Modeling the relationship between the environment and human experiences

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Abstract:

Within this special issue, different aspects of the environment are studied: aspects that are distant from the human body, close to the body and touching the human body. Consequently, different human senses are involved in these studies as well as the different consequences and effects on the brain and human behavior. This special issue also highlights many remaining questions about the effects and relationships between environments and human beings and the need for more studies and research. In particular, future studies are needed that address long-term effects and the effects of the combinations of elements which provide comfort or discomfort.

The influence of the environment on the human in a model:

According to the Environmental Design Technical Group (EDTG) of the Human Factors and Ergonomics Society [1], "Environmental design is the discipline concerned with the relationship between human behavior and the designed environment". This special issue of WORK consists of 21 papers concerned with research in the area of environmental design. These papers studied environment and many designed environments for improvement of performance, well-being, comfort or experience of humans in contact with the environment. The relationship with the human and the environment is schematically shown in Fig. 1. The scheme shows the environment, the human sensor noticing the environment, the brain processing the input, and the behavior. The process may commence as follows: the human brain decides to focus on a sense organ. These sense organs record a signal, which is processed by the brain. During this processing between the senses and the brain, experiences and the human state play a role. The human state can be excited or relaxed, which influences the way the input is processed. This process has an influence on the behavior of the human being. Time is an important factor. Sometimes the process starts with seeing the environment, which leads to the brain taking an action. Sometimes the brain activates sensors searching for an object such as an exit door. Time is also of importance as usually this action fits into a 'customer journey' or other sequence of activities and Vink [2] has shown that previous experiences influence next experiences.

An example of how the eye (a human sensor) notices the environment and affects behavior is shown in Fig. 2. When a human wants to leave an environment and the brain sends a signal to the eyes which are directed to look for a door. The eyes (sensor) see the door and the brain processes a signal to move the body towards the door (behavior).

The human has many sensors and some sensors record only processes within the body, such as recording whether the bladder is full. The focus of this special issue is outside the human body: the environment. Many sensors record the environment close to or touching the body, such as temperature, pressure, taste, itch and pain. The eyes, nose and ear are capable of sensing parts in the environment close to and distant from the body.

Within this special issue, different aspects of the environment are studied: aspects that are distant from the human body, more close and even touching the human body (See Table 1). Consequently, different human senses are involved in these studies as well as the different consequences of the effects on the brain and behavior

Aspects studied:

An aspect of the environment that touches the body is generally physical in nature, e.g., a headphone [3], the backrest contact [4] or a vehicle seat [5–8]. The environment may be close to the human body, i.e., the storage possibilities around the driver or passenger in a car [9] or a virtual reality system distracting the driver from discomfort [10]. The effect of people seated next to each other (neighbors) in an aircraft [11] and variations in posture, which result in more comfort [12], are examples of environments close to the body. These studies also show the aspects of human-to-human as well as human relationship to the environment and the effects on humans within the environment.

Examples of a distant environment and human relationship may be the effects on an interior built environment on the residents of a care facility [13]) or hospital [14]). Office interiors are another example of a distant environment and human relationship [15–17] and also the interiors of ships [18]. The distant relationship of the environment and the human in the aircraft interior such as walking seems to refresh aircraft passengers [19]. Pressure and temperature sensors [20, 21] in aircraft seats measure the effects while touching the human body. Other special edition papers involve sensors such as the eyes and nose sensing the freshness of the air [22]. The relationship of the environment, human body, and the three aspects (touching, close and distant) of the body are apparent in this special issue on environmental design. Dul et al. [23] described the future of ergonomics, which should look at performance in addition to well-being, health or comfort. This prediction exists in the papers featured in this issue. Groenesteijn et al. [24], showed bicycling, instead of sitting while working, was good for worker well-being and health. Worker performance improved by 35% and workers had better concentration on their work tasks.

Seating and office interiors are traditionally a well-studied topic in environmental design and there are many examples in the proceedings of HFES conferences in the EDTG sessions. Additionally, the inner climate within environmental design is extensively studied, i.e., conferences papers from the Environmental Ergonomics Association conferences. For this special issue the inner climate, studied by Roelofsen et al. [22], presented a model suggesting the inclusion of clothing in the prediction of office air quality.

