Mapping perceptions of safety and danger in Medellin, Colombia: a study in the perceptual geography of urban crime

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Mapping perceptions of safety and danger in Medellin, Colombia: a study in the perceptual geography of urban crime

by

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B.A. University of Colorado, 2005

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Mapping perceptions of safety and danger in Medellin, Colombia:
a study in the perceptual geography of urban crime
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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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Mapping perceptions of safety and danger in Medellin, Colombia: a study in the perceptual geography of urban crime

Thesis directed by Professor Kenneth Foote

Abstract

This study looks at perceptions of safety and danger regarding crime in Medellín, Colombia. I used two different datasets to look at this issue in both the specific situations that incite fear of crime and in the broader context of perceived safety and danger across the city as a whole. The first dataset comes from 42 interviews that I conducted with university students in May of 2009. The interviews consisted of a set of semi-structured questions followed by a cognitive mapping exercise, where I used a participatory mapping approach that I call interview mapping to record the participants’ spatial perceptions of safety and danger across the city. The second dataset is the 2008 Quality of Life survey (ECV) conducted by the municipality of Medellin, which I used to rank the level of perceived security for each neighborhood in the city. Survey respondents were asked how they feel in their neighborhood regarding security on an ordinal scale from very safe to very dangerous. These two datasets provide different perspectives from which people perceive safety and danger in Medellin; the first being a perspective looking outward across the entire city and the second looking inward on one’s neighborhood. Using fuzzy set theory in a qualitative GIS framework, the data were integrated to show the areas where perceived safety or danger corresponded between the interview and survey datasets. The results of this analysis identify the areas in the city which are perceived to have the highest and lowest levels of crime related danger.
Dedication

Medellín is an enchanting city that captures the imagination of those who visit. The bustling downtown is intriguing yet overwhelming at first. Modern development explodes in the wealthier El Poblado sector where one would almost forget about the city’s sorted past. The culture of Medellín, and Antioquia, inspires the business person in its residents and visitors alike, from the wealthy textile producer to the humble street vendor. The young man on the corner, screaming dos por milqui (two for 1500 pesos) as he tries to sell every passerby a pirated music CD with the latest hits, embodies this culture. While one might not feel completely at ease in this city, it is hard to imagine a time when widespread violence consumed the entire city. The friendliness and hospitality of the paisa is comforting and inviting. If you ask someone on the street for directions, the most precarious situation you might find yourself in is them graciously walking you to your destination. This is not a city of hit men and drug dealers, but as in every large city there are those who lurk in the shadows.

One night I was working on this thesis in my mother-in-law’s house on the outskirts of Medellín, it was around eleven o’clock and the quaint town of Copacabana was mostly quiet being a weeknight. The sound of a motorcycle passing by went unnoticed, five gunshots were fired and the motorcycle sped off. A 20 year old man was gunned down in the street in front of our house; it was the typical hit man style of the Pablo Escobar days—two men on a motorcycle, one drives the other shoots. People immediately swarmed the young man to help, while many were too afraid and only peered through their windows. A group of people held back the man’s 15 year old pregnant girlfriend from running to his body. The event was traumatic for me and clearly all of those around me; however, the next day I had an uneasy feeling that such an experience was only new for me. I remember hearing stories from the early 1990’s about the city
waking up to bodies lying in the gullies of streets and the special morgue unit that drove a van around every morning to collect the dead. I heard stories of taxi drivers pulling men with gunshot wounds off the street and driving them to the hospital, obviously free of charge. Without knowing of the past in Medellín, you would not think that this is a culture that has experienced such difficult times of violence and widespread crime. The people of Medellín are resilient, optimistic and brave. The sorted past of the city inspires civility, respect and compassion among those who share the urban space. It is for these reasons that I dedicate this thesis to the people of Medellín.
Acknowledgements

First and foremost I thank my advisor, Professor Kenneth Foote, who helped me develop this project from a vague idea we had during one of our meetings. I sincerely appreciate his direction and guidance throughout the process of completing this project. I thank my committee members, Professors Joe Bryan, Fernando Riosmena and Stefan Leyk. Their comments, criticism and support greatly improved this thesis and my ability to conduct research. I would like to thank Professor Barbara (Babs) Buttenfield and Jeremy Smith for their help in preprocessing my spatial data and conducting my initial analysis. I would like to acknowledge the help from Joshua Schwartz and Jochen Wendel in the preprocessing and initial analysis. I thank my wife, Beatriz Builes, for her help understanding some of the difficult colloquial terms unique to Medellín. I would like to thank the James A. and Jeanne B. DeSana Graduate Research Scholarship organized through the Geography Department at the University of Colorado for partially funding my field work in May, 2009.

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Chapter 1. Introduction

Overview

This study looks at perceptions of safety and danger regarding crime in Medellín, Colombia. I approach this issue by first analyzing the specific contexts of fear of crime in the city and subsequently by looking at the spatial distribution of areas perceived to be particularly safe or dangerous. In doing so, this research contributes to the study of environmental perception, cognitive mapping and fear of crime. Methodologically, I approach this issue using semantic prototypes to define the concepts of safety, danger and crime within the cultural context of Medellín. Then within a qualitative GIS framework, I use fuzzy set theory to operationalize these semantic prototypes in a spatial analysis that teases out additional meaning. Thus, one of the major contributions of this study is methodological, where I push the analytical boundaries of qualitative GIS by applying fuzzy set theory to mixed methods data. This approach uses the qualitative and quantitative data to play off each other and provide a deeper analysis of perceived crime risk.

I use two different datasets to look at these perceptions in both the specific situations of safety or danger and in the broader context of fear of crime across the city as a whole. The first dataset includes 42 interviews I conducted with university students in May of 2009. The interviews consisted of a set of semi-structured questions followed by a cognitive mapping exercise. In this latter component, I used a participatory mapping approach that I call interview mapping to record the participant’s spatial perceptions of safety and danger across the city. I had participants draw the areas which they perceived to be the safest and most dangerous on a map of the city while we discussed the specific areas that they indicated. The second dataset comes from the 2008 Quality of Life survey (Encuesta Calidad de Vida—ECV) conducted by the
municipality of Medellín. The survey was conducted face-to-face in 98 percent of the residential neighborhoods (Alcaldía de Medellín 2008b). One of the sections of this survey recorded respondents’ level of perceived safety or danger regarding crime and violence in their neighborhood.

My analysis will first use the interview data to describe and categorize the social factors and physical features of the urban landscape that influence perceptions of safety and danger. Building on these specific observations, I will then focus on the spatial representations of these perceptions across the city. Mapping the spatial patterns in each of these datasets shows the similarities and differences between the perspectives of the two datasets. In the interviews, participants were asked to describe how they perceive safety and danger across the city as a whole. In the survey, respondents were asked specific questions about the situation of security in their neighborhood alone. These two points of view can thus be described respectively as outward and inward looking. I use these different perspectives to approach the issue of perceived safety and danger from complementary yet opposing angles, and identify where they correspond and where they contradict each other. The spatial coincidence and disjuncture of the patterns that are present in these datasets will then be used to tie together the qualitative information from the interviews and the explanatory power of the survey responses.

Due to the limited time available for field work, I had to limit interviews to a sample of the population comprised of university students. While I acknowledge that this is a rather limited perspective of the population of Medellín, it provides one perspective on perceived safety and danger. I do not try to extrapolate the views of these students to the entire population of Medellín, but the views of these students do help me begin to explore some patterns in perceptions of safety and danger.
Research objectives

The broader contributions of this study are that it offers an understanding of the context in which the residents of the city perceive crime risk and it provides a spatial analysis situated from their point of view. Previous research on fear of crime has stressed the importance of the situated context of perceived danger (Ferraro 1995; Pain 2000). Focusing on the social factors and spatial situations that incite fear of crime provides a deeper understanding of the process. Looking at this process across the entire city illuminates the variation at different scales and reveals the broader spatial patterns of perceived safety and danger. My specific research objectives are therefore divided into two categories: analyzing the situated contexts of perceived safety and danger, and identifying the spatial patterns of these perceptions. To establish the situated complexity of fear of crime, I will show how semantic prototypes can be used to formalize the meanings, and the range of use, of terms safety, danger and crime from the interview responses. I will then describe the context in which university students perceive certain areas to be safer or more dangerous. In doing so, I will describe the social factors and features of the physical/built environment that incite fear of crime. Moving towards a spatial representation, I will explain why certain areas are perceived to be safer or more dangerous for certain individuals or social groups. In the spatial analysis, I will first identify the patterns of safety and danger perceived across the urban landscape by the individuals represented in each of the two datasets. I will do this within a framework of qualitative GIS which provides detail and context for the spatial data. I will then look at how these patterns correspond and how they differ between the interview participants and survey respondents. I do this by bringing the two datasets together using fuzzy set theory to identify the areas of the highest perceived safety and danger shared by the two samples of the population. I will show how fuzzy set theory is helpful in
bringing out subtleties in the data and identifying the similarities and differences between the datasets that warrant further examination. Finally, I turn these results back on the qualitative information to provide a more informed understanding of perceived safety and danger regarding crime in the city.
Violence and crime in Medellín

Medellín, Colombia is a densely inhabited metropolitan city that has a long history of violence, and therefore security is always on the minds of the residents. The city has seen waves of intense violence interspersed by periods perceived to be relatively calm. The historical connection between politics and organized crime (or the “ politicization of crime”) have been blamed for this unchanging situation (Sanin and Jaramillo 2004). The older generation of residents experienced the period of La Violencia from 1948 to 1965, where the country was consumed by a brutal civil war between the conservative and liberal parties (Sánchez G. and Meertens 2001). The most significant period of violence in recent history occurred during the reign of Pablo Escobar and the Medellín drug cartel from the mid 1980s to the early 1990s. This period formed many people’s sense of security in the city and has been slow to change among the generations that experienced it. After the death of Pablo Escobar in 1993, Medellín saw a period of increased security and safety in public spaces. Nonetheless, the stigma of the Pablo Escobar days remains engraved in the memory of the city. The armed conflict between guerrilla groups, paramilitary groups and the national army has mostly been fought in the rural areas of Colombia, yet it periodically breaks out in urban parts of country as well. Recently, there has been an increase in gang violence in the more marginalized sectors of Medellín and this has highlighted the issue of security in the public eye.

The history and situation of crime and violence in the city has had a lasting effect on the culture of Medellín. Like in most large cities in the world, residents pay extra attention to their surroundings and take caution in the route they chose when navigating the urban landscape. Intense violence and the commonality of crime in all parts of the city have heightened the awareness that residents have towards potentials dangers. The cultural memory of violence in
Medellín makes it a unique case study for spatial perceptions of safety and danger regarding crime.

**General geography of the city**

Medellín is the second largest city in Colombia with approximately 2.25 million inhabitants in the municipality (Alcaldía de Medellín 2008b). The city lies in the Valley of Aburrá between 1400 and 2100 meters above sea level, extending approximately 15 kilometers north to south and 12 kilometers east to west. The metropolitan area of the municipality is approximately 107 square kilometers (Alcaldía de Medellín 2008a). The central part of the valley is fairly level rising gradually from the Medellín River in the center; the topography rises rapidly on the periphery of the city where urbanization has expanded over the years. The city operates a modern metro system that has train service covering the extent of the metropolitan area. There are also two urban gondola lines (called *metrocables*) that serve as public transportation in steep areas unserviceable by train (fig. 1a).

The city is divided into 16 administrative sectors called *comunas* (I will refer to them as sectors), each of which contain between 7 and 22 neighborhoods. As of 2008, there were a total of 249 neighborhoods plus 20 institutional areas in the 16 sectors. Institutional areas are non-residential; among them are facilities such as universities, hospitals and government complexes, ecoparks and recreational centers, and the municipal airport. Sectors are commonly referred to by either their administrative name or number (1 through 16). I will refer to them by sector number to make it easier for the reader. Neighborhoods are always referred to by name, although they do have an administrative number.
In 1981 Colombia adopted a system of socioeconomic stratification to address the increasing social inequality in major cities. This system divides the housing units of the city into 6 classes based on their estimated value; stratum 1 is the lowest and 6 is the highest (fig. 1b). This serves to provide subsidies for the lower socioeconomic strata in the city. The cost of public services and property tax are based on the stratum to which a unit belongs—by paying higher amounts, strata 4 through 6 subsidize strata 1 through 3 (Alcaldía de Medellín 2008c). There are additional benefits for residents of the two lowest strata, such as subsidies for health services and the public transportation system. The stratum system is a good socioeconomic indicator in

Figure 1. General geography of the Valley of Aburrá and socioeconomic stata.

Topography and the public transportation system are shown in a) and socioeconomic strata in b). Sectors are labeled with their administrative numbers. Stata is shown as the mean in each neighborhood. Strata classes are defined using the Jenks method.

In 1981 Colombia adopted a system of socioeconomic stratification to address the increasing social inequality in major cities. This system divides the housing units of the city into 6 classes based on their estimated value; stratum 1 is the lowest and 6 is the highest (fig. 1b). This serves to provide subsidies for the lower socioeconomic strata in the city. The cost of public services and property tax are based on the stratum to which a unit belongs—by paying higher amounts, strata 4 through 6 subsidize strata 1 through 3 (Alcaldía de Medellín 2008c). There are additional benefits for residents of the two lowest strata, such as subsidies for health services and the public transportation system. The stratum system is a good socioeconomic indicator in
general when looking at the city as a whole. The main problem with using this as a socio-economic indicator within the neighborhood unit is that it does not say anything about the income level of residents; rather it estimates the value of the home where they live. Stratum level is widely used in government and academic research because it provides the highest spatial resolution of the socio-economic measures publicly available (Medina et al. 2008). For the scale of this study, the strata system is an appropriate indicator of socio-economic status.

**Theoretical background**

This study is situated broadly in the research areas of fear of crime and environmental perception. I approach the central issue of perceived safety and danger using perspectives from the fear of crime literature and urban crime research. I look at this issue with a spatial focus drawing on research done in environmental perception and cognitive mapping. To formalize the concepts of safety and danger, I draw on literature of semantic theory and cognitive linguistics. In following recent scholarship in critical theory, I must acknowledge that these terms are socially constructed and value loaded and, furthermore, that they are often used for political purposes, such as Davis has argued for the U.S. (1998). However, my purpose is different in that I am interested in how such terms can be qualified and defined within one particular context among one group of students. To do this I will rely on previous research that provides a framework for operationalizing complex concepts with a wide range of use among the population of the study. This will provide the context on which I will conduct a spatial analysis of the data. I apply fuzzy set theory in a qualitative GIS framework to develop a methodology for analyzing mixed methods data.

**Safety, danger and fear of crime.** Criminological research has had a continued interest in measuring levels and variation of crime across space and time since the early nineteenth century.
Extensive research at various spatial scales and with diverse datasets has described the complexity of crime patterns and shown how they are directly related to social factors and the physical and built environment (Evans and Herbert 1989; Smith 1987; Weisburd et al. 2009). However, traditional criminological studies using official police data have received significant criticism over the years as these data are known to underrepresent and misrepresent crime patterns (Herbert 1982). Since the late 1970’s, research into the effects of crime on people’s perception of the environment has become an important focus in sociology, criminology, as well as in geography (Pain 2000; Racine 2002; Smith 1987). Studies have looked towards approaches that seek to understand the social and spatial contexts of fear of crime. Recent research in geography and criminology has embraced more holistic, qualitative approaches to looking at fear of crime (e.g. Girling et al. 1998; Koskela 1999). Pain (2000) argues that qualitative field work has been the most promising in addressing the situated context of fear of crime. While factors of the build environment are clearly important in studying how individuals perceive safety and danger in urban spaces, understanding individuals’ social perspective is more relevant in understanding their fear of crime.

