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SOCIAL AND PHYSICAL COMFORT IN TWO-PERSON OBJECT TRANSFER TASKS

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ABSTRACT

An abundance of research has been dedicated to understanding human motor action and social behavioral norms separately, but little to no research looks at the interaction between them. In this study, I explored the interaction between physical comfort and social comfort during joint-object manipulation tasks. The goal of this study was to determine the effect of cooperation on the preference for physical comfort versus social comfort, and when that preference occurs. The participants (n=20) engaged in object manipulation tasks, first individual and then in 2-person pairs (Condition 1), transferring a PVC pipe through an obstacle from one side of the room to the other. Participants were presented with four obstacles, pertaining to four aperture sizes (Condition 2), in either increasing or decreasing order (Condition 3).

I found a difference in comfort preference in the Solo and Joint conditions. Results revealed a high physical comfort preference when completing the task alone and an increase in social comfort preference when completing the task with another individual. In the Joint condition, preference was dependent on aperture size. I also found significance in zone preference, with an Individual-Zone aperture size preference in the Solo condition and an Intimate-Zone aperture size preference in the Joint condition. Results also revealed a slight hysteresis effect.

My observations support the hypothesis that there is an interaction between physical comfort and social comfort during human-human cooperation. My findings suggest that preference for social comfort over physical comfort, or vice versa, can affect cooperation tasks such as joint-object manipulation.

Keywords: joint-object manipulation; physical comfort; social comfort; personal space

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Chapter 1

Introduction

During our day to day lives, we come in contact with other people. We interact, we communicate, and we work together and collaborate to complete tasks. Many of our goals are dependent on another person's willingness to cooperate and their ability to do so. The "workings" of human beings are complex. Researchers have studied the mechanical workings of our minds and our bodies, in order to understand our capacity for carrying out physical tasks and movements. Researchers have studied social interactions between pairs and groups in order to understand, and potentially improve, social comfort among various individuals. Both areas of research are vital to our understanding of human beings, yet there is little to no research which explains how these two areas interact.

It is important that we have an understanding of how social comfort and physical capabilities interact, since one could affect the other. When people work "jointly" to complete a physical task, they work "together" or "cooperate," two social aspects of an interaction. The two areas are intertwined. In order to fully understand the "workings" of human beings, it is not only important that we understand both separately but also as they work together.

Joint-Object Manipulation

The study of object manipulation has improved the understanding of the cognitive and physical properties of human motor-action. Recent research includes the concept of joint-object manipulation, incorporating the use of two entities cooperating to manipulate a single object. The manipulation of an object may occur when there is either a transfer of the object from one

location to another or a change in the object's orientation. Joint-object manipulation has focused on the cooperation of two individuals (human and/or human and non-human), or the cooperation of the left and right hand of a single individual. Some researchers have taken the goal of joint-object manipulation, understanding basic human action mechanics, and used their findings to make advances in robot technology.

Joint-object manipulation occurs when two entities (which in recent cases included a human and a robot) are connected. This connection may be direct, individuals holding hands, or indirect, individuals holding the same object. (Feth, Groten, Peer, Hirche & Buss, 2009). Therefore, joint-object manipulation can technically also occur during dancing or any time a manipulated object is in contact with both entities. In any of these cases, the entities serve as partners to one another (Bussy, Kheddar, Crosnier & Keith, 2012). In order to reach a common goal, both entities are required to adjust their behaviors during the connection (Feth, Groten, Peer, Hirche & Buss, 2009). In other words, both partners need to adjust their actions and negotiate with one another in order to complete the task at hand. Hence the word "joint," which assumes that both entities share a willingness to work collaboratively to complete the same goal (Lawitzky, Mortl & Hirche, 2010).

Previous research on partner task completion has shown that performance increases when interacting with a partner versus alone. This result was confirmed by Feth et al. (2009) through the use of virtual reality, where two humans worked collaboratively to manipulate a virtual object via autonomous robots. The increase in performance may be due the fact that the required performance energy for each partner was reduced when performing cooperatively. Since the overall "force" required remained the same, whether the task was completed individually or jointly, when two people completed the task together the total force was distributed among them, making the task easier (Feth, Groten, Peer, Hirche & Buss, 2009).

In order to better understand the concept of "load sharing," Lawitzky et al. (2010) used "environmental constraints" in their studies of joint-object manipulation. For the design of this experiment, the human-robot pairs navigated large objects through various obstacles, while one entity lead the way (walking backwards) and the other entity followed (walking forwards). Results showed that when working cooperatively, performance improved due to an increase in partner assistance. In other words, when the entities were "more proactive" performance increased.

Although, research in human-human joint-object manipulation has revealed specialized strategies during cooperative tasks, there is limited research for human-human interaction. Joint object manipulation research has also been limited to performance during cooperative task completion without acknowledgment of social performance or comfort of the individuals completing the manipulation. During human-human joint-object manipulation, the individuals involved are often required to occupy the same space while manipulating an object. Therefore, it is important to acknowledge how performing a task cooperatively could affect the social comfort of both individuals. Although cooperation suggests a common goal, the need for social comfort may influence performance, possibly inhibiting the performance of one or both individuals when cooperating in completing a task versus completing a task independently.

Personal Space

The study of social behavior in human interactions has been a topic of interest for many psychologists. Multiple researchers have conducted experiments and observations in order to better understand the social norms and boundaries involved in these interactions. These studies have shown a standard need for individuals to have space between themselves and other people. This space, most commonly known as "personal space," is the area around the body that the individual wishes to keep for themselves. In other words, personal space is the area around an

individual's body that is treated as personal property, as if it were a part of the actual body (Pease & Pease, 2008). Hence the phrase, "You're in MY personal space."

This space or area has been characterized in many ways, some of which include likening personal space to an "air space" around the body (Pease & Pease, 2008), "invisible bubbles of space" (Wolchover, 2012), "flight distance" for animals, "Soap-bubble worlds," and the "shell of a snail" (Sommer, 1959). Regardless of the name used, personal space is universally understood to be a person's territory, with the individual placed at its center. Personal space is similar to the territory that an animal would defend from outsiders, with the exception that personal space travels with the person, unlike an animal's territory which typically remains in one place. And although humans have the capacity to define and physically mark strict territories, the boundaries of personal space are unseen to the human eye (Sommer, 1959).

These invisible boundaries become more apparent with age and solidify at specific distances depending on culture and context. Although the concept of personal space is known universally, there are slight cultural differences in zone ranges. For instance, the zone sizes in a rural culture will be slightly different than the zone sizes found in a city culture. Also, depending on the circumstance and the people involved personal space can vary. Regardless, the general rule is that one is to respect, and remain outside of, another's personal space. We have developed spatial and social norms that allow individuals to communicate and interact at distances deemed acceptable and comfortable, while other distances are viewed as uncomfortable and at times taboo. We develop a general understanding of personal space around age 3 or 4, secure our understanding by age 12, and solidify our "bubble" during adolescence (Pease & Pease, 2008; Wolchover, 2012).

The Four Zones

In addition to the immediate "bubble" surrounding an individual there are multiple spaces, known as zones, which extend past this space and may be occupied by other people, depending on relationship status. The weaker the relationship, the father the zone the occupant is allowed to inhabit. As the relationship increases and becomes stronger, the occupant may inhabit a closer zone, moving inward towards the individual at its center. Although the standards for personal space may vary between cultures, there are strict measurements and rules for zones in the Western cultures. The four zones include the Intimate Zone, the Personal Zone, the Social Zone, and the Public Zone, as represented below in Figure 1.