Environmental experiences through time:

Time is an important effect influencing the humans. Bazley et al. [25] demonstrated that in many jobs discomfort is high in the middle of the week and lowest at the beginning and end of the week. In addition, during the day the discomfort increases. During sitting, discomfort increases through time. Porter et al. [26] reported an increase in discomfort during driving road trials of 135 minutes sitting in a car seat. Smulders et al. [8], indicated that the discomfort in an airline business class seat increases in time. The duration of sitting is more important than the composition of a seat. The results of a sitting duration in a laboratory setting showed discomfort for both the thin lightweight seat and a traditional airline seat.

There is more to the effects of the environment / human relationship. The human brings individual perceptions, expectations, and experiences into the environment. What happens to a person during the day, week or on a flight and what they expect in the future or experience in the past plays a large part in the environment and human interaction. Vink [2] modeled comfort in time and showed that human sensors and systems were proficient in recording differences, but did not do as with slow or small incremental changes. In a study by Kolarik et al. [27], 52 subjects were asked to report differences in temperature whilst in a climate chamber. Subjects did not distinguish a slow temperature increase of +0.6° Celsius/hour for the first three to four hours of exposure. However, as the exposure continued, a relationship between thermal sensation and temperature was observed. Another time aspect was that previous experience influenced the comfort of the next experience. Indoor climate studies have shown there is not a singular comfortable indoor temperature. For example, comfortable indoor temperature is dependent on the outside temperature [28] in the northern hemisphere; higher indoor temperatures are preferred in the summer than in the winter. The same is true for recording seat rigidity. Van Veen et al. [29], demonstrated that after sitting on a hard wooden stool, a different padded seat felt significantly softer than after sitting in a luxury chair and then sitting in a different padded seat. Before the test, Van Veen et al. [29], covered the test seat with a white blanket. The subjects were instructed to sit on the hard stool and the luxury chair to become accustomed to the environment. Half of the subjects began with the ‘hard stool’ conditions and the other half began in the ‘luxury soft chair’ condition. At the same time the next day the subjects arrived to test the ‘second seat’ and the condition was changed. The results showed that for the pre-condition “stool” (the chair feels soft: 1 = I don’t agree, 9 = I agree) a rating of 6.75±1.94, on a 9-point scale was significantly different than the pre-condition “luxury chair” with a rating of 4.96±2.46, therefore, demonstrated that sitting on a hard surface as a precondition to the test seat made the seat feel softer.

Unawareness of the environment:

In the case of the aforementioned seat test, the subjects were not aware of the difference of the precondition. Usually humans are not aware of their surrounding environment. Dijksterhuis [30] stated that in general, humans are often unaware of the environmental characteristics that cause positive experiences.

Mellert et al. [31] studied the impact of noise and vibration on the well-being of people during long-haul flights and in flight simulators. Apart from indices to characterize the human response, they found that noise had an important impact on health indicators, comfort and well-being. For instance, flight crew members with swollen feet were more aware of their feet condition during noisy conditions. The awareness increased 43% under noisy conditions, compared with quiet conditions at the beginning of the flight. Similar results were found for neck pain, with a pronounced pain increase of 57% as noise levels increased. These results showed that the awareness of the environment was not always present.

The sweetness of discomfort:

Perhaps it is neither possible nor wise to make all elements in the environment generate an optimal comfort feeling. Vink [2] proposed a theory [2] that making the environmental experience highly comfortable does not automatically make the whole experience comfortable. Perhaps phases of discomfort or low comfort should be allowed to stimulate more awareness of high comfort or low discomfort levels: “the sweetness of discomfort” (Fig. 3).

Of course, the discomfort should not be so high that the entire journey is a terrible experience. The challenge is to find the ideal balance between comfort and discomfort experiences for the overall environmental experience.

Comfortable built environment:

There is more than the physiological input during the journey through time in the environment and the unawareness of the environment. Bazley [32] wrote that humans experience the built environment on the physical, emotional, psychological and socio-cultural level. The comfortable built interior environment model showed the overlapping space between a built interior environment and the human. This overlap is where the comfort elements reside (Fig. 4).