This thesis contributes to this body of literature in two ways. First, while research on fear of crime has always had a spatial focus, little research has provided methodologies for analyzing and mapping spatial patterns of perceived safety and danger. Second, most studies have been conducted in developed countries in Europe and North America; few studies have looked at this issue in Latin America. Additionally, this study expands upon the issue of fear of crime by looking at perceived safety as well. While looking at the social and environmental factors that incite fear of crime, I also address perceptions of safety from crime.
Perception, cognition and cognitive mapping. Human spatial behavior has been studied in the social sciences under a variety of descriptive labels, such as perceptual geography, behavioral geography, psychogeography, environmental perception, and cognitive mapping to name a few. Much of this research expanded on work done in psychology in an attempt to explain how humans experience, and operate in, the physical environment around them. The 1970’s was a particularly prolific decade with a number of important publications in two general areas of research. The more humanist and phenomenological approaches were led by Tuan, Buttimer and Relph while the more empirical and positivist approaches were led by White and Saarinen in hazard perception and by Gould and Golledge in cognitive mapping (Downs and Meyer 1978). Work in the 1980’s continued along these lines with a number of applied studies and research in specific sub areas of environmental perception and behavioral geography (see Amedeo and Golledge 2003). The theory produced in the 1970’s and 1980’s established a lasting foundation for contemporary research; the theoretical background I provide here is still commonly accepted among geographers (Amedeo and Golledge 2003; Kitchin and Blades 2002).

This study is situated within the humanist, phenomenological approaches to environmental perception, while at the same time drawing on the cognitive mapping literature for conceptual understanding and research design. There is often confusion as to whether the term perception refers to the process of perceiving or to the product of the process of perception. The process of perception is studied more in experimental psychology where the focus is on sensory functions and cognitive recognition (Golledge and Stimson 1997). In this study, I refer to the term perception as the product of perception that influences human spatial behavior, that is “the awareness, impressions, information, images, and beliefs that people have about environments” (Moore and Golledge 1976, xii). This is also referred to as environmental cognition. Spatial
cognition, on the other hand, is “the knowledge and internal or cognitive representation of the structure, entities, and relations of space” (Hart and Moore 1973, 248). Environmental cognition refers to the qualitative understandings or attitudes that individuals have towards spaces; spatial cognition refers to how individuals construct a mental model of space that is used for cognitive processes such as way-finding, estimating distances and directional orientation. In geography, the concepts of spatial and environmental cognition have been joined into what is referred to as cognitive mapping (Kitchin 1994). Downs and Stea provide a useful, formal definition: “Cognitive mapping is a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls, and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment” (1973, 9).

While coming from a different background, this is very similar to how Tuan formulates his understanding of environmental perception from space and place. He argues that the concepts of space and place require each other to be defined and understood. “In experience, the meaning of space often merges with that of place. ‘Space’ is more abstract than ‘place.’ What begins as undifferentiated space becomes place as we get to know it better and endow it with value” (Tuan 1977, 6). Space is an abstract environment which allows movement and place is a pause, as Tuan puts it, where social meaning and value are attached. This is how I will use these two terms throughout this thesis. In its simplest form, the cognitive map represents the experiential perspective explained by Tuan as a mental model of space with images, attitudes, and beliefs attached to the places within that model. The phenomenological approach of space and place and the cognitive mapping approach of spatial and environmental cognition are complementary. They both provide an understanding of how experiences in a spatial context are recorded, stored and then accessed in a person’s memory.
Cognitive mapping has been applied in many areas of geographic research; for example, it has been used to study perceptions in urban spaces (Bunge and Bordessa 1975; Gould and White 1974), as a potential tool for neighborhood planning (Halseth and Doddridge 2000) and in combination with participatory methods to map crime risk (Liebermann and Coulson 2004). Such approaches are capable of building rich datasets of qualitative spatial data. In this study, I used cognitive mapping to document spatial perceptions of safety and danger regarding crime. To meaningfully compare the individual cognitive maps, it is important to establish definitions for the terms safety and danger that is representative for all participants. I draw on the theory of semantic prototypes to define the underlying concepts of the spatial analysis.

**Semantic theory and cognitive linguistics.** Semantic theory has been used in many fields to establish a framework in which to describe, and thus understand, how a concept is used by a group of people representing a population. This approach isolates each concept as a semantic category to provide a formal understanding. Such an in depth analysis of each concept establishes a foundation for a structured analysis of related concepts. The classical approach to semantic categorization follows Aristotelian logic where there are essential properties for a category and an entity must have these properties to be considered a member (Taylor 2003). This approach takes semantic categories as discrete sets where partial membership is not considered. A classic example is the category of bird; based on a set of criteria, an entity is either a bird or not a bird. The problem is that while being related to scientific classification, the concept of a bird is a semantic category of human language and is therefore interpreted differently by each individual. Prototype theory, developed by Rosch (1973), is an alternative to classical theory arguing that semantic meaning is not logically bound to a set of criteria; rather “the semantic representation of words is organized around a set of ‘most typical’ cases” (Winograd 1978, 27).
This theory argues that while a chicken is clearly a bird, the average person associates the word bird with an animal that has feathers and can fly. So, while being a bird, a chicken is a less typical bird than a robin or a canary. Expanding on the basic theory of the prototype, it is now commonly accepted in semantic theory and cognitive linguistics that categories have graded levels of membership where entities belong to a category to a certain degree (Coleman and Kay 1981; Rosch 1975; Taylor 2003). Research in this area has looked at both quantitative measures of membership (Lakoff 1973) and qualitative categorization of concepts (Wierzbicka 1996). In this analysis, I apply the latter to formalize the concepts safety, danger and crime descriptively and expressively based on the information collected from participants.

In general, research in semantic theory is concerned with the broad—yet typical—meaning of a word, and there is often an interest in such a meaning that is shared by all users of a language with similar cultural values. For this reason, most studies in linguistics have focused on relatively simple concepts, such as semantic categories of artifacts (i.e. furniture, vehicle, cup), natural categories (i.e. bird, tree), and categories of colors (Taylor 2003; Wierzbicka 1996). More complex concepts are difficult to conclusively study for an entire population sharing a common language and culture. In an influential study, Colman and Kay (1981) showed how prototype theory can be used to characterize abstract concepts; in this case they analyzed the word lie. Based on Colman and Kay’s study, Lukusa (1996) developed a semantic prototype for the Tanzanian usage of the English word responsible. The scope of my analysis follows along this line of research as I am formalizing the concepts of safety, danger and crime within the culture of Medellín, Colombia. These semantic prototypes will provide a necessary foundation on which to analyze qualitative information with GIS.
Qualitative GIS. Although GIS has traditionally been considered a quantitative approach to spatial analysis, many critical geographers have clearly shown how GIS is fully, if not inherently, capable of dealing with qualitative data (Elwood 2006; Knigge and Cope 2006; Kwan 2002). Pavlovskaya further argues that much of what is done in GIS is neither quantitative nor qualitative, but facilitates the way in which humans conduct spatial thinking or analysis (2006)—such as performing queries on a dataset, combining layers based on different criteria or finding areas of agreement between data. The field of qualitative GIS has grown rapidly since the critical theorizing of GIS in the 1990’s, which sought to change the positivist framework in which the field developed (Lake 1993; Pickles 1995). Qualitative GIS utilizes alternative data sources such as photographs, cognitive maps, interview data and participatory mapping layers among other forms of spatially related data that have descriptive, expressive qualities (Cope and Elwood 2009). For example, in a particularly relevant study, researchers used interview responses to qualify GIS data which indicated locations where improved street lighting would reduce fear of crime and improve public safety (Pain et al. 2006). Qualitative data is usually combined with quantitative spatial data in a mixed methods approach which uses each dataset to expand on the other and provides a deeper level of explanatory power and descriptive quality (Cope and Elwood 2009). One of the challenges of working with qualitative spatial data in a GIS is that a meaningful analysis is often limited to sorting, classification, description and visual interpretation. Knigge and Cope point out that even though qualitative data can effectively be represented in GIS, a strategy for the integrated analysis of mixed methods data is still needed (2006). In this study, I will look towards fuzzy set theory as an approach which surpasses this limitation and allows for a more robust analysis of mixed methods data.
**Fuzzy set theory.** Poorly defined objects in geographic space have long been a challenge to represent cartographically and to analyze effectively in GIS. When the boundaries of an object are not discrete, but rather diminish gradually, deterministic approaches fail to capture this transition (Fisher 1999). Classical set theory rests on two rules of traditional logic. First, the Law of the Excluded Middle states that every object is either a member of a given set or it is not; partial membership is not considered. The second is the Law of Contradiction which states that an object cannot be both a member of a given set and a member of that set’s compliment (Robinson 2003). Uncertainty arises when the existence of an object violates these rules of logic. Fuzzy set theory was formalized by Zadeh as a paradigm of multi-valued logic to address this uncertainty (1965). A fuzzy set is a generalization of crisp, Boolean set that allows for uncertainty in the boundary of an object as well as in the definition of the concept being represented (Fisher 2000). The degree of membership is continuous, where the highest value indicates full membership to the concept and the lowest value indicates no membership. Generally the degree of membership ranges from 0 to 1. This is called a normal fuzzy set to keep calculations and comparisons simple; alternatively a fuzzy set can have any range of values.

One of the principal concerns is how to derive the membership functions for each fuzzy set. Two approaches have been identified in the literature: the Similarity Relation model and the Semantic Import model (Burrough and McDonnell 1998; Fisher 1999). In the former, membership functions are data derived; they are based on patterns in the data or on the distribution. In the latter, membership functions are based on empirical knowledge of the data and underlying processes; they are not derived directly from the data (Fisher 1999). Since 1965, fuzzy set theory has become a well established field of study and has been extensively applied in numerous disciplines (Dubois 2005). This pervasiveness has led to an extensive theoretical
background and a broad set of fuzzy operators documented in the literature (Fisher 2000; McBratney and Odeh 1997; Mizumoto and Tanaka 1981).

In Geography, the majority of the research applying fuzzy set theory has been done in the physical sciences and most of what has been done in the social sciences has focused on quantitative data (de Kok et al. 2000; Ragin 2000). In this study, I use semantic prototypes to concretely define the meaning of membership to safety and danger. I then apply a fuzzy logic framework to analyze the vague boundaries of the geographic objects representing the survey responses and the overlay maps drawn by the interview participants.
Chapter 2. Interview mapping: a methodology

Sampling strategy and logistics

I conducted interviews with students at two universities in Medellín. The University of Antioquia is the largest public university, where socioeconomic diversity is high due to the fact that tuition is subsidized by the government. The University of Antioquia is highly regarded in Colombia and it is usually the first choice for most students regardless of socioeconomic status. The University of EAFIT is one of the largest private institutions; and although it is very expensive compared to the University of Antioquia, it does offer a number of scholarships. It is also highly regarded in Colombia and considered among the best universities in Medellín. The University of Antioquia is located in sector 4; EAFIT is located in sector 14 (see fig. 1).

I conducted the interviews over four days in 2009: May 14\textsuperscript{th} and 15\textsuperscript{th} at the University of Antioquia and May 18\textsuperscript{th} and 19\textsuperscript{th} at the University of EAFIT. Prior to this, I received permission from the administrations of both universities to conduct this field work. Of the 42 interviews that I conducted, 40 were complete with the final mapping component; 2 were interrupted by the participant because they needed to leave in the middle. Complete interviews were divided equally between the two universities, 20 at each. My sampling strategy was to approach individuals or groups around the campuses that appeared to be in between classes or enjoying leisure time. I attempted to give no preference to any particular ethnic group or social group based on appearance and I actively moved about the campuses to ensure that I did not over sample in any specific part of the university. The only conscious selection of participants that I made was in trying to keep a balance between male and female participants. Of the 40 complete interviews, I interviewed 19 men and 21 women. I interviewed participants exclusively in open,
public areas of the universities. Interviews were conducted in Spanish and recorded with the permission of the participant.

**Interview procedure**

Interviews had two parts followed by a short questionnaire; the first consisted of a set of open ended questions designed to stimulate discussion (see Appendix A for English and Spanish versions of the interview questions). The second part was the mapping component. At the end, I had participants fill out a half-page questionnaire to document basic demographic information about them (see Appendix A). Interviews lasted between 15 and 35 minutes depending on how much discussion was generated by the questions. The mapping component usually took up the last 5 to 10 minutes of the interview.

The open ended questions can be grouped into four sets and the interviews followed in that order: danger, safety, crime, and qualities of safety and danger in specific spaces. While the questions were open ended and designed to produce a discussion, at the same time I was interested in direct answers for definitions of safety, danger and crime. For the first set of questions, I asked participants which neighborhoods they considered to be the most dangerous in Medellín. I then asked them why they considered these neighborhoods to be more dangerous and for whom, asking if they considered any neighborhoods in particular to be more dangerous for all people or more so for certain individuals. Following these questions, I asked which kinds of danger were present in the neighborhoods they had mentioned. Finally, I asked them how they define the word *danger*.

The next set of questions was structured exactly the same but asked about safety, with the exception that I did not ask a question corresponding to the kinds of danger present in neighborhoods. While designing the interview, I considered the order in which to ask these two
sets of questions. Asking about danger first might have influenced the direction and the mood of the interview. Nonetheless, this study is about fear of crime, so it made sense to start the interview discussing danger. This structure also avoided discussing danger and crime back-to-back, and thus separated the two concepts in the progression of the interview.

The third set of questions asked which crimes participants believed to be most common in Medellín. I then asked them to define *crime* and explain what they considered to be a crime and what they did not. In these three sets of questions I was interested in documenting explicit definitions for the words *danger, safety,* and *crime* as these are central concepts in my analysis.

The last set of questions was more varied and sought to identify the characteristics and qualities of circumstances or situations that incited or limited fear of crime for participants. I asked participants if there were any particular places in the city that they avoided. If they needed clarification I would rephrase the question to ask about places they avoided due to fear of crime. I then asked the same question about places they avoided only at night. Next, I asked them how safe they considered their neighborhood, and why. I followed that with the same question about the area around the university. To understand the more abstract qualities of safety, I asked them to describe a safe place and the characteristics it has. Finally, I asked participants if they believe that security can be measured. This question often led to interesting discussions about the statistics presented by the media or government and the confidence that participants had in such figures. The responses to the interview questions are discussed in the next chapter.

**Overlay mapping**

At this point I took out two maps of the city and asked participants to choose with which they found it easier to orient themselves. I would then place a transparent overlay on the map and ask them to identify the areas they perceived to be the most dangerous in Medellín with a red
marker. While they drew on the map I asked them why they considered each area to be dangerous. Often this would lead to a discussion about that specific location and the characteristics and qualities that made it dangerous. Participants would then do the same with a blue marker to identify the areas they considered to be the safest. Finally, I would ask them to identify approximately where they lived on the map if they resided within the municipality; otherwise I would take note of the municipality where they lived.