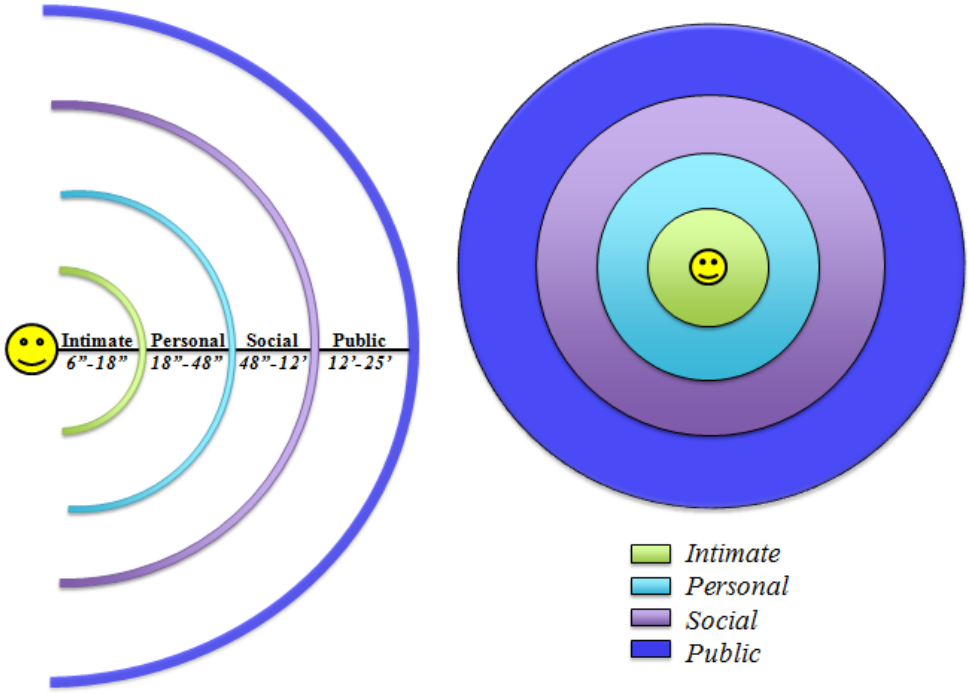

Figure 1: Personal Space Zones in Western cultures

The Intimate Zone, measuring from 6 – 18 inches (1.5 ft), is the most protected zone. Outsiders are only allowed to approach this zone if they have an emotional closeness with the individual or during "intimate physical contact." The Intimate Zone is most commonly inhabited by family members, lovers or a spouse, household pets, young children and very close friends.

All others, including acquaintances, are discouraged or, even in some cases, forbidden from entering this proximal zone. However, acquaintances, as well as friends, are allowed in the Personal Zone, measuring from 18 – 48 inches (1.5 – 4 ft). Although the Personal Zone is also protected, individuals are more willing to allow occupants to inhabit this zone at casual social gatherings. However, strangers are never welcomed in the Personal Zone (Deasy & Lasswell, 1985; Pease & Pease, 2008; Wolchover, 2012).

Strangers are kept at bay in the Social Zone (4 – 12 ft), along with new acquaintances. Occupants in the Social Zone are the ones that the individual is comfortable socializing with in most public interactions. However, the Social Zone can be divided into three sections: 4 – 7 ft is normal spacing for people who need to communicate effectively at work or at social gatherings; 7 – 12 ft is more formal; 10 ft or more allows the individual to ignore people without being considered rude. The Social Zone allows an individual to keep their distance from strangers who may include the maintenance man, service workers, a new coworker, or any other individual who we do not know personally. Finally, the Public Zone (12 – 25 ft) is open to all occupants. This zone allows the individual "noninvolvement"—the choice to disengage and/or withdraw from occupants—and is a comfortable distance for a large group of people (Deasy & Lasswell, 1985; Pease & Pease, 2008; Wolchover, 2012).

The "Natural Set Up"

In order to better understand spatial norms in social situations, researchers have conducted natural observation and experimentation in order to discover the "natural set up." In other words, how people orient or arrange themselves with respect to one another if given the opportunity to set themselves up in a comfortable place.

Through the use of a naturalistic experiment, Sommer (1959) was able to witness seating arrangements chosen by people who were already interacting (Experiment 1). Sommer observed

as 50 interacting pairs (staff members of a mental hospital) freely chose chairs to sit in, in the cafeteria. Out of the 50 observations, 73% (32 pairs) chose adjacent chairs, next to each other. The remaining pairs chose distant chairs, separated by other chairs. Sommer concluded that when communication was involved individuals oriented themselves beside one another like "neighbors." In Experiment 3, a participant was asked to approach and interact with another individual (the confederate) who was already seated. These results also confirmed the idea that "neighboring chairs" allow for more communication than distant chairs. In other words, if people intend to communicate, they are more likely to choose chairs that are adjacent, decreasing the distance between them.

In 1972, Batchelor and Goethals explored this concept with the use of groups. Similarly, in their experiment, it was important that participants freely chose their seating arrangements without being guided or provided with seating options. Results showed that group purpose or function had an effect on how participants arranged themselves. For instance, the groups that needed to make "collective decisions" oriented themselves in arrangements that would allow for more effective communication. In other words, the instructions to work collaboratively affected the arrangements chosen by the group members—arrangements allowed smaller distances between participants with more eye-to-eye contact. These findings confirmed the idea of spatial norms.

Research also showed that gender may play a role in spatial norms. In fact, when the same experiment was completed with mixed groups, results showed that same sex subjects are more often oriented closest to one another than is to be expected by chance, which was previously found by Sommer (1959). The discrepancy occurs when determining whether there is a significant difference between the distance between adjacent female participants and the difference between adjacent male participants. Sommer (1959) found a statistical difference noting that males tend to sit at farther distances from males and females than females. Although

Batchelor and Goethals (1972) acknowledged that several experiments confirmed this finding, they stated that this effect was not confirmed by McBribe et al. Yet in 2008, Pease and Pease, again found that female pairs sat at closer distances to one another than males pairs. If there was in fact a statistical difference, and females sat closer to one another than males did, one assumption was that it was just more culturally acceptable for females to be close than males (Sommer, 1959). However, it is important to acknowledge that "cultural acceptance," which is dependent on the cultural values of the time, is malleable and may change over time. Therefore, there may now be a different, more suitable, explanation for this difference due to the change in culture within the last 55 years. As time changes, effects may change.

Threatening Personal Space

Although, the four zone ranges have been confirmed by various researchers, individuals do not always abide by "the rules." In fact, the ideal concept of personal space is not always attainable. Strangers are constantly forced into each others' restricted spaces during their normal routines, whether it is on the bus, walking to and from class or work, on an elevator, etc. Constantly maintaining a 12 ft distance between yourself and the nearest stranger is sometimes not an option, although it may be preferred. Therefore, in order to maintain comfort when personal space is threatened people must learn to adjust. This suggests that personal space and social comfort must be more malleable than the strict boundaries that personal space suggests.

Spatial comfort is more complex than assigning people to the appropriate zone or forbidding them from entering a zone. For instance, assuming that being "in" someone's personal space, or being "too close," is the only trigger to spatial discomfort is incorrect. Research has shown that discomfort can occur when an individual is speaking to someone who was standing too close or too far (Sommer, 1959). Therefore, standing outside of the forbidden zone may not be enough to create comfort if the person is outside of the "appropriate" range. In fact, the

specific placement or orientation of the other individual can also affect comfort. People are more likely to be "sensitive" if another personal occupies the space in front of them, than if the other person were to occupy the space behind them or beside them (Deasy & Lasswell, 1985).

When an individual begins to feel "sensitive" in an uncomfortable social situation their fight or flight response activates. This reaction is due to the fact that the amygdala, the part of the brain involving fear, is responsible for our personal space "bubbles". When people are "too close" and personal space is invaded, the individual's amygdala becomes active, resulting in a heightened emotional response (Wolchover, 2012). In addition to this emotional response, there are also physical changes in the body: "The heart pumps faster, adrenalin pours into the bloodstream, and blood is pumped to the brain" (Pease & Pease, 2008). Animals that feel threatened often fight in order to defend their territory, but due to the fact that fighting isn't always an acceptable option for people, people instead choose to remove themselves when their personal space in invaded (Sommer, 1959). If the individual is unable to physically escape, they may choose to remove themselves mentally. In other words, in order to maintain spatial comfort people have developed coping mechanisms which allow them to imply a mental distance when a physical one is unavailable.

When a person is unable to keep people in the "appropriate" zone and is forced beyond their "comfort zone" they use mental dehumanization. The individual "cocoons" and refuses to acknowledge or respond to the people around them, minimizing their existence until they "become non-persons." In other words, they no longer exist. This is often accomplished by avoiding eye contact. This coping mechanism is a social-psychological norm that allows people to function in close proximity with one another without responding as if they have been threatened (Batchelor & Goethals, 1972; Deasy & Lasswell, 1985; Pease & Pease, 2008; Wolchover, 2012)

In 1966, Felipe and Sommer conducted multiple studies in which social norms were violated. During their second study, a confederate intentionally invaded the personal space of 80 students sitting alone in the study hall of a university library. The confederate sat within 5 feet of each student, at times as close as 3 inches, for up to 30 minutes. Typically students would space themselves as far away as possible from one another while in the hall, so the confederate's close proximity was relatively "uncomfortable." Some students reacted by choosing to "sit on the far end of the chair," while others blocked out the confederate by either turning away or using their body or objects as a "barrier." When the distance between the student and the confederate was "close," a significant amount of students chose to leave, while 30% chose to stay. This may be due to the fact that the students who left were unable to create enough distance between themselves and the confederate in order to maintain comfort. Only one student asked the confederate to move over. The reaction was not significant when the distance was 15 inches or more (73% stayed). These results clearly suggest that intruding on another's personal space can be disruptive and produce various reactions. However, results did not suggest a norm. Due to the varying reactions that were displayed by the students, it has been concluded that reaction is dependent on the individual. Regardless, results showed that when in close proximity with a strange, most students display some type of reaction.

