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Short Communication

The Importance of Psychophysiological Factors in Comfort Studies

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ABSTRACT

In the last years the concept of comfort is changed. Recent findings underline the role of physiological and psychological processes in determining the perception of individual's comfort. Comfort has been traditionally measured in terms of physiological reactivity during the exposure to an environmental stimulus. In experimental studies, the activity of the autonomous nervous system is assessed by measuring Heart Rate Variability (HRV), while participants are exposed to the stimulation. The increase of the activity of the sympathetic nervous system and the decrease of the response of the parasympathetic nervous systems are considered indices of a stress (discomfort) response. Interestingly, recent studies have shown that the response to the stressor is also influenced by psychological processes. It has been found that the response of the autonomous nervous system changed as a function of the mood states, personal believes and personality traits of the participants. Although these results suggest the importance to evaluate both physiological and psychological variables, standards and technical guidelines for supporting comfort design are still based only on the definition of the physical parameters of the environmental stressors.

This short communication examines the recent results concerning the role of psychological and physiological processes in comfort perception, showing the necessity to reduce the gap that exists between engineering research and findings of the current psychophysiological research.

Keywords: Comfort; Environment; Psychophysiology; Stress

INTRODUCTION

Current studies evidenced the existence of a gap between standards, guidelines and engineering recommendations for supporting building design and the recent findings related to human sciences [1]. This is particularly evident in the comfort research. Defining what is comfortable is not a simple task, it is conceivable as a complex mapping of feelings, perception and mood states resulting from environmental stimulation into psychophysiological reactions [2,3].

Studies on human comfort have shown that psychological and physiological factors have a significant role in the comfort perception [1,3]. Comfort during the exposure to an environmental stressor can be influenced by the psychological state of the person (e.g. mood, stable personality traits), the individual attitude toward the source stimulus (if positive or negative), believes about the possibility to modulate the intensity of the stimulus and judgments about own performance [1-6]. The individual's value system, lifestyle, personal preferences can influence comfort judgments [3].

Engineering research related to comfort, in general, focused on individuate the physical characteristics (e.g, intensity of stimulation) of an environmental stressor which can negatively influence the comfort experience of an individual. The most investigated physical stressors are acoustic noise, vibration, air temperature and illumination [2]. However, in the engineering studies, the psychological and physiological components of comfort were not systematically measured.

The main purpose for this short communication is to examine the most recent studies showing as the comfort experience during the exposure to environmental stressor is strongly influenced by the interaction between physiological and psychological processes. In particular, we are interested to

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underline the necessity to integrate theories on human physiological and psychological functioning with the engineering research for the definition of standard and guidelines necessary to design comfortable environments.

PHYSIOLOGICAL AND PSYCHOLOGICAL RESPONSE OF COMFORT DURING THE EXPOSURE TO AN ENVIRONMENTAL STRESSOR

Several studies in literature suggest that the exposure to an environmental stressor (e.g. acoustic noise and whole-body vibration) determines significant changes at physiological and psychological level. These effects, if negative, contribute to determine a negative experience of environmental comfort. Comfort, at physiological level, can be expressed as a state of excessive alert and activation which leads to tension and difficulty in relaxing. In previous researches, comfort is indexed by the activity of the Autonomic Nervous System (ANS) [7]. The ANS system includes the Parasympathetic Nervous System (PNS) and the Sympathetic Nervous System (SNS). The PNS is mediated by acetylcholine, which inhibits cardiac muscle and slows heart rate, while the SNS is mediated by norepinephrine, which excites cardiac muscle and speeds heart rate. The increase of SNS activity and decreases of PNS activity are indices of an increment of stress response [8] but see also [9,10].

Alterations of the ANS activity, as measured by Heart Rate Variability (HRV), has been found during the exposure to acoustic noise [11,12], vibration [13,14], different air temperatures [15] and light conditions [16,17].

When we take into account noise exposure, an increase of stress physiological response is, in general, associated to an increase of the noise intensities. Lee et al. [12] have found significant increases in the HRV parameter Low Frequency (LF, a marker for sympathetic activity) during exposure to noise at sound levels of 50, 60, 70 and 80 dB (A). Nassur et al. [18] have found that people living near airports showed an increase of heart rate during sleep as a function of sound pressure level generated by aircrafts. Park and Lee [19,20] have shown that the exposure to floor impact noise [from 31.5 to 63 dB (A)] for less than 30 seconds increased the electro dermal activity and the respiration rate compared to a free-noise condition.