This methodology was designed with the idea of creating a composite map of the spatial perceptions of safety and danger from all participants. Drawing on participatory mapping methodologies, I used the technique of overlay mapping where participants draw on a transparent sheet placed over a map or an aerial photograph. Since all participants were drawing on the same map, this methodology allows for better comparisons than with sketch maps. Based on the literature, aerial photographs are generally easier for participants to orient themselves and identify specific features than with tradition cartographic maps (Mather 2000; Müller and Wode 2003). However, the cartographic scale for this project is much smaller than that which has been used in participatory mapping projects. Mather (2000) used printed aerial photographs at scales between 1:5,000 and 1:1,250. Kienberger (2008) worked mostly at the 1:8,000 scale. To cover the entire city and have maps small enough to carry around in the field, I used 1:35,000. Since the effectiveness of aerial photograph overlay at small scales is not established in the literature, I also printed a traditional map at the same scale. On a 3 meter resolution aerial photograph I added minimal labels to help orient participants. I labeled major public transportation features (major roads and the metro train system and its stations), major universities (public and private), and the two large eco-parks in the city. The traditional cartographic map I used was produced by
the mayor’s office of Medellín (see Appendix B for both maps). Both maps were printed on 12 by 18 inch sheets.

**Ethical concerns**

This research was approved by the Human Research Committee (HRC) of the University of Colorado. The Spanish translation of the participant consent form used in the interview was approved on April, 29th, 2009 (see Appendix D for the English version). Participants were asked to read and sign this consent form and I provided them with a copy if desired. I asked participants if I could record the interview explaining that only my advisor and I would have access to the recordings and that they did not have to be recorded to participate in the interview. After making it clear that the recording would not be used publically and that the interview was completely anonymous, all participants agreed to being recorded. Occasionally during the interviews participants would refer to a particular event in which they were the victim of a crime. While these events were of interest to this study, I refrained from pursuing a discussion of such events if the participant seemed to be uncomfortable in any way.

**Researcher skills and positionality**

I have spent extended periods of time working and living in Latin America and received my Bachelor’s degree in Spanish and Geography. Previous to conducting this research, I lived in Medellín for three years during which time I gained an in depth understanding of the culture, history, and geography of the city as well as a strong grasp of the local language. An understanding of the local language and vocabulary was essential for this research as I conducted all field work alone and translated all of the data in my analysis.
While I made every attempt to remain neutral as to whom I interviewed, and in how I interpreted the data and conducted my analysis, it is important to recognize my position as a researcher. As an American, participants clearly received me differently than they would have received a Colombian researcher. While I am not sure how these perceptions may have influenced responses, participants appeared to be very honest and open without trying to paint a prettier or more gruesome picture of the situation in Medellín. I did observe that many participants were pleasantly surprised that a student from an American university was conducting a qualitative study on issues of security in Medellín. While positionality is important, my personal experience in Medellín and knowledge of the city is also important to recognize in this study. Moser (2008) argues that the personality and experience of an individual has an equally if not more significant role than positionality in how a researcher interacts with and is received by participants. My knowledge of the history and geography of Medellín often came out in the interviews and participants appreciated the intimacy that I have with the city. While discussing specific neighborhoods in the city, it was helpful that I had some familiarity with the areas that participants were describing; this allowed me to further pursue the context of how they perceived these spaces.

**Coding and data processing**

I coded the interviews using Microsoft Excel and Express Scribe transcription software. For the most part I summarized and paraphrased responses, initially organizing them by question number (see Appendix A). I transcribed quotes directly when they were particularly relevant or stood out as representative of broad themes present in other responses. After the coding all of the interviews, I did a second coding session to ensure that I had not missed any important details and to transcribe additional comments that I had not considered significant in the first pass. After
this process, I further coded the data into salient categories regarding safety, danger, crime and common themes that were present in the interviews.

The overlay maps were scanned into JPEG format and then imported into Adobe Photoshop. I cleaned up the images, separating the areas indicated as safe and dangerous, and then exported the data in TIFF format. In ArcGIS, I georeferenced the overlays and converted them to ESRI grids. All other analysis was conducted in ArcGIS, mostly using map algebra.
Chapter 3. Analysis of interview data

Sequence of analysis

The interviews were designed to access the two components of environmental perception: participants’ knowledge of the structure of the city and the attributes and qualities they attach to certain places from first hand and second hand experiences. I started each interview by asking participants which neighborhoods they considered to be the most dangerous; I then asked them to discuss the characteristics and qualities that they associate with these neighborhoods, and I asked them for whom they consider these areas to be dangerous. This brought forth the broad themes that participants associated with safety and danger. I followed this discussion by asking them to define danger as they understand and use the word. The next set of questions about safety followed the same structure. The interview questions revolved around this flow of motifs, from specific locations to the characteristics and qualities of these locations to the abstract concepts that underlie the discussion. The final part of the interview—the overlay mapping activity—culminated in participants identifying specific places on the map and describing why they consider these places to be safe or dangerous.

To build a foundation for what follows, I start this analysis with the most abstract and move towards the specific. I will first formalize the abstract—yet fundamental—concepts of safety, danger and crime, on which this thesis lies. Next, I will look at the abstract characteristics of a safe place and by doing so identify the central themes that were present throughout the interviews. The analysis will then look at the specific locations in the city that were most commonly indicated and described by participants as being the safest and most dangerous. This chapter closes by looking at the spatial representations of safety and danger drawn by participants.
Semantic prototypes of safety, danger and crime

Since this study focuses specifically on how and where residents of Medellín perceive safety and danger regarding crime, it is necessary to formalize how they understand and use these concepts in order to provide a context for the analysis. I start with the social construction of safety and danger in Medellín where these words have a unique cultural meaning. Because of the violent history that the city has experienced, these words are deeply associated with crime, violence and armed conflict. While in most cultures these words are commonly related to crime, the situation in Medellín has intensified this association. The popular discourse of security in Colombia, and particularly in Medellín, has narrowed the typical use of these words to issues of crime and violence. While this analysis does not aim to address such discourses, it is important to establish the cultural context of these words. Out of the 42 interviews that I conducted, there were only a few instances when safety and danger were used to refer to something other than crime and violence; other issues that were mentioned were natural disasters, traffic accidents and accidental injury. The danger of landslides illustrates the focus of these terms on crime and violence; landslides are common on the steep slopes of the valley of Medellín, destroying homes and causing fatalities. They are the most common natural disaster in Medellín and are regularly present in media reports. However, only two participants even mentioned landslides as a danger. Participants only mentioned dangers other than crime in a general sense. More so, while describing specific places in the city, none of the participants mentioned dangers other than crime and violence. I mention this to illustrate how in Medellín the words safety and danger trigger thoughts of crime and violence which are specific to the situation in the city. These words might trigger a wider range of issues in other cultures; however this was not the case in the
interviews I conducted. It is therefore necessary to establish the unique meaning of these words from the perspective of the participants.

In order to analyze perceptions of safety and danger regarding crime, I will define these three terms as semantic categories within the context of the study. My interest is in the concurrence of how participants express the meanings of and understand the concepts of safety, danger, and crime. What are the central characteristics that participants assign to these words? What are the peripheral characteristics that are held among some but not all participants?

Clearly these terms are difficult to explicitly define; they have a different meaning and range of use for each individual in Medellín. Therefore my intention is to qualify and describe the most typical uses of these three words and then synthesize their core meaning based on the definitions provided by interview participants. Since I was only able to interview university students due to the limited time available for field work, my analysis is representative of only a small sample of the population of Medellín. While this is a limitation of the study, I will demonstrate the effectiveness of the methodology I have developed and describe the perspective of university students in detail. Using semantic theory, I created a definitional frame work that accounts for the variation, and disagreement, in the range of use of these concepts among participants. I will first look at safety and danger together as related yet opposing concepts and then I will address the concept of crime.

Careful attention was given in the translation of these key terms to preserve the context in which they were used. I maintained consistency in how I used these terms throughout the interview (see Appendix A for English and Spanish versions of the interview questions). I used the word seguridad for safety and peligro for danger as nouns and seguro and peligroso as adjectives. I used the word crimen for crime.
Safety and danger are concepts describing a situation or an environment; in a broad sense, they refer to the thoughts, sensations, and emotions that individuals have about an abstract space or situation. Weirzbicka (1996) shows how definitions for abstract concepts as they are experienced by individuals—such as emotions—should consist of a prototypical scenario consisting of the typical thoughts and feelings that a person would associate with that concept. She argues that a “definition expresses a hypothesis about the meaning of a particular word, and it is valid if it accounts correctly for the range of use of this particular word. The boundaries of this range may be ‘fuzzy’, but even this fuzziness can and should be predicted by a well-phrased and well-researched definition” (1996, 183). The prototypicality of this range of use has further been categorized by Lukusa (1996) as the central and peripheral properties of a concept, where the former are held by all users and the latter are not part of the core meaning and therefore not shared by all users of the concept.

I developed a definitional framework that draws on both of these arguments. From the responses of interview participants, I established prototypical scenarios for safety and danger organized by central and peripheral properties. The central properties isolate the core meanings of these concepts; the peripheral properties encapsulate other uses that were shared by many but not all of the participants. I adapted the definitional structure used by Weirzbicka (1996) to formalize these concepts. The semantic prototypes for safety and danger are synthesized from interview responses in Tables 1 and 2.
Table 1. Central and peripheral properties of safety.

The properties of the semantic prototype for safety are listed in the left column. The right column corresponds to each set of properties with exemplary responses to the question: How do you define safety?

| Central properties of safety: | “[Safety is] a situation in which I feel tranquil and protected.” (“Una situación en la que me siento tranquila, protegida.”)  
|                              | “Where I am not threatened in any way, or do not feel at risk.” (“Donde esté sin ningún tipo de amenaza, no sentirme insegura”.)  
|                              | “[Safety] is to be secure, so that no one puts me in danger, as much physically as psychologically.” (“Estar a salvo, que no me perjudican tanto físico que sicológicamente.”)  
| Central properties of safety: | “[Safety is] a state in which one feels trusted and comfortable with the people around.” (“Un estado en que uno se siente confiado, bien cómodo con la gente alrededor.”)  
|                              | “[Safety is] welfare shared by others.” (“Un bienestar compartido con otros.”)  
| Peripheral properties of safety: | “[Safety is] places with a strong presence of public forces, the police.” (“Lugares donde está muy presente la fuerza pública, la policía.”)  
|                              | “Safety is that which I can control.” (“Seguridad es lo que controlo.”)  
|                              | “[Safety] is government security, vigilance and control, tranquility for civilians.” (“Es seguridad del gobierno, vigilancia, el control; una tranquilidad ciudadana.”)  
| Peripheral properties of safety: | “[Safety is] not having a camera watching you, nor is it having police everywhere.” (“No es tener una camara encima, ni tener un policía a cada momento.”)  
|                              | “[Safety is] stable security: being able to be part of a protest.” (“Una seguridad estable: poder ser parte de las protestas.”)  

A person perceives safety when he or she:
- is protected, calm and at peace,
- has a feeling of tranquility and personal freedom,
- is free of worries that something adverse or dreadful will happen, and
- is physically and psychologically unharmed.

“[Safety is] a situation in which I feel tranquil and protected.” (“Una situación en la que me siento tranquila, protegida.”)

“Where I am not threatened in any way, or do not feel at risk.” (“Donde esté sin ningún tipo de amenaza, no sentirme insegura”).

“[Safety] is to be secure, so that no one puts me in danger, as much physically as psychologically.” (“Estar a salvo, que no me perjudican tanto físico que sicológicamente.”)

A person may perceive safety when he or she:
- is in a secure environment which is shared and protected by the people around,
- feels comfortable, relaxed and trusted.

“[Safety is] a state in which one feels trusted and comfortable with the people around.” (“Un estado en que uno se siente confiado, bien cómodo con la gente alrededor.”)

“[Safety is] welfare shared by others.” (“Un bienestar compartido con otros.”)

A person may perceive safety when he or she:
- senses or sees the presence of the police or private security,
- feels civic tranquility and a sense of control or vigilance from the government or another force of protection, and
- feels free to move about the city.

“[Safety is] places with a strong presence of public forces, the police.” (“Lugares donde está muy presente la fuerza pública, la policía.”)

“Safety is that which I can control.” (“Seguridad es lo que controlo.”)

“[Safety] is government security, vigilance and control, tranquility for civilians.” (“Es seguridad del gobierno, vigilancia, el control; una tranquilidad ciudadana.”)

A person may perceive safety when he or she:
- does not sense or see the presence of the police or private security,
- has no inhibition to protest or express himself or herself in any way.

“[Safety is] not having a camera watching you, nor is it having police everywhere.” (“No es tener una camara encima, ni tener un policía a cada momento.”)

“[Safety is] stable security: being able to be part of a protest.” (“Una seguridad estable: poder ser parte de las protestas.”)
Table 2. Central and peripheral properties of danger.

The properties of the semantic prototype for danger are listed in the left column. The right column corresponds to each set of properties with exemplary responses to the question: How do you define danger?

<table>
<thead>
<tr>
<th>Central properties of danger:</th>
<th>“When one feels vulnerable to harm from another.” (“Cuando uno se siente vulnerable a que le hagan daño.”)</th>
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<tbody>
<tr>
<td>A person perceives danger when he or she:</td>
<td>“[Danger] is reflected by the fear that one has.” (“Se refleja por el miedo que tiene uno.”)</td>
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<td>is exposed, uncomfortable or at risk, because of this, he or she:</td>
<td>“It is an emotion that a person feels in certain circumstances because his or her fundamental values are threatened.” (“Es una emoción que uno siente en determinentas circustancias porque siente uno amenazada sus valores, valores fundamental la vida.”)</td>
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<tr>
<td>feels susceptible or vulnerable, in such a situation, he or she:</td>
<td>“Any situation that puts my physical or psychological integrity at risk.” (“Cualquier situación que puede poner en riesgo mi integridad física y sicológica.”)</td>
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<td>worries or fears that something detrimental or dire could occur, or</td>
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<td>experiences an eminent threat against his or her physical or psychological integrity.</td>
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<tr>
<th>Peripheral properties of danger:</th>
<th>“[Danger] is a situation in which one fears for his or her life.” (“Una situacion en que uno teme por lo que puede pasar con su vida.”)</th>
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<tbody>
<tr>
<td>A person may perceive danger when he or she:</td>
<td>“It is situation in which I am exposed to being harmed.” (“Una situación en la que estoy expuesta a salir perjudicada.”)</td>
</tr>
<tr>
<td>senses a vulnerability in his or her surroundings,</td>
<td>“[Danger] is experienced when someone’s life or the life of those close to them is compromised.” (“Se vive cuando uno siente que compromete su vida y la vida de quienes para uno son importantes.”)</td>
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<td>because of this, he or she:</td>
<td>“Something that endangers society, individually or collectively.” (“Algo que perjudica una sociedad, tanto individual que colectiva.”)</td>
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<tr>
<td>fears being harmed or fears that someone he or she cares about will be harmed, or</td>
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<tr>
<td>experiences a situation that could be detrimental to another individual or to society in general.</td>
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A person may perceive danger when he or she:  
feels a limitation of personal liberty,  
because of this, he or she:  
feels that the current situation is out of his or her control, or  
senses an eminent violation of his or her liberty.  

