Going Beyond Green — Green Perception
A critical paradigm change in IAQ to address health, wellbeing, and substantial cost-savings

Diotima von Kempski

DVK Air Vitalizing System, Düsseldorf, Germany

Corresponding email: dvkempski@dvk.net

SUMMARY
Buildings have been identified as sources of greenhouse gases emissions on a big scale. But it has also been observed that the enthusiasm for energy savings is eclipsing the necessity of addressing issues of health, wellbeing and productivity—all of which also involve substantial cost savings. While so-called green building standards suggest an economic benefit from addressing issues of wellbeing and productivity—and despite the recent updates of green building institutions such as LEED (2009)—these critical issues are often given little more than a cursory nod. Thus, the goal of energy savings and corresponding health improvements has only been partially addressed, even though many buildings show related health symptoms. When it comes to producing healthy indoor air, the human brain (and neurophysiological chemosensory perception) must be regarded as a critical indicator and terminator for health, wellbeing, and productivity. Such consideration should be the basis for determining for the quality of indoor air, since it is accompanied by substantial economic benefits. Such considerations should become be written into required guidelines for healthy indoor air.

KEYWORDS
olfaction, health, productivity, neuro, brain, perception

INTRODUCTION
The LEED (2009) update shows quite clearly that the indoor environment has unfortunately been playing a secondary role to other considerations. Stahl (2009) calculated that energy and sustainability had an increase from 25% to 32 %, and 20% to 24%, respectively. The losers are concerns, such as indoor quality, which reflect a decrease of 22% to 14%, and building materials, which also shows a decrease from 19% to 12%. By contrast, certificate requirements for the silver, gold, and platinum labels, show a point increase of 2% to 5%.

Given that much of the population of the Western world spends more then 90% of their lifetime indoors, the creation of brain-stimulating orientated buildings (BSOB) should be a critical consideration when establishing productive and environmentally healthy workplaces. Air, which is the most influential factor in an indoor environment, should provide a combination of thermal and olfactory comfort. The perception of natural freshness coming from positive olfactory stimulants is essential, as is the elimination of so-called artificial—or "sterile"—air resulting in neutral or negative stimulation within parts of the brain.

This paper will concentrate on the perception of indoor air, assuming that visual and acoustic effects have already been properly addressed. The explanation of the benefits of individual sensory perception with positive stimulation goes beyond the scope of this paper, but it should be understood that a holistic approach to the planning of a building is absolutely essential. For

example, one should be aware that daylight positive stimulants in the air also help encourage health and productivity**.**

Happiness, or subjective wellbeing (SWB) plays a major role as well for social economic benefits. SWB has been defined as "a person's evaluative reaction to his or her life—either in terms of life satisfaction (cognitive evaluations) or affect (ongoing emotional reactions)." (Diener & Diener, 1995). These two facets of SWB have also been defined as cognitive ("evaluation of one's life according to subjectively determined standards") and hedonic balance ("the balance between pleasant affect and unpleasant affect") (Schimmack, 2006). The cognitive component is also known as contentment. Out of these structures productivity arises.

Perception

Understanding perception means an understanding of the brain and its neurophysiological aspects. Perception is the neurological process of acquiring and mentally interpreting our expectation. It is the main instrument used to create a multi-sensual environment. The effect of mood also appears to depend on the speed of conscious perception in brain activities, rendering the cognitive system more or less sensitive to incoming stimuli. (v. Kempski, 2008)

Considering the significance of both temperature and humidity in the nose patency rating, heat loss in the nasal mucosa, and the trigeminal feedback likely play a central role in an individual's perception of patency. (Zhao, 2009) Therefore, environmental perception of the environment can vary. Chen (2009) has shown in her recent behavioral and neuroimaging work that the human olfactory system actively interacts with emotion and other senses in navigating and interpreting social and sensory terrains. She demonstrated that on the behavioral level competency at "social chemosensory emotional processing" (2009) reflects one's emotional competency**;** chemosensory cues facilitate the perception of visual emotional cues; and on the neural level, the brain encodes emotional chemosensory cues in a holistic fashion.

The perception of olfactory stimuli is dominated by hedonic values, which range from pleasantness to unpleasantness (v. Kempski, 2007). A positive hedonic value in the air creates the perception of air being "natural fresh." Since the human limbic system is linked very closely to the olfactory system, it is quite common to use the hedonic characteristics of olfactory perception to study the neural correlates of emotional processing in humans. We have an innate ability to detect bad aversive smells, as well as their opposites (v. Kempski, 2008).

A certain understanding of the brain would be an asset when attempting to understand how molecules stimulate us when reaching our olfactory systems via sniffing the receptors and extrapolation. Perception of odor is frequently the triggering event for unexplained symptoms or illnesses characterized by nonspecific, multisystem complaints, which are often attributed to occupational health or environmental chemical exposures. This could as well explain a lot of diseases such as Otitis Media, which is in the stimuli pattern of ortho- and retro-nasal patency.

Odor

Odor perception is the translation by the brain of odorant molecules from olfactory receptor neurons. Odor perception is bound by the primary dimensions of odor intensity and odor pleasantness, which have both been systematically linked to odor molecule structure. Cain has

suggested a threshold for odor detection (no one has seriously measured the recognition point, though some have polled subjects) and ventured estimates of when quality begins to emerge over mere detection. (Cain, 2009). The author sees this differential as one of the major reasons that the valuations and determinations of indoor air quality are so far apart, when in fact IAQ should also be measured with quantifiable hedonic threshold values for humans.