The Present Study

An abundance of research has been dedicated to understanding human motor action and social behavioral norms separately, but little to no research looks at the interaction between them. In this present study, physical comfort and social comfort were inversely related. Participants were given the option to choose freely between the two while completing an object manipulation task, first independently and then jointly. The purpose of this study was to determine if there was a preference between the comfort in physical performance and the comfort in social interaction,

and, if so, the critical point in which the preference switched. In other words, when was physical comfort (not engaging vs. engaging in extra physical activity) preferred to social comfort (being able to keep one's personal space "intact"), and vice versa?

During the experiment, participants were instructed to transfer a PVC pipe from one side of the room, through an obstacle, to the opposite side of the room. The "obstacle" consisted of two outside hurdles with an aperture in the center. The size of the aperture was periodically increased or decreased, therefore changing the available zone spaces inside the aperture. By using the given findings for personal space zones, I created five social comfort options which correspond to five zones: Individual, Intimate, Half-Personal, Full-Personal, and Social. In the experiment, social comfort was determined by the "zone" chosen by the participant. Physical comfort is determined by whether or not the participant chooses to engage in extra physical activity or not. Participants have the option of walking through the aperture (high physical comfort) or stepping over an outside hurdle (low physical comfort). During each transfer of the PVC pipe I observed which zone the participant chose to walk through, and whether or not they chose to step over a hurdle. Participants were asked to complete the object manipulation tasks individually and then jointly to see if there was a difference in preference when working alone versus when cooperating in an action task.

Since research shows that communication in cooperative tasks leads to a decrease in the distance between participants, I eliminated the use of communication. In order to keep participants' decisions unbiased, participants were instructed to refrain from communicating verbally during the joint-object manipulation task. I attempted to limit the participants' options of dehumanizing their partner by instructing participants to keep their bodies straight and discouraging them from rotating their bodies. Instead, participants were allowed to increase the distance between themselves and their partner by choosing to walk through an outer zone.

I predicted that preference for physical comfort versus social comfort would be highly dependent on the number of participants completing the task, as well as aperture size (in the Joint condition). I predicted a strong preference for physical comfort in the Solo condition—participants would choose to walk through the aperture (high physical comfort) regardless of aperture size when completing the task alone. In other words, I suspected an overall preference for physical comfort in the Solo condition. In the Joint condition I predicted that there would be a switch from a strong physical comfort preference to a social comfort preference dependent on aperture size. The preference for social comfort would be highly dependent on the available zones within the given aperture. When presented with larger apertures, with multiple zones, physical comfort would be preferred. When presented with smaller apertures, with a limited number of zones, social comfort would be preferred. As the aperture size decreased, participants would be more willing to forfeit their physical comfort in order to maintain an "appropriate social distance" between themselves and the other participant. In other words, participants would be more likely to choose to maintain their "personal space" by stepping over the hurdle (low physical comfort) rather than walking through the aperture (high physical comfort) when completing the task jointly, displaying a social comfort preference.

I also predicted a hysteresis effect—aperture size order (presenting the zones in increasing or decreasing order) would have an effect on comfort preference. In other words, participants' comfort preference would be dependent on which aperture size they were presented with first. I predicted that participants in the Increasing condition, who were presented with the smallest aperture size first (Individual), would remain within the "smaller" zones (walking through the aperture), showing a lower need for social comfort and therefore a higher preference for physical comfort. Likewise, I predicted that participants in the Decreasing condition, who were presented with the largest aperture size first (Full-Personal), would remain within the "larger" zones, showing a higher preference for social comfort.

Chapter 2

Methods

Participants

20 female students from the Pennsylvania State University, ages 18-21 participated in this study as a part of a psychology course requirement. This experiment was made accessible to all male and female students in the undergraduate psychology department. Whether by chance alone, because of a lack of representation in the courses subjects were recruited from, or because of an unexplained avoidance of a study involving cooperation, no males opted to participate. Subjects participated in 2-person pairs, with a total of 10 pairs; 5 pairs participated in the Increasing Aperture Size Order and 5 pairs participated in the Decreasing Aperture Size Order. According to self-reports, 60 percent of participants identified as White/Caucasian, 20 percent as Asian, 15 percent as Other/Multi-Racial, and 5 percent as Black/African American. All 20 participants responded that they had no major inhibiting physical impairments, including vision and hearing. Participants read and signed an informed consent form prior to participating and gave full consent to be videotaped. This experiment took place under the supervision of Dr. David Rosenbaum in the Cognitive and Action Lab at Penn State. This experiment was approved by The Pennsylvania State University's Institutional Review Board (IRB).

Equipment

This experiment was conducted with the use of two makeshift "hurdles" and an 8 ft PVC pipe. The two hurdles were placed strategically at varying distances to create an obstacle in the center of the room, as depicted below in Figure 2. The specific placement of the hurdles created

four aperture sizes, corresponding to four zones. The starting and ending locations, marked by two 8 ft strips of duct tape, were placed parallel on each side of the obstacle, at a distance of 5 ft.

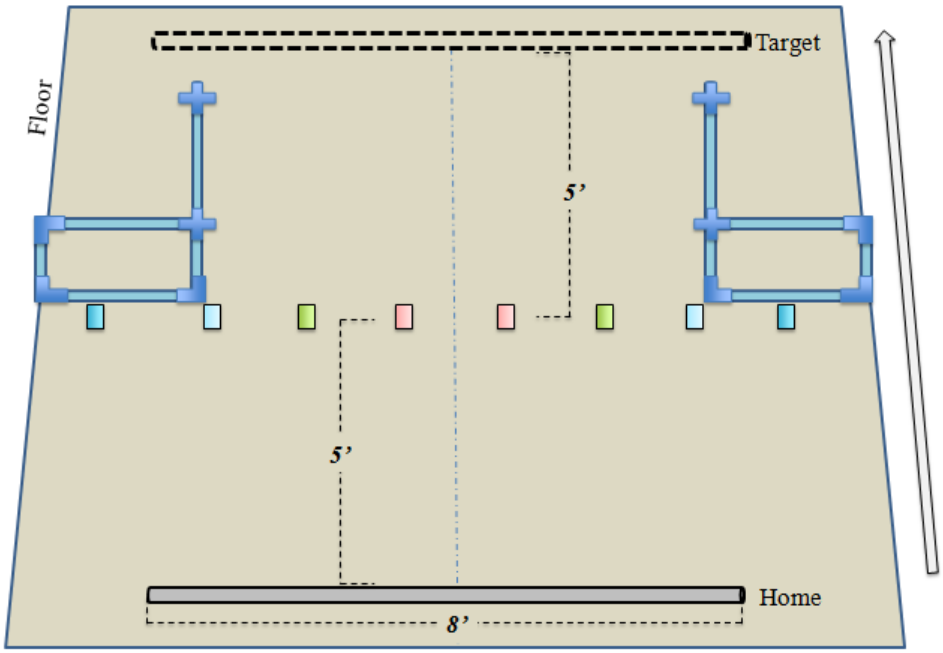

Figure 2: Experiment Set Up

The hurdles were constructed with the use of plastic tubing and connectors. Four tubes were connected to form the rectangular base of the hurdle, which stood perpendicular to the floor. The height of the hurdle (measuring vertically from the floor to the top of the hurdle) equaled a total of 18 inches—the 15 inch pipe length plus the added 3 inches of the connectors. According to requirements of the International Building Code (IBC), the stair riser height for a standard residential stairway should not exceed that of 7 inches while the maximum for places of assembly is 8 inches (International building code, 2009). Although the appropriate riser heights may vary depending on the codes—for instance, heights as tall as 8.25 inches are allowed in Canada—maximum riser heights don't tend to exceed 7.75 inches for safety reasons (Friedman, 2014; "Commonly used residential," 2009). Therefore, as depicted below in Figure 3, the hurdle height used for this experiment is more than twice the equivalent sum of two normal stair riser heights.

If the participant chose to step over the hurdle, to completely clear the hurdle, they would experience the same effort needed to lift their foot up and over the height of two stairs, one placed on top of the other.

The hurdle also served as a "barrier" in order to prevent participants from stepping over the hurdle with one foot while walking through the aperture with another. The barrier forced the participant to choose between stepping completely over the hurdle, one foot after the other, or walk through the center aperture. To create the barrier, an additional tube, measuring 25 inches, was connected to top of the inner side of the hurdle. The height of the barrier (measured vertically from the floor to the top of the barrier) measured a total of 43 inches.

