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HOW SPATIAL IS SOCIAL DISTANCE?

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by

Justin Lee Matthews

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2014

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2014

To my mom and dad

Everything I am, I am because of you

I love you both

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Curriculum Vitæ

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Abstract

How Spatial is Social Distance?

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Doctor of Philosophy in Cognitive and Information Sciences
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This dissertation examines the link between social distance and physical distance. Why do people use spatial language to describe social relationships? In particular, to what extent do they anchor their thoughts about friendship in terms of space? We readily convey loyalty, concern, and fondness with spatial language that refers to proximity, such as "I'll stand by your side," "You can lean on me in hard times," and "We're close friends." We also imply rejection, betrayal, or waning interest with spatial language that refers to distance, as in "He turned his back on me," "You seem distant lately," and "We are drifting apart." In the domain of work, employees and employers often convey consensus with language such as, "Our ideas are quite close to one another," and "We're on the same page." People in the work environment also use spatial metaphor to convey disagreement and contention, as in "Their perspectives couldn't be further apart" or "Sam has distanced himself from our way of thinking about things." Six experiments used short narratives in combination with drawing and estimation tasks to further explore the conceptual structure of social distance using friendship and employer/employee relationships as manipulations. In all six experiments, participants read short narratives and then drew what they imagined happened during the narrative. Overall, the results suggest that the conceptual structure of friendships and employer/employee relationships are linked to thought about space. Results are discussed in light of social distance, inter-character interaction, and perspective taking.

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How Spatial is Social Distance?

Imagine that you are sitting in a coffee shop talking to someone you just recently met, his name is David. The conversation starts to turn to hobbies that you two share. In the course of the conversation, you both stumble upon the fact that you both enjoy exploring outdoors. You begin to tell David about a trip you and some friends took this past summer to the Sierra Nevada Mountains. You excitedly begin describing the trip from beginning to end, making sure to include details such as which route you and your friends took to the park, the various activities you participated in, including hikes, and the beautiful scenery you enjoyed. The trip was the best in recent years, and you are looking forward to taking another this coming summer. “My friends and I are so close”, you tell David. “Without even asking, I know which hikes my friends will like best. Jason loves *Lookout Peak,* but he hates *Alta Peak* near Wolverton. Tracy likes the *Crystal Lake* hike because she loves being near water. And I don’t really care where we hike as long as the weather is nice.” Taking a sip of your coffee, you comment, “Isn’t that weird... the *closer* you are to someone, the easier it is to get these decisions right.” Why is it that we readily use spatial terms to describe relationships we have with our best friends?

Historically, social distance has been studied at many different levels of analysis. From the micro level used in neuroscience (Ames, Jenkins, Banaji, & Mitchell, 2008; Buckner & Carroll, 2006; Mitchell, Macrae, & Banaji, 2006), the physical level of real-life human interaction (Adler & Iverson, 1974; Aiello, 1977; Hayduk, 1983) and feelings toward various social groups (Weaver, 2008; Kocan & Curtis, 2009), all the way to the macro level used primarily by sociologist, anthropologists and archaeologists, for example interactions between man-made social groups, like those afflicted with mental disorders, addictions, or physical illnesses (Horch & Hodgins, 2008; Shapiro, 2005; Jorm & Oh, 2009) and anthropological examinations of knowledge transfer between past civilizations (Kay, 1975; Schumann, 1976; Stone, 1992; Morgan, Mariotti, & Maffei, 2009). Here, social distance is described from six different theoretical perspectives, where each level of analysis shows that researchers from a variety of fields use slightly different definitions of social distance to help explain human behavior in each of their respective fields of study. From the coarse use of space in sociology, anthropology and archaeology, to the fine-grained spatial relations of functional brain areas, space is a key construct used to guide research hypotheses, predict scientific outcomes and explain human behavior. Most interesting is space as a common thread woven through each perspective. Our experience with physical space is an integral part of hypothesis construction, methodological manipulation, and theoretical explanation and is evident in each of the fields of study outlined here, suggesting that such diverse fields of study can share common ground in the ways they think about, measure, describe, and explain human behavior.

What follows is a tour of six different areas of study that have both theoretical and methodological connections to understanding the connection between social distance and physical space. Studies in Linguistics show that we talk about people of varying social relationships using spatial language; research in cognitive psychology shows that understanding the physical space around us involves many facets of our experience including how physical exertion, exhaustion, and health influence our perceptions of our physical environments. Social psychological research shows us that group membership can create feelings of “closeness” and “distance” and that these feelings, both emotionally and grounded in our everyday function, influence how we understand the space in which we live. Research from sociology, anthropology, and archaeology give us a glimpse into the cultural aspects of space used both in modern times and historically with regard to the ways people organize themselves into small social groups, communities, and nations, and how these mental organizations of groups is reflected in the ways these groups are spatially co-located with regard to one another. Given the latest technological advances, research from the world of virtual reality has begun to highlight the similarities between ways people use space in real life and how they use space, in similar ways, in the virtual world. Work in VR shows that personal space preferences in VR are almost identical to personal space preferences in alternative reality environments, and that these patterns can be exploited to exert influence and persuasion in areas unbeknownst to those experiencing a virtual world. Lastly, current neuroscience research had begun to reveal that brain areas, and patterns of activation responsible for understanding our physical world in terms of space, are also recruited, to some extent, while attempting to understand a variety of social group relationships, suggesting that social distance and physical distance, might share more than just conceptual expression, and that these constructs might utilize similar brain areas and patterns of activation to help us understand an increasingly complex abstract concept in terms of a fairly concrete domain like physical space.

Social Distance: Perspectives from Linguistics

In any given language there are many tools for describing spatial relations, including the distance between objects. People routinely use words such as *near, close,* and *by* for spatial relations that are proximal, and words such as *far, away*, and *beyond* for spatial relations that are distal. They often use these same spatial terms to describe other kinds of distance, including distance in social relationships. In communicating about friendship, for instance, they use spatial language to convey how close or far they feel from others. They convey loyalty, concern, and fondness with spatial language that refers to proximity, such as *He'll stand by my side*, *Lean on me in hard times,* and *We're becoming close.* They imply rejection, betrayal, or waning interest with spatial language that refers to distance, as in *He turned his back on me*, *You seem distant lately,* and *We are drifting apart*.

Language theorists have also investigated spatial thinking and social relationships, especially in the realm of metaphor. Spatial metaphors, ubiquitous in all languages and cultures, can help people to understand relatively abstract things in terms of more concrete things (see Gibbs, 1994; Lakoff, 1987; Lakoff & Johnson, 1980). People routinely use concrete things to describe more abstract concepts. For example, people are quick to structure their understanding of time, an abstract domain, in terms of space, a concrete domain (Boroditsky, 2000; Clark, 1973; Gentner, 2001; McGlone & Harding, 1998; Nunez, Motz, & Teuscher, 2006). This is evident in descriptions of the passing of time, for instance, "June comes before July" and "The meeting goes until noon" (see Matlock, Ramscar, & Boroditsky, 2005). People also think about space when processing information about numbers (Dehaene, 1997; Lakoff & Núñez, 2000), the alphabet (Matlock, Ramscar, & Srinivasan, 2005), and the Internet (Maglio & Matlock, 1999). They also talk about friendship in terms of space, as in *Our friendship has come a long way* and *We are drifting apart* (Kovecses, 1995).

It is also common for people to think about concrete domains like space when they talk about numbers (Dehaene, 1997; Lakoff & Nunez, 2000), the Internet (Maglio & Matlock, 1999), social relationships (Kovecses, 1995; Matthews & Matlock, 2011), and the alphabet (Matlock, Ramscar, & Srinivasan, 2005). Space plays an important part in our understanding of a variety of abstract concepts, however little work has acutely examined how physical space influences the ways in which people expect to behave during social and inter-personal interactions, and interactions in the workplace.

A specific abstract-concrete relationship discussed in conceptual metaphor theory is that of the relationship between our understanding of proximity in physical space and similarity in a variety of domains. In our everyday environment, we are exposed to this unique conceptual mapping where items that share specific qualities are also co-located in shared space. Driving along the highways in California's central valley, one can see miles of similar crops planted side by side, mountains of the same size and color clustered together off in the distance, and birds of the same species flocked together in the sky. Our everyday experience with these associations strengthens our conceptualization that things that are co-located in space share certain qualities. This mapping is known as the SIMILARITY IS PROXIMITY metaphor. In addition to natural observation of this mapping in the wild, experimental evidence also confirms that, under controlled conditions, this structure holds true in a variety of domains. Casasanto (2008) found that words presented close together in physical space are rated as being more similar than words presented far apart. Winter and Matlock (2013) show that people are thought to have more similar political views when shown physically close to one another, and less similar when shown physically apart. They also give support to the notion that this mapping is bidirectional: people who are described as similar to each other in taste of music, politics, and personality are drawn in scenes closer to each other than when they are described as dissimilar in these qualities.

Surprisingly, little work has investigated how people conceptualize space when thinking about friendship or other social relationships. This dissertation aims to investigate both why and how people use simple spatial terms when describing complex social relationships. Drawing on research from a variety of theoretical perspectives, I argue that this mapping does in fact have grounding in spatial cognition. To this end, it is important to examine what factors influence our perception of physical space, including movement through and interaction with spaces both real and imagined. It is also necessary to consider how social thinking and spatial thinking intersect by examining research on how social information can influence spatial judgments. Here, investigations of spatial thinking and social relationships in the realm of metaphor are also discussed. I also review current research on whether social distance is linked to conceptions about actual physical distance, especially in light of how social distance influences our interaction with, and perception of, our physical world in the realms of friendship, familiarity, and social relationships. Finally, research on social distance is discussed, with a timely focus on two areas of social information, interaction expectation and perspective taking and how these concepts are driven by and related to conceptualization of physical distance.

Social Distance: Perspectives from Cognitive Psychology

Perceiving and making sense of our immediate surroundings is no trivial task. Studies on the perception of traversed distance suggest that people are often inaccurate when it comes to estimating distances between locations and while navigating, even in small-scale environments. A variety of factors, such as the number of turns in a path (Sadalla & Magel, 1980) or the number of intersections in a path (Sadalla & Staplin, 1980) have been shown to influence our perception of environmental qualities such as distance or hill slant. This is not surprising considering research that shows how many different systems are involved in *perception*, and how these systems are used when we are not actively *perceiving* (Slotnick, Thompson, & Kosslyn, 2005). Recognizing the high interconnectivity between human perceptual systems that handle visual processing, language, and motor movement (Richardson & Matlock, 2007) no wonder misattribution of information happens. It has been argued that many different perceptual systems work in conjunction to provide a sense of the immediate physical environment beyond the obvious (sight, sound, tactile sense). These perceptual systems are composed of many environmental, physical, and psychological variables that work together to create an environmental percept (i.e. Rock & Victor, 1964; McGurk & MacDonald, 1976).

Environmental cues play an important role in how we internally structure our physically external environment. An internally structured environment or mental model, put rather simply, is imagined space. When reading a story about a boy walking from his house to the neighborhood store, we naturally and readily imagine his world, including people, places, and things. Studies suggest that multiple layers of consistency exist between the physical and mental environment, where imagined space is similar to real space (Kosslyn, Ball, & Reiser, 1978; Morrow, Bower, & Greenspan, 1989; Rinck & Denis, 2004), and that mental models and movement pertaining to imagined space is somewhat consistent across people (Richardson, Spivey, Barsalou, & McRae, 2003;

Tversky, Franklin, Taylor, & Bryant, 1994). These consistencies emerge when asking people to interact with, move through, and subsequently interpret their immediate surroundings. When asked to estimate traversed distance after walking a 200-foot path, consisting of either seven right-angle turns or two right-angle turns, people drew longer lines depicting traversed distance in a seven turn condition when compared to those in a two turn condition (Sadalla & Magel, 1980). A second study's results were consistent with these findings using alternate methodology. Participants were asked to first walk one of two paths, one with two turns or one with seven turns. After physically traversing the path, participants were then asked to walk the previously un-walked path and stop when they felt they had traveled the length of the first path. People walked a greater distance on the second path when initially walking the seven-turn path, than those who initially walked the two-turn path. This suggests that angularity, although not correlated with distance, influences our perception of path length. Other research suggests that angularity of path is not the sole influence that can lead one to make what seem to be irrational judgments; in addition to angles, intersections can also negatively influences our perception of real distance.

When people are asked to walk paths, which include a variety of intersections, their distance estimates differ reliably by the number of intersections contained in each path, where walking heavily intersected paths lead to overestimations of distance. In simple drawing studies by Sadella and Staplin (1980), it was shown that when people were thinking about traversing paths with one, four, or seven intersections, the way they depicted path length reliably differed in absolute length where more intersections were associated with longer drawn path segments. This suggests that even simple information about our physical environment is not always readily available to us, and that interpretations of our environment, are to some extent, dependent on factors unrelated to physical distance.

When studying how people interpret their physical environment, ecological validity is an important factor to maximize. A second study was conducted in a real-life setting (Sadalla & Staplin, 1980). Local residents of a city were asked to estimate distance to two intersections equidistant from a local shopping mall. The first path that people were questioned about (path A) had fewer intersections than the second path (path B). With regard to distance estimation, estimates of path A were shorter when shoppers drew lines representing scaled distance, even though familiarity with the two paths area did not differ. These studies support the notion that seemingly irrelevant information is taken into account when making distance judgments. In addition, information not pertinent to the question tends to influence judgments, making final judgments incorrect.

Following the move to collect data in increasingly ecologically valid environments, Crompton and Brown (2006) asked people to traverse two equidistant but qualitatively different roads: Portmeiron Road in North Wales and Oxford Road in Manchester (see Figure 1). People who traversed both distances (0.31 actual miles) estimated the distance in North Wales to be roughly twice as long as estimates made in Manchester. Crompton and Brown acknowledge the fact that control conditions and path consistency are difficult to come by in highly ecological environments but suggest that estimation differences in this study could be attributed to more slopes, turns, and overall environmental complexity in North Wales as opposed to Manchester (see Okabe, Aoki, & Hamamoto, 1986).

Why do such anomalies with regard to distance estimation exist? The previous findings mentioned here support storage models of distance perception, like the model of feature accumulation theory, where path complexity influences distance perception. More complex paths require more storage space in terms of path information and greater amounts of path information are positively related to greater distance estimates about path length (Sadalla & Magel 1980; Sadalla & Staplin, 1980; see also Montello, 1997; Berendt & Jansen-Osmann, 1997). Feature accumulation theory is also given as a partial explanation of findings by Crompton and Brown (2006) where it is not uncommon for physically complex paths to be overestimated in terms of distance, where sometimes estimates of traversed distance can be up to two times the actual distance traversed solely due to path complexity. One thing is certain; humans make judgment errors when it comes to distance estimates and these studies suggest that equidistant paths are perceived very differently when extraneous environmental factors are not kept consistent, suggesting that there might be other extraneous factors that can also influence environmental perception.

Environmental misinterpretations are not only limited to distance estimates. Taking a broader look at the influence of environmental cues on perception, it has been shown that people tend to overestimate distance on uphill and downhill slants when compared to equivalent distances on flat terrain (Stefanucci, Proffitt, Banton, & Epstein, 2005). Participants viewed traffic cones placed at various distances on either flat terrain or on a 20° hill. People judged the distances on the 20° uphill slope as farther away than the same distances on flat terrain. They also overestimated the angle of the slope. Interestingly, the same pattern of results emerged in virtual reality using a similar procedure, again overestimation of uphill distance and overestimation of hill slant. Upon further investigation, a combination of real-life and virtual reality judgments resulted in overestimations in all terrains, with the largest overestimations on downhill slopes, the next largest overestimation on uphill slopes and the least overestimation on flat terrain. Further results obtained in virtual reality suggested that overestimation error in distance estimation is greatest for highly slanted hills at long distances (approximately 15 meters). These results are commonly explained in terms of perceived effort, if a hill "looks" difficult to climb (has a steep slant) this translates to a need for increased effort on our part to make it to the top, and in turn leads to overestimations of distance. This approach however lacks an explanation for persistent overestimation of hills slanted down, where actual effort to traverse is reduced relative to flat ground. These initial findings provide evidence to support the idea that absolute effort involved in task completion does seem to influence distance estimations in both real-life and virtual environments.