“[Danger] consists of a limitation of liberties.” (“Consiste en la limitación de las libertades.”)  
“It is a situation that I cannot control.” (“Una situación en que uno no la puede controlar.”)
A person may perceive danger when he or she:
- is in a marginalized situation,
- feels exposed to situations of insecurity because of violence, or
- experiences limited access to public services, education and health or medical services.

The central properties describe the characteristic thoughts and emotions that lead to an abstract prototypical situation of safety or danger. The peripheral properties describe more specific conditions that may or may not be satisfied in this situation, and therefore traverse the vague boundaries of the semantic categories. Asking participants to explicitly define these words illustrated how they use and understand the concepts.

Weirzbicka (1996) argues that one of the strengths of descriptive definitions using prototypical situations is that they contribute to the analysis of related concepts. The central properties of these prototypes demonstrate that safety and danger are contrary concepts and thus perceiving one excludes the other. A place or a situation cannot be both safe and dangerous without further contextualization; for example, a place could be safe during the day, but dangerous at night. I will address such contexts in the sections that follow. These prototypes show that even within such a specific context, the words safety and Danger are antonyms and the concepts themselves are opposite in meaning.

In contrast to safety and danger, which describe a perceived situation or condition, the term crime refers to something that happens, specifically something that is done by someone.
Crime is a concept that describes an occurrence—an act or the result of an act. The occurrence of a crime is inherently considered to be wrong or bad; however, there is a grey area—or vague boundary—as to that which is considered a crime and that which is not. The prototype I developed for crime in Table 2 accounts for the range of use among participants and the vague boundaries of this concept.
Table 3. Central and peripheral properties for crime.

The properties of the semantic prototype for crime are listed in the left column. The right column corresponds to each set of properties with exemplary responses to the question: How do you define crime?

<table>
<thead>
<tr>
<th>Central properties of crime:</th>
<th>“A harmful act that is committed against another person or group of people.” (“Algo mal que se comete en contra de unapersona o en contra de un grupo de personas.”)</th>
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<tbody>
<tr>
<td>Crime is an act or the result of an act that: adversely affects another person or group of persons; therefore, such an act: is a transgression of the liberties or fundamental rights of another, such an occurrence: infringes upon or violates the personal property or the physical or psychological integrity of another.</td>
<td>“A transgression of the liberty of another.” (“Una trasgresión de la libertad del otro.”)</td>
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<td>“Something that goes against the rights of another.” (“Algo que atenta contra los derechos de una persona.”)</td>
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<tr>
<td>“That which is committed against the personal property or personal integrity of another.” (“Lo que atenta contra los objetos personales y contra la integridad personal.”)</td>
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<th>Peripheral properties of crime:</th>
<th>“Any act that endangers the life of someone when it is not accidental.” (“Cualquier acto que ponga en peligro la vida de alguien que no sea una situación accidental.”)</th>
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<tr>
<td>Crime can be an act or the result of an act that: represents a danger or harms another person, provided that such an act: is intentional or could be avoided.</td>
<td>“Taking someone’s life in a situation that could have been avoided.” (“Quitarle la vida de una persona en una determinada circunstancia pudiendo optado por otra solución.”)</td>
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<tr>
<th>Crime can be an act or the result of an act that: goes against the morals, ethics or dignity of a population; therefore, such an act: is prohibited or penalized by the laws established by a state.</th>
<th>“It is only that which goes against the ethics and dignity of human beings.” (“Es solo lo que atenta en contra la ética y la dignidad del ser humano.”)</th>
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<tr>
<td>“Whatever goes against that which is perceived as good by the people.” (“Cualquier cosa que va en contra de la percepción de lo bien de las personas.”)</td>
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<tr>
<td>“An action that is penalized by the law.” (“Una acción que está penalizado por la ley.”)</td>
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| Crime can be an act or the result of an act that: is considered atrocious or reprehensible to a population; | “That which seems atrocious and will attack the order of things.” (“Lo que parece atroz y lo que va a atacar ese orden de cosas.”) |
The majority of participants defined crime based on how the person receiving the act is affected. The two most common responses can be summarized as that which goes against the integrity, physical or psychological, of another or that which infringes upon the liberties or rights of another. Such general definitions provide a core meaning from which the peripheral properties expand. In the most general sense, crime was defined by how the affected person perceives the situation. Personal integrity, liberty and rights are elements of an individual’s perspective of what crime is and are not shared in the same way by everyone. The structure of this definition allows for this individual perspective. One participant argued that if a person steals something to eat, it is not a crime. This act clearly falls into the grey area of the concept; however, based on the central property of a crime, one could argue that this act does not adversely affect the owner of the food that was stolen. The word adverse conveys that an act is antagonistic or harmful. However, if the act of stealing was repeated or resulted in a significant negative circumstance for the owner, then this could be considered a crime. Since the act is defined by the affected person, stealing a piece of bread is only a crime if the owner considers it to be.

There were not many participants who defined crime as an unlawful act or something that is prohibited by the state; therefore, I consider this a peripheral property of crime. The participants who defined crime as an unlawful act shared the perspective that the laws establish by the state represent the ethics and morals of society. Out of the 42 interviews, only a few
responses provided specific examples of acts which are considered to be a crime—such robbery, murder or corruption. Participants generally defined crime in an abstract sense. Therefore I excluded these examples of crimes from the prototype since the outcomes of these specific acts are described by the central and peripheral properties. Corruption is a unique example of a crime. Looking at the central properties of the prototype, an act of corruption might not directly affect someone in an adverse way; however, it is a transgression of the liberties and rights of society. Therefore it is a crime in the collective perspective. This illustrates how the prototype accounts for the individual perspective as well as the collective perspective; as such, it effectively addresses the range of uses and vague boundaries of the concept. Moving this analysis towards the specific contexts and places of safety and danger, I will now look at the characteristics of environments in general that participants associate with safety and danger.

**Characteristics of a safe place**

To better understand the situational contexts that generate feelings of safety or danger, I looked at the underlying characteristics of these concepts. I synthesized the answers to the following question: How do you describe a safe place, what characteristics does it have? I put this question at the end of the interview because it allowed participants to reflect on the overarching topics that we had discussed; this question evoked abstract feelings about safety and danger in a spatial context. In describing a safe place, participants also described what a safe place is not. Table 4 is a list of characteristics that were the most predominant in the interviews. I have organized the most common characteristics and included the interview responses in Spanish.
<table>
<thead>
<tr>
<th>A safe place:</th>
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<tbody>
<tr>
<td>Tranquility and serenity. (&quot;tranquilidad y serenidad.&quot;)</td>
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<td>makes you feel the warmth of home. (&quot;El calor que te da, como la casa.&quot;)</td>
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<tr>
<td>is where you can move about without worries and without intimidation. (&quot;Donde se puede</td>
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<tr>
<td>desplazarse sin preocupación, sin intimidación.&quot;)</td>
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<tr>
<td>is well illuminated. (&quot;Debe ser bien iluminado.&quot;)</td>
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<tr>
<td>is a place during the day. (&quot;Un lugar de día.&quot;)</td>
</tr>
<tr>
<td>is a clean, open area. (Que esté limpio y abierto.)</td>
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<tr>
<td>is where there are people you know and trust, people who respect you. (&quot;Un lugar donde tu</td>
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<tr>
<td>encuentras personas que te conozcan, que te quieren o te respeten.&quot;)</td>
</tr>
<tr>
<td>is where there are a lot of people. (&quot;Un lugar con mucha gente.&quot;)</td>
</tr>
<tr>
<td>is where people can act however they wish. (&quot;Un lugar en donde todo el mundo puede actuar</td>
</tr>
<tr>
<td>de la manera como uno es.&quot;)</td>
</tr>
<tr>
<td>has someone watching over and protecting the people there. (&quot;Un lugar donde están cuidando,</td>
</tr>
<tr>
<td>donde hay algún tipo de entidad que cuide.&quot;)</td>
</tr>
<tr>
<td>is where people can coexist in peace without law enforcement. (&quot;Donde se puede convivir en</td>
</tr>
<tr>
<td>paz sin influencias de fuerzas armadas.&quot;)</td>
</tr>
<tr>
<td>has the presence of authority, police or private security. (Que tenga presencia de autoridad,</td>
</tr>
<tr>
<td>gente de seguridad, policía.&quot;)</td>
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<table>
<thead>
<tr>
<th>A safe place:</th>
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<tr>
<td>is not where there are a lot of people. (&quot;Que no haya mucha gente.&quot;)</td>
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<tr>
<td>is not where there is discrimination. (&quot;Que no haya discriminación.&quot;)</td>
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<tr>
<td>is not under surveillance or being watched by anyone. (&quot;Donde nadie me vigile.&quot;; &quot;Que no</td>
</tr>
<tr>
<td>tiene personas que te están mirando.&quot;)</td>
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<td>does not have a presence of the police or law enforcement. (&quot;Donde no se ve fuerzas armadas</td>
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<td>de ninguna clase ni al régimen de la ley.&quot;)</td>
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<tr>
<td>is not prone to bad things like thefts. (&quot;Donde no hay un propenso que pasen cosas malas</td>
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<tr>
<td>(robos).&quot;&quot;)</td>
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<tr>
<td>is not where there are gangs, suspicious people or homeless people. (&quot;donde no veo ningún tipo</td>
</tr>
<tr>
<td>de bandillas o grupitos ni cosas así, que no hay un gamín.&quot;; &quot;Donde no hay personas sospechas.&quot;)</td>
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<tr>
<td>is not where problems occur, where people treat you badly, insult you, or commit an act against</td>
</tr>
<tr>
<td>your personal integrity. (&quot;Donde estás sin problemas que te van a robar, tratar mal,</td>
</tr>
<tr>
<td>insultar, atentan contra tu integridad.&quot;)</td>
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This list of characteristics provides an understanding of the fundamental qualities of spaces of safety and danger for participants. From this list, I identified the central themes that were present throughout the interviews. As can be seen in the summary above, certain characteristics present contradicting points of view; I will start with those that did not have conflicting perspectives. Tranquility was the most prevalent, and abstract, attribute that describes a safe place, and can be seen as a feature that is contingent upon all or any of the other characteristics. For many, a safe place is simply characterized by a feeling that one has: being carefree and feeling comfortable, calm, and relaxed. For the more concrete characteristics, street illumination at night was a very common element that participants associated with safety; dark spaces were not considered to be safe. Day time was a similar aspect of security; most participants simply felt less safe at night. Clean, open spaces were considered to be safer; dirty, depressed areas and also spaces that were closed off or that restricted movement were a common concern for security. For many participants, a defining characteristic for a safe place was the people present. On the one hand, familiar, trusted people make a place safe by providing protection and a sense of security. On the other hand, certain people can create a space of intimidation, discrimination and insecurity. Some participants were more specific about the type of people that generate insecurity; common examples were the presence of gangs, homeless people, and individuals that they considered to be suspicious.

The following characteristics were common, yet points of view conflicted among participants. For some, large amounts of people generate insecurity—safety of a few; for others large groups of people provide security—safety of the masses. Surveillance and the vigilance of another person were also characteristics of conflicting points of view. Many participants felt that having someone watching over them instills a sense of being protected, being cared for, or being
free of danger. Others saw this as an invasion of their privacy and civil liberty. Along similar lines but more specific, the presence of police, private security and other law enforcement was seen from both sides. A very common characteristic of a safe place was a constant and noticeable presence of law enforcement—public or private. In contrast, some participants were not confident in security forces as a means of providing safety. Some felt that the presence of these forces can lead violent conflict with other groups and it is therefore a source of insecurity. Others simply distrusted the very individuals of these forces.

To summarize, the central themes for safety and danger that I will discuss in this chapter can be categorized as such: time of day; the physical and built environment (illumination, cleanliness, openness); the people present (certain individuals, amount of people); and surveillance, private security and law enforcement.

**Central themes of safety and danger**

*Time of day.* Participants’ perceptions of safety and danger for many places in the city were contextualized by certain times of the day. Most participants considered nighttime to be generally more dangerous across the city. While many considered the downtown area to be dangerous in general, the majority of interviewees considered this to be the most dangerous area of the city at night. The notion that darkness incites anxiety and fear of crime is nothing new; this has been extensively documented in the literature (Ferraro 1995; Warr 1990) and was mentioned in nearly every interview. The darkness of night was associated with lonely areas and the presence of homeless people and drug users. Women tend to experience higher levels of fear and anxiety at night, particularly when alone (Koskela 1999). Many of the women I interviewed explained that being alone compounded the fear they already had about certain spaces at night. A number of men in the study also felt this way. Some participants perceived the early morning
hours to be more dangerous than the rest of the day. This was because the streets are lonely; early in the morning there is little traffic and an unsettling lack of movement of other people.

**The physical and built environment.** This was a broad theme that was present in every interview in one way or another. Many participants used geographical references of the physical environment when locating specific areas of safety and danger. Neighborhoods on the outside edge of the central to northern side of the city are situated in the highest parts of the valley. These areas are the highest in elevation and the most isolated from the rest of the city; they were commonly considered the most dangerous. While being socially constructed geographical references, certain terms such as the periphery, upwards, above, or the upper/higher parts of a certain area or neighborhood were used often to locate places that participants considered to be more dangerous. Many participants used these terms to refer to areas of limited socioeconomic resources and underprivileged working class neighborhoods which they perceived to be prone to crime, drug use and the organization of extralegal groups. These descriptors were rarely used to reference a safe area. Mountainous areas beyond the reach of the dense urbanization were often described as areas prone to muggings. Such areas were occasionally referred to as ‘the mountains’ or the mountains above a certain neighborhood. Many participants that lived in the southern, wealthier parts of the city often referred the more dangerous areas as the ‘north’ and for many participants there is a cultural and socioeconomic division between wealthier sectors on the south side of the city and the poorer sectors in the north.

In the built environment, common focal points of perceived danger were spaces that restricted movement. Bridges were often associated with homeless persons or those under the effect of drugs who present a danger. Bridges were also considered to be dangerous because they make a person feel trapped; in particular, bridges where the entrances are lonesome or feel
isolated. Alleyways present a similar sense of entrapment, more so when they are poorly illuminated. Street lighting and illumination is a factor that has been researched extensively in the fear of crime literature (see Pain 2000). A number of participants mentioned that recent improvements in illumination had made their neighborhoods safer. Many studies have shown that improved street lighting reduces fear of crime (e.g. Herbert and Davidson 1994; Ramsay and Newton 1991). Participants considered poorly illuminated spaces in the built environment—common examples were streets, walkways, bridges or parks—to be the most prone to personal crimes (such as mugging, assault or rape). Parks in general, especially at night, were indicated as areas prone to muggings due to poor illumination and dark spaces created by the trees where criminals can hide from view. For this reason, one participant considered neighborhoods with fewer parks to be safer. A few respondents associated the concentration of workshops or mechanic shops with a concentration of homeless persons and drug users. In Medellín and in Latin America in general, these types of businesses tend to be clustered in certain neighborhoods or along certain streets. Since these areas have very few residences and most businesses only operate during the day, at night these areas are extremely lonely. Depressed or abandoned areas in general were considered dangerous to pass through. Participants from the University of Antioquia frequently mentioned the abandoned railroad line next to the university as a dangerous area to pass through.

