LARGE-SCALE ENVIRONMENTAL KNOWLEDGE
Investigating the Relationship Between Self-Reported and Objectively Measured Physical Environments

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ABSTRACT: This article compares self-reported and objectively measured physical features in a large-scale environment. Environmental perception has been studied through object perception research but little is known about perception in full-scale environments. Also, few studies examine differences between self-reported and

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objective environments including the potential effects of distance and content. In this study, a questionnaire, satellite imagery, and geographic information system data were used. Results indicate that self-reported environments are different from objective environments. In addition, self-reported responses separate natural and built environments into two different dimensions. Water combines self-reported and objective measurements into a single dimension. Further analysis revealed that content (natural vs. built) and distance (300 ft vs. 1,500 ft) are important factors influencing the relationships between self-reported and objective environmental measurements. By better understanding relationships between self-reported and objective environments, landscape planners and designers can choose the most appropriate data type for analyzing specific planning and design decisions.

Keywords: *environmental perception; geographic information system; landscape content*

This article examines the relationship between self-reported and actual physical features in large-scale environments. Planners and landscape architects have been using objective measures of the environment such as aerial photographs and maps to make decisions about shaping our local environment. Appleyard (1976) stated, "The paradox is that as planners become more adept and sophisticated at conceptualizing so-called objective city—through the use of aerial photographs, maps, statistics, and mathematical modeling—their conceptual distance from the inhabitant's subjective personal city usually increases" (p. 1). That is, the way planners and designers see the city through their tools (objective measures) is different from the way that the people who live there see it through everyday contact (subjective measures). Understanding the difference between subjective and objective environments may help to improve professional decision making and reduce the distance between professional concepts and public perceptions of the city.

Environmental perception has been defined as an "information processing system in which individuals actively explore their surroundings and extract and use information in constant interaction between themselves and

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their environment" (Ittleson, 1974, p. 133). Actual content-based physical environments include elements such as structures, pavement, trees, shrubs, groundcovers, and water around our homes, neighborhoods, communities, and so forth. The question is how does our understanding of the environment coincide with the physical content of the environment?

Previous research indicates that perceived and objectively measured environments are not totally consistent with each other (Brunswik, 1956). Brunswik (1956) indicated that because of the multiple messages received from the environment, internal consistency between perceived and objective environments is often problematic. He stated that the messages the individual receives from these environments are always probabilistic rather than absolutistic. Lynch (1960) indicated that our perception of the large-scale city environment is systematically organized, and he classified the mental image of the city into five categories: paths, edges, districts, nodes, and landmarks. Theories of cognitive mapping also state that mental representations of the environment differ from the physically measurable environment (Cuff & Hooper, 1979; S. Kaplan & Kaplan, 1982) because of the information processing and memory involved in perception. It is clear that knowledge of the environment never perfectly correlates with the physical content of the environment. However, what is less clear is how much overlap exists and the extent of that overlap.

ENVIRONMENT PERCEPTION

Historically, research on environmental perception was carried out in the context of perceiving objects. Size and distance were used as the primary measures of perception of physical objects in environments. Gibson (1979) indicated that the size of an object becomes less definite with distance. Perception of size is also influenced by two proximal stimuli: distance and proximal size (Rock, 1983). The perception of distance to an object from a person is known as *egocentric distance perception* (Norman, 2002). The preponderance of existing studies shows that in natural settings people tend to underestimate distances less than 90 m (Wiest & Bell, 1985). The shorter the distance, the more accurate the estimate becomes (Gibson, 1979). *Exocentric distance perception* is the perception of distance between two objects in an environment (Norman, 2002). Although there are fewer studies of this phenomenon, the available research shows that exocentric distances tend to be overestimated by 20% to 40% (Levin & Haber, 1993).

There is a clear difference, however, between perception of objects and perception of environments. Object perception is object centered and uses focal vision, whereas environmental perception is subject centered and uses ambient vision (Ohno, 2000). Ohno (2000) concluded that ambient perception overcomes the limitations of discrete focal perception of an object. Ittleson (1974) also indicated that environmental perception is respondent centered and uses both central and peripheral information. The environmental stimuli for object perception are single and unitary, whereas the stimuli for environmental perception are continuous and holistic (Ohno, 2000). Although a substantial body of knowledge exists on environmental perception at smaller (object focused) scales, relatively little effort has been devoted directly to finding out how people perceive the large-scale environments within which they live (Ittleson, 1970). Studies of large-scale environments might be better founded on ambient vision as well as central and peripheral information gathering because they are continuous rather than discrete.