External environmental cues however are not the only influential factors when it comes to systematically distorted distance estimates. Both mental and physical states of those judging their environments are also important when examining environmental perception. It could be assumed that distance perception is strictly geometric, consisting of an elaborate interconnection between both our visual and cognitive systems that elicit a rough estimate of the physical characteristics of our immediate environment, leading to accurate and reliable estimates. Research shows however, that information related to internal states, orthogonal to simple Euclidean cues are used when estimating distance and that estimates can become skewed in predictable and systematic ways.

More recent studies have shown that not only are geometric cues important when perceiving and subsequently describing our environment, but subjective effort (Bhalla & Proffitt, 1999; Proffitt, Stefanucci, Banton, & Espstein, 2005; Witt, Proffitt, & Epstein, 2004), fatigue, physical fitness, and physical health (Bhalla & Proffitt, 1999) also influence both distance and slant perception. In a novel study, Bhalla and Proffitt found that physical exertion influences the estimation of hill slant. Experimenters recruited individuals who routinely jogged for physical exercise, and had them take part in a series of slant estimation tasks, collecting estimates in a variety of ways. First, individuals met an experimenter at one of two small hills (5° slant vs. 31° slant) on school grounds; estimates on a variety of distracter measures were obtained as well as an estimate of the slant of the nearby hill. Individuals provided slant estimates three ways: verbal estimates were simply stated, by the participant, in degrees; visual estimates were obtained by having the participant position a numeral-free protractor-like device in relation to the flat terrain, and haptically by having the participant adjust a flat board to mimic the slant of the hill. After initial collection, participants were asked to go on a self-selected run, and to end at another designated hill. At this second collection more distraction tasks were administered as well as the three critical estimates of the second hill slant. Results showed reliable differences between pre-run and post-run responses on matched hill inclines. Individuals routinely overestimated hill slant in all conditions, but overestimated to a greater degree after their tiring run. Most interesting though was the type of measure not affected by the intermediate run, that of haptic slant estimation. Both visual and verbal overestimations increased after the run, but no reliable differences were found using haptic measures. It is suggested that visually guided estimates are immune to overestimation bias, possibly due to our experience routinely traversing ground that shifts with regard to slant without falling down, while estimations that first need to be *translated*, in this case into either a verbally or visually grounded medium, could succumb to inaccurate estimations.

Fatigue effects and their influences on physical estimation tasks have continued to receive attention and newly discovered factors have been discovered that mimic, or serve as a proxy to, fatigue. Bhalla and Proffitt (1999), tested whether or not the mere *feeling* of potential exertion would influence physical judgments. Under the guise of general questions related to the estimation of weights, distances, and angles, participants donned a weighted backpack containing a constant fraction of their self-reported body weight. Participants then made a series of judgments, including one about the slant of a nearby hill. As predicted, participants wearing the weighted backpack overestimated the slant of a nearby hill by more degrees than those not wearing a weighted backpack. Again, everyone consistently overestimated hill slant but to a greater degree when wearing a weighted backpack. In support of previous findings, again, visual and verbal measures succumbed to the fatigue effect, while haptic responses were consistent across backpack conditions. Participants were also asked to represent different angles that were verbally assigned to them. These judgments were performed immediately after the hill judgment task, and those in the backpack condition continued to wear the backpack throughout this second judgment task. Wearing a weighted backpack did not reliably influence verbally instructed angles using visual or haptic measurement methods. These results suggest that in the realm of estimation, fatigue effects are somewhat domain specific. When judging physical qualities of geographic locations, fatigue effects are present, perhaps due to the anticipation of having to traverse the estimated location. However, when replicating verbally communicated angles by either visual or haptic means, fatigue effects do not seem to appear. In a final study, participants completed both angle and slant estimation tasks as well as a physical fitness assessment, concluding that even physical fitness is a successful predictor of slant estimation bias. Here, participants estimated the slants of various hills (verbally, visually, and haptically) and within a week were assessed for physical fitness using two standardized physical fitness protocols: (1) a cycle-ergometer test and (2) heart rate change during physical exertion. Overall, individuals tended to overestimate hill slant, however, overestimation was greater for those of poorer physical fitness. These overestimations were present in both verbal and visual estimations, while absent in haptic judgments. As before, a disconnect between verbal/visual responses and haptic responses emerged, suggesting that slant estimations may or may not approach normative measures, depending on how the information is presented and subsequently reported by the participant. These results were also replicated using a senior population where healthier seniors overestimated less than seniors rated as less healthy.

The above studies make a strong case for the presence of consistent judgment errors made about our physical environment, and suggest a variety of factors that systematically influence our perception of physical space. This influence can take the form of physiological potential. It is possible that the conscious perception of a hill's incline or slant is influenced by the viewer's physiological ability to climb it (Bhalla & Proffitt, 1999). There is also a possible ecological reason why this pattern has emerged. When people are weighed down by a heavy backpack, fatigued after a tiring run, physically unfit, or advanced in age, their physical ability to traverse steep inclines functionally decreases, and our cognitive systems adjust our perception to better inform our conscious awareness of said ability. It is interesting, however, that theses systematic biases are not apparent to those making the judgments.

Continuing the examination of non-physical factors that influence distance perception, Witt, Proffitt, and Epstein (2004) conducted a series of studies that bolster the argument that visual characteristics of a scene are not the sole factors that influence judgments concerning our physical environment. Using interactive object throwing tasks, these studies build on previous work and continue to support the hypothesis that internal states of the perceiver play an influential role in the interpretation of external, environmentally based qualities. Participants placed at the center of a radial pattern on a grassy field were instructed to throw a ball at cones placed at distances varying from three to eleven meters from the center of the radial pattern. Participants were given either a light ball or a heavy ball, equidistant in diameter, to throw at the target cones. After three throws, participants were asked to estimate the distance to the target in feet. Both thrown distance and estimated distance were recorded. Participants who threw heavy balls estimated distance to be farther than those who threw light balls, while thrown distance did not differ across weight conditions. Again, simple distance estimation in a small-scale environment does not adhere to the normative standard prescribed by physical measurement, although participants did not differ with regard to aim accuracy, suggesting that they could competently estimate distance during a throwing task, however verbal estimates did not match this accurate pattern. This suggests that the effort needed to throw the ball altered the perception of distance when expressed but only when expressed verbally.

While it is interesting to study how people perceive their environment from a perspective that facilitates a *bystander-ish* interpretation of the world, some researchers have begun to examine these phenomena with an increasing interest in person-environment *interaction*. Taking a more embodied view on environmental perception, researchers have examined action intentions and their relationship to distance estimation (Witt, Proffit, & Epstein, 2004). Researchers had participants throw heavy balls to targets varying from three to eleven meters from the center of a radial pattern on grassy turf. After three throws to a target, some participants were told to close their eyes and throw the ball at the target, while others were instructed to walk blindfolded to the target. Prior to the toss or walk phase they first provided absolute distance estimates. Participants who intended on throwing the ball blindfolded estimated greater absolute distance than those who were intending to walk blindfolded. This finding suggests that distance distortion is task specific, for participants who intended to walk to the target; previous experience with heavy ball weight failed to skew their distance estimates, while distances were overestimated for those who had to complete a task with ball weight as a relevant factor. In these studies, distance perception was specific to task, and skew depended on the action or actions the perceiver intended to complete. Again, estimated-actual distance congruency with the normative standard is violated, but only when the task at hand and the effort needed to complete the task are related. It is suggested that perception and judgment are not solely *about* the environment in which we are situated but also about *interaction* with the environment. If we intend to walk to a target, distance estimates are influenced by the effort required to physically walk to the target. On the other hand, if we intend to throw an object to a target, distance estimates are influenced by the effort required to throw the object to the target.

Combining the qualities of some of the previously outlined studies with information about social factors could inform about the influence of social information on spatial perception. Incorporating social information into a version of the Sadalla and Magel (1980) and Sadalla and Staplin (1980) work would be interesting in that the newly added social information, making the goal of the walking task a meeting with a friend or a stranger, could clarify the effects of feature accumulation in route traversal. One could also incorporate the methodology used by Witt, et al. (2004) and have individuals toss differently weighted objects toward friends or strangers to examine the effect social information has on judgments that are truly multi-modal in information processing. The previous work discussed gives support to the idea that a multitude of environmental and situational factors influence our perception of the environment in which we live. A variety of variables about a specific path we take (i.e. number of turns in a route) change the way we *see* our environment and plan our movements. We also incorporate information regarding effort related to those movements (i.e. energy needed to traverse) when gathering data and interpreting physical factors that are relevant to intended actions. Even internal factors like an individual's level of physical fitness seems to change reasoning about the costs involved in negotiating our environment. All of these factors are interesting, and in most cases can be intuitively explained and justified by drawing on our own experience and interaction with our *physical* environment. A different line of research, however, suggests that these physical attributes are not the only influential factors in our ability to interpret our external world. Studies also suggest that information regarding non-physical social dynamics can influence our perception of space, an influence that is hinted at linguistically, culturally, and most of all socially.

Social Distance: Perspectives from Social Psychology

Social scientists have often discussed social behavior in terms of physical space. Some of this work has focused on the attitudes that members of one group hold toward members of another group. This is aptly reflected in the term *social distance*, which describes the "distance" that exists between two or more social groups (Bogardus, 1933). Bogardus pioneered the first systematic study of social distance with a series of 60 simple phrases describing a variety of social interaction and relationship situations, where individuals would read each situational sentence and rate the degree to which they agreed or disagreed with the each statement. People would read phrases like, "Would allow one family only (of their group) to live in my city block" or "Would have their children attend school with my children". Bogardus would instruct readers to imagine a variety of different social groups (i.e. member of a specific race or ethnic group) being referenced in each phrase. Bogardus ultimately constructed a seven level scale of differing social situations raging from "Would marry" to "Would have live outside my country", with phrases like "Would have several families in my neighborhood" as intermediate levels. Bogardus found that people readily categorized individuals of different social groups into different levels of interaction comfort. More recent research shows that social distance can affect how comfortable one group feels interacting with another group. For example, individuals in some racial groups may be reluctant to interact with individuals in other racial groups. African-Americans tend to feel *close* to other African-Americans, but *far* from people of Asian or European ancestry (Hoxter & Lester, 1995). People of Southeast

Asian descent (e.g., Laotian, Vietnamese) feel *close* to members of their own group, but also desire *close* ties with Caucasians (Lee, Templer, Mar, & Canfield, 2002). Social distance can also influence decisions made by social groups, including choices related to selection of educational attainment (Akerlof, 1997) and even the ease with which people learn a second language, where increased social distance in the form of cultural incongruency, social group dominance, and intergroup negativity all lead to poor second language acquisition outcomes (Schumann, 1976). It may also refer to the strategic use of language to create distance to exhibit power or control (Shepard, Giles, & Le Poire, 2001), and it can be used to make others feel excluded (Riggins, 1997). Social distance can also refer to physical distance between individuals while they are interacting (Hall, 1966). It can also influence how people reason about space. In one study, Americans with negative attitudes toward Mexicans estimated that Mexican cities were farther south than they actually are, and Americans with negative attitudes toward Canadians estimated that Canadian cities were father north than they actually are (see Kerkman, Stea, Norris, & Rice, 2004).

More generally, this sort of psychological distance has also been studied with regard to how people think about everyday objects and events. For instance, construal level theory (CLT) holds that when thinking about events, people naturally think about temporally distant events (e.g., a birthday party next year) in more abstract ways (e.g., celebrating, eating cake) while temporally proximate events (e.g., a birthday party tomorrow) in a more concrete fashion (e.g., dancing with friends, eating chocolate cake) (see Liberman, Sagristano, & Trope, 2002). This type of mapping has also been applied in other domains such as procrastination, politeness, self-control, and representations of the self (McCrea, Liberman, Trope, & Sherman, 2008; Stephan, Liberman, & Trope, 2010; Fujita, Trope, Liberman, & Levin-Sagi, 2006; Wakslak, Nussbaum, Liberman, & Trope, 2008; Trope & Liberman, 2010, Liberman & Förster, 2009). More specifically, experimental investigations have hinted at a systematic relationship between social distance and physical distance. When asked to either indicate the spatial location of a presented word or verify a word's presence, people respond more quickly when "we" is displayed in a spatially proximate (Figure 2, panel B) versus spatially distant location (panel D), and when "others" is displayed in a spatially distant (panel C) versus a spatially proximate location (panel A) (Bar-Anan, Liberman, Trope, & Algom, 2007). This suggests that social distance and physical distance are conceptually related.

Burris and Branscombe (2005) recently addressed one aspect of the social relationship / distance question and found that when presented with two cities, Americans overestimate distance between the cities when one city is in the United States and one is in a foreign location, when compared to two equidistant U.S. cities (see Figure 3). This result replicated with Canadians as well, and only held when the estimating party was nationally tied to one of the countries used. This suggests that spatial thinking is involved when participating in on-line distance estimation tasks involving nationality.

Off-line studies also suggest a connection between spatial thinking and thoughts about social relationships. When examining children's drawings, Holmes (1995) found that when asked to draw a picture of themselves and a cross-race other, five year old children drew themselves closer to the in-group member compared to the out-group member. In line with this type of social dichotomy, a study examining how a person would behave during the presence of a friend or a stranger might be a reasonable approach to understanding the relationship between being “close” to someone in an abstract psychological sense, and being “close” to someone in a more grounded physical sense. A task in which physical measurement is available is ideal in order to quantify the “physical” distance and compare it to its “social” counterpart.

The idea that people think of relationships in terms of physical space is intuitively appealing, especially given the ubiquity of linguistic expressions that refer to friendship in terms of spatial relations. This has been discussed at length in cognitive linguistics, including details about cross-domain mapping (e.g., Lakoff & Johnson, 1980, 1999; Gibbs, 1994) and relations to other metaphors (e.g., emotion metaphors, see Kovecses, 2008). But it has also been discussed in social psychology, primarily in the realm of “social distance”.

Matthews and Matlock (2008) explored social-spatial thinking using a distance estimation task where participants interpreted simple maps to explore whether spatial thinking underlies thought about social relationships. The findings suggests that “social distance” information about friendship influenced spatial thinking, specifically in terms of velocity, where participants imagined travelling more quickly toward friends than toward strangers, yet another result that suggests a spatial component to social distance. Results like these suggest that an underlying spatial framework may influence socially relevant information and that the link between “social distance” and “spatial distance” may not always be a simple positive relationship, where greater social distance is analogous to greater physical distance. Based on research on social distance, construal theory, and conceptual metaphor, it is difficult to deny that there is a basic connection between the conceptualization of human relationships and that of physical space. Still, many questions remain about how the connection is realized. Do people conceptualize closer physical space when they are thinking about friends versus strangers?

Matthews and Matlock (2008) suggest that in addition to information regarding effort, fatigue, environmental features, and multi-modal data collection, social information should not be ignored and future studies should begin to explain how information regarding relationships and personal familiarity influence the physical perception of our environment. The use of the term “close friend” can no longer stand idly by, explaining itself solely as metaphor, but now may have to incorporate social embodiment as part of its definition.

Social Distance: Perspectives from Sociology, Anthropology, and Archaeology

Social distance has been used as an indicator of preferred contact between individuals afflicted with certain social stigmas and those not afflicted. Bogardus coined the term “social distance” in the first half of the twentieth century (Bogardus, 1933). It describes perceived “distance” between different groups of people (i.e. social class, race, ethnicity, or sexuality). People feel differently toward in-group peers when compared to out-group members on a variety of hypothetical social situations, such as marriage to, friendship with, working with, and living near individuals of differing group status. For instance, Hoxter and Lester (1995) found that African-American adults have been shown to be less willing to foster personal friendships with people of Chinese, Japanese, Korean, or European decent. While many studies find racial divides ubiquitous, some find reduced cross-ethnic tension with regard to social distance. In some cases, studies on social distance focus on in-groups and out-groups, and the extent to which an individual feels accepted and part of the group (Olkin & Howson, 1994; Parrillo & Donoghue, 2005). These studies have even addressed how people feel toward individuals of different religions (Cavan, 1971) to individuals of varying sexual orientations (Gentry, 1987) and in some cases examining how identification on one scale can influence and predict responses on a different but related scale (i.e. religiosity and its predictive power related to views toward homosexuality). These studies on social distance show that people vary with regard to their feelings about members of similar and different social groups.

