

## **Sustainability | Individual communication**

### **IC - (20841) - THE INFLUENCE OF VIRTUAL ENVIRONMENT ON THERMAL PERCEPTION: PHYSICAL REACTION AND SUBJECTIVE THERMAL PERCEPTION ON OUTDOOR SCENARIOS IN VIRTUAL REALITY**

Chunya Wu<sup>1,2</sup>; Jinyuan Cui<sup>1</sup>; Xiaowan Xu<sup>1</sup>; Dexuan Song<sup>1,2</sup>

1 - College of Architecture and Urban Planning, Tongji University, Shanghai, 200092, China; 2 - Key Laboratory of Ecology and Energy-saving Study of Dense Habitat (Tongji University), China

#### **Background and objectives**

Positive thermal perception can affect users' climate-controlling behavior, then indirectly reduce a building's operational carbon emission. Studies show that some visual elements, such as window sizes and light colors, can influence thermal perception. However, until recently there has been little interest in the interaction of thermal perception and outdoor visual scenarios or natural elements like water or trees, and little quantitative evidence has been found associating visual and thermal comfort. This experiment explores and quantifies the extent to which visual scenarios outdoors affect thermal perception.

#### **Process and methods (for empirical research)**

The experiment used a double-blind clinical trial. To eliminate temperature changes, all tests were done in a stable laboratory environment, and scenarios were shown through a virtual reality (VR) headset. 45 participants were divided into three groups randomly, separately watched VR-outdoor scenarios with natural elements, VR-indoor scenarios, and a control scenario of the real laboratory, then finished a subjective questionnaire conducted to evaluate their thermal, environmental and overall perception while their physical data (heartbeat, blood pressure, pulse) was real-time recorded.

#### **Main results (or main arguments in the case of critical reviews)**

Results show that visual scenarios could significantly influence thermal perception (Cohen's  $d$  between groups  $>0.8$ ). Significant positive correlations were found between key thermal perception index, thermal comfort, and visual perception indexes including visual comfort, pleasantness, and relaxation (all  $PCCs \leq 0.01$ ). Outdoor scenarios, with better visual perception, ranks higher average scores ( $M \pm SD = 1.0 \pm 0.7$ ) in thermal comfort than indoor groups (average  $M \pm SD = 0.3 \pm 1.0$ ) while the physical environment remains unchanged.

#### **Implications for research and practice/policy | Importance and originality of the contribution**

This connection between thermal and environmental perception can be used in building design. By being visually exposed to pleasing outdoor environments, positive thermal perception will increase, and thus reduce building energy consumption. Designing positive visual environments with outdoor natural elements is not only a requirement of health but also a feasible path toward a sustainable net-zero future.

**Palavras-chave : Thermal perception, Visual-thermal interaction, Environmental Psychology, Virtual Reality**