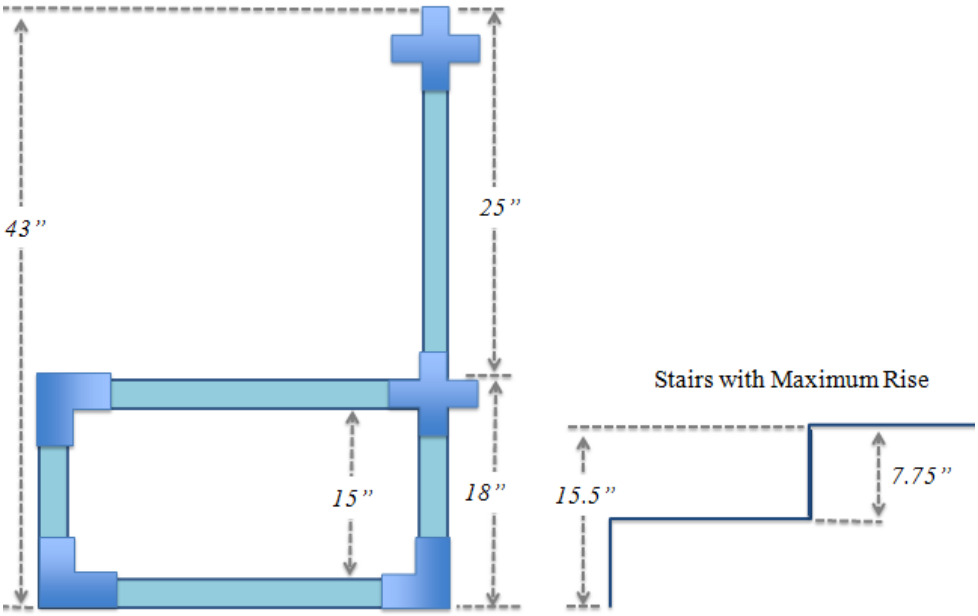

Figure 3: Hurdle Measurements vs. Stair Measurements

The object used for transfer was an 8ft unmarked PVC pipe. This pipe length was chosen to ensure that participants would have the option of walking within the range of all five zones, without letting go of the pipe. The largest aperture size measured 6.5ft (78 inches). The remaining 1.5ft of the pipe allowed both participants to walk outside of the largest aperture size, stepping over the hurdles without letting go of the PVC pipe.

Independent Variables

A total of three independent variables were manipulated in this experiment: (1) Number of Participants (one person, two people); (2) Aperture Size; and (3) Aperture Size Order.

Participants were asked to complete the object manipulation task in an independent Solo condition (one person) and in a cooperative Joint condition (two people). In the Solo condition, the participant completed a total of 8 trails—2 transfers for each zone, starting on opposite sides of the obstacle. For the Joint condition, participants completed a total of 8 trials in which Participant 1 began on the left side for the first transfer of each zone and then began on the right side for the second transfer for each zone. Each initial transfer started on the same side of obstacle for each zone.

The "Aperture Size" referred to the amount of space available in the center of the obstacle, between the inner barriers of the two hurdles. The size of the aperture varied between four calculated measurements. The four measurements, as depicted below in Figure 4, correspond with the following zones, starting from smallest to largest: Individual Zone, Intimate Zone, Half-Personal Zone, and Full-Personal Zone.

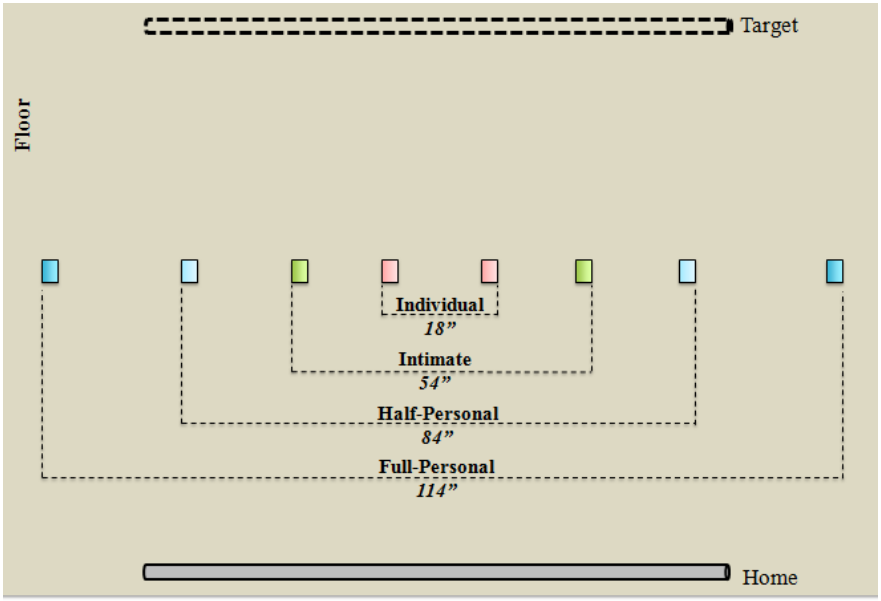

Figure 4: Aperture Size Measurements

The Individual Zone measured a total of 18 inches, the average width of a human from shoulder to shoulder (Griggs, Human Figure Average Measurements). The aperture size of the Individual Zone only allowed space for one person to walk through "comfortably" without touching the outside hurdles. The Individual Zone was placed in the center of the room and its barrier served as the starting place for the remaining three zones.

The remaining three zones were calculated by using the standard known measurements for the Intimate Zone and the Personal Zone, adding the average width of a human. Due to the physical constraints of the room, I was unable to include an accurate representation of the Social Zone and Public Zone. For the purpose of keeping the change between aperture sizes relatively consistent, the Personal Zone was divided into two separate aperture conditions—Half-Personal and Full-Personal. For each zone measurement the difference within the range provided was calculated and then added to the measurements of the previous inner zone. The additional distance was distributed evenly on both sides of the previous zone. The highest distance within the range was used to mark the outer boarder of each zone so that the entire range would be included in the zone measurements.

The Intimate Zone, given as 6-18 inches, was recalculated to contain a total of 54 inches, measured from the center of the room to the zone border—18 inches for the average width of a human (centered), 18 inches for the radius of the zone (added on each end of the Individual Zone). As previously noted, the Personal Zone, given as a range from18-48 inches, was divided into two equivalent zones ranges—18-33 inches and 33-48 inches. The first zone, Half-Personal Zone, measured a total of 84 inches from the center of the room to the zone border (after adding the first 15 inches of the first range on each end of the Intimate Zone). The second zone, Full-Personal Zone, measured a total of 114 inches (including the remaining 15 inches of second range added on each end of the Half-Personal Zone). Since the width of the room used for the experiment was smaller than the 12 feet needed to include the entire Social Zone, ranging from 4-

12ft (48-144 inches), an aperture size for the Social Zone was not included. It is important to note that if the participant chose to step over the hurdle when the size of the aperture is the Full-Personal Zone, the participant would have chosen the Social Zone. For each zone, the inner sides of the hurdles were placed on the outer boarder of the zone in question so that the aperture would only include that zone and any inner zone. Anything outside of the aperture (under the hurdles) included larger zone spaces. For instance, when the size of the aperture was placed to incorporate the Half-Personal Zone (18-33 inch radius), the participant had the option of walking through the Individual, Intimate, or Half-Personal Zone when walking through the aperture, or walking through the Full-Personal Zone, the second half of the Personal Zone (33-48 inch radius), or the Social Zone if stepping over the hurdle. The zones were marked by duct tape placed on the floor, too small to be distinguishable or visible to the participants.

"Aperture Size Order" consisted of two conditions: Increasing or Decreasing. For each 2-pair, the size of the aperture either increased in size from start to finish, or decreased in size. For Increasing Aperture Size Order, the aperture size started at the Individual Zone, then increased to the Intimate Zone, then the Half-Personal Zone and ended with the Full-Personal Zone. Decreasing Aperture Size Order began with the aperture size at the Full-Personal Zone, decreased to the Half-Personal Zone, then the Intimate Zone, ending with the Individual Zone. Aperture Size Order was consistent throughout each 2-pair, for both participants' solo trials as well as all joint trails.

Procedure

Each participant signed up for an experiment called "Joint-Object Manipulation Task" through the undergraduate psychology subject pool and received course credit upon completion of the experiment.

Prior to the start of the experiment participants were asked to fill out a basic information sheet with preliminary questions pertaining to her background. Upon completion of the sheet, the participants were read the standard instructions by the main experimenter, who was a female.

The experimenter informed the participants that they would complete a series of object manipulation tasks, first independently and then jointly. The experimenter explained that the goal of the study was to transport the 8 ft length PVC pipe, starting on one side of the room and ending on the opposite side of the room. The participants were informed that upon completion of one transfer they were to place the pipe on the ending strip and turn around, facing the opposite direction, and then transport the PVC pipe back to the initial strip. After two complete transports, the experimenter adjusted the size of the aperture. Before every transfer, the experimenter instructed the participant to begin by saying the "Go."

