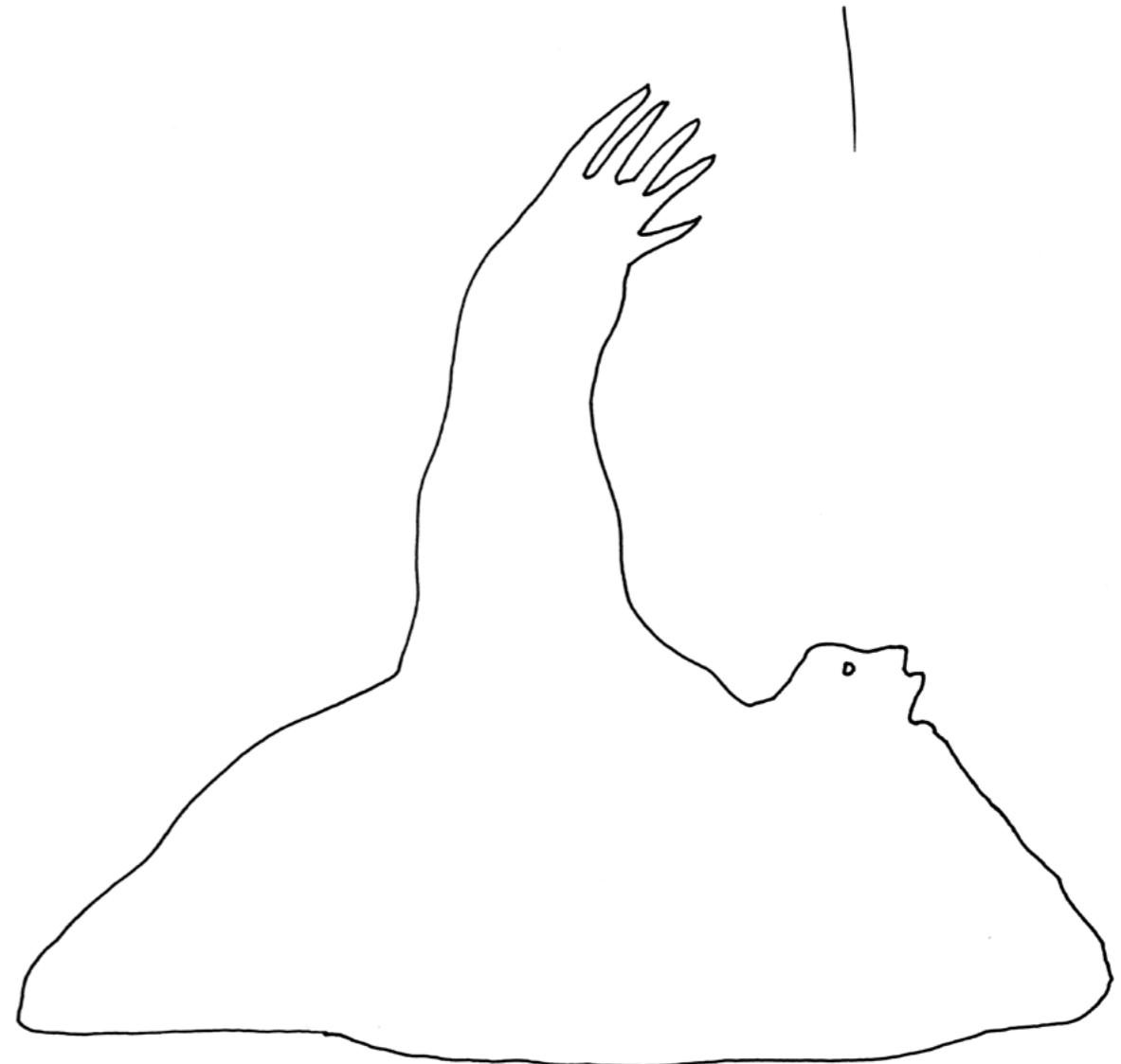
During winter with little solar gains, a local hot spot should be provided for in e.g. the living room, typically with a high temperature (vertical) radiant heat source. This hot spot allows the occupants to seek a warm or cool position in the room that suits them.

Residents should be able to control the heating at room level, e.g. with thermostats on radiators or adjustable wall thermostats. In any case, the heating system and heating controls should be designed so as to react quickly when the thermostats are turned up or down.