A variety of more recent sociological literature has suggested that even while these “social groups” can be created using more natural divides (i.e. ethnicity, gender, or race), other less natural divides can also be studied using similar social distance methodology. Recent work has examined how people feel connected, or in some cases disconnected, to individuals that are members of groups where group membership is not necessarily “natural” in etiology. Research related to addictive behaviors has shown that people tend to prefer increased social distance from individuals stricken with alcohol dependence or chronic gambling, than they do, for example, from individuals suffering from cancer (Horch & Hogkins, 2008). Individuals were asked to indicate how willing they would be to take part in a variety of situations (outlined in Figure 4) using the following responses: “definitely willing”, “probably willing”, “probably unwilling”, or “definitely unwilling”. Individuals preferred more social distance from people suffering from alcohol dependence, gambling problems, and schizophrenia, than they do from people stricken with cancer. Some recent research has begun to addresses the level of control individuals have in belonging to certain types of social groups, and how the need for social distance varies with regard to how much an individual believes being a part of a group is due to choice. For example, an individual cannot “choose” to be of a certain race, where choosing to take part in unhealthy behaviors could be seen as being, to some degree, dependent on choices made by an individual. How are judgments of preferred social distance influenced by choice-mediated social groups? Does preferred social distance increase for individuals when their membership in a stigmatized social group is dependent, to some degree, on choices they make? Research is somewhat limited with regard to how inclusion by choice *specifically* influences preferred *social distance*, and a variety of factors have been found to influence what types of people prefer increased social distance and which types of groups elicit more social distance than others. The majority of these investigations have examined mental disorders and suggest that at a minimum, experience with individuals with mental disorders or increased knowledge about mental disorders is reliably related to preferred social distance, where both experience and education reduce preference for increased social distance (Corrigan, Green, Lundin, Kubiak, & Penn, 2001; Ouellette-Kuntz, Burge, Brown, & Arsenault, 2009; Jorm & Oh, 2009; Feret, Conway, & Austin, 2011, Smith & Cashwell, 2011). Related are studies that address other stigmas like being infected with HIV or AIDS, where research shows that those with increased knowledge of how HIV/AIDS is transmitted desire less social distance with people suffering from the disease than individuals who have limited knowledge of how the disease is transmitted (Shapiro, 2005). This again shows that knowledge of the causes of disease, be they mental or physical, information about how the disease manifests, as well as how the disease is treated or spread influences people's willingness to associate or be near individuals stricken with these conditions. The sociological perspective of social distance, while different in many aspects from other fields of study, contributes to the overall knowledge base of *what* social distance means to different scholars, as well as *how* social distance is operationalized, measured, and interpreted. While its viewpoint is sometimes different, its diversity supports the idea that many academic fields of study recognize how humans interact, think, communicate, and position themselves with respect to one another in real life.

Similar to sociology, archeology is another field of study that occasionally uses *social distance* when describing interactions within and between previous human cultures. A good amount of archaeological research that uses social distance as a measured or hypothesized variable concerns the nature of knowledge transfer (social distance has been shown to be a factor in second language learning, see Schumann, 1976). In this section, two different areas of archeological research are discussed: differential tool making in central Missouri Hopewell settlements and economic autonomy in the prehistoric Mogollon culture in the American Southwest. These lines of research suggest that knowledge is transferred cross-generationally as well as cross-sectionally and that physical space is a major predictor of successful knowledge transfer person to person, person to group, or between groups.

The use of tools by our human ancestors does not only allow us to speculate about ancient people's cognitive capacities, but it also allows us to examine not only *how* these tools were made or used, but also about how these tools developed and adapted to different locales over both time and space. Archaeologists have posited that, in addition to interesting information about what tools were used for and how they were used, the different methods and designs of tools could shed some light onto how different groups of ancient peoples interacted in physical space. Wilmsen (1973) has posited that data from archaeological excavations can be used to measure a type of social distance defined as "social interaction intensity between groups occupying different territories." Archaeological data is nice in that these data are preserved in a way that includes information about both time and place and that artifacts can be counted and measured lending them well to statistical inquiry. Using a collection of over 70 different projectile points from four different central Missouri Hopewell settlements, researchers set out to discern social interaction data from similarity information obtained from a variety of collected projectile points (Kay, 1975). Using points gathered from four discrete locations within 60 river miles of each other (Lamine river localities: Mellor and Imhoff settlements; Big Bend localities: Givens and Fischer-Gabbert settlements), discriminant function analysis was used to measure similarity among chipped stone projectile points since its statistical techniques attempt to both minimize intragroup variation, and maximize variation (or statistical distance) between groups. This method lends itself nicely to controlling for intra-settlement projectile variation, while at the same time teasing out variation that can be attributed to actual physical separation of the settlements. Discriminant function analysis uses plots in Euclidean distance to show how "similar" or "dissimilar" items are to one another. After measuring a variety of physical qualities of the collected projectiles (i.e. total length, thickness, proximal half length, blade base width, etc.) the graphed Euclidean patterning was remarkably similar to the absolute geographic locations the projectiles were found while in the field (see Figure 5) Findings suggested that intra-settlement differences were minimal (similar shaped projectiles) while inter-settlement differences were more exaggerated (projectiles of different shapes), relative to one another. This suggests that knowledge transfer about projectile production techniques (as shown in their physical attributes) tells a story as to how the individuals who made these tools possibly interacted and passed, to one another, tool design and tool making skills, a manifestation of social distance not typically studied by social or cognitive scientists, albeit useful when attempting to create a holistic definition encompassing a variety of scientific methods into understanding distances of different types in our everyday lives.

While variability in tool making, like that in the central Missouri Hopewell settlements, has been linked to social distance, *behaviors* surrounding the practice of agriculture have also been linked to social distance. Leone (1968) found that members of the prehistoric Mogollon culture of the American Southwest increasingly relied on agriculture as a way of life between 600 and 1200 A.D. Using a variety of measures, including physical characteristics of pottery shards and agriculture tool findings and descriptions, Leone found that an increasing dependence on agriculture leads to an increase in social distance between pre-historic tribes of the area of present day Southwest United States and Northwest Mexico. As reliance on agriculture increased within the tribes, both pottery design variability and tool kit heterogeneity tended to decline, while between tribe variability on both measures increased, suggesting less interaction between tribes of different regional locales. Leone argues that as tribes grow in population and reach a stable number of people required to successfully use agriculture as a sustainable way of life, interaction between tribes to trade goods decreases due to goods being produced locally. Leone refers to these tribes with sufficient population numbers as minimal economic units, where these units' population numbers ebb and flow resulting in both increasing and decreasing inter-tribe interaction which results in changes in the frequency of sharing goods, tools, and production techniques. This operationalization of social distance, although different from definitions used in other areas of study like social and cognitive psychology and sociology, contains definitional parts that are conceptually related to other areas of study. Archeological data, like those mentioned here, are described in terms of both human interaction and knowledge transfer, and touch on how space plays a central role in guiding the use of both of these concepts.

Social Distance: Perspectives from Virtual Reality

On a slightly smaller scale of analysis, where inter-group interaction is replaced with inter-personal interaction, it is quite common to initially think of interpersonal distance as the end all measure of how people share personal space while interacting in their physical environment. Research on social distance spans multiple areas of research, from cognitive and social psychology and linguistics, to sociology and neurology. These diverse areas of study have recently enjoyed a resurgence of research dealing with how space is used by people in various environments, specifically environments where social interaction is also present. Research shows that people use space as a supplementary form of communication when interacting with other individuals. Research in the realm of interpersonal distance usually asks questions about how men and women differ in how they use distance in environments populated with individuals of different genders. The majority of research on interpersonal distance has found that physical distance is greatest in male-male dyads (Adler & Iverson, 1974), smallest in female-female dyads (Aiello, 1977), and somewhere in between for dyads of mixed genders (Hayduk, 1983). A new, more recent twist in this line of research has been to examine interpersonal distance in interactive virtual environments (IVE). IVEs have been argued to possess certain qualities that are not readily available in the real world. In classic human studies researchers in cognitive science, psychology, and the like, are typically forced to choose between experimental control and ecological validity. Prior to advances in IVE technology many researchers resorted to using environments created within lab spaces that typically lack real-life qualities existing in the real world. This was, and to some extent still is, troublesome in that heightened experimental control is gained at a cost of low ecological validity. Fortunately, IVE technology has offered a somewhat elegant partial solution to this historically inconvenient trade-off (see Figure 6).

Immersive Virtual Environments allow researchers to vary, systematically, environmental cues to understand their influence on the ways in which people function in “virtual” space. In two experiments Bailenson, Blascovich, Beall, and Loomis (2003) examined the impact a variety of social interaction variables have on individuals’ spatial placement in the virtual world, in other words how these variables influence interpersonal distance. Interpersonal distance has been studied by a variety of researchers since the late 1800’s however, technologically advanced interactive systems now allow for studies to be carried out in the virtual world. Bailenson and his colleges brought individuals into the lab and had them don a head-mounted display (HMD) where a pair of display monitors render an individual’s entire field of view artificially over each eye. This results in visual scenes that provide true stereoscopic depth. Individuals were instructed to traverse a series of virtual rooms and collect information about stationary virtual people positioned in each room. These virtual people had nametags on the front of, and numbers on the backs of, their shirts. The goal was to approach each stationary person and gather as much visual information about each character as they could. They were told they would be answering a series of questions about these people at a later time. Unbeknownst to the participants, the stationary people varied along a handful of dimensions thought to influence interpersonal distance: gender, gaze behavior, and perceived agency of the virtual human. Bailenson and his colleagues found that: (1) individuals stayed farther away from female virtual humans (as opposed to male virtual humans), (2) individuals stood farther away from agents who engaged in mutual gaze (than agents who did not), and (3) women stood farther away from avatars than from agents, while men did not show this effect. These results pattern nicely and suggest that, indeed, people tend to treat virtual humans like they do actual humans, at least with respect to interpersonal distance. This virtual human - actual human distancing pattern was extremely true to life in that the average minimum distance was about .5 meters suggesting that virtual humans are treated similarly to actual humans with regard to interpersonal distance. In addition to the basic distancing effect, their data suggest that similarities in interpersonal distance between virtual/actual and actual/actual human dyads are strikingly similar, even down to the shape of the "interpersonal distance bubble" that is formed when actual humans interact, where interpersonal distance is greater when facing another individual's front plane, and not as great when approaching an individual from behind (Argyle, 1988). Bailenson and his colleagues, in a second experiment, continued to examine interpersonal distance by altering "who" did the walking and found that when approached by an embodied agent (a virtual human controlled by a computer program) participants moved out of the way to a greater extent than they did when they were approached by an avatar (a virtual human controlled by a real human). This somewhat counterintuitive finding makes some sense if the perspective of the participant is taken into account. Perhaps the participants trusted that an avatar would "know" when to stop and avoid collision, and that an embodied agent, lacking human intervention, would not know when to stop and would not readily avoid a collision. Both of these experiments show that people exhibit the types of interpersonal distance effects that we see out in the real world even when they are in a laboratory setting in an interactive virtual environment. This suggests that humans, although used to interacting with other humans in real life, carry with them, certain behavioral patterns from their real life into their virtual one, supporting the notion that experimental research using IVEs can be a worthwhile methodology for studied behavior typically studies only in real-world contexts.

While Bailenson et al. (2003) showed that similar patterns of interpersonal distance are witnessed in both real life and in virtual environments, some researchers have criticized IVEs as not being an ecologically valid way of collecting human interaction data (see Hebl & Kleck, 2002; Zebrowitz, 2002). More recent research had suggested that IVEs do in fact provide an interesting and ecologically valid environment for collecting human interaction data that is strikingly similar to data gathered in real life human interactions (Yee, Bailenson, Urbanek Chang, & Merget, 2007), suggesting that IVEs are both useful and valid for examining human interpersonal interaction patterns. Recognizing that laboratory experiments pose problems with regard to ecological validity, Yee et al. chose to study equilibrium theory in virtual environments not methodologically tied to a contrived laboratory space. Equilibrium theory posits that humans moderate their degree of intimacy during communication by altering both mutual gaze and interpersonal distance, where an increase in mutual gaze is associated with a decrease in interpersonal distance (Argyle, 1988; Burgoon & Walther, 1990; Hayduk, 1981; Patterson, 1982; Rosenfeld, Breck, & Smith, 1984). In other words, when conversing with others we do not want to share a high amount of intimacy with, but are required to be proximally close to, averting our gaze will compensate for and reduce the amount of perceived intimacy during communication. Yee and colleagues collected a variety of interaction information including: interpersonal distance information, speaking behavior, mutual gaze, and physical location of interaction. Data from over 800 unique avatar dyads in Second Life, a popular 3D online world created and maintained by its users, was collected and showed that equilibrium theory holds true in IVEs just as it does in real life. When "standing" within 12 feet of one another, a distance posited by Hall (1959) as a maximum for successful verbal interaction, avatars standing closer to one another tended to shy away from mutual gaze. This pattern mimics results collected in real life situations where people actively regulate communication intimacy by adjusting interpersonal distance and mutual gaze respectively. In addition, Yee et al. found that mixed-gender pairs stood closer together and engaged in more mutual gaze than same-gender pairs, findings also found in real life communication research.

The previous findings begin to shed some light on to how humans control and use virtual characters in IVEs, suggesting that they control their virtual selves similarly to how they behave in real-life environments. These types of studies typically examine how space influences a user's emotional state (see Nasser, Powell, & Moore, 2010), how space mediates persuasion effectiveness or co-worker agreement (see McCall, Bunyan, Bailenson, Blascovich, & Beall, 2009; Matthews & Matlock, 2010) or how humans naturally position themselves while conversing or engaging one another socially (see Kirkorian, Lee, Chock, & Harms, 2006; Bailenson et al., 2003; Yee, et al., 2007).

Unfortunately, research concerning the perception of space or how interpersonal distance is spontaneously created under various social situations is scarce. Recently, Matthews and Matlock (2011) reported how narrative perspective and expected character interaction can influence agent placement in a simulated work environment. After imagining being either an employer or an employee in a meeting about salary adjustments, participants drew an employee figure in a virtual office environment. When taking the employee's perspective, participants placed virtual agents reliably closer to their employer's agent when expecting to discuss a pay raise, and farther away when expecting to discuss a pay cut. However, no inter-agent differences with regard to distance were found when readers took the employer's perspective. These results suggest that agent viewpoint is important in virtual environments. Not only does inter-agent distance influence employer/employee agreement, as previous work has shown (see Matthews & Matlock, 2010), this relationship seems to be bi-directional, where narrative content also influences the use of space via virtual agent placement. Future research should investigate this promising area of research. Findings would be immediately beneficial to large multi-national businesses who conduct business, not only within their country of residence, but also in countries that would require expensive, time-intensive travel to conduct face-to-face meetings. It would be advantageous for these large businesses to utilize online virtual environments in place of real life meetings to regularly conduct business within their own companies as well as between companies. Changing to a virtual model for only a portion of business meetings could reap many benefits not limited to time saved in travel, immediacy of communication, and cost savings due to travel. While not all business meetings might work well in a virtual environment, large companies like Adobe, IBM, Microsoft, and Oracle would benefit from at least looking into these technologies to augment their current business communication plan.

Social Distance: Perspectives from Neuroscience

Attempting to understand how people conceptualize *how* and *why* other people take part in a variety of behaviors can be informed by the ways in which we take part in behavior ourselves, both in real life and in virtual reality. A growing body of research suggests that patterns we witness in human-human physical interaction, be they real or virtual, also take part in our brain. A central tenant of social distance research follows that we as social creatures assign social value to people based on their membership in differing social groups (Hall, 1959), where we feel closer to those who overlap to some degree with our own group membership and more distant to those who do not share overlapping group membership. Recent research in neuroscience has shown that by using advanced neuroimaging techniques, like fMRI, we can see that making self/other distinctions are associated with specific regions of the brain (Buckner & Carroll, 2006; Mitchell, Macrae, & Banaji, 2006). Both neuroimaging and neuropsychological research has shown that the medial part of the prefrontal cortex is active when making judgments or inferences about other people's mental states (Frith & Frith, 1999; Gallagher & Frith, 2003; Gregory et al. 2002; Stuss, Gallup, & Alexander, 2001), more specifically both the ventral and dorsal sections of the mPFC have been implicated in mental state inferences of others (Saxe & Kanwisher, 2003; Fletcher et al., 1995; Mitchell, Banaji, & Macrae, 2005, Kumaran & Maguire, 2005). These research lines suggest that specific parts of the brain might be recruited when attempting to perform self-referential tasks as well as when thinking about the mental state of another individual believed to be "similar" to ourselves, while other areas are recruited when thinking about people we feel "dissimilar" to. This differential mentalizing hypothesis posits that some areas of the mPFC will be recruited when thinking about our own mental states and states of similar others, and that spatially different areas of mPFC will be recruited when thinking about dissimilar others, suggesting that even in the recruitment of brain areas, a type of social distance is inherent where information about self draws on brain areas physically different from areas drawn upon to process information about people we see as "different" or not in an overlapping social group.