In addition to being continuous and respondent centered, environmental perception should consider the effects of content. The influence of different content such as trees, water, pavement, or structures on environment perception is not clear. Perception is "largely or completely determined by the characteristics of the external stimulus" (Ittelson, 1970, p. 808). Ames (1951) indicated that different environmental contexts have different environmental significances. R. Kaplan and Kaplan (1995) discussed how people have perceptually differentiated and categorized the environment into two different contents: natural and built. People have also consistently preferred natural environments over built environments (Chokor & Mene, 1992; Getz, Karow, & Kielbaso, 1982; Herzog, Kaplan, & Kaplan, 1976; Sullivan, 1994; Ulrich, 1993). What content, then, is more influential on environmental perception? Are preferred natural environments more dominant on perception than built environments?

Space perception integrates the perception of size, depth, and distance (Coeterier, 1994). It requires a continuous background surface rather than discrete objects (Gibson, 1979). Coeterier (1994) examined the relationship of features of a space to the perception of the size of that space using photographic images. However, the study of large-scale environmental perception might be more difficult to measure effectively with photographs because photographs are limited in the amount of information that can be captured. This study measures out in all directions from respondents' homes and asks them to report amounts of certain features existing within a given boundary. A more effective way to objectively measure the features existing within this boundary might be to examine spatial data stored in a geographic information system (GIS).

OBJECTIVE ENVIRONMENTS

GIS technology enables the measurement of large-scale environments. Spatial data stored in raster and vector format can be quantified quickly and accurately using a computer. Consequently, objective environmental measurements can be compared to self-reported environmental measurements of the same regions. Several studies have used a similar approach. Sallis, Melbourne, and Hofstetter (1990) found objective environmental measures were related to physical activity, whereas perception of the same environmental measures was not significantly related to physical activity. Both perceived and objectively measured distances were negatively related with bikeway use (Troped et al., 2001). Kirtland et al. (2003) found that the agreement between objectively measured environments and perception of those environments is higher within a neighborhood distance (0.5 mile) than within a community distance (10 miles). Other than these findings, very few empirical research studies have compared perception with the actual content of physical environments.

Objective measurements of the environment are limited in some ways due to mechanisms for sensing the content as well as the typical methods for data storage. Space-borne satellites are able to sense reflected energy from the earth's surface and store it in a two-dimensional raster format similar to a digital photograph. The sensors can read visible light in the red, green, and blue wavelengths as well as the near-infrared (which is particularly useful for identifying water and vegetation). Other forms of data include municipal GIS data sets in which the contents of the built environment are often recorded for planning, design, and construction purposes. These data are frequently collected via property surveys, global positioning technology, aerial photo interpretation, and so forth, and stored in a geometric format called *vector*.

The vector data format simply abstracts spatial information into one of three types of geometry: points, lines, or polygons. Examples of this type of data might include building footprints or property boundaries stored as polygons, electric cables, or bike routes stored as lines, and utility poles or manhole covers stored as points. The raster data format used by digital cameras and satellite sensors stores information in a grid using rows and columns. Each cell in the raster grid stores a single value corresponding to such things as a color map (used for aerial photos and imagery) or a category list (used for land use or landcover maps). Both raster and vector data types are supported by GIS that are used for creating, editing, and evaluating spatial data in a real-world coordinate system. Although advancements in collecting and storing three-dimensional environmental data are continuing, the vast majority of existing data currently used by most municipalities are two-dimensional.

This article examines environmental knowledge in terms of its natural and built character and its relationship to corresponding objective measures. The effect of distance on these relationships is also considered. Three research questions need to be answered: (a) Does our perception of the environment coincide with the physical content of the environment? (b) How does distance influence the relationship between perceived and objective environments? and (c) Is the relationship stronger when registering the contents of natural environments than built environments?