As with any sensory system, the primary purpose of the olfactory receptor neuron layer is to transduce environmental variance into profiles of neural activity. (Cleland, 2009) Olfaction differs from other distal senses in its pronounced quantal temporal sampling. Whereas audition is continuous, and vision may be broken into saccades, olfaction consists of pockets of information gathering at the frequency of sniffing. Research is difficult since humans are primarily visual species and our cognition is dominated by visual perception. (Sobel et al, 2009). But the chemosensory quality of indoor air nevertheless plays a major role in the perception of the indoor environment, and therefore for the health and the wellbeing of occupants. (v. Kempski, 2003) This has already been confirmed by Engen (1982), and is consistent with the view that it is clearly the hedonic meaning of the odor that dominates odor perception.

Methods Of Observation

Modern neuroimaging provides a common platform for neuroscience and related disciplines to explore the human brain, mind and behavior. The brain's mirroring system supports the understanding of nonverbal messages, such as air. The different methods have been described in the Proceedings of Indoor Air 2008. (v. Kempski, 2008)

Economic Effects: Human Versus Energy

Energy savings are clearly important factors, but the IAQ impact on humans should be even more highly valued. Yudelson (2008) explained why productivity is so important in justifying green buildings. The annual operations cost for people (salary and benefits) in an average space of 200 square feet will typically cost $300 per year per square foot. For commercial buildings, people costs are about 10 to 20 times greater than rent ($15 to $30 per square foot/year), which is in turn about ten times greater then energy (about $1.50 to $3 per square foot/year). This result does not diminish the importance of energy savings, but rather that even a 1% gain in worker productivity will offset the entire annual energy bill. Moreover, a 5% to 10% gain in productivity will pay for the entire rent in a building. Using just these figures, one can easy calculate the ROI from the possibility of a higher initial investment in IAQ.

The author of this paper presented a report during HB 2003 with findings that demonstrated financial gains for an investor, whose building incorporated a multi-sensual approach—including the addition of natural olfactory substances into the HVAC system—to realize a sufficiently positive number of attributing stimulants to the indoor air. These financial gains included: the ability to charge a higher rent; a reduced absenteeism rate; and an increase in productivity. (v. Kempski, 2003) To this day, the facility manager has also recorded an energy saving by reducing air changes without loss of "natural fresh" perception or comfort. No complaints were registered.

DISCUSSION

In order to avoid the same mistakes committed in the 1970s and 80s in energy management policies that resulted in the development of serious IAQ problems, a new paradigm change needs to be implemented in concert with the green movement. The evaluation of indoor

environments should be based on the perception of the hedonic threshold level of indoor air. A holistic approach that takes into account neurophysiological chemosensory perception will provide a basis for the harmonization of all senses, thus creating a sense of wellbeing that promotes good health and leads to significant financial savings. As any implication for a better indoor environment is difficult to permeate without economic benefits, research findings should embed the perception of the environment against economical gains, such as beneficial hidden costs (i.e. productivity variables).

CONCLUSIONS

More research is needed evaluating chemosensory reactions, behavior, and the cues relating to indoor air quality. It should be more thoroughly analyzed using neurophysical measurements based on neurophysiological and psychological wellbeing findings—and not under the assumption that the absence of pollutants—"sterile air"—is equivalent to the state-of-the-art of wellbeing. The positive aspect of stimuli should be included in any research. Such research will show that the challenge for sustainable and green buildings is the optimization of health and wellbeing aspects by means of perception when concurrently considering energy efficiency. Furthermore, it has to be understood that neglecting these aspects will result in economic losses, also referred to as a company's "soft factor hidden costs."

REFERENCES

Cain, W.S. 2009. The recognition point in odor detection. *Proceedings 31st Annual Meeting ACHEMS 2009*, Sarasota, FL.

Chen, D. 2009. Olfaction and cognitive information processing. *Proceedings 31st Annual Meeting ACHEMS 2009*, Sarasota, FL.

Cleland, Thomas A. 2009. Olfactory system theory. *Proceedings 31st Annual Meeting ACHEMS 2009,* Sarasota, FL.

Diener, E. & Diener, M. 1995. Cross-cultural correlates of life-satisfaction and self-esteem. *Journal of Personality and Social Psychology, 68, 653-663*

Engen, T. 1982. *The perception of odors* New York: Academic.

Zhao, K. Kara, J. Blaker, E. Pribitkin, Y. L. 2009. Is perception of nasal patency a function of air temperature, humidity, mucosal heat loss, nasal resistance or trigeminal sensitivity? *Monell Chemical Senses Center,* Philadelphia, PA, USA,

LEED 2009. *For new constructions and major renovations.* USGBC approved 11/2008

Schimmack, U., 2006. Internal and external determinants of subjective well-being: review and policy implication. *Happiness and public policy: Theory, case studies and implications.* New York: Palgrave McMillan

Sobel, N. et al. 2009. A view of the world through the nose. *Proceedings 31st Annual Meeting ACHEMS 2009*, Sarasota, FL.

Stahl, M. 2009. CCI , Promotor Verlag, Stuttgart, Germany.

von Kempski, D. 2003.Air And Well Being – A Way To More Profitability. *Proceedings Healthy Buildings 2003*, Singapore.

von Kempski, D. 2007. Why positive olfactory perception is an issue for evaluation of buildings. *Proceedings of the 9th Rehva Congress Clima 2007 - Well-Being Indoors -,* Helsinki, Finland.

von Kempski, D. 2008. The engineer: A caterer for the brain – How to achieve well-being. *Proceedings Indoor Air 2008*. Copenhagen, Denmark.

Yudelson, J. 2008. *Green Building A to Z*, New Society Publishers, Canada.