Some prominent characteristics of the built interior environment are temperature, air quality, light, and sound that influence the “balance” between the human and interior environment. Human interaction with built interior expectations and pre-experiences when accompanied by physical, psychological (intellectual and emotional) and socio-cultural are some of the influences of perceived comfort or discomfort in the interior. Ideally, the characteristics of the built environment and the human experience are “in balance” and contain elements, e.g., being in control, stimulating human interactions and sensory variability, indicating the interior environment as a “comfortable built environment” space. The concept of time and change, shown in the outer ring, indicate that interior environments and people change through time. For example, an interior considered comfortable, e.g., a bedroom, kitchen, during childhood may or may not be comfortable for an adult. Everything changes and evolves through the cycles of time. Built interiors perceived as comfortable have certainelements that provide comfort through time. Therefore, time is an important factor to consider in the design process.

Future research

The papers in this special issue show new insights on the effects of the interior environment on people. Lewis et al. [10] demonstrated that people can be distracted from discomfort caused by the environment, but also showed that the distance between the human and the environment determines the types of senses involved. In the Lewis et al. [10], study the eyes played a more dominant role than the close to the body pressure sensors.

Studying the effect of the journey in the environment through time is essential as shown in the theory by Vink [2] and in the model by Bazley [32]. Hiemstra-van Mastrigt [33] showed the passenger felt more refreshed after walking throughout the airplane and Van Veen [12] showed that a small movement of the backrest and seat pan reduced discomfort over time. This special issue also highlights many remaining questions about the effects and relationships between environments and human beings and the need for more studies and research. In particular the study of long-term effects and the effects of the combinations of elements which provide comfort or discomfort need attention. Additionally, the effects of socio-cultural changes in the environment need more study. Bazley [32] showed that people were factors creating the most comfort, but also the most discomfort in the built interior environment.

Predictions for future control room interior designed environments envision a human centric design focusing on comfortable, seamless collaborative workspaces [34–37]. However, this prediction is not job type, or workplace specific. In the future robots will likely take over the mundane functions of human society. The assimilation of artificial intelligence (AI) and robots into all environments is highly probable. It will be especially interesting if AI and robots take over the activities that create human discomfort. This means new research for designing environments for these changes and studying the effects of these changed environments. The challenge will be to design balanced environments that address the technological achievements but maintain the innate comfort of nature. In addition, the definition of task, workplace, and role of the human will change for humans as systems incorporate, drop ing automation. Changes in materials, i.e., clothing and more smart materials will, introduce possibilities for more research on the effects of these environments touching the human body. In combination with the Internet these materials could be personalized, which would generate new fields of research.

Conclusion

Modeling the relationship between environment and human experiences is possible in space as shown in Fig. 1. Table 1 shows the focus of each paper in this special Issue as related to this model. The modeling in time shown in Figs. 3 and 4 is not applicable to all the papers, as time was not a component of every study presented here. Although several studies showed the experience of an interior environment fluctuated over time. Time is an important aspect to account for in the study of the effects of an interior environment on human beings.

For the future, environmental design is certainly full of new opportunities and needs new research in the areas close to and far away from the body as new materials are introduced and artificial intelligence, robots, new materials and automated systems are assimilated and incorporated within the environment.