METHOD

This research compared people's knowledge of physical environments with the actual content of the physical environments measured by satellite imagery and municipal GIS data. Palmer and Hoffman (2001) examine the validity and reliability of visual landscape assessments comparing what people say they see in two-dimensional photographs with what is actually seen in the field. These assessments focus specifically on what is seen through the focal lens of the eye. This study takes a broader approach to study environmental knowledge. Participants are not shown any pictures of the environment being studied nor are they instructed to conduct an investigation of that environment. Rather, they are simply asked to answer questions about the areas near their home (300 ft.) and within their neighborhood (1,500 ft.) without being given any visual aids. The specific content measured in this study included trees and shrubs, groundcover, water, pavement, and structures. A methodological strength of this study is the combination of self-report survey methods and GIS methods to measure the perceived and objective environmental measurements.

SAMPLING AND RESPONDENTS

This study was conducted in College Station, Texas. Eight hundred survey questionnaires were mailed to a systematic random sample of 9,116 single-family households. We randomly chose respondents ranging from mostly green environments to mostly built environments to ensure the variability of physical environment. Mostly green and mostly built sampling areas were determined by conducting an unsupervised classification on a panchromatic aerial photo at 1-m resolution using Earth Resources Data Analysis System (ERDAS) Imagine. Among 800 survey questionnaires, 39 questionnaires (5%) were returned with a vacant notice, whereas 311 questionnaires (41%)

were returned with a valid street address. The address was essential for comparing the perception data with the GIS data.

MEASURES

Self-reported environment. We used a survey questionnaire to examine 311 respondents' perceptions of home (300 ft) and neighborhood (1,500 ft) environment. Self-reported environment measures the amount of trees/shrubs, groundcovers, water, structure, and pavement that exists in the respondent's home and neighborhood environment. An example question for home environment included "How much of the following exists within 300 ft of your home?" Categories included *trees and shrubs*, *groundcovers*, *water*, *structures and buildings*, and *pavement*. An example question for neighborhood environment included "How much of the following exists within 1,500 ft of your home?" The categories used were the same as home environments. Participants responded by using a graphic rating scale. The two ends of the scale were *none* and *very much*, with six equal segments identified between the end points. These measures are considered perception of the environment variables in that they are typically unaided human observation.

GIS environmental data. The variables measured using a GIS included *trees and shrubs*, *groundcovers*, *water*, *structures and buildings*, and *pavement*. Data values for the *trees and shrubs* and *water* variables were derived from satellite imagery (see Figure 1). Four-meter multispectral and 1-m panchromatic satellite imagery were collected in August 2001 to obtain vegetation values during leaf-on conditions, meaning that aerial photographs were taken while leaves were present. These data were processed mechanically by computer using a normalized difference vegetation index formula[1] and were classified into standard land cover categories including *trees and shrubs* and *water*. The amount (square feet) of tree and shrub cover located within 300 ft and 1,500 ft of the centroid of each respondent's home parcel was calculated and recorded in the database.

Pavement and building footprints data were available in polygon format from the City of College Station Geographic Information Services. Again, the amount of each within 300 ft and 1,500 ft of each home was recorded. Groundcover (including open lawns and under-story) for each distance was derived by subtracting the recorded amount of pavement, structure, and water from the total area. For example, if the total area of pavement, structures, and water within 300 ft was 5,000 ft^2, then $\pi(300\text{ ft})^2 - 5{,}000\text{ ft}^2$ = the area of groundcover. Observations of both the satellite-originated measures and the municipal government–originated measures were mechanically