The participants were told that they had only two options when encountering the obstacle: walk through the center aperture or step completely over the hurdle. Participants were also informed that both participants did not need to choose the same option during the Joint condition (i.e. Participant 1 may step over the hurdle, while Participant 2 walks through the center aperture, and vice versa).

The participants were informed that they were allowed to change their hand placements or grip styles during any point of the transfer. Participants were told not to rotate the PVC pipe in any direction and that it had to remain parallel to the floor and to the obstacle during the entire transfer. Participants were also informed not to rotate their body at any point of the transfer and to remain parallel to one another during the Joint condition.

After the instructions were read, the experimenter separated the participants in order to ask both participants to explain the instructions for the experiment in their own words and answered any questions that the participants had. Prior to the start of the experiment, one of the participants, later treated as Participant 2, was escorted to wait in the hallway. Participants were

separated during the Solo condition so that Participant 1's choices would not bias the choices made by Participant 2. The experiment consisted of three sections: Participant 1 Solo, Participant 2 Solo, and Joint. The participants were instructed not to speak during the Joint condition.

After the completion of the experiment, the experimenter asked both participants to return to the two person couch. Participants were asked to give their option about the hypothesis of the experiment as well as questions about their choice of options during the experiment. A complete debriefing form was then presented to each participant revealing the true purpose of the experiment.

Measures

The two dependent variables were "physical comfort" and "social comfort". Each transfer was recorded during each 2-pair session and was later coded by video.

For the purpose of this experiment, physical comfort was measured by whether or not the participant chose to step over the hurdle. Stepping over the hurdle requires more physical effort than walking through the aperture. For this experiment more physical effort was equivalent to less physical comfort. Therefore, choosing the hurdle corresponds with low physical comfort while choosing not to step over the hurdle (walking through the aperture) corresponds to high physical comfort. Hurdle choice was coded with a 0 for No Hurdle/Aperture and 1 for Hurdle.

Social comfort corresponded to the participant's zone choice: Individual, Intimate, Half-Personal, Full-Personal and Social. For this variable, I looked to see which zone was chosen by the participant when presented with a given aperture size. Social comfort was directly related with zone range. When the zone range/size increased, social comfort increased. Therefore, the Social Zone was "more socially comfortable" than the Full-Personal Zone while the Intimate Zone was "less socially comfortable" than the Half-Personal Zone. The Individual Zone was coded as 1, the Intimate Zone as 2, the Half-Personal Zone as 3, the Full-Personal Zone as 4, and

the Social Zone as 5. If the participant walked through two adjacent zones, the placement of the participant's inside foot was used as the indicator of the participant's zone choice.

For this experiment physical comfort was inversely related to social comfort. As the size of the aperture increased or decreased, the zones within high physical comfort changed. If the aperture size was "small" and the participant chose to walk through the aperture (within a smaller zone range) then they were in turn choosing high physical comfort with lower social comfort, showing a preference for physical comfort. Given the same aperture size, if the participant chose step over the hurdle, they were in turn choosing low physical comfort with higher social comfort, showing a preference for social comfort (more distance between participants).

Chapter 3

Results

I predicted that the preference for physical comfort versus social comfort would depend on the number of participants and the given aperture size (in the Joint condition). I expected participants to show a preference for physical comfort (walk through the aperture) in the Solo condition and that this preference would decline in the Joint condition, due to a higher preference for social comfort. I also expected that in the Joint condition preference would be dependent on aperture size, with the preference for physical comfort increasing as the aperture size increased. As seen below in Figure 5, our predictions were confirmed.

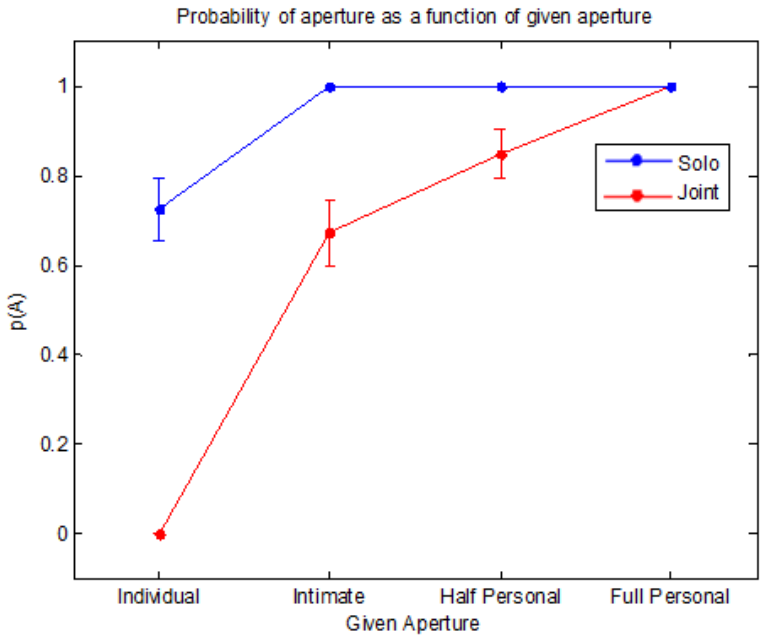

Figure 5

The probability, p(A), of walking through the aperture as a function of given aperture size was higher in the Solo condition than in the Joint condition, showing that preference was

dependent on the number of individuals. In the Solo condition, when given Individual, participants chose to walk through the aperture 72.5% of the time. During debriefing, virtually all subjects who chose to step over the hurdle in the Solo condition, said, "I did not think I would fit through the opening without hitting the hurdle". I concluded that the decision to step over the hurdle was not due to a preference to engage in extra physical activity, but instead was due to the participants' perception of their width in comparison to the restraints on the aperture. Participants chose to walk through the aperture 100% of the time for the remaining aperture sizes—Intimate, Half-Personal, and Full-Personal. There was a high physical comfort preference in the Solo condition.

In the Joint condition, when presented with Individual, zero participants chose to walk through the aperture. In other words, when the aperture measured 18 inches, the average width of a human, every participant chose to step over the hurdle 100% of the time when completing the task with another individual, as seen in Figure 6. Participants chose a social comfort preference (to step over the hurdle) over a physical comfort preference (to walk through the aperture). Participants chose the aperture 67.5% of the time when given Intimate, 85% of the time when given Half-Personal and 100% of the time when given Full-Personal. In the Joint condition, p(A) was directly related to aperture size and therefore also directly related to the number of zones within the aperture. As aperture size increased, p(A) increased, the preference for social comfort decreased and the preference for physical comfort increased. Likewise, as aperture size decreased, p(A) decreased, the preference for social comfort increased, and the preference for physical comfort decreased.

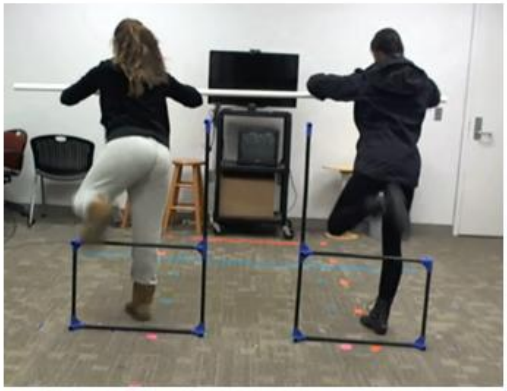

Figure 6: Participants stepping over hurdle given "Individual" aperture, Joint Condition

In both the Solo and Joint conditions, there was a sharp increase in p(A) when presented with the Intimate Zone. In the Joint condition the Intimate Zone allowed enough social comfort for 67.5% of the participants to switch to a physical comfort preference. Also, when presented with Full-personal zero of the participants, in either condition, chose to step over the hurdles into the Social Zone. The Full-Personal aperture allowed every participant enough social comfort to walk through the aperture, choosing a physical comfort preference. Overall, participants were more likely to use hurdles (social comfort preference) in the Joint condition than in the Solo condition and the degree of preference was dependent on aperture size in the Joint condition. The primary hypotheses were supported.

According to the data, participants also displayed a preference in zone choice. In the Solo condition, the probability of zone choice as a function of given aperture size, p(Zone), revealed a consistent preference for the Individual zone, as shown below in Figure 7.