On the other hand, there were certain characteristics of the built environment that were perceived to make an area safer. In contrast to the comments regarding poor street lighting, parts of the city that had comparatively better illumination were considered to be safer. Participants described a number of enclosed environments that provide shelter from danger and instill a sense of safety. Enclosed urbanizations and residences with gated entrances and high walls have
become very common in Medellín. A few participants contextualized the sense of security in such units as sheltering the residents from seeing what was going on outside. One participant argued that although enclosed residences provide safety inside, the areas around can be dangerous as criminals prey on those entering and exiting. Modern enclosed shopping centers were another environment that provided a sense of safety for many participants. Shopping centers and the immediate area around them were described as safe spaces. Many respondents considered the sectors of the city with a higher density of such commercial centers to be safer.

The people present. The most common response regarding safety or danger had to do with the people or individuals present in a space. On the one hand, crowds and agglomerations of people incited fear of personal crime for many participants. For example, the downtown area was frequently mentioned as being dangerous simply for the fact that it was crowded—crowded with pedestrian traffic, street traffic, mobile and street vendors, storefronts, and commercial centers. On the other hand, many participants felt safer in areas where there was a notable presence of people in general; lonely areas with a lack of movement led to a sense of uncertainty regarding safety. While a comfortable median of the amount of people present was preferred by most participants, some had a general fear of unfamiliar people. Among the commonly feared unfamiliar persons were homeless people, street recyclers (those who travel the streets collecting recyclable materials), individuals who are selling or using drugs, delinquent youth, and gang members or members of militant groups.

The majority of participants described certain spaces as being dangerous because of the heightened presence of homelessness and drug use—the latter usually being associated with the former. Examples of these specific places were the downtown, areas along the sides of the rivers and canals in the city, areas around the municipal soccer stadium, and areas underneath the
elevated metro line. In general, any presence of homeless or destitute persons in public spaces produced a sense of insecurity and danger. Street recyclers are common in Medellín and are often associated with homelessness or indigence. While only mentioned by a few participants, the presence of street recyclers was described as a warning of insecurity in public spaces. Most participants described dangerous neighborhoods as those where these individuals were selling or using drugs. These dangers were not associated with specific features in the built environment, as was seen with homelessness for example, but more generally described certain sectors or neighborhoods. The presence of local gangs and armed conflict between militant groups and police (or between different militant groups) were frequently mentioned as significant dangers in certain parts of the city. I will address this in more detail in the next section.

**Surveillance, private security and law enforcement.** There were many conflicting and varied opinions regarding this theme. The use of surveillance cameras in public and private spaces—such as commercial centers, metro stations, outside of banks and private university campuses—generated two opposing perspectives which extended to a broader context of vigilance in general. On the one hand, those who saw it as a sign of safety and protection also felt safer in areas with a noticeable presence of authority, either from private security or law enforcement. For these participants, security is ensured by someone watching over an area, either in person or through surveillance. On the other hand, those who considered surveillance as an encroachment of their personal space and an invasion of their privacy also saw private security and law enforcement as forces that limit personal freedom and civil liberties. The majority of participants had opinions regarding the police and law enforcement that fell somewhere in between these two extremes. While the presence of law enforcement was considered a characteristic that made a space safer in general, many participants mentioned a sense of distrust
or unease with their presence. For most participants, this was not necessarily mistrust with the officers themselves but more a fear of being caught in the middle of a violent conflict between these forces and criminal groups. Some participants explained that although the presence of police usually makes a space safer, when they are called into a neighborhood or into an enclosed space it often creates a very dangerous situation. One participant explained how recently the police were called into the University of Antioquia because of some criminal activity and their presence generated a feeling of insecurity across the campus. Others described the violent conflicts in marginalized neighborhoods between gangs and the police (and also between urban guerrilla groups and the national army) which have left many innocent bystanders wounded or dead. There were a few participants who expressed a general mistrust with the police and armed forces and strongly associated them with insecurity. Corruption and abuses of power were reasons that were mentioned. An abnormally high presence of the police in a space was mentioned as indicating one of two situations. In the first, a high presence of the police indicated to participants that the area was very secure and therefore they felt safer. In the wealthier, more affluent parts of the city this type of situation was commonly associated with a high presence of the police. However, one participant did mention that in such a situation, there is a lot of crime that escapes the vigilance of the police. The other situation indicated eminent danger where the high presence of the police was associated with a presence of armed criminal groups; an abnormally large amount of police officers indicated a strong presence of criminal groups. This second situation was often located in the most marginal neighborhoods of the city where gangs, paramilitary forces and urban guerrilla groups operate. I will now look at some of the specific parts of the city where these themes were most relevant.
Specific areas of safety and danger

In each set of interview questions regarding safety and danger, I started by asking which neighborhoods they considered to be the safest or most dangerous respectively. In a simple activity of cognitive mapping, participants named the specific neighborhoods and sectors that first came to mind. This provided a general overview of the areas perceived as the safest and most dangerous. Many participants explained that their perceptions of certain places were based on the reputation the area had or on information presented by the media and not necessarily from personal experience. I will return to the issue of first and second-hand experience in cognitive mapping towards the end of this chapter. To get an initial impression of collective perspective among participants, I created a list of neighborhoods and sectors that were mentioned by more than one individual. Surprisingly, there were not any conflicting opinions in this list where a neighborhood or sector was considered among the safest and the most dangerous. This list of named places is mapped in figure 2a.
Participants tended to divide the city into sectors as they described specific areas of safety and danger; one interviewee used the verb *sectorizar* (to sectorize) to explain how he perceived security in Medellín. Such sectors were usually partitioned geographically but also identified by the social factors regarding safety and danger that were present in these areas. Additionally, certain areas were considered to be prone to specific types of crime and violence. As far as general orientations, most participants considered sectors 11, 14 and 16 to be the safest parts of Medellín. The downtown area (sector 10), the most western (sector 13), and the northeastern and

Figure 2. Areas of perceived safety and danger, and socioeconomic strata.

a) Shown in red and blue are only the sectors and neighborhoods that were mentioned by at least two participants. b) Level (by weighted average) of socioeconomic strata by neighborhood; 1 is the lowest, 6 is the highest. Sectors are labeled with their administrative number. Strata classes are defined using the Jenks method.

Participants tended to divide the city into sectors as they described specific areas of safety and danger; one interviewee used the verb *sectorizar* (to sectorize) to explain how he perceived security in Medellín. Such sectors were usually partitioned geographically but also identified by the social factors regarding safety and danger that were present in these areas. Additionally, certain areas were considered to be prone to specific types of crime and violence. As far as general orientations, most participants considered sectors 11, 14 and 16 to be the safest parts of Medellín. The downtown area (sector 10), the most western (sector 13), and the northeastern and
northwestern regions of the city were considered to be the most dangerous. However, many participants clarified that there are no safe neighborhoods in Medellín and those they listed were only relatively safer. A few participants simply answered that there are no safe neighborhoods and felt that all areas of the city are best described as dangerous to a certain degree. Therefore comparing levels of safety and danger is only meaningful in a relative sense. Keeping that in mind, the majority of participants made a clear distinction between the safest and most dangerous parts of the city.

The safest sectors were frequently described to have a higher socioeconomic level. The relationship between perceived safety and danger and socioeconomic level can be seen in figure 2. Other general characteristics included: more presence of the police, private security and other law enforcement; the people in these neighborhoods are more educated; most people have cars so there are less people on the street; and these areas are more organized and have better illumination. Sector 14 was the most commonly mentioned among the safest sectors. This is the wealthiest part of the city with the largest amount of enclosed residences and modern shopping centers. Participants often described this sector to be cleaner, calmer and more organized relative to other parts of the city. After the downtown area, this is the second most important sector of the city for commerce and banking. Many participants argued that it is safer because the residents are financially affluent and have no need to steal. On the contrary, a number of participants explained that sector 14 and other wealthy parts of city are more prone to robbery of homes as individuals from other areas come to these areas to steal. Sector 11 was the second most commonly named among the safest parts of the city. This sector is one of the most affluent parts of Medellín, yet many participants felt that it experienced rather high levels of specific crimes. Because of its central location in the city, it is along a major thoroughfare and is less isolated
than sector 14. Most participants considered this sector to be safe in general, but rather prone to muggings, car or motorcycle theft, robbery and assault by homeless persons.

Among the parts of the city that were considered to be the most dangerous, the downtown area (sector 10) was mentioned the most; it was frequently described as dangerous during the daytime because of muggings, pick pocketing and theft in general. This area was described as unique by many participants in that there are relatively few residences and it has the highest concentration of street traffic, pedestrians, and commerce in the city. Participants had different impressions of the sector regarding the time of day. While some did not necessarily fear the downtown during the day and argued that security in the sector had improved recently, after dark the area was described as being a dangerous focal point for crime in nearly every interview. A few participants described this as a transformation of the downtown area at night: almost all businesses close except for bars and casinos and the streets become dark and empty except for homeless people and drug users. In addition to crimes of theft, at night it was considered highly prone to assault (particularly if one resists in a mugging), crimes against women (rape or sexual assault), prostitution and also murder. Therefore most participants indicated the downtown as one of the most dangerous parts of the city in general.

Aside from the downtown area, the most dangerous parts of the city were characterized as zones of drug dealing, organized crime and urban guerrilla or paramilitary presence. Sector 13 was frequently mentioned as a one of the most dangerous parts of the city, described as a lower class area that has experienced intense armed conflict in the last decade. In 2002 the national army entered this sector to remove the presence of urban guerrilla forces. The military operation resulted in a bloody armed conflict that left a lasting memory among residents (Ramirez 2008). A number of participants explained that their fear of sector 13 was based on information from the
media and word of mouth and not necessarily from personal experience. Because of this, the descriptions of potential dangers in sector 13 were less specific than the downtown. Participants feared this sector of the city because of armed conflict that has continued intermittently since 2002. Many also mentioned the presence of gangs, drug dealing and delinquency in general. The neighborhoods in the most eastern extent of the city were also described in a similar manner but much less frequently.

The northwestern and northeastern parts of the city (sectors 1 through 6) were often described in a similar context, where many participants characterized these areas as marginal with high levels of poverty and criminality, as focal points for drug dealing, as spaces affected by territorial control of gangs, and as the sectors of the city that have a general lack of police presence. Many participants felt that these issues of insecurity were the result of a lower level of education among residents, indigence and poverty, high levels of unemployment, and a general lack of opportunity. Difficult access to education and public services and an overall lack of government support in these areas were mentioned a number of times as reasons for these conditions. One participant explained how these conditions contribute and feedback into the situation of violence: “such a depressed neighborhood is dangerous for a mother to have her children in because at some undetermined moment, they will have to choose which gang to become part of.” Many participants felt that these sectors were the most dangerous for children and youth because they grow up in these conditions of violence and marginality.

Among these areas, sector 3 and sector 4 were described in the most detail. A number of participants did describe personal experiences in these sectors and a few participants either lived or had previously lived in one of these sectors. These opinions supported the previously mentioned perception of these sectors of the city, but offered more context about the situation.
One participant explained that when returning to his home in sector 4 at night, he had to take a specific roundabout route to avoid areas that were controlled by local gangs. He explained that in this sector, gangs control specific areas and are very territorial about who resides within and who passes through them. Residents often have to avoid certain areas that are particularly dangerous because of gang territoriality. Thus, residents in this sector have to learn the territories of the local gangs to avoid being threatened or other potential dangers. A few participants had experienced this type of situation as non-residents in other sectors of the northeastern and northwestern parts of the city, mostly after dark. They explained that neighborhood gangs are suspicious of individuals they do not recognize—especially at night—and outsiders are not allowed to enter or even pass through areas under their control. While many participants feared entering or passing through a neighborhood where they would not be recognized, one participant who had previously lived in sector 3 explained how the sense of community where she lived actually created a very safe space and that the gang controlling the neighborhood was part of this community. She felt that this sense of community was not common in the more affluent parts of the city and residents must therefore rely more on the police and private security. She argued that although the presence of local gangs was a danger for outsiders, these groups usually watched over neighborhood residents and protected them from other gangs and from personal crimes (such as muggings, rape or assault). The spatial coincidence of these perceptions shows certain patterns across the city. I close this chapter with the results of the cognitive mapping exercise.

**Overlay mapping**

The overlay methodology of participatory mapping fixes the scale, and essentially the coordinate system, at which each of the cognitive maps are drawn. This provides for a consistent comparison between the spatial perceptions. I offered two different base maps to choose between
to allow for different levels of comfort that participants might have working with maps. In 33 of the 40 completed interviews, participants chose to use the aerial photograph. Among the 7 who chose to use the traditional map, many mentioned that the sector and neighborhood boundaries were helpful in orienting themselves. Many of those who preferred the aerial photograph commented on how they liked to be able to see the actual features in the city. 31 of the 40 participants indicated safe or dangerous places using areas (circles or polygons mostly). 9 used lines, points or x’s. The two base maps with the corresponding cognitive maps overlaid on them are shown in figure 3. While this was an interesting experiment in map preference and the ways in which participants used the maps, it limited the number of comparable overlays. 28 of the 40 participants chose the aerial photograph and indicated safe and dangerous places with areas. This is the subset of the overlay maps that I will use in the spatial analysis of this study.