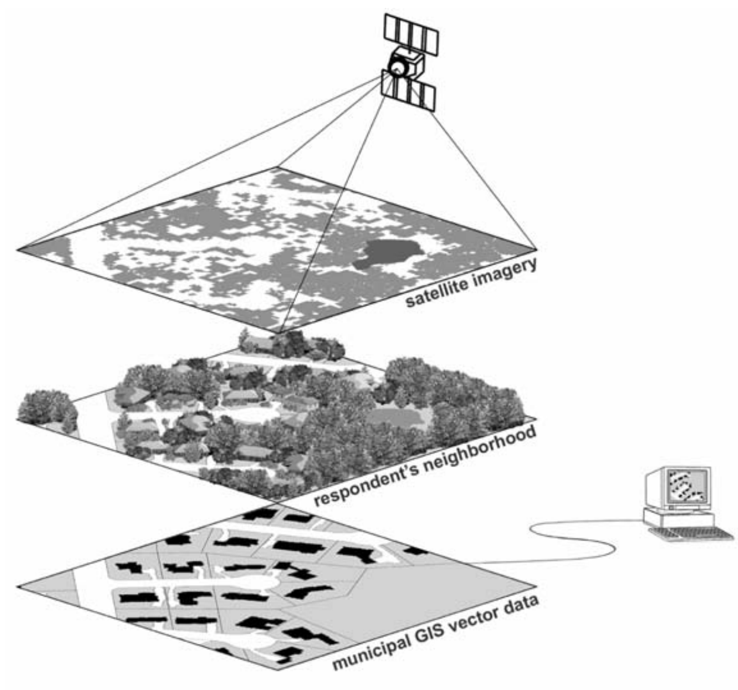

Figure 1: Illustration of Objective Environmental Measurements

assisted. They are henceforth considered objective in the sense that these mechanically assisted observation methods limit the human biases associated with human observation alone.

Other variables. We also recorded the respondent's age, gender, education level, and total annual household income before taxes. Respondents were 43.7 years of age on average, with a range from 18 to 80 years of age. Of the respondents, 163 (55%) were female, whereas 132 (45%) were male. Of the respondents, 230 (77%) had at least a college degree. The total annual household income before taxes was measured in $20,000 intervals with a mean value between $60,000 and $80,000.

HYPOTHESES

The first hypothesis (H_1) concerns the relationship between the objectively measured and self-reported environments. The null hypothesis posits that there are no differences between the objective environment (E_o) and the perceived environment (E_p), H_1: $E_o = E_p$. Finding distinct dimensions for objective and self-reported environments would confirm that they play independent roles in measuring the environment in which people live and plan for their future.

The second hypothesis (H_2) addresses the trend observed in the literature that the closer an object is to a person, the higher the degree of agreement between perceived and objective measures of that object. The nearer the environment is to the household, the stronger the relationship between the objective environment and the perceived environment (r_{EoEp}), hence, the null hypothesis is directional, H_2: $r_{EoEp300} \leq r_{EoEp1,500}$. This hypothesis will be tested for all contents of the environment within the built and natural environment independently.

The third hypothesis (H_3) addresses the strong preferences for the natural environment over the built environment. Because the natural environment is strongly preferred, the relationship between objective and perceived environment is expected to be stronger in natural environments (r_{EoEpN}) than it is when in built environmental settings (r_{EoEpB}), hence, the null hypothesis is directional, H_3: $r_{EoEpN} \leq r_{EoEpB}$. This hypothesis will be tested for all contents of the environment by distance from the household.

RESULTS

The results are presented in terms of descriptive statistics, correlations, factor analysis, and structural equation models. The descriptive statistics of the variables are presented to clarify the character of the measures and examine the face validity of the variables. The zero-order correlations allow a preliminary examination of the relationships among specific variables. The factor analysis reveals important relationships between self-reported and objectively measured physical content of the environment. The structural equation models show the distance and content effects of perceived and objectively measured environments.

The self-reported and objective means for each environmental content were examined in terms of the original sampling clusters to assure that the pattern was consistent with the sampling design. Households selected from natural areas showed more of trees and shrubs, groundcover, and water than households selected from areas dominated by built environments. Conversely, households selected from built environment areas showed larger amounts of pavement and built structures. The means and standard deviations for both objective and self-reported environmental variables are pre-

TABLE 1
Means and Standard Deviations for Environmental Variables

	Distance (ft)	Self-Reported Environments		Objective Environments	
		M	SD	M	SD[a]
Trees and shrubs	300	3.77	1.52	2.58	0.93
Groundcovers	300	4.27	1.25	4.26	0.63
Water	300	0.80	1.31	0.01	0.07
Structure	300	2.37	1.23	1.02	0.34
Pavement	300	3.40	1.39	1.17	0.40
Trees and shrubs	1,500	3.48	1.38	61.36	20.54
Groundcovers	1,500	3.79	1.19	113.86	13.84
Water	1,500	1.08	1.35	0.33	0.64
Structure	1,500	2.56	1.24	19.81	6.70
Pavement	1,500	3.34	1.35	27.46	8.42

a. Acres.

sented in Table 1. The descriptive statistics indicated that groundcover is the most abundant environmental content, whereas water is the least abundant.