Using a novel theoretical approach Mitchell et al. (2006) set out to see if different areas of the mPFC were used to mentalize or respond in the manner another person would respond to a variety of questions vs. responses you would make yourself. First, participants read short vignettes describing two unfamiliar people, one individual engaged in activities common for students who both held liberal sociopolitical views and who matriculated at a liberal arts college, while the other individual was described as a fundamentalist Christian who was fairly conservative both politically and socially and that took part in activities common amongst individuals who belonged to both religious and republican university organizations. Individuals were then told to use the information they had gained from the vignettes to answer over 60 questions about the two individuals' opinions, likes, and dislikes as well as their own opinions, like, and dislikes. These opinion ratings were elicited from the participants while fMRI scanning data was collected. After scans were acquired, participants completed a variety of on-line (Implicit Association Test) and off-line (explicit sociopolitical attitude questionnaire) measures. fMRI data showed that a ventral mPFC region was more active during judgments made of people who shared both their social and political views (liberal participants judging liberal targets, and conservative participants judging conservative targets). Other areas were also more active during “similar” judgments: right inferior frontal gyrus, cingulate cortex, and bilateral occipital cortex. However, when participants judged targets who were “different” in both social and political beliefs, greater activation was present in dorsal mPFC (liberal participants judging conservative targets, and conservative participants judging liberal targets). Incorporating their reaction time measures (IAT) they also found that a person’s positive self-association with a specific social or political stance (measured by response latency) was tightly coupled with ventral mPFC activation and negative self-association with social or political stance was tightly coupled with dorsal mPFC activation (see Figure 7). These results suggest separate functional areas of the mPFC, mainly the dorsal and the ventral regions, that seem to be specifically associated with processing information about others and that these areas are sensitive to how similar the target individual is to ourselves.

Not only is differential activation seen in both ventral and dorsal mPFC during judgments made about individuals thought to be similar or dissimilar to ourselves, but these differential effects are also elicited during tasks where perspective taking is manipulated (Ames, Jenkins, Banaji, & Mitchell, 2008). Here, participants were instructed to compose short narrative essays about a target individual’s experience at a common event, in this case meeting a friend for lunch. Prior to writing a short narrative, participants were instructed to imagine either taking a first person perspective viewpoint of this individual’s experience “imagine that you are this person... walking in their shoes... seeing the world through their eyes” or a third person perspective “gather clues about what this person might be like... think about how they might experience this event". In addition to predicted differences in the ways individuals constructed their event narratives, differences were found with regard to specific brain areas that were differentially active when taking the first person perspective vs. the third person perspective. While under the guise of predicting the narrative target's preferences on a variety of issues, like "prefers autumn to spring" or "enjoys playing video games" fMRI collection and analysis revealed striking differences in activation during differential judgments made in regard to targets previously imagined in first vs. third person (participants also answered questions about themselves). Ventral mPFC activation was higher overall in trials where participants answered questions about themselves when compared to trials where they answered questions about the narrative targets. Most important however, was that activation in the same area (ventral mPFC) was higher while answering questions about narrative targets "experienced" in the first person than those narrative targets "experienced" in the third person. This result is inline with previous studies that have found differential activation in both ventral and dorsal mPFC during self and other mentalization.

While some neuroscience research shows that egocentric (self) and allocentric (other) perspective taking recruit different regions of the brain, other research complement these findings using conceptually similar but different, methodology. Using fMRI, researchers have been able to show that different areas of the human brain are recruited when making judgments about our external physical world, and depending on what external objects we use while making these judgments, different parts of the brain are involved at different times (Neggers, Van der Lubbe, Ramsey, & Postma, 2006). In this experiment, participants were instructed to simply indicate the location of a horizontal bar presented on a screen. In the egocentric condition, participants were asked to indicate if the horizontal bar was on their left or right side (with respect to their own body's midline), in the allocentric condition participants were asked to indicate the bar's position with respect to a vertical bar also presented on the display (a third non-spatial color coding task was used as a baseline). Egocentric judgments resulted in increased activation in the superior parietal lobule (SPL) and no activation changes in the superior temporal gyrus (STG), while for allocentric judgments, marked deactivation in STG was witnessed along with no signal change in SPL (see Figure 8). These data suggest that simply judging the position of a line on a presentation screen recruits different regions of the brain depending on *what* is being used during the physical reference judgment (your body or an externally presented object).

Whether it is thinking about how *you* would react in a specific situation or about how someone you would consider ideologically "distant" from yourself would react or judging the location of objects with reference to your own body or an external reference point, research suggests that differential activation is witnessed in brain areas when thinking through decisions where those decisions involve factors related to information that is "physical" (Neggers et al., 2006) or "attitudinal" (Mitchell et al., 2006), two conceptualizations that have a common metaphorical underpinning that can be (and to some degree is beginning to be) described as distance. These neuroscience findings not only show that differential brain areas are recruited while performing tasks that vary in predictable ways but also hints at the possibility that when thinking about ourselves we "think" in a way that is functionally different from the way we "think" about other individuals.

The preceding research, from six theoretical perspectives: linguistics, cognitive psychology, social psychology, sociology/anthropology/archaeology, virtual reality, and neuroscience show that the ways in which we use space as a factor to predict, measure, and describe human behavior share some commonality. From using space to describe knowledge transfer between prehistoric civilizations, to the ways in which people use space when interacting in virtual environments, methodologies and theories that pertain to human use of space can be found in a many fields of science. The task now is to branch out from our comfort zones in each of our respective fields of study and begin to interact with scientists from a variety of disciplines, allowing research from *other* areas to inform and guide *our* research. Collaborations between areas like virtual reality and archaeology have shown to be fruitful, where scientists and lay people alike can interact with and learn from ancient people and their culture from the comfort of their home office or research lab (see Galeazzi, Di Giuseppantionio Di Franco, & Dell'Unto, 2010). As cognitive science continues to evolve these types of collaborations will be critical to fully understanding human behavior from a variety of perspectives, hopefully leading to a time and place where human behavior patterns can be explained from a multitude of scientific perspectives, and not from within a vacuum that is familiar and comfortable to only one specific field of study.

Given research findings from linguistics, cognitive and social psychology, sociology, anthropology, archaeology, virtual reality, and neuroscience, a natural question emerges: How spatial is social distance? My main research questions, in this dissertation, address the link between the physical spaces in which we live, act, and behave and the social spaces where we live, think, and communicate. I answer three main questions in this dissertation:

(1) Does social group information, specifically friendship, influence the way we use physical space?

(2) Can physical space influence our expectations with regard to inter-personal interaction?

(3) Does our understanding of both social distance and physical distance share conceptual expression?

In this dissertation, six experiments set out to test these questions in two methodological paradigms: a goal-directed path planning task where participants were given a simple task to complete, and asked to draw how they would complete the task, and a mock office meeting task where participants read narratives, arranged furniture, and made judgments regarding their expectations of future interactions. In these tasks, if social distance and physical distance share conceptual expression, we should expect social information to change the way one conceptualizes and interacts with their physical environment. We should also expect that space in a physical environment would influence how people think about social information and inter-personal interactions.

Social Distance and Physical Distance in a Goal Directed Path Planning Task

In any given language there are countless ways to describe spatial relations, including the distance between objects. People routinely use words such as *near, close,* and *by* to describe spatial relations that are proximal, and words such as *far, away,* and *beyond* to describe spatial relations that are distal. They use these same spatial terms to describe other kinds of distance as well, including distance in social relationships. In communicating about friendship, for instance, they use spatial language to express how they feel close to or far from others. They convey loyalty, concern, and fondness with spatial language that refers to proximity, such as "I'll stand by your side," "You can lean on me in hard times," and "We're close friends." They imply rejection, betrayal, or waning interest with spatial language that refers to distance, as in "He turned his back on me," "You seem distant lately," and "We are drifting apart." Surprisingly, little work has investigated the extent to which people actually conceptualize space when they are thinking about friendship or other social relationships. Our research investigates this connection and provides new insights into social distance in the realm of friendship.

Social scientists have often discussed social behavior in terms of physical space. Some of this work focused on the attitudes that members of one group hold toward members of another group. This is aptly reflected in the term *social distance,* which describes the "distance" that exists between two or more social groups (Bogardus, 1933). Social distance can affect how comfortable one group feels interacting with another group. For example, individuals in some racial groups may be reluctant to interact with individuals in other racial groups. African-Americans tend to feel *close* to other African-Americans, but *far* from people of Asian or European ancestry (Hoxter & Lester, 1995). People of Southeast Asian descent (e.g., Laotian, Vietnamese) feel *close* to members of their own group, but desire *close* ties with Caucasians (Lee, Templer, Mar, & Canfield, 2002). Social distance can also influence decisions made by social groups, including choices related to selection of educational attainment (Akerlof, 1997) and even the ease with which people learn a second language (Schumann, 1976). It may also refer to the strategic use of language to create distance to exhibit power or control (Shepard, Giles, & Le Poire, 2001), and it can be used to make others feel excluded (Riggins, 1997). Social distance can also refer to physical distance between individuals while they are interacting (Hall, 1966). It can also influence how people reason about space. In one study, Americans with negative attitudes toward Mexicans estimated that Mexican cities were farther south than they actually are, and Americans with negative attitudes toward Canadians estimated that Canadian cities were father north than they actually are (see Kerkman, Stea, Norris, & Rice, 2004).

More generally, this sort of psychological distance has also been studied with regard to how people think about everyday objects and events. For instance, construal level theory (CLT) holds that when thinking about events, people naturally think about temporally distant events (e.g., a birthday party next year) in more abstract ways (e.g., celebrating, eating cake), while temporally proximate events (e.g., a birthday party tomorrow) is thought of in a more concrete fashion (e.g., dancing with friends, eating chocolate cake) (see Liberman, Sagristano, & Trope, 2002). This type of mapping has also been applied in other domains such as procrastination, politeness, self-control, and representations of the self (Fujita, Trope, Liberman, & Levin-Sagi, 2006; McCrea, Liberman, Trope, & Sherman, 2008; Stephan, Liberman, & Trope, 2010; Trope & Liberman, 2010; Wakslak, Nussbaum, Liberman, & Trope, 2008). More specifically, studies have hinted at a systematic relationship between social distance and physical distance. When asked to either indicate the spatial location of a presented word or verify a word's presence, people respond more quickly when "we" is displayed in a spatially proximate versus spatially distant location, and when "others" is displayed in a spatially distant versus a spatially proximate location (Bar-Anan, Liberman, Trope, & Algom, 2007). This suggests that social distance and physical distance are conceptually related.

Based on research on social distance, construal theory, and conceptual metaphor, it is difficult to deny that there is a basic connection between the conceptualization of human relationships and that of physical space. Still, many questions remain about what types of relationships and how the connection is realized. Do people conceptualize closer physical space when they are thinking about friends versus strangers? In the current work, we explore this issue using a novel offline approach designed to capture people's implicit sense of distance and friendship while doing a goal-directed spatial activity. Three experiments combine drawing and time estimation to address the hypothesis that spatial reasoning is related to thought about friendship (for related work, see also Matthews & Matlock, 2007; 2008). In each experiment, participants first read narratives about traveling through a park to deliver a package and passing other figures (strangers or friends) along the way. Then they drew a line on a map of the park to represent the route they would take to accomplish the goal. Next they estimated how long the trip took. If conceptualizing friendship is related to thinking about spatial distance, information about a stranger or friend in the narrative should influence the way people think spatially. In particular, people should draw their routes closer to the figures in the map when those figures are thought to be friends. They may also estimate that the trip will take longer when they are thinking about friendship (versus when they are thinking about strangers) because they may imagine spending more time near the figure or taking more time to interact with the figure.

Experiment 1

Will thinking about friends as opposed to strangers influence how people complete a spatial task? After participants read a short narrative about walking past friends or strangers through a park to deliver a package, they drew the route they would follow on a map and made an estimate about how long the trip would take. Included on this map were figures incidentally designated as friends or strangers (in the narrative). If friendship includes thought about physical distance, participants should differ in how they conceptualize space between themselves and strangers or friends. Participants should conceptualize greater distance with strangers than friends, and this should be revealed in drawings and temporal estimates.

Method

Participants. A total of 263 University of California, Merced undergraduate students (159 women; age $M = 18.49$, $SD = 1.09$) enrolled in either a cognitive science or a psychology course participated for extra credit.

Stimuli and Procedure. The task appeared on a single page in a booklet consisting of unrelated experimental materials. Participants read a narrative about delivering a package by going through a park. The narrative mentioned traveling past figures, which were either friends or strangers, in the park. The narrative was written in the second person (you, your) to encourage people to imagine making the delivery themselves. Half the participants read a passage that included figures that were strangers: “Imagine you need to deliver a package. Along the way, you walk through a park and pass by different people. You do not know these people. They are strangers.” And half of the participants read a passage that includes figures that were friends: “Imagine you need to deliver a package. Along the way, you walk through a park and pass by different people. You know these people well. They are your friends." Critically, the narratives did not mention anything about physical distance from the figures. Nor did they mention anything about the possibility of interacting with these figures. The emphasis of the task was on delivering the package. (For the full set of stimuli used in all experiments reported in this paper, see Table 1.)

The following instructions appeared below the narrative on the page that participants completed: "Please draw the route you take through the park using a continuous line." Below the instructions was a map of the park that contained "Start" at the bottom and "Finish" at the top. Between these two points were three horizontal rows of trees and/or fencing with a figure at the end of each tree/fence row (see Figure 9). Maps were constructed so a single path from start to finish served as the only solution to the task. This was intended to force participants to pass by the three friends or strangers mentioned in the narrative. To depict their delivery route through the park, participants drew a continuous line from "Start" to "Finish." After the drawing task, participants provided written estimates of elapsed time: "Using your best guess, how much time (in minutes) did it take you to walk through the park?" The same procedure and stimuli were used in Experiments 2 and 3 reported here except for changes in the mode of transportation (walking, driving a car, riding in a taxi).

Each participant who volunteered for the experiment was randomly assigned to the friend condition or to the stranger condition, and each completed only one task.

Results and Discussion

We analyzed both drawings and time estimates. The same coding and analysis procedures were used in Experiments 2 and 3 reported here.

Drawing Data. We coded each drawing by measuring (in millimeters) the absolute distance from the three figures to the closest point in the route drawn. We did this for the bottom, middle, and top figure in the scene. We also averaged these three scores for an overall average distance score.

Overall, participants' routes came closer to friend figures (M = 14.54, SD = 12.60) than to stranger figures (M = 22.76, SD = 15.68), $t(261) = –4.68$, $p < .001$, as shown in Figure 10. A closer analysis of the three figures revealed the same trend for bottom (M = 13.73, SD = 12.93; M = 21.14, SD = 16.03), middle (M = 15.63, SD = 16.08; M = 24.55, SD = 18.19), and top (M = 14.25, SD = 12.35; M = 22.59, SD = 16.95) positions on the map, Wilks' $\lambda = .92$, $p < .001$; $F_{bottom}(1,259) = 17.66$, $p < .001$, $\eta^2 = .06$; $F_{middle}(1,259) = 16.90$, $p < .001$, $\eta^2 = .06$; and $F_{top}(1,259) = 19.26$, $p < .001$, $\eta^2 = .07$.2

For a secondary distance measure, we analyzed whether participants intersected (drew a line through) the figures in the scene. Overall, participants intersected a figure more times when it was a friend (10%) than a stranger (1.5%), $\chi^2(1, N = 263) = 8.82$, $p = .003$ (see Table 2).

Estimate Data. Prior to the analysis, all the time estimates provided by participants were converted into minutes. Estimates from four participants were removed prior to the analysis because they fell beyond three standard deviations from the respective group mean. Participants who imagined walking past friends while delivering a package estimated that it took more time to walk through the park overall (M = 19.43, *SD* = 14.19) than participants who imagined walking past strangers (*M* = 11.56, *SD* = 7.01), $t(257) = 5.67$, $p < .001$ (see Figure 11).