At the end of the mapping activity, I asked participants to indicate approximately where their house was located. Of the 42 participants, nine live outside the municipality of Medellín. Two located their home within an area they had identified as dangerous and six located their home inside a safe area. The sample size is too low to draw any significant conclusions; however, it is interesting that the majority of participants did not indicate the area where they live as either safe or dangerous. All of the participants who reside outside of Medellín live in a neighboring municipality that is within the metro area. There were no noticeable differences between the perspectives of these participants compared to those who live within the municipality of Medellín.
Participants’ perceptions of specific areas of safety or danger were formulated from personal experiences and other sources of information. Participants described these places based on word of mouth and warnings from friends and family; based on stories they had heard from a person who lives there; based on media reports and newspaper articles; and also based on first person experiences in these places. Trying to sort out which locations participants experienced
firsthand rather than through other inputs of information is an unnecessary and pointless effort. I argue that since participants’ perceptual terrains of safety and danger are not based solely on personal experiences, their perceptions extend to the broader context of perceived security in the city. While stories, media reports and word of mouth warnings are likely to exaggerate actual events, these sources of information are based on actual events, at least loosely, and have a relevant role in the perceptions of specific places. I make the important distinction between perceptions of reality and representations of reality. The former is the experiential perspective of an individual in his or her environment, while the latter is an attempt to accurately represent reality unaltered by the human experience. Comparisons between perceived danger and rates of victimization have shown mixed results, aside from the argument that the logic behind such comparisons is problematic in the first place (Pain 2000). This study is concerned with describing the overall spatial patterns of perceived safety and danger in Medellín, rather than arguing that these patterns represent the spatial distribution of victimization rates. While the comparison is interesting, subjective and objective representations of crime patterns address different social processes. As I have shown in this chapter, fear of crime is explained more by social factors and features of the built environment than by actual victimization. When a person is the victim of a crime, a strong association of danger is attached to the place of victimization. This association is then projected to other places with similar characteristics and circumstances. This is exemplified by dark, lonely area and fear of crime; when a person is victimized in such a space, he or she is likely to fear dark, lonely areas in general. The perspective represented in this dataset provides an overview of public perception in Medellín. While the interview sample was limited to university age students, their perceptions speak about the broader public opinion. The general patterns from the overlay maps in figure 3a suggest that an increased number of
participants would produce a similar representation of safety and danger in the city. While the variation among the cognitive maps in non-trivial, the majority indicate the same ‘hotspots’ of perceived safety and danger.
Chapter 4. Spatial analysis of safety and danger

Terrains of safety and danger

This chapter addresses the broader context of perceived safety and danger across the city as a whole by first analyzing the overlay maps, then the ECV dataset and finally the two datasets together. I begin with an initial overview of these two datasets as terrains of safety and danger which establishes the context for a comparison between them. As shown in Chapter 3, the semantic prototypes I have developed for safety and danger cover the range of use of these terms; and furthermore the central properties of the prototypes encapsulate the core meanings of these concepts within the cultural context of Medellín. Thus I argue that the definitions of safety and danger presented here apply not only to the interview maps but also to the responses from the ECV dataset regarding neighborhood security. I will argue this by showing how the two datasets correspond spatially and in how they describe specific parts of the city. To provide formal definitions which underlie the spatial analysis of these two datasets, I have reformulated the central properties in a dictionary-style format:

Safety: a state of being protected, calm and at peace that produces a feeling of tranquility and personal freedom: as a) free of worries that something adverse or dreadful will happen: b) being physically and psychologically unharmed.

Danger: a state of being exposed, uncomfortable or at risk that produces a feeling of susceptibility or vulnerability: as a) being worried or fearful that something detrimental or dire could occur: b) experiencing an eminent threat against one’s physical or psychological integrity.

While these definitions might be representative for many cultures, in the data translation from individual cognitive maps to a GIS dataset the context of these terms must be preserved.
For the interview data, it is important that the terms safety and danger are not reduced to vague labels without any connection to the qualitative collection of the data. In the fuzzy logic analysis of the interview and survey datasets, these definitions will provide a formal meaning for the membership functions. Essentially, this is the central component of the underlying metadata for the GIS data in this analysis. Additionally, I will draw on the information from Chapter 3 to provide context as I identify specific areas of safety or danger from the overlay maps. For the survey data, this context in specific areas will be provided by questions asking about neighborhood security.

*Overlay maps from interviews.* Since I used two different base maps in the overlay activity and participants used different symbols to represent areas of safety and danger, not all of the surfaces are cartographically and geometrically comparable. The different ways in which participants indicated areas on the cartographic map and on the aerial photograph—as described in Chapter 3—made a comparison of the two sets incompatible. Furthermore, a comparison of the overlays where participants indicated places with points to those indicated with enclosed areas was incompatible geometrically. Therefore, to provide a consistent comparison I used the subset of 28 interviews where participants chose to use the aerial photograph and indicated places in the city by drawing enclosed areas. Figure 4 shows the cumulative surfaces of safety and danger drawn by these participants. Of the 28 participants in this subset, the maximum spatial coincidence for safe areas was 17; for dangerous areas it was 14. The minimums for safe and dangerous are the areas that were identified by only one participant. The areas that were not indicated were perceived as neither safe nor dangerous.
The ECV survey was administered in 243 of the 249 neighborhoods asking a total of 220 questions regarding quality of life in Medellín. The sample represented between 1.4 and 7.1 percent of the population by neighborhood with a mean of 3.4 percent. Of relevance in this analysis are two of these questions which addressed perceptions of security in the respondents’ neighborhood. The main question of interest asked respondents: how do you feel in your neighborhood? The question offered four response options: very safe, safe, dangerous, or very dangerous. ‘No response’ was also recorded in the dataset; however, the frequency was extremely low—0.3 percent—therefore these responses will be omitted from the analysis. I will

Figure 4. Surfaces of safety and danger from interview data.

Areas of a) safety in blue and b) danger in red drawn by interview participants. Darker areas indicate a higher coincidence of perceptions among participants.

**ECV dataset.** The ECV survey was administered in 243 of the 249 neighborhoods asking a total of 220 questions regarding quality of life in Medellín. The sample represented between 1.4 and 7.1 percent of the population by neighborhood with a mean of 3.4 percent. Of relevance in this analysis are two of these questions which addressed perceptions of security in the respondents’ neighborhood. The main question of interest asked respondents: how do you feel in your neighborhood? The question offered four response options: very safe, safe, dangerous, or very dangerous. ‘No response’ was also recorded in the dataset; however, the frequency was extremely low—0.3 percent—therefore these responses will be omitted from the analysis. I will
refer to this question as ‘perceived neighborhood security.’ The other question of interest—which provides context for the former—asked respondents: which are the two most serious problems, in order of importance, in relation to security in your neighborhood? The following eleven options were offered: existence of gangs, occurrence of muggings in the street, theft of vehicles, robberies of homes, robberies of businesses, homicides, drug dealing, occurrence of rape, vandalism, presence of militant groups, or none. To clarify, the last option was offered as part of the list and was not recorded as ‘no response.’ The frequency of no response was quite low—1.8 percent—and will therefore be omitted. This question also provided an option for ‘other’; however, these write-in answers were not documented in the survey dataset and therefore cannot be considered. These responses accounted for 0.8 percent of the sample. I will refer to this question as ‘neighborhood security problems.’ The survey form for these questions is included in Appendix C.

To get an initial idea of the distribution of perceived neighborhood security, I have mapped the percent response to the options very safe and safe together in figure 5a and the percent response to the options very dangerous and dangerous together in figure 5b. While the maps in figure 5 are a simplified representation of the data, they provide a general overview of how safe or dangerous respondents perceived their neighborhood to be. 86.9 percent of respondents considered their neighborhood to be safe (77.7 percent safe and 9.2 percent very safe); only 13.1 percent of respondents considered their neighborhood to be dangerous (12.1 percent dangerous and 1.0 percent very dangerous).
Conceptually, a 100 percent response of very safe and a 100 percent response of very dangerous would indicate the safest and most dangerous neighborhoods respectively. Since the full range of responses was not represented in the dataset, the level of perceived safety or danger in each neighborhood can only be compared in a meaningful way relative to other neighborhoods. Responses to either safe or very safe ranged from 45 to 100%; responses to either dangerous or very dangerous ranged from 0 to 55%. In terms of the options offered in the

Figure 5. Surfaces of safety and danger from ECV dataset.

Shown is the percent response of how survey respondents considered their neighborhood: a) very safe or safe, and b) very dangerous or dangerous. I used the same classes for both maps to illustrate how these responses must be considered in a relative sense and not in absolute percentages; therefore neither map spans the entire range of the legend. Classes are defined by six equal intervals. Responses to safe ranged from 45 to 100%; responses to dangerous ranged from 0 to 55%. In terms of the options offered in the
survey, most respondents considered their neighborhood to be quite safe. While the data is recorded in a quantitative manner, responses to this question are clearly subjective in nature and only meaningful when compared to all other responses. As I have clearly illustrated in the previous chapter, the concepts of safety and danger are subjective and relative.

This analysis brings these two datasets together in a mixed methods analysis, which provides a comprehensive understanding of perceptions across the city as a whole. As mentioned previously, the two datasets provide two distinct, yet complementary, perspectives of safety and danger. The overlay maps show the point of view of interview participants looking outward across the entire city, while the ECV dataset shows the point of view of survey respondents looking inward on their neighborhood. Since the overlay maps represent an outward looking perspective that is based not only on experiences in these areas but also on popular opinion, word of mouth and media influence, it complements the perspective of the residents in each neighborhood who experience these spaces every day. The overall spatial patterns in figures 4 and 5 illustrate the differences in these two perspectives. Compared to the survey data, the overlay maps show fairly concentrated spaces of perceived safety and danger. The survey data show similar patterns but with high local variation from neighborhood to neighborhood. This variation reflects the local context in each neighborhood. As many interview participants mentioned, the perspectives of those who live in a neighborhood and those who are outsiders—passing through or visiting—will be very different and often conflicting. Thus bringing these two perspectives together better represents perceptions of safety and danger in Medellín. In the analysis that follows, I will use fuzzy set theory in a framework of qualitative GIS to create a composite surface of these two terrains of safety and danger. I will then look at the specific context of the areas of the highest perceived safety and danger.
A qualitative GIS framework

As discussed in detail in Chapter 3, the interview participants considered specific parts of the city to be safer or more dangerous for specific reasons and because of certain crimes or sources of danger. This information provides texture and context for the surfaces of safety and danger drawn by the participants. For example, the northeastern and northwestern parts of the city were considered to be more prone to gang related violence and drug dealing because of difficult access to education, government services and a lack of opportunity in general. The downtown area was considered to be particularly prone to muggings and pick pocketing; this was often attributed to the heightened presence of homeless people and drug users. It was also perceived to be the most dangerous part of the city after dark due to increased risk of personal crimes (such as assault, rape, or murder). These specific contexts add a layer of depth to the qualitative nature of the overlays, which have been translated into a GIS dataset (fig. 4). I will use the explanatory power of the survey data to show how and where the outward and inward looking perspectives correspond and differ.

While the interview data clearly have more descriptive quality, the survey data do show certain spatial patterns that help describe the surfaces of perceived neighborhood security (shown in fig.5). The responses to the question of neighborhood security problems provide context for why residents consider their neighborhood to be safe or dangerous. Certain crimes were considered to be more serious in certain parts of the city. This question allowed respondents to identify two problems from the list of response options. The maps in figures 6 through 8 show the percent of respondents by neighborhood who chose a certain security problem as one of their two response options.
Figure 6 shows percent response to problems related to violence from organized crime. The existence of gangs was considered to be a significant problem in the northeastern and northwestern parts of the city and also in the extreme eastern and western neighborhoods (fig. 6a). The presence of militant groups was perceived to be one of the most significant problems in the most eastern and western neighborhoods and to a lesser extent in the northwestern sectors.

Figure 6. Neighborhood security problems: gangs and militant groups

Shown is the percent response of a) the existence of gangs and b) the presence of militant groups as one of the two most serious problems of neighborhood security. Classes are defined by the Jenks method.
In contrast, the areas of the city where property crimes were considered to be the most significant are shown in figure 7. Car theft was among the most significant problems in the central western part of the city, which is one of the most affluent areas (fig. 7a). To a lesser extent, the southeastern sector (which is also a wealthier area) and the downtown sector were also considered to be prone to car theft. Figure 7b shows the areas where burglary is considered one of most serious problems. Again, respondents living in the more affluent parts of the city felt this was more significant, yet there is less consistency among these responses.

Figure 7. Neighborhood security problems: car theft and burglary

Shown is the percent response of a) car theft and b) burglary as one of the two most serious problems of neighborhood security. Classes are defined by the Jenks method.
Finally, I contrast the neighborhoods where drug dealing was considered one of the most significant problems with responses of none in figure 8. Figure 8a coincides spatially to the presence of violent groups in figures 6a and 6b, and is spatially disjoint with the neighborhoods where respondents answered none (fig. 8b). While the descriptive quality of the responses to this question is dampened by the limited number of response options, they help contextualize the perceived level of neighborhood security. The mean response of none was 69 percent. This indicates that there were not enough response options (or that the options did not reflect the

![Figure 8. Neighborhood security problems: drug dealing and none](image)

Shown is the percent response of a) drug dealing and b) ‘none’ as one of the two most serious problems of neighborhood security. Classes are defined by Natural Breaks.
respondents’ concerns) and it also reflects that most residents surveyed considered their neighborhood to be relatively safe (thus none of the problems listed in the survey were significant). The latter is supported by the high level of responses to safe and very safe for how respondents consider their neighborhood.

Figures 6 through 8 show the strongest patterns among the 11 options to this question. While there is potential for further statistical analysis, I will only utilize the responses to this question in their descriptive capacity to provide context for perceptions of safety and danger in specific areas. The problems of neighborhood security correspond very closely to the information provided by interview participants discussed in Chapter 3. I argue that this further supports the basis for an analysis integrating these two datasets. A qualitative GIS framework offers multiple perspectives for looking at mixed methods datasets. I will use this approach to triangulate between the qualitative analysis from Chapter 3, the descriptive qualities of the survey data and the results of the spatial analysis. This allows me to use these different perspectives to better understand the process of perceived safety and danger in the city.

**Fuzzy membership functions**

Fuzzy set theory is an effective analytical framework for working with poorly defined, vague concepts. Thus, it is an appropriate approach for these data. In Chapter 3 I have addressed the vagueness in the definitions of the concepts of safety and danger. Based on the semantic prototypes, I will now address the vagueness in the spatial extents and boundaries of perceived safety and danger in the two datasets. The formal definitions provided at the beginning of this chapter establish the meaning of full membership (a membership value of 1) for the fuzzy sets that I define as safety and danger; a value of 0 is no membership to the corresponding definition. To derive fuzzy membership functions for the two datasets, I used a simple approach based on
the Similarity Relation model: membership functions were derived from the data values and not from previous research or another form of expert knowledge. I calculated the degree of membership from the level of correspondence among the perceptions represented in each dataset. By *correspondence*, I refer to the spatial coincidence of areas indicated by participants as either safe or dangerous in the interviews and to the range of percent response from very safe to very dangerous for the survey. I will address this correspondence in each dataset within a fuzzy logic framework. Figure 9 shows the sequence of operations in the analysis.