Table 2 presents the zero-order correlations for all perceived and objective measures of the environment at both the 300 ft and 1,500 ft distances. The direct comparisons of environmental content are identified in bold along the diagonal of the table. Seven of 10 direct comparisons are positive with perceived and objective trees/shrubs at 300 ft and 1,500 ft being the strongest correlations (.50 and .35, respectively), and water at 1,500 ft and 300 ft being the third and fourth strongest (.34 and .25, respectively). Structures and pavement at 1,500 ft and groundcover at 300 ft are not significant. The magnitude of the correlations indicates that no more than 25% common variance exists between the two types of measures.

THE RELATIONSHIP BETWEEN SELF-REPORTED AND OBJECTIVE ENVIRONMENTS

To examine the relationship between self-reported and objective environments, an oblique rotation factor analysis was undertaken. The factor analysis of self-reported and objective data produced four factors (Table 3). These four factors appear to be aligned with measures of the objective environment, the self-reported natural environment, the self-reported built environment, and self-reported and objective water. The first factor consists of the seven items characterized by the objective environmental measures. It has positive factor loadings for built contents and negative loadings for natural contents of the environment. The second factor consists of the four items characterized

TABLE 2
Intercorrelations Between Self-Reported and Objective Environmental Content

	Self-Reported Environment									
	300 ft					*1,500 ft*				
Objective Environment	*Trees and Shrubs*	*Groundcovers*	*Water*	*Structures*	*Pavement*	*Trees and Shrubs*	*Groundcovers*	*Water*	*Structures*	*Pavement*
300 ft										
Trees and shrubs	**.50**††	.18**	.39††	–.29††	–.20†	.35††	.12*	.31††	–.22†	–.17**
Groundcovers	.26††	**.08**	.36††	–.19**	–.15**	.21†	.08	.29††	–.20†	–.10
Water	.10	.06	**.25**††	–.06	–.05	–.05	–.08	.18**	–.02	–.03
Structure	–.23††	–.06	–.32††	**.22**†	.10	–.18**	–.06	–.25††	.19**	.09
Pavement	–.22†	–.07	–.29††	.13*	**.16****	–.18**	–.06	–.25††	.16**	.10
1,500 ft										
Trees and shrubs	.43††	.17**	.25††	–.28††	–.21†	**.35**††	.15**	.23$\dagger\dagger$	–.18**	–.18**
Groundcovers	.20†	.08	.18**	–.07	–0.09	.21†	**.17****	.19**	–.01	–.05
Water	.30††	.19**	.43††	–.08	–.09	.25††	.06	**.34**††	.01	–.04
Structure	–.23	–.07	–.22†	.10	.08	–.23††	–.13*	–.21†	**.00**	.03
Pavement	–.17**	–.09	–.15**	.04	.10	–.18**	–.18**	–.17**	.02	**.07**

NOTE: Bolded numbers indicate the direct comparisons of environmental content.
$^{\dagger\dagger}p < .0001$. $^{\dagger}p < .001$. $^{**}p < .01$. $^{*}p < .05$.

TABLE 3
Oblique Factor Loadings of Objective and Self-Reported Environments

	Factor 1: Objective Environment	*Factor 2: Self-Report Nature*	*Factor 3: Self-Report Built*	*Factor 4: Water*
Self-reported environments				
Trees and shrubs (300 ft)		.73		
Groundcovers (300 ft)		.77		
Water (300 ft)				.73
Structure (300 ft)			.74	
Pavement (300 ft)			.77	
Trees and shrubs (1,500 ft)		.83		
Groundcovers (1,500 ft)		.77		
Water (1,500 ft)				.58
Structure (1,500 ft)			.75	
Pavement (1,500 ft)			.77	
Objective environments				
Trees and shrubs (300 ft)				
Groundcovers (300 ft)	–.70			
Water (300 ft)				.73
Structure (300 ft)	.64			
Pavement (300 ft)	.53			
Trees and shrubs (1,500 ft)	–.51			
Groundcovers (1,500 ft)	–.97			
Water (1,500 ft)				.68
Structure (1,500 ft)	.91			
Pavement (1,500 ft)	.88			
Eigenvalues	6.02	2.82	2.21	1.59
Percentage of variance	30	14	11	8
Cronbach's alpha	.89	.82	.79	.73

TABLE 4
Intercorrelations Among the Four Factors

	Factor 1	*Factor 2*	*Factor 3*
Factor 2	–.18		
Factor 3	.15	.03	
Factor 4	–.24	.20	–.11

by knowledge of the natural environment. It has positive factor loadings in the range of .73 to .83 for trees/shrubs and ground cover at the home and neighborhood scales. The third factor consists of four items concerning knowledge of the built environment. These four items have factor loadings in the range of .74 to .77. The four items concerning water comprise the fourth factor. This is the only factor that combines both self-reported and objective measurements. Loadings on this factor range from .58 to .73.