Together, these results indicate that information about social relationships can influence the way people conceptualize physical space. In particular, imagining friends resulted in closer physical distance than did imagining strangers. People came closer to the figures, in some cases even intersecting them, when they were imagined to be friends. Friendship also resulted in longer travel time estimates, suggesting that people may have imagined interacting with the figures when they were friends.

Experiment 2

Next, we were interested in further exploring the conceptual link between friendship and space. In Experiment 1, closer lines, more intersecting lines, and longer time travel estimates could have arisen because participants imagined talking to figures when they were friends. What will happen if the participants imagine riding in cars past other figures in cars? Standing on a street while others are walking near you naturally affords interaction as few barriers are in place. What if, however, a barrier was introduced that could reduce the ease at which two individuals could interact? Delivering the package in a car should make it especially difficult to imagine interacting with others also travelling in cars.

Method

Participants. A total of 324 University of California, Merced undergraduate students (199 women; age *M* = 20.33, *SD* = 2.72) enrolled in either a cognitive science or psychology course participated for extra credit.

Stimuli and Procedure. The stimuli were adapted from Experiment 1. The narrative was about driving a car to deliver a package. Figures were the cars of friends or strangers. Participants followed the same procedure as Experiment 1.

Results and Discussion.

Drawing Data. Overall, participants drew their driving routes closer to the cars of friends (M = 16.16, SD = 14.20) than to the cars of strangers (M = 22.36, SD = 14.44), $t(322) = -3.87$, $p < .001$. Closer analysis showed this was also true in the bottom (M = 15.82, SD = 15.73; M = 21.22, SD = 15.46), middle (M = 16.97, SD = 17.33; M = 23.39, SD = 16.91), and top (M = 15.69, SD = 16.94; M = 22.47, SD = 16.52) positions; Wilks' $\lambda = .94$, $p < .001$; $F_{bottom}(1,320) = 12.86$, $p < .001$, $\eta^2 = .04$; $F_{middle}(1,320) = 14.87$, $p < .001$, $\eta^2 = .04$; and $F_{top}(1,320) = 18.30$, $p < .001$, $\eta^2 = .05$. On average, people intersected figures more often when they believed those figures were friends (23.8%) versus strangers (10.5%), $\chi^2(1, N = 324) = 10.30$, $p = .001$ (see Table 2).

Estimate Data. Prior to the analysis, all the time estimates provided by participants were converted into minutes. Estimates from four participants were discarded because they fell three or more standard deviations from the respective group mean. Participants who imagined driving past friends estimated that it took more time to drive through the park (M = 16.57, SD = 13.70) than participants who imagined driving past strangers (M = 9.34, SD = 7.32), $t(318) = 6.06$, $p < .001$ (see Figure 11).

These results are consistent with Experiment 1. Once again, these results indicate that social relationship information affected the way people drew routes and estimated time. The results show that even when interacting with the figure would be more difficult (in this case, in a car), participants still came closer to the friend figures.

Experiment 3

This experiment used the approach described in Experiments 1 and 2, but here we were interested in how people might produce routes while conceptualizing a passive type of movement. In this experiment, participants imagined delivering a package by riding in a taxi through a park. In this scenario, it would be exceedingly difficult or impossible to interact with a friend along the way. Would our participants still draw paths closer to the friend figures?

Method.

Participants. A total of 190 University of California, Merced undergraduate students (115 women; age *M* = 19.11, *SD* = 1.67) enrolled in either a cognitive science or psychology course participated for extra credit.

Stimuli and Procedure. The materials were adapted from Experiment 1. The narrative was about riding in a taxi past friends or strangers to deliver a package, and the map included taxis. Participants followed the same procedure as Experiment 1.

Results and Discussion.

Drawing Data. Overall, participants drew taxi routes closer to friends (M = 16.76, *SD* = 14.16) than to strangers (*M* = 21.82, *SD* = 13.22), $t(188) = -2.54$, $p = .012$. They did this in the bottom (*M* = 15.67, *SD* = 14.40; *M* = 19.69, *SD* = 15.35), middle (M = 17.32, *SD* = 15.68; *M* = 23.93, *SD* = 14.83), and top (*M* = 17.29, *SD* = 16.67; *M* = 21.83, *SD* = 15.00) positions; Wilks' $\lambda = .96$, $p = .048$; $F_{bottom}(1,186) = 3.05$, $p = .08$, $\eta^2 = .02$; $F_{middle}(1,186) = 7.78$, $p = .006$, $\eta^2 = .04$; and $F_{top}(1,186) = 2.71$, $p = .10$, $\eta^2 = .01$. People were also more likely to draw a line through a vehicle when they believed the vehicle was occupied by a friend (22.1%) than when they believed the vehicle was occupied by a stranger (7.4%), $\chi^2(1, N = 190) = 8.21$, $p = .004$ (see Table 2).

Estimate Data. Prior to the analysis, all the time estimates provided by participants were converted into minutes. Data from four participants were removed because they were over three standard deviations from their respective group mean. Participants estimated that it took more time to make the delivery when they believed they were passing friends in the park ($M = 17.13$, $SD = 14.35$) than strangers ($M = 11.21$, $SD = 8.11$), $t(184) = 3.45$, $p = .001$ (see Figure 11).

The results are consistent with Experiments 1 and 2. People conceptualized closer distance when they believed the figure was a friend (versus a stranger). They did so even when it would be difficult to interact with that individual.

Experiments 1, 2, and 3 show that social distance, operationalized as friendship, influences how we conceptualize and use physical space. When drawing simple routes through a fictitious environment, participants drew paths of travel reliably closer to those they were under the impression were their friends, and farther away from those they were under the impression were strangers. These first three experiments support the notion that social distance and physical distance share some sort of conceptual expression. The map-drawing paradigm offered a novel and interesting way to test the hypothesis that social information influences use of physical space. How can this conceptual relationship be harnessed and examined in a situation where the possible bi-directionality of this relationship can be assessed? The next three experiments use a fictional workplace paradigm to explore directional relationships between social distance and physical distance.

Interaction Expectation and Physical Space in Work Environments

In the modern age, workers all over the world spend a great deal of their time co-located in office settings. In shared physical spaces, they engage in face-to-face activities, including meetings, presentations, and brainstorming sessions. Despite recent innovations in telecommunications that allow for augmented business interactions, such as Skype and Facetime, face-to-face meetings in shared physical space still prevail. The physical workspace is where we relay business plans to co-workers, impart advice to colleagues, and brainstorm new ideas. This research investigates how spatial distance relates to attitudes and expectations in business environments.

Social scientists often discuss social behavior and relationships in terms of physical space. For instance, they talk about "in-groups" and "out-groups". They also like talking about feeling "close to" or "distant from" others, as reflected in everyday statements such as "We have grown close lately," and "We are drifting apart". Such language is used to describe all sorts of relationships, including romantic relationships, working relationships, and friendship. Language theorists have provided extensive evidence to show that such language is structured by metaphorical reasoning (Gibbs, 1994; Lakoff & Johnson, 1980). They argue that space is often used to anchor our everyday understanding of love, work, friendship, time and countless other abstract things in the world (Clark, 1973; Gibbs, 1997; Lakoff & Johnson, 1999; Lakoff & Nunez, 2000). Space is used in all cultures and all languages in this way.

In the domain of work, employees and employers often use spatial language metaphorically. For instance, they convey consensus with language such as, "Our ideas are quite close to one another," and "We're on the same page". People in the work environment also use spatial metaphor to convey disagreement and contention, as in "Their perspectives couldn't be further apart" or "Sam has distanced himself from our way of thinking about things".

Research studies on office environments have used a variety of methods to evaluate the influence of physical space on human behavior. Many studies employ an "observe and report" approach, where researchers examine how environments are set up, then ask those who work in the environments to report about their feeling and thoughts about their interactions in that space. Some studies purposefully manipulate built environments to assess their influence on the thoughts, feelings, and action of the people who work in them. Research has examined how intimacy influences the use of interpersonal distance during interaction (Hall, 1966), how eye contact can be encouraged or hindered by the built physical environment (Sommer & Ross, 1958), as well as how personal space and eye contact are used, together, to manage comfort in environments were space is at a premium, like in an elevator (Altman, 1975; Patterson, 1973; Hall, 1966). Focusing strictly on the ways in which office layouts are constructed has also been an emphasis of research examining built spaces in which people work. Joiner (1976) cataloged a variety of possible office arrangements that contained a single desk and a single chair. Office dwellers in government and commercial settings preferred an office layout that positioned the desk *between* the office "owner" and guests, whereas a more open layout, no desk between occupants, was preferred in academic settings (Campbell, 1980). These studies, while valuable, utilize observation to define patterns of preference in office layouts; the three experiments detailed here examine how space and interaction influence one another experimentally.

Many interpersonal office interactions take place inside physical offices, but some companies incorporate virtual environments into their business models to encourage employee interaction when distance prevents face-to-face meetings. Some work on interactive virtual environments has shown that interpersonal distance shapes the way we think about others in the same physical space. In virtual classroom settings, research shows that physical distance reliably predicts how a person perceives a speaker giving a lecture. Using head mounted displays and a virtual environment setup, McCall, Bunyan, Bailenson, Blascovich, and Beall (2009) found that while listening to a speaker giving a persuasive speech, perceived distance from the speaker during the presentation reliably influenced both persuasiveness and overall impression of the speaker. Participants whose immersive virtual environment was constructed so they sat about 2 m from the speaker (as opposed to about 10 m from the speaker) in a classroom, were significantly more persuaded by the message as well as gave significantly more positive impressions of the speaker. Interpersonal distance, irrespective of message, changed the way the participants reacted to the information being presented by the speaker.

Drawing on earlier work on metaphor (e.g., Gibbs, 1994; Lakoff & Johnson, 1980), here we explore how physical space is conceptually linked to attitudes in the workspace. How important is spatial information to people's attitudes and expectations in interactions in work environments? In this work, we use a series of novel offline measures to assess how people conceptualize the relationship between interpersonal communication and physical distance in work environments. Three experiments use agreement assessment, drawing, and likelihood estimation to test the hypothesis that attitudes formed in employee-employer interactions in work environments are partly determined by the physical space in which they take place.

In each experiment, individuals imagined working for a fictitious company while viewing mock office setups that varied with regard to chair placement. In two cases, participants viewed specific office setups and made judgments about how much they would agree with certain individuals or how likely a business decision would affect them. In another case, participants read narratives then simply placed themselves in the mock office environment. The first experiment asks whether inter-personal distance in an office setting can influence how much we expect to agree with our employers during a routine business meeting? If so, the metaphor, SIMILARITY IS PROXIMITY predicts that, closeness in physical space will be associated with closeness in shared attitude with regard to a business decision. Winter and Matlock (2013) recently explored SIMILARITY IS PROXIMITY in a similar domain and found the mental link to be robust under a variety of experimental conditions. Their studies show people judge entities to be more similar when close to each other in physical space, and that close physical proximity increases judgments of similarity. The second experiment examines to what extent this metaphor is bi-directional. How does the expectation of receiving "good news" or "bad news" influence the use of space in an office environment? SIMILARITY IS PROXIMITY predicts that a person will want associate themselves with "good news" and distance themselves from "bad news". The third experiment examines this relationship in the realm of likelihood estimation. How do interpersonal distance and the delivery of good or bad news influence how likely we are to think an outcome will pertain to us. SIMILARITY IS PROXIMITY predicts that, news, either good or bad, will be more likely to affect you if you are physically close to the bearer of the news, and less likely to affect you if you are physically removed from the source.

Experiment 4

Will physical distance in an imagined work environment influence how much agreement people anticipate there will be on business topics? After participants read a short narrative about attending a meeting and discussing a variety of personnel matters with some of their co-workers and their boss, they viewed a mock-up of an office space. They then estimated how much agreement would be gained during the meeting with their boss on a variety of topics. If mutual understanding and agreement include thoughts about physical distance, participants should differ in how they anticipate agreeing with others based on how physically "close" or "far" they are from each other. Participants should anticipate more agreement with those they are physically close to, and less agreement with those they are physically distant from.

Method

Participants. A total of 416 undergraduate students (231 women; age $M = 18.96$, $SD = 1.53$) enrolled in either a cognitive science or a psychology course, at the University of California, Merced, participated for extra credit.

Stimuli and Procedure. The task appeared on a single page in a packet consisting of various unrelated pencil and paper tasks and surveys. First, participants read a narrative about working at a fictitious advertising firm. The narrative mentioned details about their company's current financial state. The narrative was written in the second person (you, your) to encourage people to imagine attending in the meeting themselves. All participants read the same narrative: "Imagine you work for an advertising firm. Your firm's finances require that some people be laid off. Today, you and three of your co-workers meet with your boss. The four of you have had meeting before. In past meetings, disagreements have happened. Like in most meetings, getting people to agree can be difficult. During the meeting you discuss which employees should, for sure, be laid off. You discuss how and when these lay-offs should take place. You also discuss how to re-assign current projects to employees that will stay." Below the narrative was a mock-up of an office. The office mock-ups depicted a total of five chairs (one chair for the boss, four chairs for the employees) and one desk. The office mock-ups only varied with regard to the absolute distance between the employee chairs and the chair of the boss (see Figure 12). A third of the participants viewed the "close" office arrangement (10mm chair-desk distance), another third viewed the "medium" arrangement (20mm chair-desk distance), and the final third viewed the "far" arrangement (30mm chair-desk distance). The following instructions appeared below the office mock-up: "On a scale from 1 to 7 (1 = no agreement and 7 = total agreement), please answer the following questions:" Below the instructions, the following four questions appeared (each questions was answered by circling one number on a scale of 1 to 7): 1) Between you and your boss, how much agreement was there on the number of employees that needed to be laid off?, 2) Between you and your boss, how much agreement was there on the names of specific employees that should be laid off?, 3) Between you and your boss, how much agreement was there on the amount of money that needs to be saved in order to continue business?, and 4) Between you and your boss, how much agreement was there on how to re-assign current projects to employees that will stay? Each participant who volunteered for the experiment was randomly assigned to one of the three distance conditions, and each completed only one task.

Results and Discussion

A single scale of agreement was calculated for each participant by averaging the responses to questions 1 through 4 (coefficient alpha = .66). Participants' average agreement scores reliably differed across distance conditions, $F(2,413) = 4.47$, $p = .01$. Post-hoc tests (Tukey HSD = .27, $p < .05$) confirmed participants anticipated more agreement with their boss in the close ($M = 4.51$, $SD = 0.95$) and middle ($M = 4.57$, $SD = 0.90$) distance conditions, when compared to the far ($M = 4.23$, $SD = 1.05$) distance condition (close vs. far = $p < .05$; middle vs. far = $p < .05$), anticipated agreement did not differ between the close and middle distance conditions ($p > .05$), as show in Figure 13.

These results indicate that information about inter-personal physical distance in a fictitious work environment can influence the way people anticipate interacting with their employer. In particular, imagining being seated relatively close to your boss in a meeting, as opposed to relatively far away, leads to more anticipated agreement with your boss on a variety of work-related topics.

Experiment 5

In Experiment 5, we were interested in exploring the bi-directionality of the conceptual link between physical distance and attitudinal distance. In Experiment 4, people anticipated more agreement with a boss whom they sat closer to than with a boss whom they sat farther from; supporting the notion that physical distance can influence thought about mutual agreement. Does this conceptual link function bi-directionally? Will anticipated mutual agreement in a business setting influence peoples' use of physical office space? If so, having views that are "close" to one another on a topic should be associated with "close" physical distance with that individual.

Method

Participants. A total of 215 undergraduate students (123 women; age *M* = 18.93, *SD* = 2.38) enrolled in either a cognitive science or a psychology course, at the University of California, Merced, participated for extra credit.