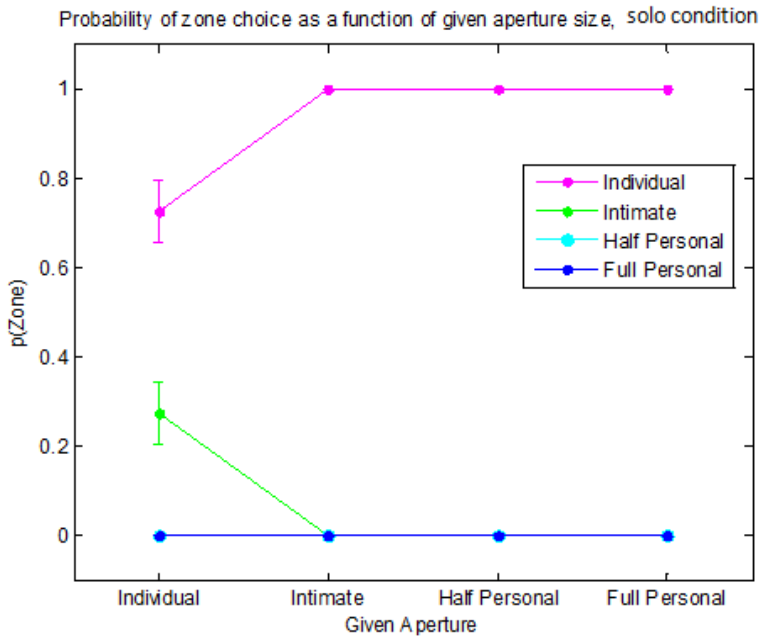

Figure 7

When presented with Individual, 72.5% of participants chose to walk through the Individual Zone in the center of the obstacle. The remaining 27.5% chose to walk though the Intimate Zone (by

stepping over the hurdle). As previously explained, the decision to step over the hurdle was attributed to participants' perception of width and not due to a comfort or zone preference. For the remaining aperture sizes, 100% of participants chose to walk through the Individual Zone. The preference for the Individual Zone was present across all given aperture sizes in the Solo condition showing a definite zone preference regardless of aperture size.

In the Joint condition, there was greater fluctuation in participant zone choice. Even though zone choice was more variability, participants still demonstrated a zone preference. As seen in Figure 8, p(Zone) was higher for the Intimate zone across all aperture sizes.

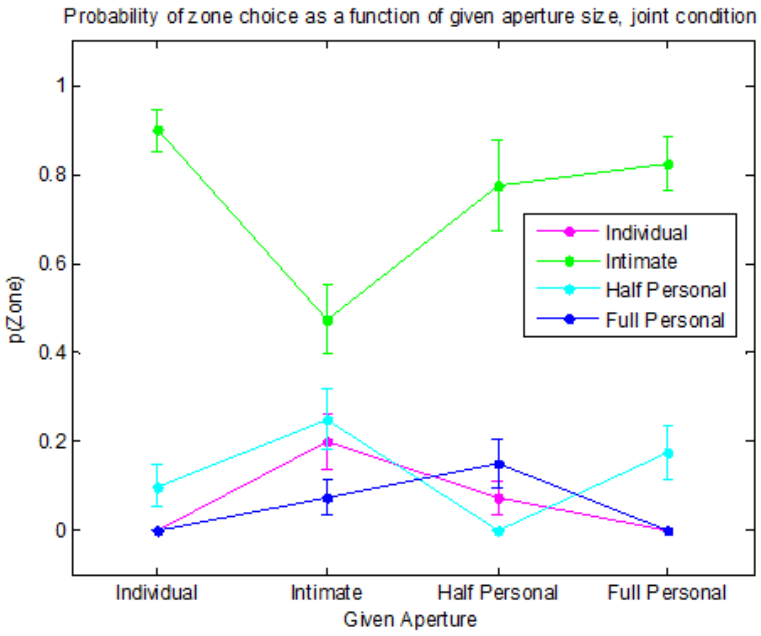

Figure 8

When given Individual, 90% of participants chose Intimate, followed by the remaining 10% who chose Half-Personal. When given Intimate, the preference for Intimate decreased to 47.5% but still remained the highest, followed by Half-Personal at 25%, whose error overlapped greatly with Individual at 20%. When given Half-Personal, Intimate remained the highest choice, increasing to 77.5%, followed by Half-Personal at 15%, which overlapped with Individual at 7.5%. When given Full-Personal, Intimate was chosen 82.5% of the time by participants, while the remaining

17.5 percent chose Half-Personal. Across all four given aperture sizes, the value for the Intimate Zone was different from the three other options, confirming an overall Intimate Zone preference.

Although participants showed a consistent preference for the Individual Zone in the Solo condition, the preference changed to the Intimate Zone in the Joint condition. The low percentage of participants that did walk through the Individual Zone during the Joint condition, did so when the aperture size given was Intimate or larger. During debriefing, when asked why they chose to step over the hurdles when given Individual participants said "I did not think that two people could both fit through the opening." Participants acknowledged that they were aware that they could walk though the aperture as the other participant stepped over the hurdle, and vice versa. In fact, when presented with Intimate or larger, there were some cases in which this occurred. Yet, when presented with Individual, zero participants chose to be the "selfish one" who walked through the aperture, since the space could only "comfortably" fit one.

Another interesting effect that I noticed was that when participants did choose to walk through the aperture they rarely chose to walk through the full extent of the distance provided, through the largest given zone. For instance, when given Full-Personal, zero participants chose to walk through the Full-Personal Zone. When given Half-Personal, zero participants chose to walk through Half-Personal Zone. When given Intimate, 47.5% did walk through the Intimate Zone which I attributed to the Intimate Zone preference. It is important to note that the choice to walk through Intimate when given Intimate was 30% lower than when given Half-Personal and 42.5% lower than when given Individual. This sharp decrease reveals the participants' reluctance to use the full extent of the aperture provided. In other words, participants would rather walk within an inner zone or step over a hurdle, into an outer zone, than walk through the extent of the aperture.

Finally, I tested for a hysteresis effect by randomly assigning participants to two equal groups—Increasing Aperture Size Order and Decreasing Aperture Size Order. I expected aperture size order to have an effect on comfort preference. I predicted that participants in the Increasing

condition would display a higher preference for physical comfort while participants in the Decreasing condition would display a higher preference for social comfort. As seen below in Figure 9, our predictions were confirmed in the Solo condition but not in the Joint condition. The opposite effect was revealed in the Joint condition.

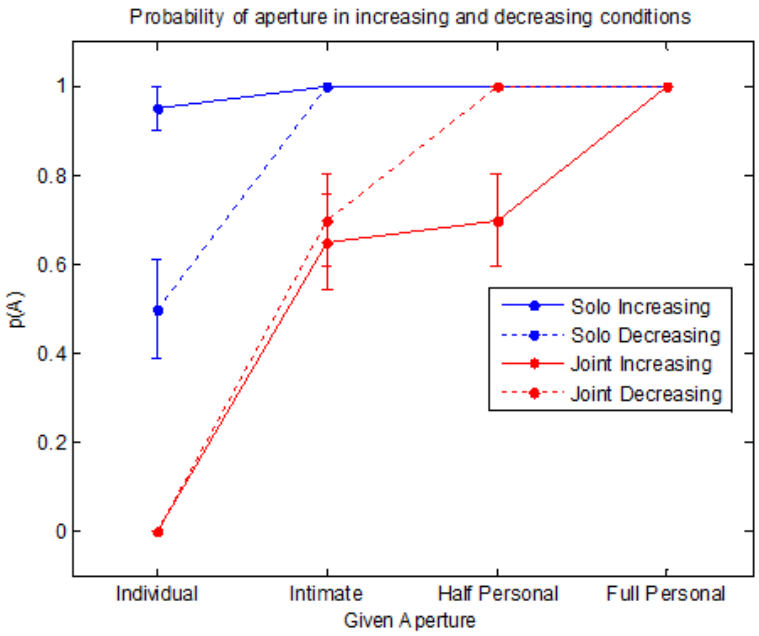

Figure 9

In the Solo condition, there is a difference in comfort preference for participants in the Increasing condition versus the Decreasing condition when given Individual. Participants in the Solo-Increasing condition chose to walk through the aperture 95% of the time (showing a high preference for physical comfort), while participants in the Solo-Decreasing condition chose to walk through the aperture only 50% of the time. The Individual aperture was the first aperture presented to participants in the Solo-Increasing condition and the last aperture (following the Intimate Zone) in the Solo-Decreasing condition. When the participants are presented with the Individual aperture first they were highly likely to walk through aperture, choosing high physical comfort. When participants were presented with the Individual aperture last, participants' comfort preference were split in half. The reason for this effect may be due to the fact that participants

were biased by previous apertures. In the Solo-Decreasing condition, participants walked through three larger apertures before encountering the Individual aperture, resulting in them perceiving the Individual aperture as “smaller” than it was. This result does confirm a slight hysteresis effect, even though there was overlap between comfort preferences for the remaining aperture sizes.