References

1) Human Factors Ergonomics Society, 2015. http://tg.hfes.org/edtg/.
2) Vink P . The sweetness of discomfort: Designing the journey, Delft University of Technology, Delft, 2014.
3) Stavrakos SK , Ahmed-Kristensen S . Methods of 3d data applications to inform design decisions for physical comfort. WORK 2016;54(4).
4) Nijholt N , Tuinhof T , Bouwens JMA , Schultheis U , Vink P . An estimation of the human head, neck, and back contour in an aircraft seat. WORK 2016;54(4).
5) Silva Menegon L da , Vincenzi SL , Merino EAD , Barbetta PA , Andrade DF de . Interaction levels between comfort and discomfort in aircraft seats. WORK 2016;54(4)
6) Kok BNE , Slegers K , Vink P . Are seat design processes of students similar to those of professionals? WORK 2016;54(4).
7) Kokorikou A , Vink P , Pauw IC de , Braca A . Exploring the design of a lightweight, sustainable and comfortable aircraft seat. WORK 2016;54(4).
8) Smulders M , Berghman K , Koenraads M , Kane JA , Krishna K , Carter TK , Schultheis U . Comfort and pressure distribution in a human contour shaped aircraft seat (developed with 3d scans of the human body). WORK 2016;54(4).
9) Wagner A , Kilincsoy Ü , Reitmeir M , Vink P . Functionalcustomization – Value creation by individual storage elements in the Car Interior. WORK 2016;54(4).
10) Lewis L , Patel H , Cobb S , D'Cruz M , Bues M , Stefani O , Grobler T . Distracting people from sources of discomfort in a simulated aircraft environment. WORK 2016;54(4).
11) Ahmadpour N , Kühne M , Robert J-M , Vink P . Attitudes towards personal and shared space during the flight. WORK 2016;54(4).
12) van Veen S , Vink P . Posture variation in a car within the restrictions of the driving task. WORK 2016;54(4).
13) Roberts E . Negotiated risk and resident autonomy: Frontline care staff perspectives on culture change in long term care in Nova Scotia, Canada. WORK 2016;54(4).
14) Smith TJ . Occupancy and Patient Care Quality Benefits of Private Room Relative to Multi-Bed Patient Room Designs for Five Different Children's Hospital Intensive and Intermediate Care Units. WORK 2016;54(4).
15) Smith-Jackson T , Middlebrooks R , Francis J , Gray T , Nelson K , Steele B , Townsend K , Watlington C . Open Plan Offices as Sociotechnical Systems: What Matters and To Whom? WORK 2016;54(4).
16) Bodin Danielsson C . Office type's Association to Employees' Welfare - Three Studies. WORK 2016;54(4).
17) Bazley C , Vink P , Hedge A , Montgomery J . Interior effects on comfort in healthcare waiting areas. WORK 2016;54(4).
18) Mallam SC , Lundh M . The Physical Work Environment & End-User Requirements: Investigating Marine Engineering Officers Operational Demands & Ship Design. WORK 2016;54(4).
19) Hiemstra-van Mastrigt S , Meyenborg I , Hoogenhout M . The influence of activities and duration on comfort and discomfort development in time of aircraft passengers. WORK 2016;54(4).

20) Kilincsoy Ü , Wagner A , Vink P , Bubb H . Application of Ideal Pressure Distribution in Development Process of Automobile Seats. WORK 2016;54(4).
21) Luximon Y , Sheena KA , Luximon A . Time dependent infrared thermographic evaluation of facemasks. WORK 2016;54(4).
22) Roelofsen P . Adjustment of the Stolwijk model with regard of clothing, temperature sensation and skin temperature. WORK 2016;54(4).
23) Dul JBruder R , Buckle P , Carayon P , Falzone P , Marras WS , Wilson JR , Doelen B van der . A strategy for humanfactors/ergonomics: Developing the discipline and profession. Ergonomics 2012;1–27.
24) Groenesteijn L , Commissaris DACM , Zwetsloot M , Hiemstra-Van Mastrigt S . Effects of dynamic workstation Oxidesk on acceptance, physical activity, mental fitness and work performance. WORK 2016;54(4).
25) Bazley C , Nugent R , Vink P . Patterns of discomfort. Journal of Ergonomics 2015;5(1):1–7. 10.4172/2165.10000136
26) Porter JM , Gyi DE , Tait HA . Interface pressure data and the prediction of driver discomfort in road trials. Applied Ergonomics 2003;34:207–14.
27) Kolarik J , Olesen BW , Toftum J , Mattarolo L . Thermal Comfort, Perceived Air Quality and Intensity of SBS Symptoms During Exposure to Moderate Operative Temperature Ramps. Proceedings of Clima Well-Being Indoors 2007).
28) De Dear RJ , Brager GS . Thermal comfort in naturally ventilated buildings: Revisions to ASHRAE Standard 55. Energy and Buildings 2002;34:549–61.
29) Veen S van , Orlinskiy V , Franz M , Vink P . Investigating Car Passenger Well-Being Related to a Seat Imposing Continuous Posture Variation. J Ergonomics 2015;5:3 10.4172/2165-7556.100014
30) Dijksterhuis A . Het slimme onbewuste, Uitgeverij Bert Bakker, Amsterdam, 2009.
31) Mellert V , Baumann I , Freese N , Weber R . Impact of sound and vibration on health, travel comfort and performance of flight attendants and pilots. Aerospace Science and Technology 2008;12:18–25.
32) Bazley CM . Beyond comfort in built environments. PhD Delft University of Technology, Delft, doi: 10.4233/uuid:ebb82e2d-e786-4bcf-8c49-b7871932726d, 2015.
33) Hiemstra-van Mastrigt S . Comfortable passenger seats. Recommendations for design and research. PhD TU-Delft, 2015.
34) Montaque J . The control room of the future - smarter reality, The Control Global Website: http://www.controlglobal.com/articles/2012/montague-smarter-reality/, 2012.
35) Wood J . The future of control rooms. The Display Insight Website: http://www.displayinsight.com/the-future-of-control-rooms/, 2013.
36) Schwarz S , Kehr F , Herme K , Reitere H . Holistic workspace: Future control room design. Proceeding of HFES, 2012.
37) Stedinger J , Howard C . Control room II looking further into the future, Hydro World Review Website: http://www.hydroworld.com/articles/print/volume-18/issue-3/articles/looking-ahead/control-room-ii-looking.html, 2010.