An increase of SNS activity has also been found during the exposure to whole-body vibration. Zhang et al. [14] found that participants with high levels of drowsiness show an increase of SNS activity within 15-30 min of exposure to whole-body 4-7 Hz vibration, during simulated driving tasks. According to the authors, the increment in sympathetic activity during drowsiness reflects the increased effort (mental workload) to maintain the level of alertness during the task. This finding is confirmed also by other studies. Jalilian et al. [21] have shown that participants performing a visual complex mental task exhibited a greater increase of SNS response during the exposure to vibration compared to no vibration condition. Jiao et al. [22] have observed a different involvement of the SNS and PNS as a function of vibration frequency.

At psychological level, comfort can be defined as a mentally relaxed state, free from pain, danger, tension, troubles and negative thoughts. The exposure to environmental stressors can influence this psychological state. For instance, it has been found that whole-body vibration can lead to drowsiness [23], increased mental workload [24], fatigue, depression, anxiety [25] and memory alterations [26]. Acoustic noise can induce depressive symptoms [27], annoyance experiences [28-30], sleep disturbances which correlate with anxiety and depressive symptoms during the day [31]. The exposure to environmental stressors has thus strong consequences at physiological and psychological level. Interestingly, there are also evidences that these psychophysiological responses can vary according to the mental state of the person.

Vastfjall et al. [32] found that the mood state of participants can influence annoyance judgments for sound. Thomas et al. [33] have shown that people with an internal locus of control demonstrated to be more “noise-annoyed” and to have lower noise tolerance thresholds compared to people with an external locus of control. The sensitivity to noise has been found to correlate with extroversion [34,35].

The psychological state of the individual can also influence the physiological response during environmental stimulation. Wang and Liu [3] found that, during the exposure to a thermal stimulus, SNS activity and discomfort judgments were higher for participants under boring states compared to participants in a joyful or neutral state. Choi et al. [36] have shown that the exposure to red light for 5 minutes decreased the PNS activity for depressed and anxious people, but this did not occur for subjects without these symptoms. Acoustic noise has been found to determine a greater physiological activation for people more sensitive to noise [20].

These findings show that, in the definition of comfort, different factors should be considered. The psychological characteristics of the individual can be more relevant compared to the intensity of the stimulation in determining the comfort experience. This is particularly evident in the study of [4]. The authors exposed participants to increasing levels of white noise [between 45 and 55 dB (A)] inside a full-scale mock-up of a ship cabin and found smaller changes of the ANS activity in response to noise variations for participants who were in a negative mental state (i.e., they perceived themselves in a discomfort condition and/or were anxious) compared to participants in a positive mental state. Therefore, participants with negative mood did not perceive the negative effects due to the increase of the intensity of noise. These results suggest the psychological state of the individual was more relevant in the determining the physiological response of comfort compared to the intensity of the environmental stimulation.

This can have practical consequences. In the study of [4], participants were exposed to noise intensities which identify different comfort classes according to the naval Classification Societies. The authors found that the variations I the comfort response did not occur for all the comfort thresholds identified by the Classification Societies [37]. In other words, the definition of comfort classes did not correspond really to the human perception of comfort. This evidences that, if physiological and psychological variables are not measured when defining technical guidelines and standards, the design of comfortable environment can be inaccurate.

DISCUSSION AND CONCLUSION

In summary, these findings show that a systematic research on the effect of environmental stressors on comfort should be based on the measurement of physiological and psychological response to the stimulation. Experimental studies show an interaction between physiological and psychological processes in determining the comfort experience, suggesting that psychological characteristics can be more relevant than physical characteristics of the stimulus. The knowledge of the psychological and cardiovascular autonomic responses to physiological stressors (e.g. noise exposure) can provide new insights to improve the comfort service for people. Lorenzino et al. for instance, show that the improvements of the psychological state of a person may be useful to reduce the negative physiological effects due to the exposure to an external stressor.

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