Stimuli and Procedure. The task was similar to the task used in Experiment 4. Participants read a narrative about working at a fictitious advertising company. The narrative mentioned details about salary adjustments that were happening to employees of the company, some employee salaries were slated to be raised, while other employee salaries were slated to be cut. The narrative mentioned a meeting that participants were to have with their boss. The narrative was written in the second person (you, your) to encourage people to imagine attending in the meeting themselves. Narratives varied along two dimensions. The first dimension narratives varied on was perspective. Half the narratives were written so the participant took the perspective of the employee, the other half of the narratives were written so the participant took the perspective of the manager. The second dimension the narratives varied on was salary adjustment. Half suggested the employee was to receive a pay raise, while the other half of the narratives suggested the employee was to receive a pay cut. These two dimensions were fully crossed, creating four distinct narratives. The first narrative took the perspective of the employee and told of a possible pay raise: "Imagine that you work for an advertising company. Your manager has scheduled a meeting with you for later today. Some co-workers recently received a pay raise and you suspect that you are next. Note that managers must take along their own chairs when they talk to their employees." The second narrative also took the perspective of the employee but the phrase "pay raise" was replaced with "pay cut", all other wording remained the same. The third narrative took the perspective of the manager and suggested that the employee was to receive a pay raise: "Imagine that you are a manager for an advertising company. You have scheduled a meeting with one of your employees later today. In the meeting you will tell the employee that he will receive a pay raise. Note that managers must take along their own chairs when they talk to their employees." The fourth narrative also took the perspective of the manager but the phrase "pay raise" was replaced with "pay cut", all other wording remained the same.

On the same page below the narrative was a mock-up of an office, similar to mock-up used in Experiment 4. This mock-up contained one desk and one office chair (see Figure 12). No other chairs were included in this office setting. Above the one chair in the scene the word "you" or the word "employee" was printed, corresponding to the narrative previously read; this was done to reinforce the information relayed in the narrative. The word "you" was used in the office scenes when the accompanying narrative took the employee's perspective. The word "employee" was used in the office scene when the accompanying narrative took the manager's perspective. The following instructions appeared above the office scene when the narrative took the employee's perspective: "Please draw an "X" to show where your manager will place their chair in your meeting about receiving a pay raise." A slightly altered set of instructions appeared above the office scene when the narrative took the manager's perspective: "Please draw an "X" to show where you will place your chair in the meeting about giving your employee a pay raise." The phrase "pay raise" was replaced with the phrase "pay cut" when appropriate to match the accompanying narrative. After reading the instructions, participants simply drew an "X" in the office scene to represent where they would place the chair discussed in the instructions. Each participant who volunteered for the experiment was randomly assigned to one of the four conditions, and each completed only one task.

Results and Discussion

We coded each chair placement for horizontal location by measuring (in millimeters) the absolute distance from the intersection of the "X", marked by the participant, to the far left edge of the office scene. No reliable differences in chair placement were found when taking into account narrative perspective alone, $F(1,211) = 0.49$, $p = 0.48$. The anticipated meeting topic did influence chair placement; participants placed chairs closer to their meeting partner when the participants anticipated discussing a pay raise ($M = 74.83$ mm, $SD = 5.72$ mm) than when they anticipated discussing a pay cut ($M = 77.26$ mm, $SD = 9.01$ mm), $F(1,211) = 5.68$, $p = .02$. Narrative perspective and anticipated salary-related information also interacted, $F(1,211) = 4.71$, p = .03: Participants who read the narrative in the employee's perspective placed their chair closer to their manager when they expected they would receive a pay raise ($M = 73.26$ mm, $SD = 5.32$ mm) than when they expected they would receive a pay cut ($M = 78.08$ mm, $SD = 7.39$ mm), but no reliable differences were found with regard to chair placement between the pay raise ($M = 76.17$ mm, $SD = 5.76$ mm) and the pay cut ($M = 76.56$ mm, $SD = 10.22$ mm) conditions when the narrative was written in the manager's perspective. Post-hoc tests confirmed that the differences in chair placement found between the pay raise and pay cut conditions when the narrative was written in the employee's perspective were reliable, $t(87.12) = -3.72$, $p < .001$. The differences in chair placement found between the pay raise and pay cut conditions when the narrative was written in the manager's perspective were not reliable, $t(87.67) = -0.25$, $p = 0.80$ (see Figure 14) (degrees of freedom for independent-samples t-tests are decimalized due to unequal sample variances).

These results indicate that valence of anticipated information (positive or negative) in a fictitious work environment can influence the way people intend to position themselves physical space. In particular, imagining having a meeting with someone who will relay good news (a potential pay raise) leads to people choosing to be closer to that individual than if the person was anticipated to relay bad news (a potential pay cut). Critically, this distance effect is only reliable when the narrative relaying the story is written in the employee's perspective (i.e. the person the news will affect most), and not when the narrative is written in the manager's perspective. These results, taken with the results from Experiment 4, suggest that mutual agreement in an office setting and inter-personal physical distance might share conceptual expression, and that this relationship is possibly bi-directional, where physical space can influence how we anticipate communicating with each other, and where anticipated interactions, either positive or negative in nature, can influence how we use physical space while communicating.

Experiment 6

This experiment used the approach described in Experiment 4, participants viewed fictitious office layouts that varied with regard to the amount of interpersonal distance between the boss's and the employee's chair. First, participants imagined working for an advertising company, where some employee salaries were to be raised, and others were to be cut. Then, they viewed a fictitious office layout and estimated how certain they were to receive a pay raise or pay cut. Would interpersonal distance influence participant certainty judgments with regard to the perceived likelihood of receiving a pay raise or a pay cut?

Method

Participants. A total of 618 undergraduate students (383 women; age $M = 19.62$, $SD = 2.71$) enrolled in either a cognitive science or a psychology course, at the University of California, Merced, participated for extra credit.

Stimuli and Procedure. As in Experiment 4, participants read a narrative about working at a fictitious advertising company. The narrative mentioned details about salary adjustments that were happening to employees of the company, some employee salaries were to be raised, while other employee salaries were to be cut. The narrative mentioned a meeting that participants were to have with their boss. The narrative was written in the second person (you, your) to encourage people to imagine attending the meeting themselves. Two narratives were used. One narrative led the participant to believe their salary would be raised: “Imagine you work for an advertising company. Your boss has scheduled a meeting with you for later today. Due to new financial circumstances, your manager will increase some employee’s pay.” The other narrative led the participant to believe their salary would be cut: “Imagine you work for an advertising company. Your boss has scheduled a meeting with you for later today. Due to new financial circumstances, your manager will decrease some employee’s pay.” The following phrase appeared below the narrative but above the office scene in the pay raise condition:

“Below is your boss’s office where you will find out if you will receive a pay raise”. A slightly altered phrase appeared above the office scene in the pay cut condition: “Below is your boss’s office where you will find out if you will receive a pay cut”. Below the narrative and phrase was a mock-up of an office. The office mock-ups depicted a total of two chairs (one chair for the boss and one chair for the employee) and one desk. The office mock-ups only varied with regard to the absolute distance between the employee chair and the chair of the boss, close (10mm chair-desk distance) and far (20mm chair-desk distance) (see Figure 13). The two different narratives were completely crossed with the two different office setups, creating four unique conditions: the pay raise narrative with low interpersonal distance, the pay raise narrative with high interpersonal distance, the pay cut narrative with low interpersonal distance, and the pay cut narrative with high interpersonal distance. Two questions followed the office mock-up. The first question asked: “Will you receive a pay raise?” the participant simply answered by circling either a “Yes” response or a “No” response. The alternate question “Will you receive a pay cut?” was used when appropriate. The second question asked: “How certain are you? (circle the number that reflects your certainty)” the participant simply answered by circling a number on a number line ranging from 1 to 7, where 1 was labeled “Very Uncertain” and 7 was labeled “Very Certain”. Each participant experiment was randomly assigned to one of the four conditions, and each completed only one task.

Results and Discussion

A simple calculation was done to create a single measure that incorporated both the valence of a participant’s response to the first question (yes or no) as well as the magnitude of how certain they were of a pay raise or pay cut happening in the second question (certainty rating 1 through 7). A “yes” response to the first question was coded as a +1, while a “no” response was coded as a -1, these values were then multiplied by the value circled in the second question (ranging from 1 through 7). The resulting product was calculated for each participant. This product ranged from -7 (very certain they *would not* receive a “pay raise” or a “pay cut”) to +7 (very certain they *would* receive a “pay raise” or a “pay cut”). This product, which we named “outcome certainty”, served as the dependent variable in the following analyses.

There were no reliable differences in outcome certainty, taking into account inter-personal distance alone, $F(1, 614) = 1.25$, $p = .26$. With regard to pay change information alone, participants were more certain they would receive a pay raise ($M = 1.81$, $SD = 4.93$) than a pay cut ($M = 0.92$, $SD = 5.02$) regardless of inter-personal distance, $F(1,614) = 4.96$, $p = .03$. Critically, outcome certainty reliably differed when taking into account both inter-personal distance and pay change simultaneously, $F(1,614) = 4.80$, $p = .03$. Participants expecting a pay raise felt more certain they would get that raise when they were seated close to their boss in the office mock-up ($M = 2.45$, $SD = 4.61$) than they did when they were seated farther away ($M = 1.13$, $SD = 5.18$), $t(306) = 2.36$, $p = .018$. Participants expecting a pay cut were equally ambivalent about the possibility of receiving that pay cut regardless of how far they sat from their boss in the office mock up, either close ($M = 0.70$, $SD = 5.04$) or far ($M = 1.14$, $SD = 5.01$), $t(308) = -0.77$, $p = .44$ (see Figure 15).

Results from Experiment 6 suggest that spatial information, when combined with expectations about conversation topic, influences one’s predictions about the likelihood of a positive event happening to them, in this case a pay raise. Experiment 6 builds upon

Experiments 4 and 5 by showing that spatial information combined with topic expectations work together to influence how one calculates the odds of a specific outcome being realized.

General Discussion

This dissertation explored the relationship between social distance and physical distance. A series of six experiments examined (1) how thinking about social relationships, like friendships, can change the way people express their use of space in a path planning task and (2) how the ways we expect to interact in work environments can change the way we structure an office environment where interaction takes place, and vice versa, how structured office environments can influence our expectations of social interactions. The results suggest that social distance is, to a certain degree, spatial, and that our conceptualization of distance between social groups, commonly expressed in everyday sayings like "Sam and I are close friends" or "Tom came between me and my best friend" is conceptually related to physical space in the real world. These studies suggest that this shared expression persists even when social interaction between parties is difficult, and may be mediated by perspective, where the use of space in specific work environments somewhat depends on which perspective in a social dynamic an individual is taking.

The first three experiments investigated the link between type of social relationship (friend, stranger) and spatial distance. In all experiments, participants were primed to think about a friend or a stranger relationship before drawing a line to depict a route they would take through a park to deliver a package. In all cases, social relationship influenced how participants reasoned about physical distance and time.

The first three experiments support the notion that social distance, defined as friendship, and physical distance are conceptually linked. Like previous work by Bar-Anan et al. (2007) suggests, psychological distance (defined using social group memberships: friend and stranger) and physical distance (defined using route-figure distance) seem to draw on similar processes where, friends are conceptualized as proximate and strangers as distant. This finding is in line with current work and complements findings of other studies using CLT as a platform for investigating the link between social distance and physical distance where the effect was elicited in a simple but novel drawing task.

In Experiment 1, participants were encouraged to imagine walking through a park past friends or strangers to deliver a package. When figures were imagined to be friends, they drew a line closer to them and provided higher estimates for travel time. They were also more likely to intersect a figure when it was a friend. In Experiment 2, participants imagined driving a car, in which case they drew routes closer to other cars, were more likely to intersect other cars, and provided higher time estimates when they believed the other cars belonged to friends (versus strangers). In Experiment 3, participants imagined riding in a taxi; here, too, they drew routes closer to other cars, were more likely to intersect other cars, and estimated that it took more time when they believed the other cars belonged to friends.

Using a novel spatial task, the first three experiments examined the interplay between social distance and spatial distance, two concepts that have been studied largely by independent groups of researchers. The assumption that "distance" in relationships is analogous or metaphorical appears to be motivated by thought about actual space. These distance and time effects were present even when inter-character interaction was made increasingly more difficult by changing the mode of transportation used in the package delivery task. One could argue that distance effects are driven by people “simulating” interaction with friends but not strangers, but Experiment 2 and Experiment 3 show that even when interaction is nearly impossible, people still draw routes closer to friends (compared to strangers) and estimate longer travel time in the presence of friends (compared to strangers) suggesting the “simulation” hypothesis needs to be readdressed.

With regard to the first three experiments, many intriguing questions remain. Is it possible that differences in figure-path distances are a consequence of heightened emotions or increased desirability? For instance, participants in our studies may have felt more positive about figures they believed were friends, which alone could have caused them to draw their lines closer to them. And what about familiarity? Perhaps the mere presence of a figure that implied familiarity (i.e., a friend versus a stranger) could have resulted in shorter figure-path distances. And what about similarity? Research shows that out-group members are seen as more similar to each other (known as the out-group homogeneity effect), while in-group members are seen as slightly more variable and possess some unique characteristics not afforded to out-group members (Jones, Wood, & Quattrone, 1981; Quattrone & Jones, 1980; Judd & Park, 1988; Linden-Andersen, Markiewicz, & Doyle, 2008). While not specifically social in nature, Casasanto (2008) gathered similarity ratings of various stimuli (abstract nouns, unfamiliar faces, line drawings) under different conditions and found that when stimuli items were placed close to one another, pairs of stimuli were judged as more similar during conceptual judgments and less similar during perceptual judgments. The answers to these questions are clearly still facets of friendship and space, and they deserve close examination. There are also questions surrounding the action of drawing itself: How might participants' attitudes change toward the friend or stranger figure *after* drawing themselves spatially proximate or distal? Can simply drawing oneself closer to others influence feelings of "closeness"? Such questions are also worth further exploration. In addition, it would be informative to explore magnitude effects using this approach: Will people draw lines closer to the figures when the figures are close friends than when they are acquaintances? And how might rate of movement affect figure-path distances? In the current set of studies, we examined movement on foot, driving a car, and riding in a car. We cannot yet determine how this variability may have influenced the results. And importantly, how might these results vary across cultures? No doubt this will be a rich area to explore in depth. Future research should also address how reasoning about space in the construal of relationships unfolds in time, including collecting information regarding travel speed: When people pass by a friend, will they slow down, and if so, how much? Future explorations could also include manipulations based on social categories, such as including race, sexual orientation, and gender.

The results of the first three experiments have implications for research on social distance and conceptualization of space (Burris & Branscombe, 2005; Bar-Anan, Liberman, Trope, & Algom 2007). Previous research shows that when estimating "as the crow flies" distances, people consistently overestimate distances between U.S. cities and cities in other countries (i.e. Canada and Mexico) when compared to estimated distances between two U.S. cities. When the entities involved in distance estimation task have differing qualities with regard to their social group membership, in this case nationality, a strong distance effect is present where greater distance is associated with entities that are members of dissimilar social groups and less distance with entities that are members of similar social groups. Here, this relationship is replicated in the domain of friendship. When drawing paths in a goal-oriented path-planning task, people consistently drew their paths closer to individuals who they believed to be their friends, and farther from individuals who they believed to be strangers. This result gives evidence to the idea that social distance, commonly defined as a cognitive feeling of closeness to a particular group or individual, in fact, is conceptually linked to how we think about and use physical space. In addition to support for a conceptual link between social distance and physical distance, these data suggest that people imagining interactions between individuals taking place do not solely drive this relationship. These data support the notion of a conceptual link even while inter-personal interaction is extremely difficult (driving or riding in a car while passing by another person doing the same). These path-planning experiments have set the stage for rich, follow-up research on the link between spatial thinking and social relationships. For now, the hope is that we are one step closer to understanding how people conceptualize friendship and space.

The final three experiments examined the link between spatial distance and decision expectations in business settings. Expectations were defined differently across the experiments including expected supervisor-employee agreement in an office meeting (Experiment 4), expectations surrounding impending employee salary adjustments (Experiment 5), and the likelihood of receiving salary adjustments given office settings with varying degrees of interpersonal distance (Experiment 6). In all studies, participants read narratives instructing them to imagine working in a fictitious business setting, spatially relevant information regarding inter-personal distance was also provided to the participants in the form of mock office layouts where hypothetical business interactions and meeting were to take place. Experiments 4, 5, and 6 revealed that thought about space and thought about business interaction expectations influenced one another, Experiment 5 specifically suggests that this influence could be bi-directional.

Experiments 4, 5, and 6 support the idea that physical distance and inter-personal interactions, defined here as business expectations, are conceptually linked. Like previous work by McCall et al. (2009) and Bailenson et al. (2003) suggests, interpersonal distance can have a substantial impact on how we expect to interact with others, and how we actually interact with others in both physical and virtual worlds.