In the Joint condition there was a difference in comfort preference for participants in the Increasing condition versus the Decreasing condition when given Half-Personal, but the effect was flipped. Participants in the Joint-Increasing condition walk through the aperture only 70% of the time, while participants in the Joint-Decreasing walked through the aperture 100% of the time (showing a complete physical comfort preference). This was the opposite of what I expected. The Half-Personal aperture was the third aperture presented to participants in the Joint-Increasing condition (following the Intimate Zone) and the second aperture (following the Individual Zone) in the Joint-Decreasing condition. Participants were more likely to walk through the aperture when given Half-Personal if the aperture preceding it was smaller than if it was larger. There were no other differences between the Joint-Increasing and Joint-Decreasing conditions for any of the other given aperture sizes. However, the rate of change of aperture preference (physical comfort preference) between given aperture sizes is slightly greater for the participants in the Joint-Decreasing condition. Even though I saw the opposite effect in the Joint conditions, aperture size order did have an effect on comfort preference. Therefore, results suggest a hysteresis effect, albeit a small one.

Chapter 4

Discussion

The present study began with the question, is there a preference between physical comfort and social comfort? I found that when the two are set against one another, that was the case. Participants displayed a physical comfort preference when completing the task alone in the Solo condition. Participants displayed an increase in a social comfort preference when working with another individual in the Joint condition to complete a joint-object manipulation task. Although results did reveal a slight hysteresis effect, the effect was not strong enough to completely influence participants' preference choices. Comfort preference was dependent on the number of people involved and the work space available.

The main finding in this study was a correlation between aperture space available and comfort preference during joint-object manipulation. As aperture size decreased the preference for social comfort increased, decreasing the preference for physical comfort. I conclude that the need for social comfort did interact with and affect the need for physical comfort when engaging in a cooperative task. People preferred social comfort (maintaining their personal space) in cooperative situations over physical comfort (using the least amount of physical energy), although they did have a general preference for physical comfort. In other words, people were willing to exert more physical effort than was "required" in order to maintain social comfort when in the presence of a stranger. In fact, results showed that there was a willingness, of not one, but both participants to step over the hurdles (choosing a social comfort preference) when the aperture size measures 18 inches (Individual Zone). Although one participant could have been "selfish," no participant chose to do so. This suggests both the need to maintain personal space as

well as a potential social norm—maintaining the option of "fairness" between partners in cooperative tasks. Since participants were aware that they did not have the option to walk through the aperture together, no one walked through the aperture.

Another finding revealed that participants held a zone preference for the Intimate Zone when working with another individual. This finding was interesting since participants were not "close friends," "lovers," or "relatives" and therefore, should not be allowed to occupy the Intimate Zone. It was possible that a slight bias was created for this preference since each pair of participants sat within each other's "personal space" for about 15-20 minutes prior to the start of the experiment. Upon arrival, participants were invited into the room and asked to sit on a two-person couch, measuring approximately 45 inches. When the average width of two people, 36 inches, is subtracted, that leaves 9 inches between the participants on average which falls within the 6-18 inches of the Intimate Zone. This could explain the prevalence of Intimate Zone choices, but due to the relationship strength usually required to create comfort in this zone, I do not believe that 15-20 minutes in this space would be sufficient to synthesize such comfort.

I do acknowledge that the limitations of the room used for the experiment may have restricted participant's zone choices. The width of the room was only large enough to include up to the full range of the Personal Zone, and some of the Social Zone. It may be the case that if all zones were present participants' zone preference would change. It may also be the case that if participants were to complete the task in an open area versus in a room, zone preference would change. Future studies should attempt to incorporate all zones and their full ranges, keeping in mind that object for transportation would need to span all zones simultaneously to give the participants all zone options.

Another bias was created by one participant in the joint-object manipulation task. As was previously stated, I attempted to restrict communication between participants prior to beginning each experiment but there was one instance in which verbal communication occurred between

participants. After the experimenter placed the hurdles at the Intimate Zone, Participant 1 said to Participant 2, "Let's step over the hurdles." Participant 2 then shifted out and proceeded to step over the hurdle. During debriefing when Participant 2 was asked what her decision would have been had there not been verbal communication, Participant 2 said, "I would have walked through the opening." This bias affected a maximum of 2 transfers out of 160 in the Joint condition.

Due to limitations of time, participants were only asked to complete the Solo condition and Joint condition one time through. It is my belief that repeating the experiment over various trials could affect both preference and performance. It may be the case that after repeating multiple trials over time with the same "stranger" participants will become more socially comfortable, decrease the distance between them, and changing their overall comfort preference. Also, would the time that it takes to complete the transfer change over time? Since this experiment was not looking specifically at performance, I did not analyze the time required to complete the task alone versus cooperatively. However, if there is in fact a difference in performance, which has been previously noted in other studies, does this performance increase or decrease over time? It is my prediction that if social comfort increases over time performance will increase as well.

Prior to beginning experimentation, I was interested in the additional independent variable Race/Ethnicity, which was self-reported by participants on a basic information sheet. However, due to the lack of representation across various racial groups I was unable to draw any conclusions about preference based on race. 60% of the participants reported within the majority group, White, while the remaining 40% reported within the minority. Since there was not an equivalent representation of individual racial groups or equal numbers of the majority and minority in each condition, I was not able to run an analysis. It would be interesting to see if there is a difference between preferences due to race, as well as due to racial pairing. For instance, would participants who were paired with a person of the same race display different preferences

than participants who were paired with a person of a different race? In order to better understand social comfort amount various racial groups, future studies should explore these questions.

Future studies could also look at other social categories such as socio-economic status, social status, sexual orientation, and gender. In this present study all participants were female. The same experiment should be run with males, transgender individuals, and mixed gender groups. This experiment can also look at people of different ages such as children, young adults, and adults. Researching any of the previously mentioned social categories would increase our understanding of social comfort within and between these groups. Then, we could use this information to potentially increase performance and overall comfort in cooperative tasks by increasing social comfort between the individuals of these different groups. There is the possibility that understanding social comfort when cooperation in joint space could lead to a reduction in "isms" associated with different social groups.

Regardless of if we are trying to increase performance or increase social comfort among various people, it is important to acknowledge that social comfort and physical comfort do interact during cooperative tasks. Further research involving human-human collaboration and physical effort should also take into account the social comfort of the individuals completing the task.

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Appendix A

Table 1: Probability of aperture as a function of given aperture

		Given Aperture			
		Individual	Intimate	Half-Personal	Full-Personal
Number of People (*Condition 1)*	Solo	.7250	1	1	1
	Joint	0	.6750	.85	1

Table 2: Probability of zone choice as a function of given aperture size, *Single Condition*

		Given Aperture			
		Individual	Intimate	Half-Personal	Full-Personal
Zone Chosen by Participant	Individual	.7250	1	1	1
	Intimate	.2750	0	0	0
	Half-Personal	0	0	0	0
	Full-Personal	0	0	0	0
	Social	0	0	0	0

Table 3: Probability of zone choice as a function of given aperture size, *Joint Condition*

		Given Aperture			
		Individual	Intimate	Half-Personal	Full-Personal
Zone Chosen by Participant	Individual	0	.2	.0750	0
	Intimate	.9000	.4750	.7750	.8250
	Half-Personal	.1	.25	0	.1750
	Full-Personal	0	0.0750	.15	0
	Social	0	0	0	0

Table 4: Probability of zone aperture in increasing and decreasing conditions

	Given Aperture			
	Individual	Intimate	Half-Personal	Full-Personal
Solo Increasing	.9500	1	1	1
Solo Decreasing	.5000	1	1	1
Joint Increasing	0	.6500	.7000	1
Joint Decreasing	0	.7000	1	1

Appendix B

Informed Consent Form

Informed Consent Form for Biomedical Research

The Pennsylvania State University

Title of Project: Control of Movement Sequences

Principal Investigator: Professor David A. Rosenbaum
Department of Psychology
642 Bruce V. Moore Building
University Park, PA 16802
814-863-1991; dar12@psu.edu

1. **Purpose of the Study:** The purpose of this research is to shed light on the way people control movement sequences.

2. **Procedures to be followed:** If you agree to take part in this research, you will be asked to reach out and move an object from one place to another. You may be asked to wear wires to which tiny infrared emitting diodes (IREDs) are attached. The IREDs send signals to a set of cameras and then to a computer so the positions of the markers can be tracked. The IREDs and wires are completely harmless. The IREDs are tiny light bulbs. Their positions are picked up by the OPTOTRAK cameras and an associated computer. The infrared emitting diodes are housed in plastic sleeves and will never touch your skin. Beneath the plastic sleeve for each diode is a bit of adhesive tape that will be put on your shirt sleeve and/or on your gloved hand or gloved hands. No heat or visible light will be emitted by the diodes and there is no danger associated with them. You will be asked to grab simple objects such as a bowl or dowel and your movements will be recorded using the IRED technology described above.

3. **Discomforts and Risks:** There are no risks in participating in this research beyond those experienced in everyday life.

4. **Benefits:** The benefit to you may be gaining a better understanding of behavioral research. The benefits to society may include better methods for teaching skills, better methods for designing robots, and better methods for rehabilitating individuals with movement difficulties.