Figures and Tables

Fig.1

This schema shows the relationship between the environment and behavior.

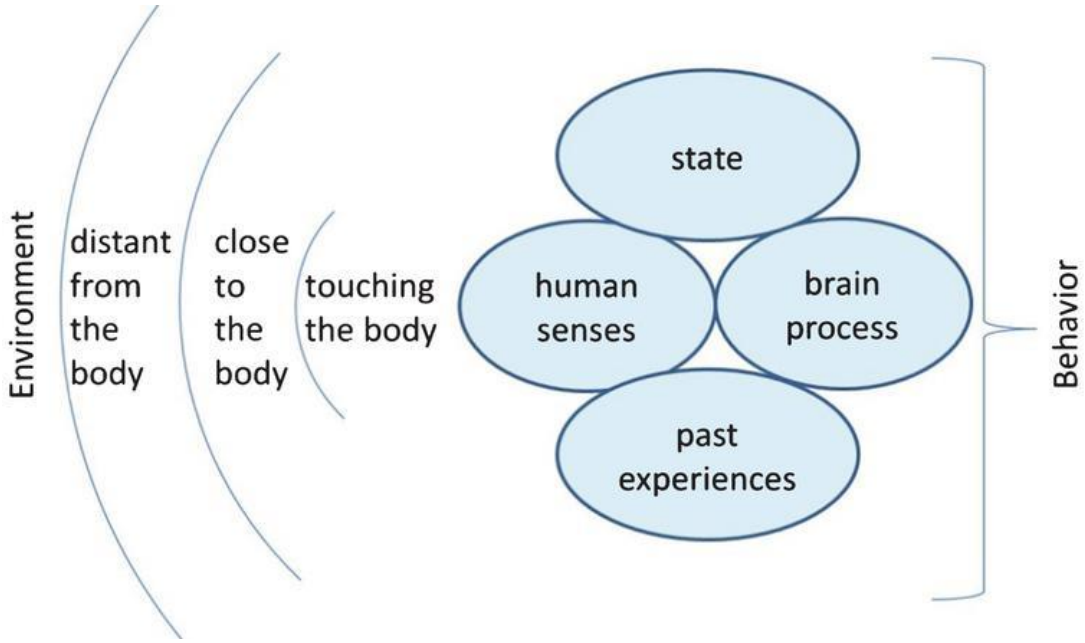

Fig.2

An example of how the eye (a human sensor) notices the environment.