In Experiment 4, participants were instructed to imagine working for an advertising firm that was downsizing due to budget cuts. During a meeting with their boss a variety of topics were to be discussed regarding different actions that resulted from their firm's financial trouble. Participants predicted higher agreement with their boss when they imagined sitting closer to their boss during the discussion, and that they expected less agreement when they imagined sitting farther away. In Experiment 5, participants were asked to imagine working for an advertising firm where rumors regarding pay adjustments were circulating among the employees. Those who heard the rumor of salary increases placed their chair closer to their bosses during a meeting about impending salary adjustments than those who heard regarding salary cuts. This effect was only seen when participants imagined being the employee, and was not seen when participants took the perspective of the supervisor. In Experiment 6, participants predicted the likelihood that they would be affected by a potential salary adjustment.

When expecting a pay increase, those who imagined sitting close to their boss during a meeting thought they were more likely to receive that increase than those who imagined sitting farther away. When expecting a pay cut, distance from their boss during the meeting did not influence likelihood predictions.

This set of studies used a simple, novel combination of narrative and static visual stimuli to examine how interpersonal physical distance and social expectations both influence one another and work in concert to influence expectations related to business related interactions between employers and employees. The notion that entities that are physically proximate to each other also share conceptual and metaphorical “closeness” is supported by the results reported here. In Experiment 4, closeness in anticipated physical proximity, between the employer and the employee, affected how close the predicted shared attitudes were on a variety of business-related topics; being close in physical space led to greater anticipated agreement, while distance in physical space led to lesser anticipated agreement. Here, attitudinal distance and physical distance are linked, where greater physical distance between individuals lead to greater expected attitudinal distance. This relationship, as Experiment 5 suggests, has, at a minimum, some bi-directional qualities. When expecting to receive good news (potential pay raise) at an upcoming meeting from their boss, people placed themselves closer to their boss in office mock-ups than those who expected to receive bad news (potential pay cut). Again, one could argue that changes in physical proximity are being influenced by the amount of attitudinal agreement both parties are sharing. A moderating factor, perspective, clarified this finding; attitudinal agreement (expecting a pay raise vs. a pay cut) only influenced anticipated physical proximity when the narrative was written from the employee’s point of view, not when the narrative was written using the employer's perspective. This finding is intriguing and could be a test bed for examining how perspective in business situations influences the use of space in both enjoyable and/or stressful situations.

The results of the final three experiments have implications for theories about how interpersonal space can substantially impact how people interact and navigate interpersonal communication in business environments. Many important and interesting questions remain. Business meetings have the possibility to include a wide variety of players asked to share their opinions on a variety of topics. How does the number of individuals present in a given meeting influence how influential interpersonal distance is on attitude expectation? In these three experiments, the majority of imagined interactions involved the presence of only two individuals, a boss and an employee. How would the presence of more than one boss or more than one employee alter the ways in which people anticipate agreeing or disagreeing in these different contexts. For example, when receiving news about an impeding pay cut, would having your fellow co-workers present in a meeting provide a sense of protection, where bad news would "diffuse" across those being affected? Or would the presence of co-workers somehow allow an individual to possibly maintain a "surely not me" attitude, where the possibility of negative actions harming them would be momentarily decreased? The idea of having multiple people present in one meeting is not necessarily limited to the number of employees attending a given group interaction, but also the number of potential bosses in attendance as well. It is not uncommon for meetings to include more than one individual you might consider your supervisor. How would having more than one supervisor present in a meeting differentially influence spatial information's power over attitudes held during interactions?

The final three experiments presented here support the notion that experience in physical space plays an important role in attitude formation in the business environment. There are direct implications for industrial/organizational psychology, management, and environmental psychology. When planning a meeting in a business environment, it is not uncommon to "set the stage" prior to the start of the meeting. When preparing to relay bad news, a supervisor might practice what they are going to say to minimize anger or fear from the recipient. When getting ready to make an announcement of a positive nature, one might plan how and when the good news will be shared. For now, if a supervisor is interested in "setting the stage" before delivering news to an employee, these data show that space is another factor that can be used to alter expectations during interpersonal business interactions.

These results have implications for research on social distance and the conceptualization of physical space. They have also set the stage for rich, follow-up research on the link between spatial thinking and social relationships. For now, the hope is that we are one step closer to understanding how people similarly conceptualize both social and spatial information.

Table 1. Figures and narratives presented to participants by mode of transportation.

Mode	Figure	Friend narrative	Stranger narrative
Walk		Imagine you need to deliver a package. Along the way, you *walk* through a park and pass by different people. You know these people well. They are your friends.	Imagine you need to deliver a package. Along the way, you *walk* through a park and pass by different people. You do not know these people. They are strang-ers.
Drive		Imagine you need to deliver a package. Along the way, you *drive* through a park and pass by different people. You know these people well. They are your friends.	Imagine you need to deliver a package. Along the way, you *drive* through a park and pass by different people. You do not know these people. They are strang-ers.
Ride		Imagine you need to deliver a package. Along the way, you *ride in a taxi* through a park and pass by different peo-ple. You know these people well. They are your friends.	Imagine you need to deliver a package. Along the way, you *ride in a taxi* through a park and pass by different peo-ple. You do not know these peo-ple. They are strangers.

Note. Italics added here for emphasis only.

Table 2. Frequencies and percentages of route-figure intersections by transportation and relationship.

Transportation	Relationship	Intersected		X^2	*p*	N
		Yes	No			
Walk	Friends	13 10%	117 90%	8.82	.003	263
	Strangers	2 1.5%	131 98.5%			
Car	Friends	34 23.8%	109 76.2%	10.30	.001	324
	Strangers	19 10.5%	162 89.5%			
Taxi	Friends	21 22.1%	74 77.9%	8.21	.004	190
	Strangers	7 7.4%	88 92.6%			

Note: percentages given are within relationship.

Figure 1. Portmeiron Road in North Wales (left) and Oxford Road in Manchester (right) from. Image courtesy of Crompton and Brown (2006)

Figure 2. Example stimuli used in Bar-Anan, Liberman, Trope, and Algom (2007).

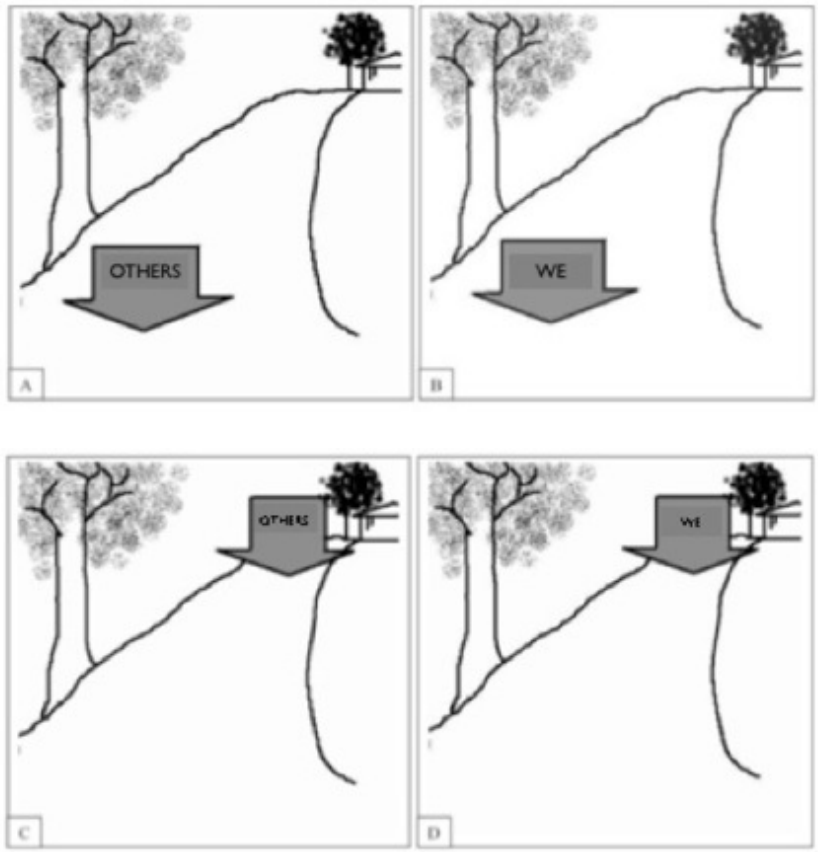


Figure 3. Depiction of stimuli referenced in Burris and Branscombe (2005). Cities depicted using circles: Pierre, SD; Toronto, Canada; Nuevo Laredo, Mexico; and Cape Hatteras, SC. City depicted using diamond: Memphis, TN.

Figure 4. Social distance items used by Horch and Hodgins (2008).

(I) "move next door to a person described as having ______"
(II) "make friends with a person described as having ______"
(III) "spend and evening socializing with a person described as having ______"
(IV) "start working closely on the job with a person described as having ______"
(V) "have a group home for people described as ______ opened in my neighborhood"
(VI) "have a person described as ______ marry into my family"

Figure 5. Discriminant Function Analysis scores (left pane) and actual physical collection sites (right pane) as reported by Kay (1975).

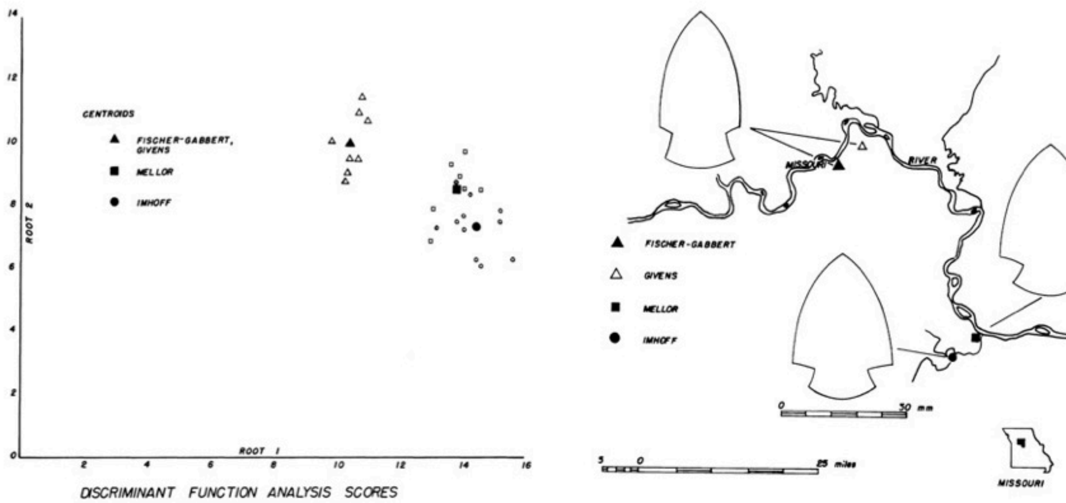


Figure 6. The relationship between experimental control and ecological validity as presented by Loomis et al. (1999).

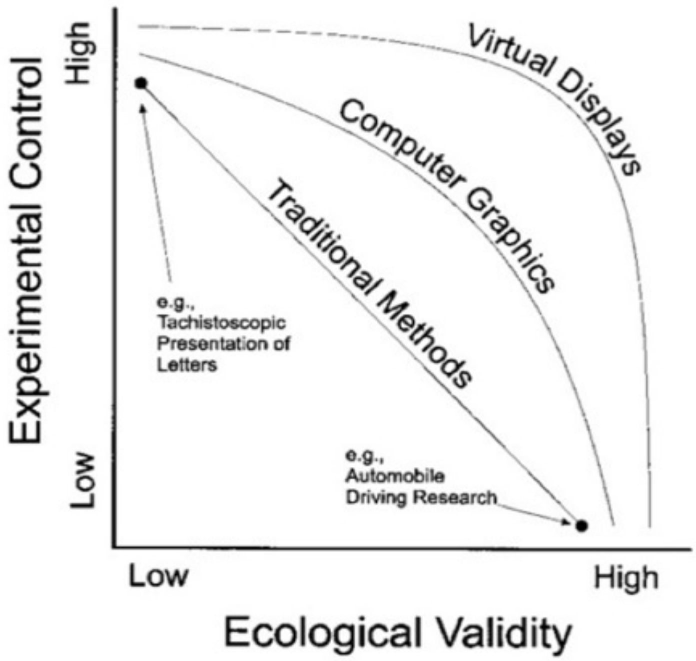


Figure 7. Ventral (A) and Dorsal (B) mPFC activation by IAT latency difference by Mitchell, Macrae, and Banaji (2006).

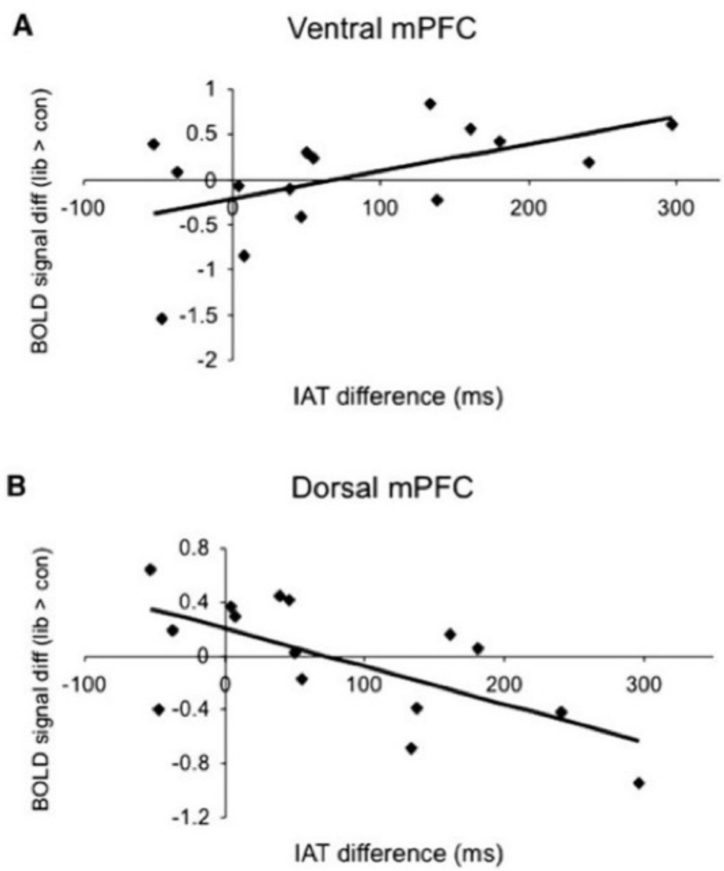


Figure 8. Superior parietal lobule (SPL) and superior temporal gyrus (STG) average activation amplitudes with respect to egocentric and allocentric judgments as reported in Neggers, Van der Lubbe, Ramsey, and Postma (2006).

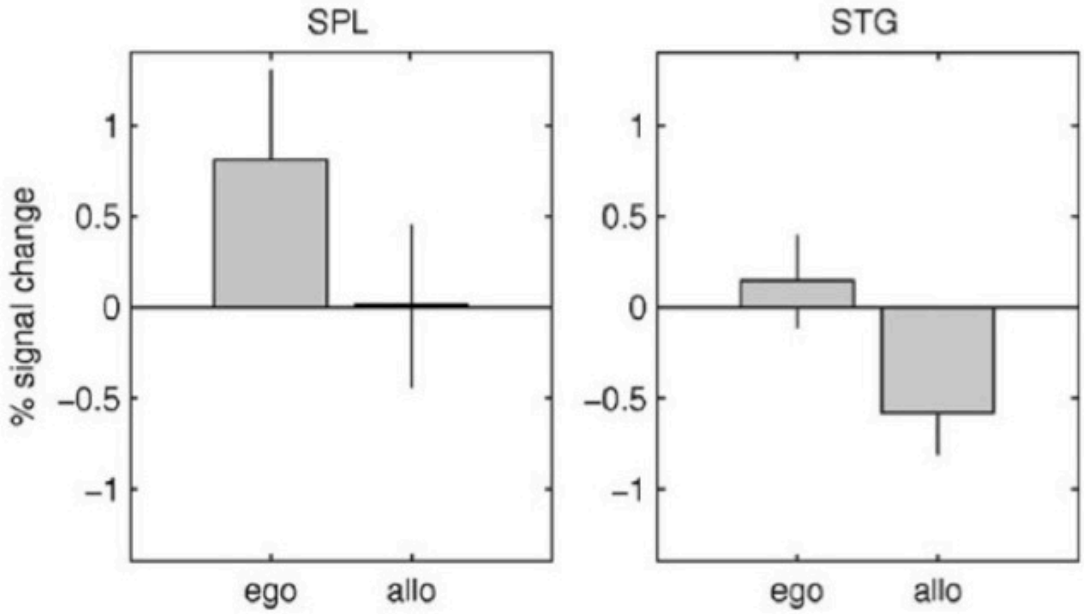


Figure 9. Examples: (A) visual stimuli presented to participants in the *driving* condition. (B) participant drawings from the *friend/driving* condition, (C) participant drawing from the *stranger/riding* condition.