Figure 9. Flow chart of fuzzy analysis.
**ECV dataset.** In a simple application of the Similarity Relation model, I derived membership functions for the survey data based on an ordinal scale. Survey respondents were asked how they feel in their neighborhood regarding security. The response options were presented in an ordinal fashion in the following order: very safe, safe, dangerous, or very dangerous (see Appendix C for the original survey form). Thus the most appropriate method for deriving the membership function was to base it on how the survey question was asked. I simply applied an ordinal ranking to the four options: 1 to very safe, 2 to safe, 3 to dangerous, and 4 to very dangerous. I then multiplied the percent response in each neighborhood by its ordinal rank and summed the values. The membership function (on this ordinal scale) for the fuzzy set ‘survey dangerous’ is defined in equation 1.

\[
\mu(\text{survey dangerous}) = \%VS + (\%S \times 2) + (\%D \times 3) + (\%VD \times 4)
\]  

(1)

Where \%VS is the percent response to very safe by neighborhood; S is for safe; D is for dangerous; and VD is for very dangerous. The values ranged from 1.21 to 2.67; I then normalized the ordinal values from 0 to 1 to get a normal fuzzy set. Figure 10 shows the distribution of responses to each of the four options by neighborhood and the membership function for perceived danger (red line) derived from the ordinal ranking. Each vertical bar represents a neighborhood and the percent response to the four options (dark blue for the percent response to very safe, light blue to safe, light red to dangerous and dark red to very dangerous). The neighborhoods are then ordered from left to right from safest to most dangerous based on their rank from equation 1. The value from equation 1 is then plotted for each neighborhood—the red line in figure 10. This line is the membership function for the fuzzy set ‘survey dangerous.’
As I have argued previously, the level of perceived safety and danger in each neighborhood must be considered relative to others in the dataset. From the ordinal ranking, there is a continuous gradient from the neighborhood perceived as the safest to the one perceived as the most dangerous. The former has a membership value for the fuzzy set ‘survey dangerous’ of 0 and the latter has a membership value of 1 (illustrated with the red line in fig. 10). According to classic set theory and the Law of Contradiction, a location cannot belong to both the set ‘dangerous’ and to the compliment of that set. This would imply that a neighborhood cannot be perceived as dangerous and also as safe. This dataset clearly violates this assumption. Fuzzy set

![Figure 10. Distribution of ECV response options.](image)

The percent response to each of the four options by neighborhood is shown on the left y axis and neighborhoods are ordered from safest to most dangerous on the x axis, according to the ordinal ranking. The red and blue lines show the shape of the membership functions for ‘survey dangerous’ and ‘survey safe,’ respectively. Membership values are shown on the right y axis.
theory relaxes the Law of Contradiction and allows a location to have varied degrees of membership to a set and to its compliment concurrently. The fuzzy set ‘survey safe’ is defined as the compliment of ‘survey dangerous,’ shown in equation 2 as defined by Zadeh (1965).

\[
\bar{\mu}(\text{survey dangerous}) = 1 - \mu(\text{survey dangerous}) = \mu(\text{survey safe})
\]  

Equation 2 implies that the sum of ‘survey dangerous’ and ‘survey safe’ in any given neighborhood will be 1. The membership function for ‘survey safe’ is shown as the blue line in figure 10, which illustrates the fuzzy compliment relationship (shown spatially in fig.11).

**Overlay maps from interviews.** The interview sets ‘safe’ and ‘dangerous’ have ranges of spatial coincidence for areas indicated by participants from 1 to 17 and from 1 to 14, respectively (see fig. 4). Although the surfaces of perceived safety and danger were created from 28 overlay maps, the maximum number of participants that indicated any specific area was less for each set. For the first set, the spaces indicated by 17 participants are the safest according to this subset of the population and have full membership to the concept of safe defined at the beginning of this chapter. The degree of membership decreases in areas indicated by fewer participants. The same
The degree of membership is shown for the fuzzy sets a) ‘survey safe’ and b) ‘survey dangerous.’ Survey safe is the compliment of survey dangerous.

interpretation applies to spaces indicated as dangerous, where the maximum was 14. However, the two sets are not mutually exclusive (see fig. 4); in many cases, an area that was perceived by one participant as dangerous was perceived by another as safe. Therefore the level of perceived safety or danger at any given location must be considered as relative to all other locations in the dataset, the same as with the survey responses.

As argued in Chapter 3, safety and danger are antonyms, and more importantly they are concepts of opposite meaning according to the interview participants. I extend this argument into the spatial domain; if the level of correspondence of safety and danger is conceptually situated
on a number line, danger would move in one direction (say positive) and safety in the other
direction (negative). Thus, positive 14 is relatively the most dangerous location—or pixel in this
case—and negative 17 is the safest, as shown in equation 3.

\[ \bar{\mu}(\text{interview dangerous}) = \text{coincidence of dangerous} - \text{coincidence of safe} \quad (3) \]

Pixels where the two sets overlap have a positive value when they were perceived to be more
dangerous than safe and negative when perceived safer than dangerous. I derived the fuzzy
membership function for ‘interview dangerous’ by normalizing this range of values from 0 to 1,
as shown in figure 12. The fuzzy set ‘interview safe’ is defined as the compliment of ‘interview
dangerous’ as was done with the ECV dataset. The spatial distribution of membership values is
shown in figure 13.
Figure 12. Membership functions for interview data.

The level of spatial coincidence for safe and dangerous areas drawn by participants is shown on the left y axis. The unique combinations of levels of spatial coincidence from the overlay maps are ordered from safest to most dangerous on the x axis. The red and blue lines show the shape of the membership functions for dangerous and safe respectively. Membership values are shown on the right y axis.
This approach treats the perceptions of all participants as equal and assigns a membership value to each pixel based on the spatial coincidence of both perceived safety and danger. The areas where the two sets overlap can be addressed with a measure of confusion. The confusion index indicates the degree of overlap between two sets (Burrough and McDonnell 1998).

\[
\text{Confusion Index} = 1 - |\mu(\text{dangerous}) - \mu(\text{safe})| \tag{4}
\]

Figure 13. Membership values for interview data.

The degree of membership is shown for the fuzzy sets a) ‘interview safe’ and b) ‘interview dangerous.’ Interview safe is the compliment of interview dangerous.
As shown in the graph in figure 12, the highest levels of confusion are centered on where the two membership functions intersect (between values of 0.4 – 0.6). Figure 14, shows the spatial distribution of the confusion index for the interview sets.

**Patterns and context of perceived safety and danger.** As indicated previously, the survey dataset shows less clustering of perceived safety and danger than the interview dataset. This variation at relatively short distances highlights the changing situation in each neighborhood. This variation is likely not observed by the outsider; hence the interview data does not show it. In the survey data, the subtleties of perceived security from one neighborhood to another are better explained by the specific security problems indicated by respondents (shown in figures 6 through 8). For example, the high membership to danger in the extreme western and eastern neighborhoods corresponds to the opinion that gangs and militant groups are the most serious security problems in these neighborhoods. These security problems reflect the dangers of organized crime and urban violence. In contrast, neighborhoods where the most serious security problems were muggings, car theft and burglary had lower memberships to danger. These less violent crimes were considered to be more serious in the southeast and west.
central parts of the city, yet membership to danger in these areas is significantly lower than in neighborhoods where gangs and militant groups were the most serious problems. In the west central neighborhoods, the less violent security problems were indicated more and membership values to danger were also higher than in the southeast. These patterns illustrate the relationship between membership values to safety or danger and the different security problems perceived in each neighborhood. Additionally, they help explain the variation among adjacent neighborhoods and the different situations perceived in them.

On the other hand, the interview data shows an outsider’s perspective that appears to generalize more in specific areas indicated as particularly safe or dangerous. Four areas of perceived danger stand out. The western area of sector 13 was described as being overrun by urban gangs and militant groups. The northeastern and northwestern concentrations of perceived danger were characterized by gang violence and focal points for drug dealing. The central concentration in the downtown area was considered the most prone to muggings and assault, often associated with homeless people and drug users. The southeastern part of the city has the highest membership to perceived safety; this was described as an area that has a higher presence of the police, private security and is more affluent compared to other areas. The central-western concentration of perceived safety was described as more affluent, with a high presence of private security, but vulnerable to property crime and personal violence at the same time. This was explained by its central location in the city where criminals, homeless people and drug users tend to frequent. This area was considered particularly prone to car theft.

So, the fuzzy membership values for the interview and survey datasets show the same broad patterns and situations of safety and danger across the city. The membership functions for the two datasets represent the range of safety and danger perceived spatially by these different
samples of the population. In each of the datasets the membership functions span from the safest to the most dangerous places indicated by participants or respondents. Deriving the membership values with a consistent methodology allows for a bringing together of these data.

**Fuzzy logic operators**

The advantage of modeling vague concepts with unclear boundaries using fuzzy set theory is that it provides a consistent framework in which a set of logical operators can be used. The fuzzy *intersection* is a minimum operator that returns the area shared by the two input sets. In other words, the intersection takes the lower membership value of the two fuzzy sets where they are spatially coincident. I am interested in identifying the areas between the two datasets where perceptions correspond. The intersection is appropriate here because it provides the minimum corresponding perceptions of safety and danger; while the outward looking participants from the interviews may perceive a low level of safety in a given area, the inward looking residents from the survey may consider the level to be much higher in that area. The lower of the two membership values creates a surface that identifies the minimum level to safety or danger perceived by both samples of the population.

The fuzzy intersection (McBratney and Odeh 1997; Zadeh 1965) of the two datasets for the concepts safety and danger is given in equations 5 and 6.

\[
\text{safe} = \text{survey safe} \cap \text{interview safe} = \min(\mu(\text{survey safe}), \mu(\text{interview safe})) \tag{5}
\]

\[
\text{dangerous} = \text{survey dangerous} \cap \text{interview dangerous} = \min(\mu(\text{survey dangerous}), \mu(\text{interview dangerous})) \tag{6}
\]
Figure 15 shows the results of this operator between the two datasets for safety and danger. The fuzzy intersection brings together of the perceptions of the interview participants and the survey respondents. Now the resulting fuzzy sets can be brought together into one spatial representation of perceived safety and danger.

The intersection sets of safe and dangerous are exactly mutually inclusive; they completely overlap each other. The difference between the two thus gives an adjusted level of perceived safety or danger that accounts for opposing perceptions. The *bounded difference* fuzzy

![Image of Figure 15](image_url)

**a)**

**b)**

Figure 15. Intersections of the fuzzy sets safe and dangerous for the two datasets.

The fuzzy intersections between the interview and survey sets are shown for a) safety and b) danger. It should be noted that the resulting fuzzy sets have lower maximum values.
operator takes the difference between one set and another when the difference is positive and returns 0 when the difference is negative (Burrough and McDonnell 1998; Mizumoto and Tanaka 1981). Thus for safe, the bounded difference subtracts the membership values of dangerous from those of safe where the latter is greater than the former, and 0 where the former is greater than the latter. The bounded difference for danger is computed by switching the order of operation. I use this operator to bring together the intersections of safe and dangerous into two mutually exclusive fuzzy sets. The bounded difference, based on Mizumoto and Tanaka (1981), is defined for safety and danger as:

\[
\text{safe } \ominus \text{ dangerous } = \max(0, \mu(\text{safe}) - \mu(\text{dangerous}))
\]

\[
\text{dangerous } \ominus \text{ safe } = \max(0, \mu(\text{dangerous}) - \mu(\text{safe}))
\]

The bounded difference returns the adjusted levels of perceived safety or danger, but does not clearly show the level of opposing perceptions. Therefore, it is important to consider the bounded difference with the confusion index for the intersection sets. The bounded difference and confusion index (see equation 4) from the intersection sets are shown in figure 16. While the two are mathematically similar, the confusion index shows how close the membership values were between safe and dangerous. The higher the confusion index, the closer the membership values are, essentially cancel each other out. Confusion of 1 indicates equally opposing levels of perceived safety and danger; confusion of 0 indicates that only one of the two sets was non-zero, thus there is no opposing perception at such a location.
The ECV survey dataset was prepared in Microsoft Excel. In ArcGIS I joined the spreadsheet to a shapefile provided by the Planning Department of Medellin (Alcaldía de Medellín 2008a). I then converted the data into raster format. All analysis between the two datasets was done using map algebra in ArcGIS.

Figure 16. Bounded difference and confusion index for safe and dangerous.

The mutually exclusive sets of safe and dangerous from the bounded difference are shown together a) and the confusion index for the intersection sets b). Higher levels of overlap (or confusion) are shown in darker green.
Results

The interview data show the general, broader perspective of safety and danger while the survey data provide a local perspective in each neighborhood. Both perspectives are important in understanding public perceptions. The insight provided by the fuzzy set analysis can be seen in the bounded difference of the intersections. Bringing the two datasets together refines the broad perspective of the interview participants with the neighborhood experience of the survey respondents. In the cognitive mapping exercise, participants indicated large areas of the city which they characterized as either safe or dangerous for particular reasons. While the survey perspective generally agreed with the broad patterns from the interview overlays, in a few cases the survey perspective strongly disagreed, showing the differing contexts and situations of safety and danger from neighborhood to neighborhood. The two datasets not only represent different perspectives but also at different scales.

I highlight three examples of how the fuzzy analysis teases out significant differences between the two datasets. On the edge of the downtown area (fig. 17, area 1), the residents of two neighborhoods perceived a very high level of safety while those in nearby neighborhoods

Figure 17. Areas of differing perspectives

The bounded difference is shown with three areas highlighted that show the significant differences between the perspectives of the two datasets.
did not. The interview participants perceived this general area to be rather dangerous due to the commonality of personal crimes. The residents of these two neighborhoods perceived violent and non-violent security problems to be significantly low (see figures 6 through 8). Burglary was the only security problem that was considered to be moderate. These two neighborhoods stand out as having a different situation of perceived crime risk to those surrounding them; this situation is perceived among residents but was not indicated by any of the interview participants. As a second example, the neighborhoods in the central western part of the city (fig.17, area 2) were considered to be among the safest in the city for the interview participants. While many described this area as being prone to car theft, burglary and muggings, they considered it to be very safe overall. However, the survey responses vary significantly in this area; some of these neighborhoods have significantly higher levels of perceived danger and also showed car theft, burglary and muggings to be significant problems. Thus the most common types of crimes between the two datasets were the same; however, the survey responses identify where these crimes are most significant within this area and show where perceived danger is higher. The third example is the extreme western part of the city (fig.17, area 3). Both the interview participants and survey respondents considered it to be one the more dangerous parts of the city. However the two perspectives locate the concentration of perceived danger differently. The interview participants place the focal point of danger around the most western metro station. This is likely because this is the farthest west that most people in the city experience. The survey respondents who live in the neighborhoods around that metro station perceived moderate levels of danger. The area where the survey indicated extreme levels of danger was farther west where, other than the residents of these neighborhoods, few people venture. These subtle differences in the spatial patterns identified by these complementary perspectives are drawn out by the fuzzy overlay of
the two datasets. This analytical framework allows me to identify the similarities and examine the differences.

**Discussion**

Within the conceptual framework of fuzzy set theory, the quantitative levels of perceived safety and danger in figure 16a must be interpreted as the degree of membership to the definitions presented at the beginning of this chapter. Identifying the semantic meaning for the terms used in a fuzzy logic analysis is a central concern; when working with qualitative data and vague concepts this is even more important. The results can only be expressed with the degree of certainty to which these terms are defined within the context of the analysis. Applying the semantic prototypes from the interviews to the survey data was only appropriate using the narrowest definitions given by their central properties. This allowed me to bring together the spatial representations of safety and danger from the two datasets. Therefore the analysis in attribute space must lay the foundation for the analysis in cartographic space. The descriptive nature of each dataset offered different possibilities in the qualitative component of the spatial analysis. The survey data was rather limited in this sense; however, the general patterns that came out did correspond to those from the interviews. At the same time, the survey data provided detailed information at a finer spatial scale. This revealed a finer layer of detail within the broader spatial patterns of safety and danger identified by both datasets.

The non-residential areas and the neighborhoods with no data present in the survey data created spatial discrepancies between the two datasets. Many participants in the interviews identified some of these areas as being particularly safe or dangerous. For instance, participants generally considered the universities in the city to be safe spaces; and some indicated the two large ecoparks as dangerous spaces because there are few people and limited presence of law
enforcement. In the interview dataset I had the same issue of spatial discrepancy with a small area where the aerial photograph I used did not extend westward enough to include all of the four most western neighborhoods in the survey; therefore participants did not have the option to indicate this area. This issue created holes in the results of the fuzzy intersections. Spatial discrepancies such as these between datasets highlight some of the analytical issues that can arise from certain fuzzy operators—the intersection in this case. This is an issue that needs to be addressed when working with datasets that are not exactly spatially coincident.