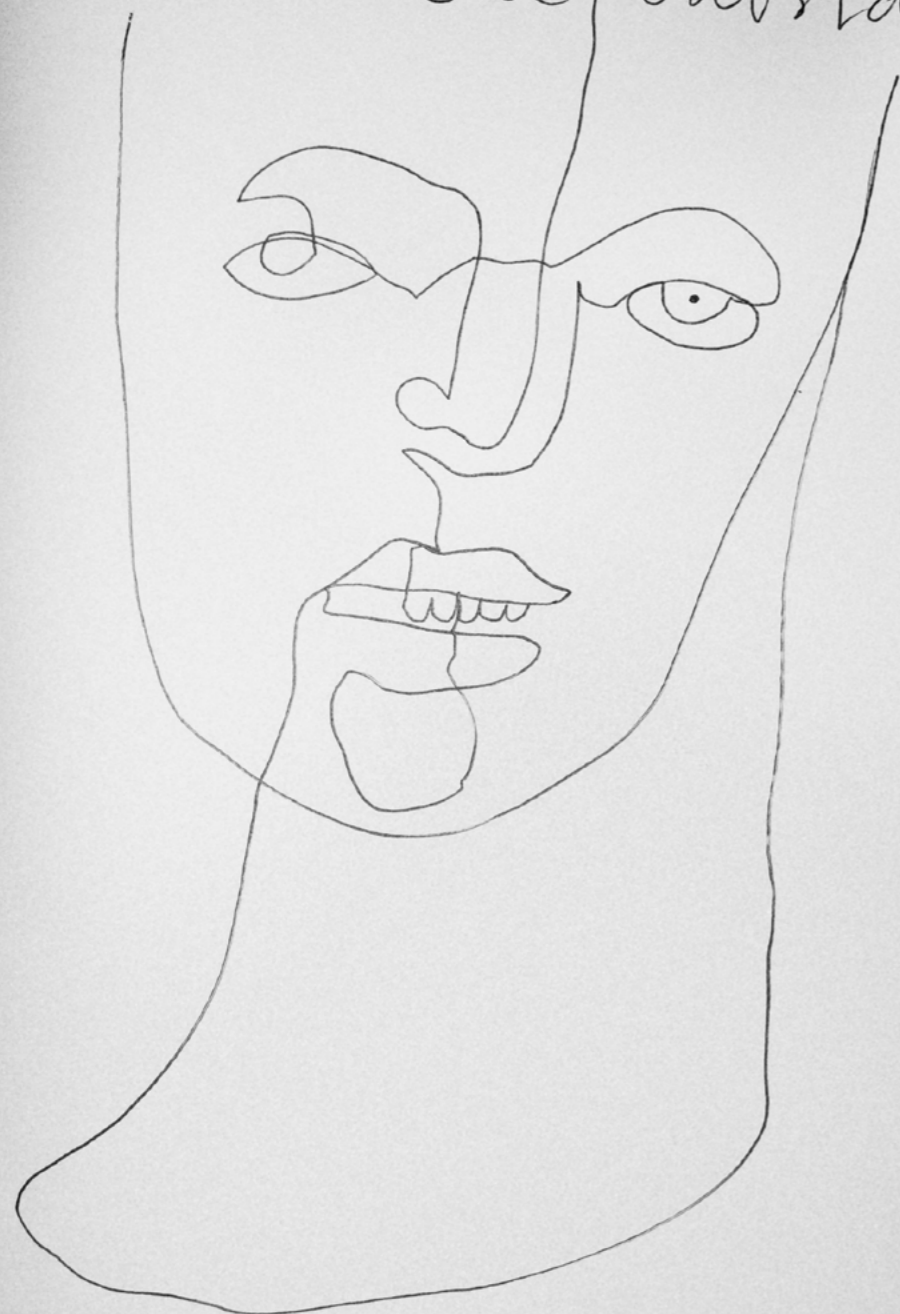
Source:

Circadian House - Principles and Guidelines for Healthy Homes, VELUX, Hørsholm/Denmark 2013

HONEY. I THINK
IT'S A LITTLE BIT
TO HOT AT
HOME. DON'T
YOU THINK?



Excuse me | is this
the outside?



“Air is our most important form of sustenance. Without water, we would survive for three days and without food, up to three months. But only very few people can hold their breath for longer than three minutes. Indeed, every day, an adult pumps an astonishing 17 to 19 kilogrammes of air through their body. Paradoxically, the quality of indoor air in buildings is often disregarded. In new and renovated buildings, an increasing degree of airtightness is leading to astonishing and, in some cases, alarming levels of pollutants in the air indoors, where the average Western person spends up to 90 per cent of their time.”