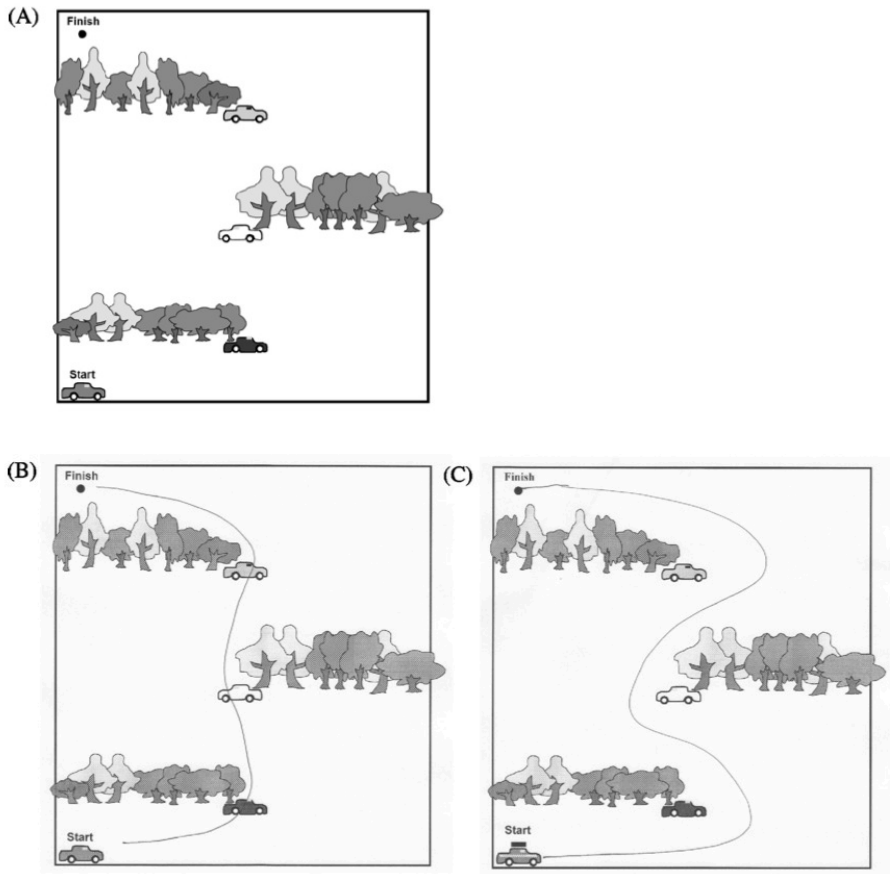


Figure 10. Average path-figure distances (mm) by mode of transportation and narrative type. Path-figure distance differences by friendship narrative type were found in all modes of transportation. Standard errors are represented by the error bars attached to each column.

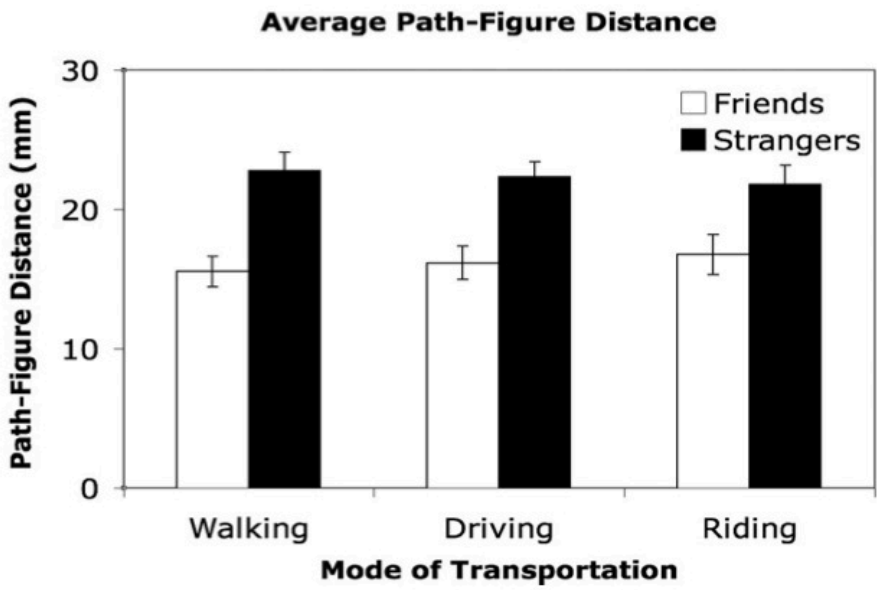


Figure 11. Temporal estimates (min) by mode of transportation and narrative type. Temporal estimate differences by friendship narrative type were found in all modes of transportation. Standard errors are represented by the error bars attached to each column.

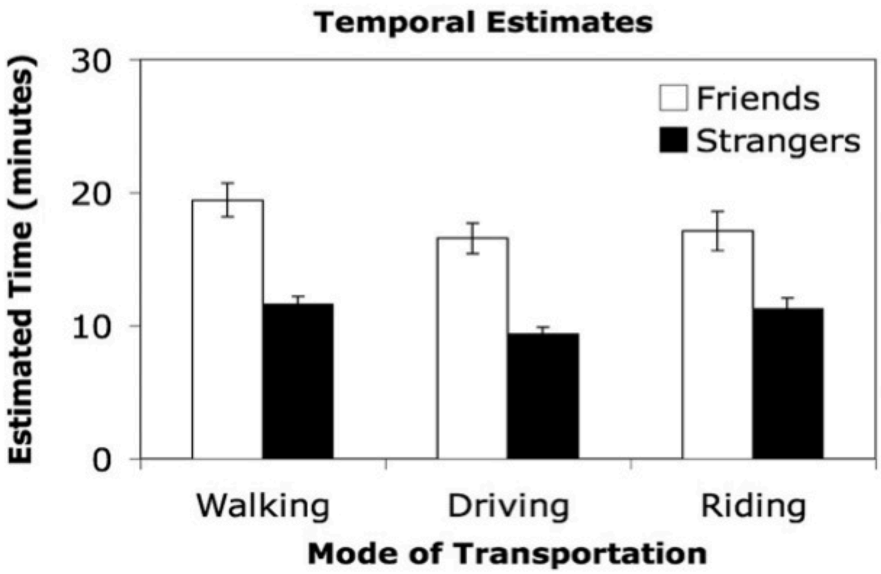


Figure 12. Office layout example stimuli used in Experiments 4, 5, and 6. Stimuli measured 160mm wide and 80mm tall and was positioned on a standard US Letter sized paper in portrait orientation. The layout consisted of a mock office environment, an employer's chair (dark-colored chair), a desk, and an employee's chair (light-colored chair). In Experiment 4, employee chair-desk distance varied across condition: close (10mm, pictured here), medium (20mm), and far (30mm). In Experiment 5, no employee chair was present. In Experiment 6, employee chair-desk distance varied across condition: close (10mm) and far (20mm).

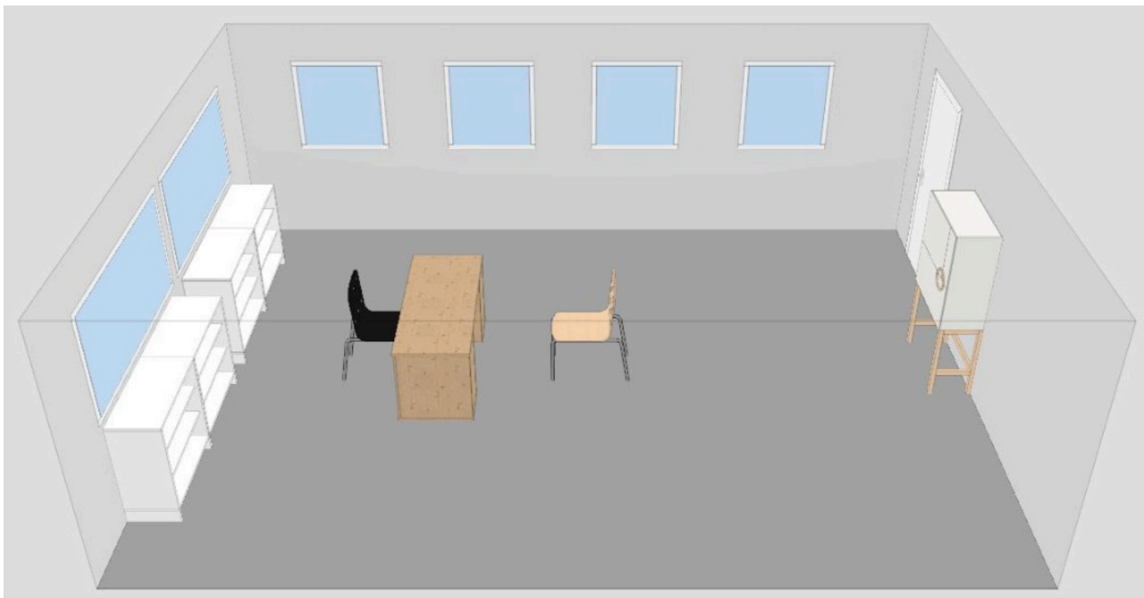


Figure 13. Interpersonal distance influences average agreement with employer. Error bars represent +/-1 standard error.

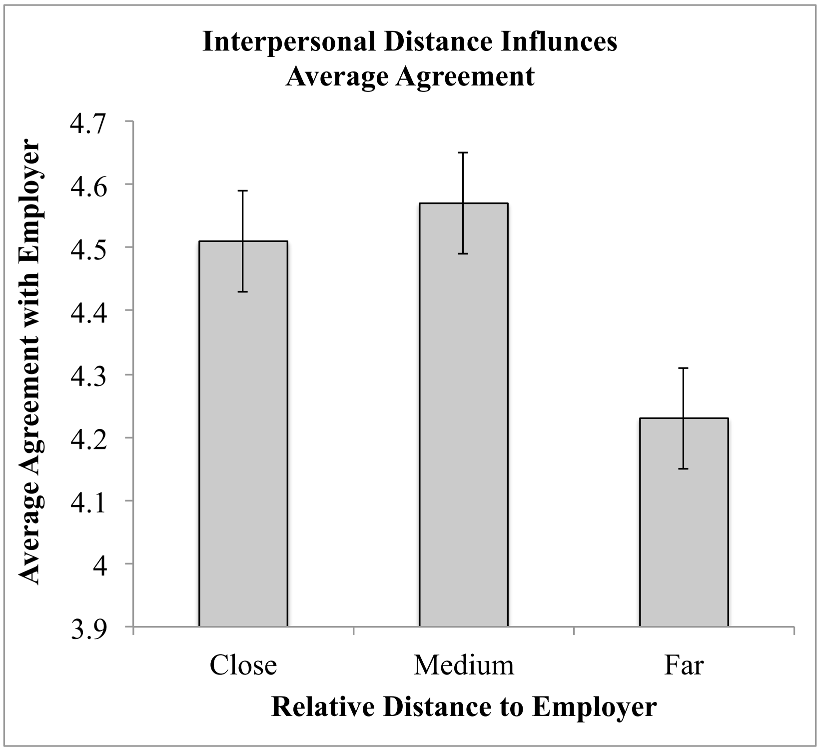


Figure 14. Narrative perspective and meeting expectations influence distance chair was placed from office perimeter in office setting. Error bars represent +/-1 standard error.

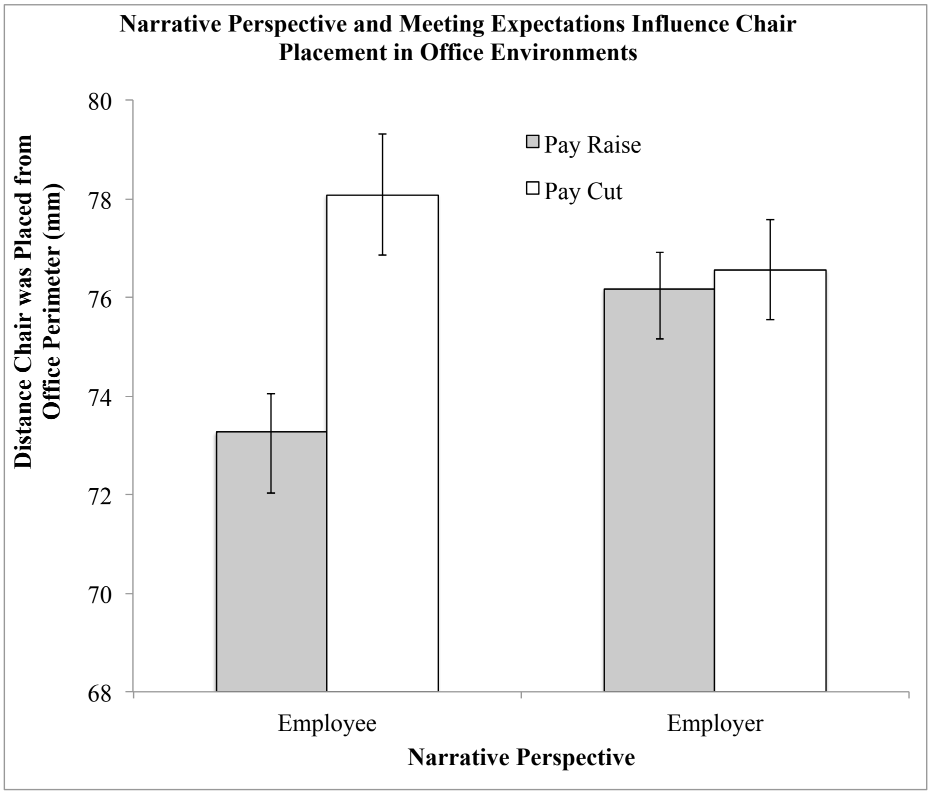
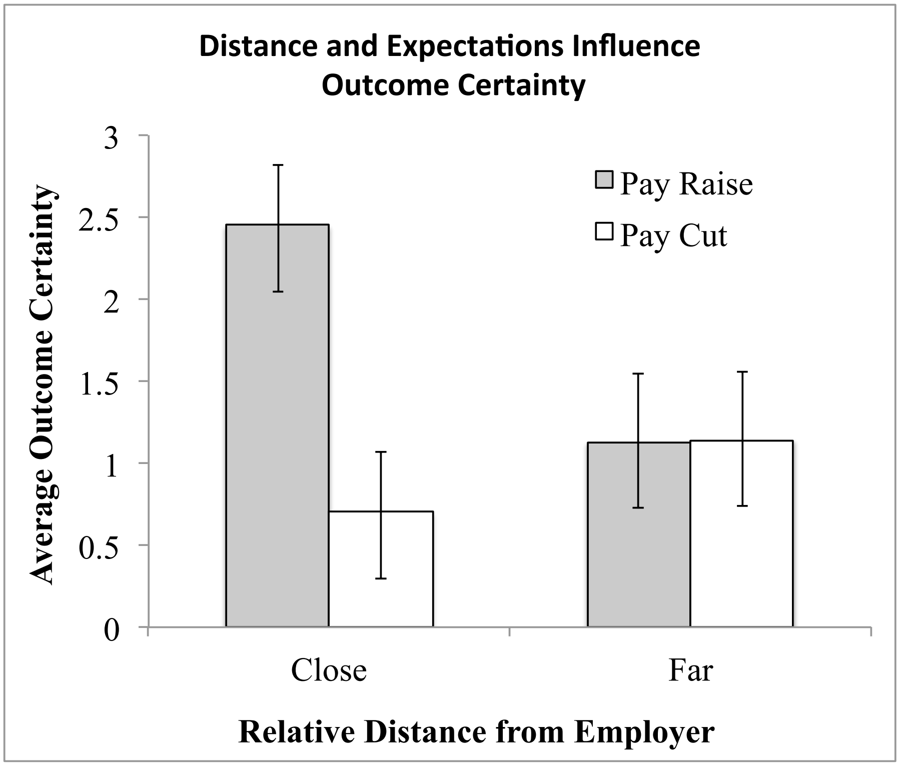


Figure 15. Distance and expectations influence average outcome certainty. Error bars represent +/-1 standard error.



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