While the results of this analysis provide a look at the general perspective in Medellín regarding safety and danger from crime, the sample population of each dataset had its own limitations. The interview population consisted of college age students mostly at the undergraduate level. Their view of safety and danger is likely to differ from older generations and also from those of the same generation who do not have the opportunity to attend the university. The ECV dataset represents a broader sample of the population, yet still not completely comprehensive. Since the survey was conducted door to door during the day, the majority of respondents were those who do not work or work in the evening. With the traditional gender roles of Latin America, this sample is likely to over represent the perspective of housewives and elderly women. Therefore it is important that these results are qualified within the sample of the population represented in the study.
Conclusion

This study has shown how the situated context of fear of crime in Medellín fits with many of the patterns observed in other cities and countries, yet it also reveals many important differences that make it a unique case study. While many of the factors that incite fear of crime—such as illumination, marginality and the lack of police presence—have been well documented in the literature, other factors that I have identified deserve more research attention—such as the presence of militant groups, gangs and homelessness. Since most research addressing fear of crime has been conducted in developed countries, these factors have not been sufficiently addressed. Although the history of violence and the current situation of crime in Medellín are unique, the observations I have made will be helpful to future studies of this issue in other cities in developing nations, particularly in Latin America. While some of the more specific observations would require further research to show that they are representative for the greater population of Medellín, these general conclusions are clearly shown from the two datasets.

Since I was only able to conduct interviews over a short period of time, I had to confine the perspective of participants to represent university students. This limited the scope in which my results describe the overall population of Medellín. The correspondence between student views and the ECV survey data does indicate that there may be commonalities in how university students and the broader population perceive safety and danger across the city. However, to pursue this comparison in detail I would need to expand the interview sample to a broader distribution of ages, socioeconomic status, education levels and ethnic backgrounds. This would allow me to provide a more comprehensive representation of the population. That said, I would argue that the general patterns of perceived safety and danger would be very similar with a
broader sample. While the survey offered important insights into the situation of perceived crime risk at the neighborhood level, the format of the questions could have been improved to provide more descriptive qualities. Despite these limitations, I was able to draw out the situated context of fear of crime and identify the specific and general patterns in these perceptions.

Methodologically, I have shown how qualitative spatial data can be collected to facilitate a robust mixed methods analysis. The interview mapping methodology effectively captured the qualitative information needed to interpret the cognitive mapping overlays and documented the participants’ perspectives of what the terms safety, danger and crime mean to them. This not only allowed me to integrate this information with the survey data, but it also provided context for the survey respondents’ perceptions of safety and danger. The fluidness of the terms safety and danger was a principal concern in this study. While acknowledging the subjectivity of these terms, I have used the literature of semantic theory and cognitive linguistics to analyze these terms and develop a framework in which to address this issue. Using semantic prototypes and fuzzy set theory, I operationalized these concepts in a spatial context. I have shown how fuzzy set theory can be used with mixed methods data to conduct a robust spatial analysis. Within a qualitative GIS framework, such an analysis brings out subtleties in the data and provides a deeper level of analysis. Previous research has been limited in this type of approach; further work is needed to establish fuzzy set theory as an effective methodology for addressing mixed methods analysis and qualitative GIS. Future work should focus on a research design that facilitates a fuzzy set analysis within a qualitative GIS framework. Such an approach would orient the qualitative and quantitative data collection towards directly comparable datasets.

The main contributions of this study are twofold. First, I have conducted a unique analysis of perceived safety and danger that can be used to inform the study of crime in
Medellín, as the perspective of residents is not often considered. The analysis of perceptual data can be used to qualify patterns identified using crime reports. In a broader sense, this study contributes to the limited fear of crime research that has been conducted in Latin America. Second, I have developed a mixed methods methodology that can be adapted to address a wide range of research topics. The combination of semantic prototypes, fuzzy set theory, and qualitative GIS provides significant potential for mixed methods research. This methodology extends the boundaries in which these approaches have been applied and proposes a new direction for this type of research.
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Appendix A

Interview Questions:

1. Which neighborhoods do you consider to be the most dangerous in Medellin? Why?
   For whom?
2. What types of danger exists in these neighborhoods?
3. How do you define danger?
4. What neighborhoods do you consider to be the safest? Why? For whom?
5. How do you define safety?
6. What types of crime are most common in Medellin?
7. How do you define crime? What do you consider a crime and not a crime?
8. Are there any areas or places in the city that you avoid?
9. Are there any areas or places that you avoid after dark, but not during the day?
10. How safe do you consider your neighborhood?
11. How safe do you consider the area around your university?
12. How do you describe a safe place? What characteristic does it have?
13. Do you believe that safety can be measured?

Mapping Questions:

1. Indicate the most dangerous areas of the city.
2. Describe these areas.
3. Indicate the safest areas of the city.
4. Describe these areas.
5. Indicate approximately where your house is located.
6. Describe the way you indicated areas on the map. Why did you use certain symbols? How do these symbols represent areas of safety or danger?
Preguntas de la entrevista:

1. ¿Cuáles barrios consideras que son los más peligrosos en Medellín? ¿Por qué? ¿Para quién?
2. ¿Cuáles tipos de peligro existen en esos barrios?
3. ¿Cómo defines el peligro?
4. ¿Cuáles barrios consideras que son los más seguros en Medellín? ¿Por qué? ¿Y para quién?
5. ¿Cómo defines la seguridad?
6. ¿Cuáles tipos de crimen son más comunes en Medellín?
7. ¿Cómo defines crimen? ¿Qué consideras un crimen y qué no?
8. ¿Hay partes de la ciudad por las que evites ir o pasar? ¿Por qué?
9. ¿Hay partes de la ciudad que evitas en la noche pero no durante el día? ¿Por qué?
10. ¿Qué tan seguro consideras tu barrio?
11. ¿Qué tan seguro consideras el sector de la Universidad?
12. ¿Cómo describes un lugar seguro? ¿Cuáles características tiene?
13. ¿Crees que se puede medir la seguridad? ¿Cómo? ¿Por qué?

Preguntas del componente de los mapas:

1. Indica las partes más peligrosas de Medellín. (con el marcador rojo)
2. Describe estas áreas.
3. Indica las partes más seguras de Medellín. (con el marcador azul)
4. Describe estas áreas.
5. Indica aproximadamente donde está tu casa. (con un X azul)
6. Describe la manera que marcaste el mapa. ¿Por qué escogiste ese símbolo para definir las áreas? ¿Cómo representan áreas de seguridad o peligro?
General Information Questionnaire

This questionnaire is meant to be completely anonymous, please do not disclose your name or any identifying information. If you prefer not to answer any of the questions, please leave them blank.

1. Age ______  2. Male___ Female ___
3. City of residence __________________ Period of residence: From (year) _______ to _______
   Previous cities of residence (if applicable) ___________ from (year) ______ to _______
   Previous cities of residence (if applicable) ___________ from (year) ______ to _______
4. Means of transportation you use: Bus/Metro___ Motorcycle___ Car___ Taxi ___ other _____
5. Are you currently (check only one):
   □ Married  □ Single  □ Separated  □ Divorced  □ Widowed
6. Circle the level of education you are working towards or have completed:
   Undergraduate  Graduate Certificate  Master’s  PhD
7. Circle the highest level of education your father has completed:
   Primary  High School  Undergraduate  Graduate Certificate  Master’s  PhD
8. Circle the highest level of education your mother has completed:
   Primary  High School  Undergraduate  Graduate Certificate  Master’s  PhD
9. What strata is your house in? _________________
CUESTIONARIO DE INFORMACIÓN GENERAL

La intención de este cuestionario es para ser completamente anónimo, por favor no ponga su nombre ni compartá informacion que le podría identificar. Si no quiere responder a una pregunta, déjela en blanco.

1. Edad ______ 2. Hombre ___ Mujer ___

3. Municipio de residencia ___________ Duración de residencia: De (año) ___ a _____
   Municipio de residencia previa (si aplica) ___________ De (año) ___ a _____
   Municipio de residencia previa (si aplica) ___________ De (año) ___ a _____

4. Medio de trasporte que utiliza: Bus/Metro ___ Moto ___ Carro___ Taxi ___ Otro ______

5. Estado civil (marca solamente uno):
   ☐ Casado/a   ☐ Soltero/a   ☐ Separado/a   ☐ Divorciado/a   ☐ Viudo/a

6. Indíque el nivel de educación en que está terminando o ha terminado:
   Pregrado  Posgrado/Especialización  Maestría  Doctorado

7. Indíque el nivel de educación más alto que terminó su padre:
   Primaria  Bachillerato  Pregrado  Posgrado/Especialización  Maestría  Doctorado

8. Indíque el nivel de educación más alto que terminó su madre:
   Primaria  Bachillerato  Pregrado  Posgrado/Especialización  Maestría  Doctorado

9. ¿A qué estrato pertenece su vivienda? ____________________
Appendix B

Aerial photograph used in interviews
Traditional map used in interviews
Appendix C

Survey form for questions # 130 and 131

<table>
<thead>
<tr>
<th>130</th>
<th>131</th>
</tr>
</thead>
<tbody>
<tr>
<td>Como se siente en el barrio o vereda donde vive?</td>
<td>¿Cuáles son los dos problemas más graves en orden de importancia para usted en relación con la seguridad que se presentan en su barrio?</td>
</tr>
<tr>
<td>1. Muy seguro</td>
<td>1. Existencia de pandillas</td>
</tr>
<tr>
<td>2. Seguro</td>
<td>2. Se presentan muchos atracos callejeros</td>
</tr>
<tr>
<td>3. Inseguro</td>
<td>3. Se roban muchos carros o partes de estos</td>
</tr>
<tr>
<td>4. Muy inseguro</td>
<td>4. Se asaltan casas y apartamentos</td>
</tr>
<tr>
<td>68. No sabe</td>
<td>5. Se atraen las tiendas de barrio</td>
</tr>
<tr>
<td>99. No responde</td>
<td>6. Se presentan casos de homicidios</td>
</tr>
<tr>
<td></td>
<td>7. Hay tráfico de drogas</td>
</tr>
<tr>
<td></td>
<td>8. se presentan casos de violaciones</td>
</tr>
<tr>
<td></td>
<td>9. Vandalismo contra edificaciones</td>
</tr>
<tr>
<td></td>
<td>10. Milicias (guerrilla urbana / paramilitarismo)</td>
</tr>
<tr>
<td></td>
<td>11. Ninguno</td>
</tr>
<tr>
<td></td>
<td>77. Otro, cuál?</td>
</tr>
<tr>
<td></td>
<td>88. No aplica</td>
</tr>
<tr>
<td></td>
<td>98. No sabe</td>
</tr>
<tr>
<td></td>
<td>99. No responde</td>
</tr>
</tbody>
</table>
Appendix D

Title of Study:
Mapping perceptions of safety and danger in Medellín, Colombia:
A study in visualizing qualitative and quantitative data

Principal Investigator: Galen J. Maclaurin

PARTICIPANT INFORMED CONSENT FORM
April 21, 2009

Please read the following material that explains this research study. Signing this form will indicate that you have been informed about the study and that you want to participate. We want you to understand what you are being asked to do and what risks and benefits—if any—are associated with the study. This should help you decide whether or not you want to participate in the study.

You are being asked to take part in a research project conducted by Galen Maclaurin, a graduate student in the University of Colorado at Boulder’s Department of Geography, UCB 260 UCB, Boulder, CO 80309-0260. This project is being done under the direction of Professor Ken Foote, Department of Geography, 260 UCB. Galen Maclaurin can be reached at 009-1-303-492-2631 in the United States or 4-274-9377 in Medellín, Colombia. Professor Ken Foote can be reached at (303) 492-6760.

Project Description:
This research study is about mapping perceptions of safety and danger and comparing these to crime statistics. This project will be conducted in Medellín, Colombia to better understand perceptions of safety and danger in urban Latin America. This study contributes to previous research on mapping non-traditional information, perceptions of environment and methods for using maps in interviews. You are being asked to be in this study because you are either a student, faculty or staff member of the University of Antioquia or EAFIT University. It is entirely your choice whether or not to participate in this study. Approximately 50-70 participants will be invited to participate in this research study.

Interview participants will be asked questions about perceptions of safety and danger in Medellín and about information regarding crime statistics and census data. You will be asked to draw your perceptions of safety and danger on a map of the city. You will also be asked to fill out a short questionnaire about your residence in Medellín.

Focus group participants will be asked to compare and interpret maps of crime incidence and perceptions of safety and danger collected during the interview component of this study. Focus groups will consist of drawing on maps and commenting on the patterns seen in the maps. You will be asked to share your opinions about these patterns in a group discussion.
**Audio Recording of Participation**

Participation in this research may include audio recording. These recordings will only be used for quoting responses in the writing and maps of this study and will be retained for approximately one year. Those individuals who will have access to these recordings will be the Principal Investigator, Galen Maclaurin, and Professor Ken Foote. Being recorded is not a requirement for participation. You may still participate in the study should you choose not to be recorded.

**Risks and Discomforts:**

There are no foreseeable risks or discomforts in participating in this study; however, if you feel uncomfortable answering any of the questions you can simply ask to move to the next question.

**Benefits:**

There are no direct benefits for participating in this study.

**Ending Your Participation:**

You have the right to withdraw your consent or stop participating at any time. You have the right to refuse to answer any question(s) or refuse to participate in any procedure for any reason.

**Confidentiality:**

We will make every effort to maintain the privacy of your data. Confidentiality and anonymity will be ensured at all stages of the study. Names and identifying information will not be recorded, and therefore your name will not be used in this study. Audio recordings will be erased after the completion of this project approximately one year your participation.

Other than the researchers, only regulatory agencies such as the Office of Human Research Protections and the University of Colorado Human Research Committee may see your individual data as part of routine audits.

**Questions?**

If you have any questions regarding your participation in this research, you should ask the investigator before signing this form. If you should have questions or concerns during or after your participation, please contact Galen Maclaurin at (303) 492-2631 in the United States or 4-274-9377 in Medellin, Colombia.

If you have questions regarding your rights as a participant, any concerns regarding this project or any dissatisfaction with any aspect of this study, you may report them...
confidentially, if you wish -- to the Executive Secretary, Human Research Committee, 26 UCB, Regent Administrative Center 308, University of Colorado at Boulder, Boulder, CO 80309-0026, (303) 735-3702.

Authorization:
I have read this paper about the study or it was read to me. I know the possible risks and benefits. I know that being in this study is voluntary. I choose to be in this study. I know that I can withdraw at any time. I have received, on the date signed, a copy of this document containing 3 pages.

Name of Participant (printed) __________________________________________

Signature of Participant ___________________________ Date ______________.
(Also initial all previous pages of the consent form.)

I am consenting to audio recording during the participation of this research.
_____ Yes, I would like to be recorded during my participation in this research.
_____ No, I would not like to be recorded during my participation in this research.

For HRC Use Only
This consent form is approved for use from __4/24/2009____ through ____Exempt______.
_________________________________ Panel Coordinator, Human Research
(Signature) Committee

3 of 3 initials _____

Version: 1.0 Edit date: April 3, 2009