Personal Environmental Control Systems: Occupant-system interactions and impact on cognitive performance

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ABSTRACT

Personal environmental control systems (PECS) allow office occupants to regulate their immediate environment, yet there remains a limited understanding of how users interact with such systems under changing thermal conditions. This study aimed to investigate how occupants respond to different room temperatures and a gradual decrease in temperature during winter months. The experiments were conducted in a full-scale office laboratory consisting of 12 workstations, each equipped with a PECS that provided desk cooling, desk heating, floor heating, and adjustable fan speeds. Before the test day, participants received comprehensive training on how to operate the PECS. During the experiment, participants were allowed to freely adjust the PECS settings, thereby simulating realistic office conditions. The tests' temperatures ranged from 74°F to 78°F. Each test consisted of two sessions. During the first session, room temperature was maintained at 74°F for 40 minutes. It was followed by a 30-minute transition to 78°F room temperature when the second session began and lasted 40 minutes at 78°F. Data on PECS settings and environmental conditions were continuously recorded. During each session, participants completed a series of cognitive tasks assessing learning, memory, attention, perception, mathematical reasoning, and divergent thinking. When the room ambient temperature was 74°F, 78.5% of participants chose to use the PECS, with an average usage time of 31.4 minutes. This proportion increased to 93.9% at 78°F, with the average usage time extending to 37.6 minutes. Most participants preferred the desk cooling function, and average fan speed selections showed little variation between the two ambient temperature conditions. The results reveal how occupants adapt to temperature changes through different control strategies, indicate preferences for specific functions in warmer environments, and demonstrate the impact of these adaptations on cognitive performance. Furthermore, the cognitive performance data enable the identification of optimal temperature ranges for maximizing occupant productivity. These findings provide new insights into the interaction between occupants and PECS, which can inform the design of systems that are more practical, energy-efficient, and responsive to user comfort while improving work performance.

KEYWORDS

Personalized environmental control systems (PECS), Floor Heating, Desk Heating/Cooling, Cognitive Performance