SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The main goal of the study was to look at the effectiveness of a novel self-luminous LED night-lighting system that provided linear spatial orientation cues plus low ambient lighting for enhancing postural control in healthy seniors. A second goal was to determine if the night-lighting system would be acceptable to older adults in a mockup of a single-bed, senior living facility.

A Novel Night Lighting System for Postural Control and Stability in Seniors

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Key Concepts/Context

Age-related changes may result in impaired balance control, and thus can lead to increased risk of falls among the elderly. Visual information provides a spatial reference for self-position and location of obstacles within a person's environment. Lack of this information results in increased body sway. In addition, low ambient light levels reduce postural control. Therefore, this study investigated the effectiveness of a novel self-luminous light emitting diode (LED) night-lighting system that provided linear spatial orientation cues plus low ambient lighting for enhancing postural control in healthy seniors.

Methods

The first experiment looked at postural control.

Since participant fatigue was a major concern in this experiment, the experimental design used Latin squares, a strategy for enhancing efficiency while minimizing potential confounding between the presentation order of the experimental conditions and the levels of the independent variables. The researchers used three self-contained Latin squares in each of two sessions. Each Latin square counterbalanced the presentation order of the four LED illuminances (10 lux, 3 lux, 1 lux, and 0.3 lux at the cornea) and two door-frame positions (correctly oriented versus tilted, either left in the first session or right in the second session). The experimental trials were divided into two sessions to limit very long sessions.
The researchers recruited 12 participants (all ages 65 years or older), however, only eight subjects participated in both sessions. After additional recruiting, the study ended up with 6 females and 6 males in session 1, and 9 females and 3 males in session 2.

DESIGN IMPLICATIONS

The study suggests that a novel night-lighting system that provides visual cues has the potential to positively impact postural orientation and stability in older subjects and, after being placed in a simulated living environment with a motion sensor feature, is well-accepted by seniors. Therefore, it is necessary that designers make an every effort to identify innovative night-lighting systems, proven to positively impact postural orientation and stability in older subjects and other patient outcomes, and then to incorporate them into design. The novel night-lighting system in this study was not a commercially available

They assessed postural control with a standardized sit-to-stand (STS) test. In this test, participants shift their center of gravity forward from a seated position to a location centered over a base of support (feet), and then extend their bodies to a standing position.

The authors used sway velocity (SV) and left/right (L/R) weight symmetry to measure participants' ability to transfer from sitting to a standing.

Two lighting systems were developed for the study. One lighting system used three linear arrays of amber LEDs. The arrays consisted of two vertical strips of 140 LEDs and one horizontal strip of 68 LEDs, with a connected power totaling 16.2 W when operated at the highest intensity. The other lighting system used four conventional, 7 W incandescent night lights, each with a clear bulb in a plastic lens. Three conventional night lights were placed where the floor and the wall met next to the STS test instrument. The fourth night light was put across the room at the junction of the floor and wall. Although the number of night lights was more than what is usually found in residences, they were needed to provide relatively uniform, dim ambient lighting equal to the LED night-light system at the lowest illuminance, 0.3 lux, at the subjects' corneas when they were standing at the STS test apparatus. Only one lighting system was used on a given trial.

The second experiment compared the acceptability of the novel night-lighting system in the first experiment, including a passive infrared motion sensor for automatically turning on the night-lighting system when someone gets up at night and then automatically turning it off when he or she goes back to bed, with a conventional wall-plug night light.

When subjects sat up in the bed, they were sequentially presented the novel lighting system producing 1 lux at the eye or the conventional night light producing 0.1 lux at the eye. They saw the two lighting conditions in a counterbalanced order. After they had seen both lighting conditions, including enough time for the novel night-lighting system to turn on and off automatically, the experimenter asked the subjects to respond to a series of questions on a 5-point scale from strongly disagree to strongly agree:

Q1. I prefer the night light on the baseboard more than the other lighting system framing the door.
Q2a: I like the on motion sensor feature of the lighting system framing the door and why.
Q2b: I like the off motion sensor feature of the lighting system framing the door and why.
Q3: I can easily see all three hazards on the floor.
Q4: Compared to the conventional night light on the baseboard, I like the lighting system framing the door with the motion sensor feature.

Findings

In the first experiment, researchers performed a statistical analysis using the difference between the percentage of weight applied to the two feet when the door frame was tilted relative to the percentage of weight applied to two feet when the door frame was positioned correctly. If visual cues are important for postural stability, then tilting the door frame should affect the relative weight applied to each foot in the transition from sitting to standing. The researchers calculated the difference for the same lighting condition.

The independent variables included the five lighting conditions (four LED light levels plus the conventional night light) and the two door-frame positions (tilted left versus tilted right) sessions. They treated these as fixed variables and the subject (N = 12) as a random variable.

They found that there was no statistically reliable difference between lighting conditions, however the two door-frame position sessions were significantly different ($P < 0.005$). In every lighting condition, the participants leaned more to the left when the door frame was tilted to the left and more to the right when the door frame was tilted to the right. These results show an influence of the visual environment on postural orientation.

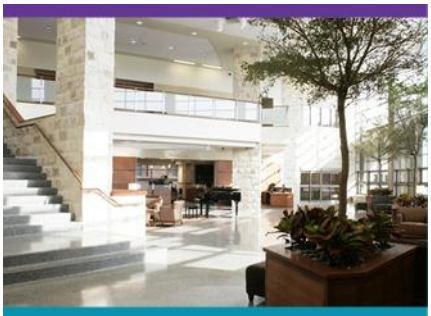
The researchers also measured SV, which is an important measure because it indicates how stable people are during the STS task. If visual cues affect SV, then the participants should be less stable when visual, proprioceptive, and vestibular information about the environment are incompatible.

During the analysis, the research revealed a statistically significant main effect of door-frame tilt (correct orientation versus tilted, both left and right). The tilted door frame made the subjects less stable, but toward the end of the trial, there was little if any difference in SV when the door frame was tilted or when it was positioned consistent with proprioceptive and vestibular information. Older adults are particularly affected by visual cues during the initial phase of the transition from sitting to standing, but by the end of the trial, they appeared to rely more on proprioceptive and/or vestibular cues for maintaining a standing position.

In the second experiment, the authors found that the participants preferred the novel lighting system framing the door to the conventional wall-plug night light. Further, in general, older adults saw objects on the floor better as illuminance increased (0.1 lux to 1.0 lux). However, the analysis did not show any statistically reliable differences among the lighting scenarios.

Limitations

The authors mentioned following limitations.



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- Further studies are needed to confirm whether or not the findings of this study, which was conducted in a laboratory, can be replicated in a real-life situation.
- More investigations are needed to solidify any generalizations about the use and acceptance of the novel night-lighting system, particularly with those who have disabilities, such as vertigo or dementia.