Christine Overath: *Quality management for healthy indoor spaces*. In: *Detail Green 2-2012*

THE BENEFITS OF BEING OUTDOORS

Physical contact with nature has been linked to stress reduction among adults, better cognitive development among children, and, at least in some studies, to improved social cohesion among people. Researchers in Chicago have found that the more trees and grass there are in an urban area, the more frequently residents tend to use common spaces, the better their informal social contact becomes, and the lower the crime rate in the area will be. However, it is not merely the quantity of greenery that matters in this respect, but also its quality. This fact is highlighted by environmental psychologist Terry Hartig and his co-authors in a recent paper: “Arguably, local parks must be well maintained and provide attractive recreational facilities to realise their full potential in developing social ties”.

Above all, contact to nature has repeatedly been praised for its restorative effect. This works in two distinct ways. First, natural areas and features can increase the distance to challenging environmental features. This happens, for example, through trees that reduce noise from nearby, heavily trafficked roads, or landscaped areas around housing that

help residents maintain privacy and avoid feelings of crowding.

Second, nature can help people restore their adaptive resources, which allows them to better cope with stress in the long run. In the 1980s, environmental psychologists Rachel and Stephen Kaplan developed the so-called ‘attention restoration theory’ to explain this phenomenon. In a nutshell, the theory holds that effortless attention, which is engaged by intrinsically interesting aspects of nature, is an effective antidote to the fatigue caused by prolonged ‘directed attention’ (or, in other words: concentrated work) at the workplace.

A large number of studies so far have highlighted the beneficial effects of nature on the self-reported well-being of people. Researchers in Sweden found that joggers who exercise in a natural green setting felt more restored and less anxious, angry, or depressed than people who burned the same amount of calories jogging in a built urban setting. A study at the University of Essex found that even a five-minute dose of exercise in green settings may already improve mood and self-esteem. The greatest benefits were found among young and mentally-ill people.

Most restorative effects of nature can be observed regardless of the level of physical activity. However, physical ex-

ercise as such has several additional benefits for human health. First, it is among the most effective means of preventing cardiovascular diseases and obesity. Second, physical exercise in the afternoon may even be an antidote to night-time insomnia, as it has been shown to produce a phase advance in our circadian system (which is a very welcome effect for most people). The same cannot be said of night-time physical activity, which tends to phase delay our internal clock.

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CIRCADIAN HOUSE

Principles and guidelines for healthy homes. The previous articles have made it clear that evolution has attuned human beings to living in close contact with nature, and that buildings, first and foremost, need to support the biological needs of their inhabitants. To provide designers with a comprehensive vision and hands-on advice on how to create healthier homes, the VELUX Group has held a series of five workshops with an interdisciplinary team of experts. These resulted in a number of recommendations and guidelines for circadian houses – i.e. buildings that allow their inhabitants to live 'in sync' with the rhythms of nature and enjoy the benefits this way of living imparts on human health and well-being.

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Luc Schlangen, *Phillips Lighting, The Netherlands*
Mariëlle Aarts, *Eindhoven University of Technology, The Netherlands*
Nick Baker, *University of Cambridge, UK*
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Thomas Witterseh, *Danish Technological Institute, Denmark*
Truus de Bruin, *Delft University of Technology, The Netherlands*

KEY PRINCIPLES OF CIRCADIAN ARCHITECTURE

- | | | | | | |
|----------|---|----------|--|----------|--|
| A | Live in balance with nature
A house in balance with nature allows the occupants to live with and follow the daily and seasonal cycles of the outdoor environment. | B | Adaptability
A house whose space and occupants can adapt to changing conditions (daily as well as seasonal) and needs. | C | Sensibility
A house that provides protection against harmful substances that humans cannot sense and allows freedom to control parameters that they can sense. |
|----------|---|----------|--|----------|--|

DESIGN ASPECTS TO TAKE INTO ACCOUNT

- | | | | | | |
|----------|--|----------|--|----------|--|
| 1 | Variation
The indoor environment should vary in time and space rather than target uniformity or non-variability. | 2 | Stimulation/absence of stimulation
The level of stimulation from environmental factors (light, sound, air and temperature) should be higher during day than the night. | 3 | Outdoor/indoor relation
Outdoor and semi-outdoor areas should be designed to be inspiring and easily accessible; occupants should be able to follow (changes in) outdoor conditions in all main living areas of the house. |
| 4 | Warm/cool
The house should provide temporal and spatial variations in the thermal environment that are logical and follow (to a certain extent) variations in the outside temperature. | 5 | Silence/sounds
The presence of sound and contact to sounds from outdoors are desirable in the day, whereas quiet spaces are needed at night. | 6 | Light/darkness
Exposure to high levels of daylight is needed in the main living areas of the house during daytime; special attention should be given to rooms that are mainly used in the morning, whereas bedrooms should provide complete darkness at night.
Electrical lighting should follow, support and supplement the changes and variations in the daylight spectrum and intensity through the course of the day, as well as its distribution in space. |
| 7 | Rest/activity
The house design should inspire the occupants to be active – but also provide areas for rest and restitution. | 8 | Flexibility related to the seasons
The use of outdoor and semi-outdoor spaces should be stimulated outside the heating season. | | |
| 9 | Control
The occupants should be able to control the systems influencing parameters that can be sensed, e.g. the lighting level, air quality and indoor temperature. | | | | |

Sleep,

Work,

~~Rest,~~

PLAY.