5. **Duration/Time:** Your participation in this research will take a total of one hour.

6. **Statement of Confidentiality:** Your participation in this research is confidential. The data will be stored and secured in Professor Rosenbaum's lab, 6A Thomas, in a locked file. The Pennsylvania State University's Office for Research Protections, the Institutional Review Board and the Office for Human Research Protections in the Department of Health and Human Services may review records related to this research study. In the event of a publication or presentation resulting from the research,

no personally identifiable information will be shared. All data from this study will be stored with only your participant number. The link between your name and your participant number will be kept locked up in 6A Thomas and unavailable to anyone else. In the event that a researcher in this laboratory wishes to show a video of your performance at a presentation of this research to anyone outside the laboratory, the video will only be shown with your express written consent even though your face will not appear on the videotape. If the videotape is shown, your name will never be revealed. The only people who will have access to the video recordings will be research personnel who are specifically approved for involvement with this project. The videos will be kept in a locked cabinet within the laboratory (6A Thomas Building). The recordings will be destroyed 3 years after the study is done. Please indicate your willingness to allow the video to be shown outside of the laboratory by checking one of the two lines below.

_____ I agree to allow the video to be shown outside of the laboratory.

_____ I do not want the video to be shown outside of the laboratory.

7. **Right to Ask Questions:** Please contact Professor David Rosenbaum at (814) 863-1991 with questions, complaints or concerns about this research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University's Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. **Voluntary Participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

9. **Payment for Participation:** You will receive course credit for participating as specified in the syllabus provided by your instructor. Alternative means for earning this course credit are available as specified in the syllabus.

You must be 18 years of age or older to consent to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

You will be given a copy of this consent form for your records.

_____ _____

Participant Signature Date

_____ _____

Person Obtaining Consent Date

Appendix C

Subject Information Form

1. Background information

Name: _____ Sex (M/F):_____ Birthdate: _____

Address: _____

Phone: _____Email Address: _____

Height (feet, inches): _____ Weight: _____

Race/Ethnic Identity (Requested only to provide summary statistics to the agency that has provided grant support for this research, at their insistence):_____

2. Health information

Vision OK? (Indicate any problems): _____

Hearing OK? (Indicate any problems): _____

Yes or no: Do you now, or have you ever, suffered any of the following:

Concussion with loss of consciousness: _____ Seizure: _____ Brain tumor: _____ Spinal injury: ____

Other neurological problems (please describe): _____

Other health problems or medications: _____

Please indicate if you have ever had any serious injury (**I**), if you experience chronic discomfort (**D**), Or if you are chronically stiff (**S**) in any of the following areas:

Neck	_____	Right elbow	_____
Upper back	_____	Left elbow	_____
Lower back	_____	Right wrist	_____
Right shoulder	_____	Left wrist	_____
Left shoulder	_____	Hips	_____

3. Miscellaneous information

Musical Experience: _____

Athletic Experience: _____

------ turn page over to complete -----

4. Handedness Questionnaire

Read each of the questions below. Decide which hand you use for each activity and then circle the answer that describes you the best. If you aren't sure, try acting it out to see which hand you are using.

1. With which hand do you normally write?	Left	Either	Right
2. With which hand do you draw?	Left	Either	Right
3. Which hand would you use to throw a ball to hit a target?	Left	Either	Right
4. In which hand do you use your racquet for tennis, squash, etc.?	Left	Either	Right
5. With which hand do you use your toothbrush?	Left	Either	Right
6. Which hand holds a knife when you are cutting things?	Left	Either	Right
7. Which hand holds the hammer when you are driving a nail?	Left	Either	Right
8. When you strike a match, which hand holds the match?	Left	Either	Right
9. In which hand would you use an eraser on paper?	Left	Either	Right
10. Which hand removes the top card when you are dealing from a deck?	Left	Either	Right
11. In which hand would you hold a fly swatter?	Left	Either	Right

---

To Be Filled In By Experimenter:

Experimenter: _____
Date : _____ Time:_____
Comments: _____

Appendix D

Robinson Joint-Object Manipulation Instructions

1. Today you will be participating in an object manipulation task. You will each complete the task alone, and then you will complete the task together.
2. Notice the two strips of grey duct tape located on the floor on either side of the room. These strips of duct tape will serve as starting and ending points for the remainder of the experiment. At the start of each trial, you should stand with your toes directly behind the strip of tape.
3. Resting on the floor directly in front of the starting position is a PVC pipe. Please note the orientation of this pipe. At the end of each trial, the pipe should be placed in this orientation at the ending point.
4. Please also note that there is an obstacle placed in the center of the room. This obstacle consists of two hurdles. There will always be an opening between these two hurdles. However, the size of the opening will change during the experiment.
5. Your job in this task is to pick up the pipe placed in front of the starting point using two hands. Then, walk with the pipe oriented horizontally at a comfortable pace from the starting point to the ending point. I will indicate when you should begin this movement in each trial by saying the word “Go.”
6. As you reach the obstacle placed in the center of the room, you must choose between two options.
7. One option is to walk through the opening between the two hurdles. Please note that if you choose this option, you may not turn your body while walking through the opening. Your body must remain parallel to the obstacle the entire time.

8. Another option is to step over the hurdle. Please note that if you choose this option, you must step over the hurdle with both feet, one at a time. Your body must remain parallel to the obstacle the entire time.
9. If you are completing the task together, you and your partner do not need to choose the same option. In any given trial, one of you may choose to walk through the opening and the other may choose to step over the hurdle, or vice versa. However, whether you choose to walk through the opening or to step over the hurdle, you must remain parallel to your partner for the entire duration of the movement, and you must reach the obstacle at the same time as your partner in every trial.
10. While you are walking, you may adjust your grasp type or placement along the length of the pipe as well as the height of the pipe from the floor. However, please be sure to keep the pipe horizontal to the floor and parallel to the obstacle. You may not rotate the pipe.
11. When you have reached the ending point and have placed the pipe on the floor in the correct orientation, the trial is over. Please turn around, face the opposite side of the room, and re-orient yourself with your feet behind the duct tape. This is now the starting point for the next trial. When I say "Go," you may begin the next trial.
12. You will encounter a total of xxx trials individually, and xxx trials together.
13. *To one participant* Please follow me to this room *indicate room*, where you will wait for your turn to complete the task. *When in the room with the door closed* Can you please explain to me, in your own words, what you will be doing in this task? Do you have any questions?
14. *To the second participant* Can you please explain to me, in your own words, what you will be doing in this task? Do you have any questions?
15. Okay, let's begin.

Appendix E

Debriefing Form for Object Transport Study: Laboratory for Cognition and Action

You participated in an experiment involving object transportation. The experiment was designed to study partner planning when transporting an object through an obstacle. The question was, what paths do people choose when transporting an object with another person? As you may have noticed, there are different ways to do the task you did. We were interested in how you, as someone representative of the larger population of which you are a part, elected to do it.

From the video recordings of your performance, we will measure several variables: (1) whether you walked through the opening or stepped over the hurdle; (2) the relative distance between you and the other participant; and (3) if and how this distance changed over time.

We hypothesized that people would have a strong preference to step over the hurdle when the opening was smaller. We also hypothesized that people would change this preference and be willing to walk through the opening after repeated trials. We were interested in how physical comfort (stepping over a hurdle) and social comfort (walking in a confined space with a stranger) work together.

We hope this research can be useful for helping to improve productivity in careers that involve social contact while moving objects and we hope this research can also be useful for the development of more self-sufficient robots and better human-machine interfaces more generally.

We appreciate your participation. Thank you very much for helping with this research.

If you have any questions, please contact the director of the Lab for Cognition and Action:

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Education

The Pennsylvania State University, University Park 2014

Bachelor of Science, Psychology (Business Option) in the Schreyer Honors College

Bachelor of Science, Economics in the College of Liberal Arts

Honors and Awards

- The Evan Pugh Scholar Award (Fall 2013), The Evan Pugh Scholar Award (Fall 2012), President Sparks Award (Fall 2011), President's Freshman Award (Fall 2010)
- Inducted into Phi Eta Sigma National Honor Society, Inc (Spring 2011)
- Dean's List, Fall 2010-Spring 2014

Association Memberships/Activities

- Schreyer's Honors Scholar
- Penn State's Residence Life, Resident Assistant (RA)
- Student Minority Advisory & Recruitment Team (SMART)
- Caribbean Student Association (CSA)
- Krimson Kourts Incorporated, National Service Organization (KKINSO)

Professional Experience

- Research Assistant in Dr. David Rosenbaum's Lab of Cognition and Action, 2013-2014
- Research Assistant in Dr. Theresa K. Vescio's Social Cognition Laboratory, 2012-2013