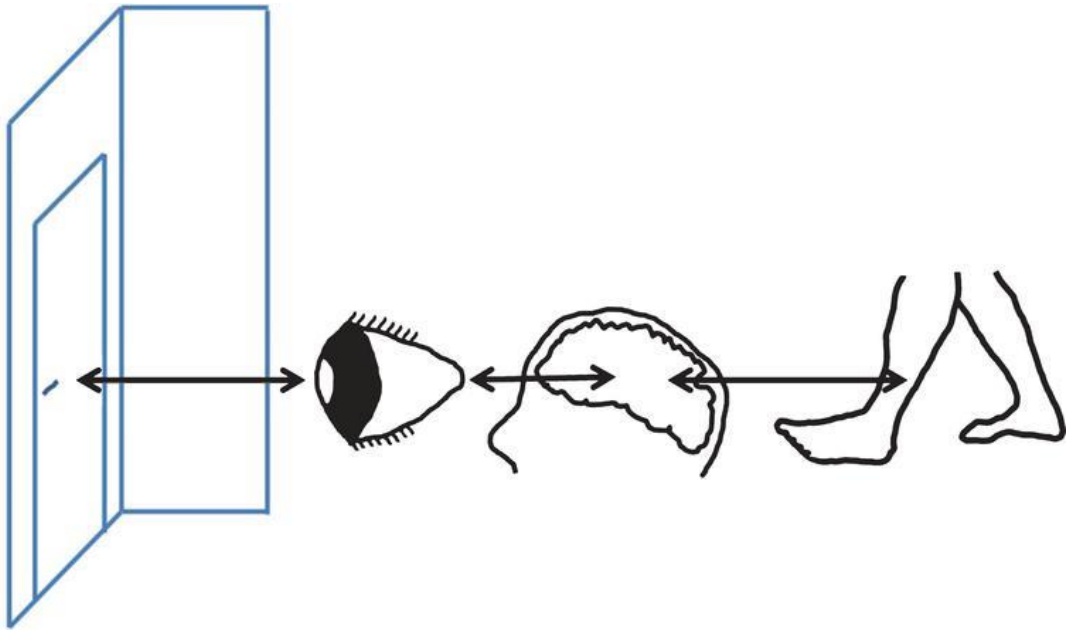

Fig.3

Model of the hypothetical curve of how the comfort reduces slowly and then increases steeply, causing humans to become aware of the comfort.

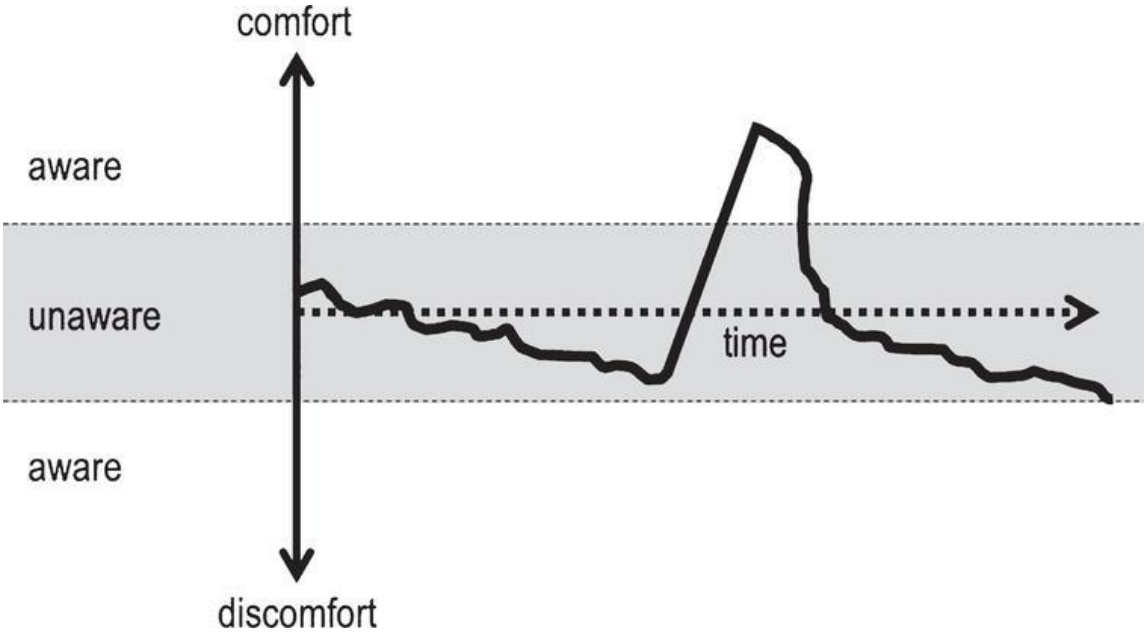

Fig.4

The Comfortable Built Interior Environment Model [32].