I'm

Finally

OUT.

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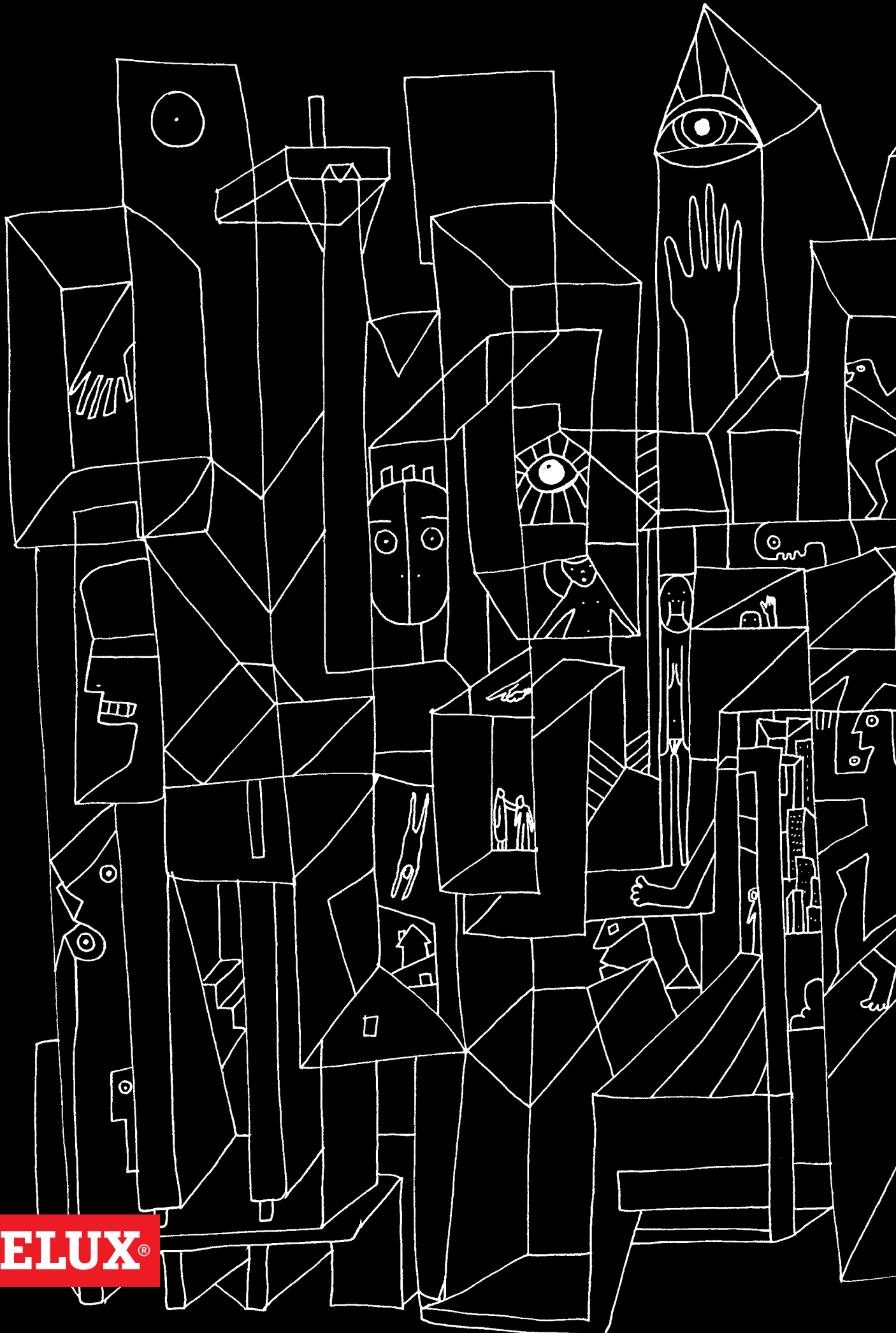
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