The Role of Chromaticity in the Visual Control of Stance

It is often assumed that the vestibular system, or "inner ear" is primarily responsible for maintaining body balance. However, many studies over the past several decades have demonstrated that vision also plays a powerful role. An example is the "moving room paradigm", in which standing participants are exposed to subtle oscillations of their visual surroundings while standing in a chamber that has walls but no floor. The room moves, oscillating gently back and forth. The absence of a floor means that the motion is purely visual, yet it reliably results in participants swaying back and forth in synchrony with the room (e.g., Lee & Lishman, 1975; Stoffregen, 1986). Over decades, research has focused on dynamic properties of the situation, such as the magnitude and frequency of stimulus motion. I will address a novel aspect of this relationship with my proposal.

I will build upon the findings from previous moving room studies to investigate the effects of presenting participants with visual stimuli in the moving room paradigm. The visual system is sensitive to motion but also to many other stimuli. Among these is color, or chromaticity. Visual control of stance is mainly dependent upon sensitivity in the periphery of the retina (e.g., Stoffregen, 1986) but our color sensitivity is concentrated in the fovea. Thus, it is not clear whether variations in the color of visual motion stimuli might influence their use for the visual control of stance.

The fact that visual sensitivity differs at different wavelengths (colors, or chromaticity) is not controversial. Some scholars have shown that wavelength-specific sensitivity effects extend to the perception of motion. Burr, Fiorentini, and Morrow (1998) altered the wavelength chromaticity of visual stimuli. Reaction times for perceived speed varied with the chromaticity of the stimuli. In my project, I will combine the known effects of visual motion on postural control as well as the effect chromatic sensitivity on visual motion. In a moving room, I will vary the chromatic gradient (color contrast) to study these effects. My principal research question will be whether participants modify their postural responses to room motion as a function of variations in chromaticity within the moving room. The general method will resemble previous research conducted by my advisor in the moving room paradigm (e.g., Stoffregen, 1986; Stoffregen et al., 2004). The primary innovation will be the controlled variation in chromaticity of in-room lighting, as an independent variable. Participants will be undergraduate Kinesiology majors, who will participate in exchange for extra credit. Participants will be recruited from undergraduate Kinesiology courses to partake in this study. My role in this study will be to participate in data collection in the laboratory, and in the reduction and analysis of postural data. I will also present the results in at least one scientific meeting and will contribute to preparation of a manuscript for publication in a peer-reviewed journal.

I will use a within-participants data collection procedure, in which each participant will be put through the full range of conditions. The participants will have their postural motion assessed at rest (assessing a baseline sway) and again while the moving room oscillates (moving room sway). Each participant will have their postural motion assessed under varying qualities of lighting. Three different lighting conditions will be used to provide the illumination required for optic flow for participants. These include full-spectrum, blue, and red LED lights. It is important to note that while standing in the moving room, participants' visual field is limited to the interior of the room, that is, the room motion and light color that I determine.

There are three components to the experimental design, which should take approximately an hour to complete. First, participants will enter the laboratory and complete the necessary paperwork, receive briefing on the study protocol, and will have any questions that they have answered as well as be given a written, informed consent for participation. Participants will have several, small Polhemus sensors attached to their person at this time. These sensors placed on the participants torso, cervical-vertebral region, and on a helmet which the participant will have on throughout the duration of the experiment. The electromagnetic motion tracking sensors record kinematic data related to the motion of the participant such as the velocity, acceleration, and displacement of the participant's person. Second, participants will stand comfortably, with their hands at sides, for approximately two minutes at a time. A chair will be provided nearby, and participants will be encouraged to rest between trials, or at any time they feel is necessary. Each participant will then be asked to complete a series of 18 one-minute trials in random order (three sets of the six listed conditions). Third, the Polhemus motion capture system, attached to the participant, will collect a time-series of kinematic data throughout the trials.

Upon the completion of data collection, a repeated-measures ANOVA analysis will be conducted to determine the degree of perception-action coupling that may occur between motions of the surrounding room and the participants' postural motions. This analysis will provide us with the evidence necessary to determine the answers to the proposed question of whether adults modulate their posture in synchrony to the moving room with varying degrees as a function of wavelength lighting differences between each trial. I am hoping to show with this research that adults modify their posture in response to imposed visual stimuli illuminated by different wavelengths of light. This research will provide a novel take to the growing literature surrounding postural modulation in the moving room paradigm and would hopefully start a new paradigm of its own.

References

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