Jeanine Stefanucci - Research Statement

"There are things known and there are things unknown, and in between are the doors of perception." - *Aldous Huxley*

Perception is the means by which we experience the world and acquire long-term knowledge about it. It is the starting point for all of cognition. I am interested in understanding how people perceive, act in, and remember the spaces around them. For example, how do we perceive the steepness of hills or the magnitude of heights? How do we effectively navigate spaces and remember where we have been? Theoretically, my research addresses whether a person's bodily states, be they emotional, physiological, or physical, and their bodily size modulates their perception of and memory for spatial layout (e.g., distance, slopes, height, and size). To conduct this research, I gather data in outdoor natural settings, indoors in hallways or buildings, and in mixed realities (virtual and augmented environments). I also test a wide range of age groups to further examine how the relationship between emotion and spatial cognition develops and changes over the lifespan. I find my work rewarding because I strive to make it applicable to issues beyond psychology, including but not limited to the design and development of virtual environments for simulation and training, the participation of women in STEM fields, and the development of anxiety or fear in children able to range freely (i.e., in hunter-gatherer societies) as opposed to those who are not. I believe the applicability of my work has been integral in securing continued funding since obtaining my first academic position. Below, I discuss in more detail the ways in which my work has explored both theoretical and applied questions of spatial perception, action, and memory.

Section 1: Does emotion influence perception and action?

To posit a relationship between emotional processes and perceptual processes is not entirely radical. Anecdotal evidence from clinical psychologists suggests that people with phobias report perceptual biases when they are exposed to fearful or threatening stimuli. My research demonstrates that many emotional states of the body influence perceptions of the environment (be these perceptions visual or auditory). I have written invited chapters and reviews on this work (*Stefanucci, 2010; Stefanucci, Gagnon, & Lessard, 2011; Stefanucci et al., to appear).* My experiments investigating the perception of height finds that heights are grossly overestimated when viewed from the top and bottom. Importantly, the extent to which this overestimation occurs is related to the level of fear in the observer (*Stefanucci & Proffitt, 2009)*, is exaggerated in people who are high in height fear (*Teachman, Stefanucci, Clerkin, Cody, & Proffitt, 2008)*, and is increased when the costs associated with falling from the height are emphasized (*Clerkin, Cody, Stefanucci, Teachman, & Proffitt, 2008)*. Because fear is a complex emotion with both physiological and psychological characteristics, I investigate which of these symptoms (or combination of symptoms) influence perception in order to pinpoint a possible locus of the effect of emotion on perception. I have shown that a single component of the fear response, arousal, can influence the perception of height (*Stefanucci & Storbeck, 2009)* and that this influence of arousal on height perception can be moderated by emotion regulation strategies (*Storbeck & Stefanucci, 2011).* Manipulations of perceived risk in an otherwise safe environment may also produce perceptual biases (*Stefanucci, Gagnon, Tompkins, & Bullock, 2012),* and self affirmation can temper height overestimation, suggesting a potential approach for overcoming height overestimation (*Huynh, Stefanucci, & Aspinwall, 2014).* Finally, I have also found that fear (*Stefanucci, Proffitt, Clore, & Parekh, 2008*) and sadness (*Riener, Stefanucci, Proffitt, & Clore, 2011*) increase slant perception, but that the presence of a friend (a potentially positive state) may reduce overestimations of slant (*Schnall, Harber, Stefanucci, & Proffitt, 2008)*.

Changes in perception due to emotion, if functional, should lead to measurable differences in action (e.g., serving to alter actions to be safer) given the intimate links between

perception and action. I have co-authored a general review on such connections between space perception and action that appears as a chapter in a handbook on embodied cognition (*Riener & Stefanucci, 2014).* One of my PhD students, Michael Geuss, assessed both perception and real action in virtual height environments for his dissertation. We found strong state x trait emotion interactions that predicted not only perceptual biases but also changes in action (actual stepping over a gap at a height; see *Geuss, McCardell, & Stefanucci, 2016*). Recently published work by former graduate advisee, Ian Ruginski, and former post-doctoral researcher, Dr. Brandon Thomas, showed that anxiety affects the perceptual-motor calibration of the visual guidance of braking (*Ruginski, Thomas, Geuss, & Stefanucci, 2018).* Further, a funded grant (for which I am the PI at Utah) with collaborators at Vanderbilt University tests how middle-aged children perceive and act in immersive virtual environments in order to assess whether rapid changes in growth affect the ability to perceive and execute actions in risky environments (i.e., stepping over a gap at a height). Our findings thus far suggest that children's actions are affected by risk in a manner consistent with adults in virtual environments (*Creem-Regehr, Gill, Pointon, Bodenheimer, & Stefanucci, 2019)*.

Section 2: Does emotion influence spatial cognition?

My more recent work (in collaboration with anthropologists) investigates the effects of emotion on navigation and spatial memory. Our primary hypothesis is that caution when exploring environments may lead to poorer spatial memory of those places. Caution and/or risk related to exploration could also serve as a deterrent for women to travel, thereby reducing their exposure to different viewpoints of environments or landmarks. Such differences could lead to deficits in other spatial cognitive tasks, such as mental rotation or perspective taking and may contribute to the robust sex differences observed in most spatial cognition tasks. We have found that experiencing anxiety during spatial learning can reduce survey spatial knowledge of the learned environment, as well as create a less accurate cognitive map. Anxiety affected both sexes, but had a greater effect on females (*Ruginski, Stefanucci, & Creem-Regehr, 2018)*. Our work also found that females who travel farther and have been to more unique places in their lives, as assessed by a mobility questionnaire, show better performance on a virtual Morris water maze task when compared to females who travel less (*Padilla, Creem-Regehr, Stefanucci, & Cashdan, 2017).* Finally, we show that more harm-avoidant people (as assessed by a scale) tend to explore virtual environments in ways that are less efficient, resulting in worse memories for those environments (*Gagnon, Cashdan, Stefanucci, & Creem-Regehr, 2015).* Adopting different patterns of exploration of space while wayfinding in a desktop virtual environment predicts spatial memory for targets in that environment (*Gagnon, Thomas, Munion, Creem-Regehr, Cashdan, & Stefanucci, 2018*) and also affects military cadets' navigational success in a real-world, large-scale navigation task (*Munion, Stefanucci, Rovira, Squire, & Hendricks, 2019).*

Future Directions and Conclusions

My research program investigates interactions between emotion, perception, and cognition as they pertain to our understanding of spatial layout. Emotional influences are a fascinating field of study because they challenge typical notions of "cognition" and help to elucidate links between social and cognitive aspects of behavior. The ways in which cognition and perception are modulated by our emotional states will continue to be the focus of my research program, but I also foresee my work broadening to address developmental aspects of these relationships, as well as the cultural and demographic determinants of spatial expertise. Further, I hope to broaden my approach to include more investigations of these interactions within virtual and augmented environments. In conclusion, I feel strongly that this research should be applied to settings where it can be of most help and use, from treatments for clinical populations to the design of human interfaces and the education of spatial cognitive abilities for women in the sciences.