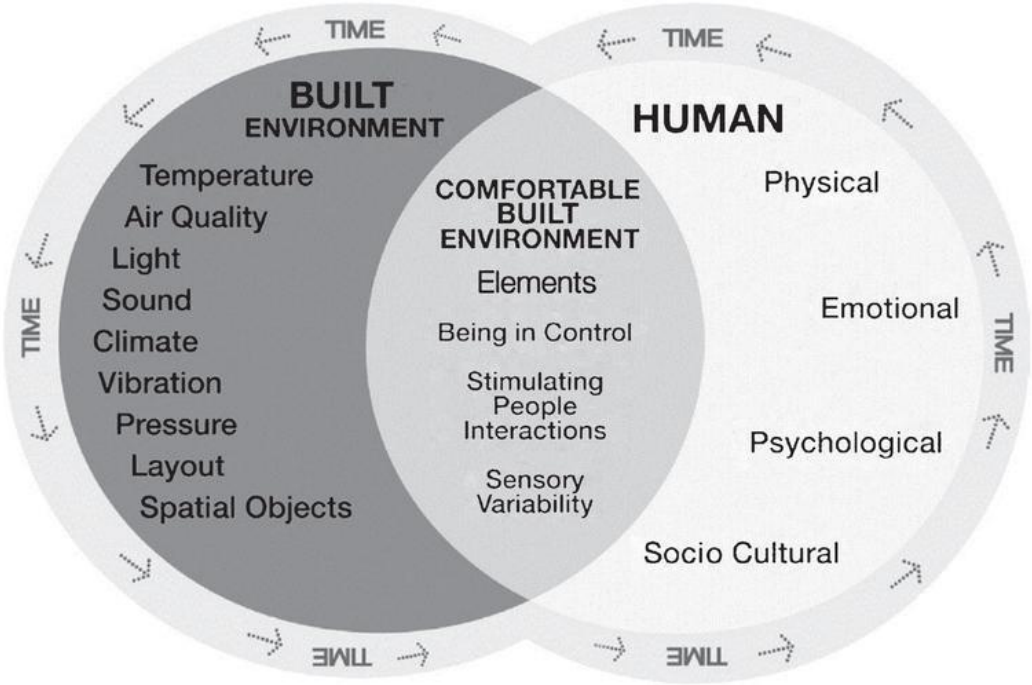

Table 1

The highlighted areas indicate the areas of focus for each featured paper in this special issue of WORK on environmental design

Topic	Author	Core of the Title	Aspect in the Environment to the human body		
			Distant	Close	Touching
Office	Groenesteijn	Dynamic office work station and performance			
Office	Bodin Danielsson	Office interior and employee welfare			
Office	Bazley	Effects of eastern and western interior design			
Office	Smith-Jackson	Open plan office and socio-technique			
Healthcare	Luximon	Thermographic study on face masks			
Healthcare	Roberts	Staff perception in various care residents			
Healthcare	Smith	Private and multi-bed patient rooms			
Automobile	Wagner	Storage possibilities in a car			
Automobile	Van Veen	Posture variation in a car while driving			
Automobile	Kilincsoy	Pressure distribution in car seat design			
Aircraft	Menegon	Aircraft seat (dis)comfort			
Aircraft	Nijholt	Back contour in aircraft seat			
Aircraft	Smulders	Comfort and pressure in aircraft seat			
Aircraft	Kokorikou	Light weight aircraft seat			
Aircraft	Hiemstra-van Mastrigt	Activities in the aircraft			
Aircraft	Lewis	Distracting from aircraft discomfort			
Aircraft	Ahmadpour	Personal and shared aircraft space			
Ship	Mallam	Work environment in a ship			
Method	Kok	Seat design process of professionals and students			
Method	Roelofsen	Thermophysiological model for interiors			
Method	Stavrakos	Methods to design product touching the body			