The correlation coefficients among the factors ranged from .03 to –.24 (Table 4). Maximum shared variance between two factors is 5.76% (–.24 × –.24), hence, each factor has its own unique variance of at least 94.24%. In other words, each factor is nearly independent from the others.

In summary, the factor analysis of the 10-item self-reported and 10-item objectively measured environment variables generates four factors. The four factors are the objectively measured environmental contents, the self-reported natural environmental contents, the self-reported built environmental contents, and self-reported and objective water. First, objective environments are different from self-reported environments. Second, self-reported natural environments are different from self-reported built environments. Third, both self-reported and objectively measured water load into the same factor.

DISTANCE AND CONTENT EFFECTS BETWEEN SELF-REPORTED AND OBJECTIVE ENVIRONMENTS

In the factor analysis, we found a difference between self-reported and objective environments. In this section, we divided the data by content (nature vs. built) and distance (300 ft vs. 1,500 ft) to determine if the same results hold for these four groups. We expected that the overlap between self-reported and objective measurements would be influenced by content and distance, as specified in our second and third hypotheses. Four sets of structural equation models examine whether the relationship between self-reported and objective environments is influenced by distance (300 ft vs. 1,500 ft) and content (nature vs. built).

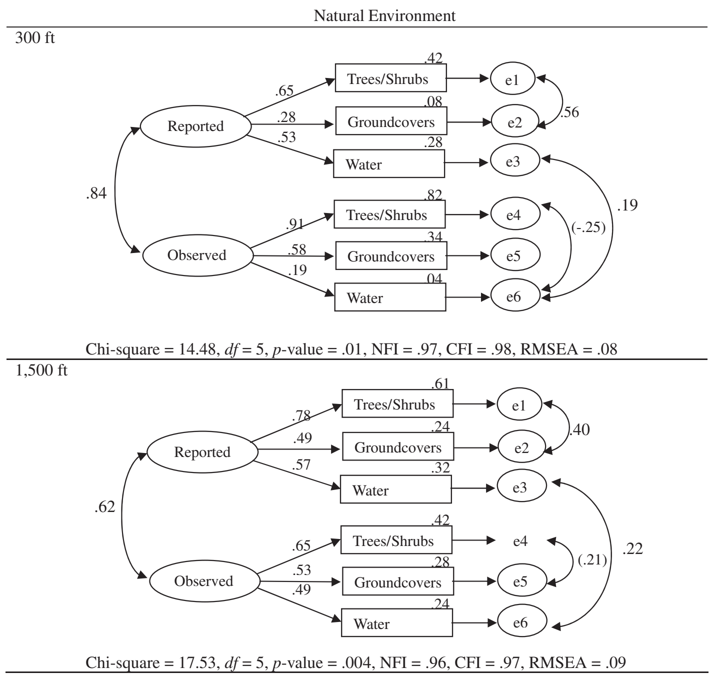

Figure 2: Structural Equation Models for the Natural Environment Using Home (300 ft) or Neighborhood (1,500 ft) Distances

NOTE: NFI = Normed Fit Index, CFI = Comparative Fit Index, RMSEA = root mean square error of approximation.

Distance effect. The rationale for dividing the data by distance came from the findings of previous research. As shown in Figures 2 and 3, the relationship between self-reported and objectively measured environments is stronger within 300 ft of home than within 1,500 ft. The structural equation correlations between the self-reported and observed variables are .84 within 300 ft and .62 within 1,500 ft for the natural environment models. To test for the significant differences between the two correlations, we calculated the normal curve deviate using the procedure described by Cohen and Cohen (1983). The deviate z score (5.75) exceeds 3.29, the one-tailed $\alpha = .0001$ significance criterion. A similar trend exists for the built environment models. The correlations between the self-reported and observed variables in these models are .35 within 300 ft and .05 within 1,500 ft. The difference between these correlations is also significant ($z = 3.91$, $p < .001$). In other words, agreement between self-reported and objective measurements within 300 ft

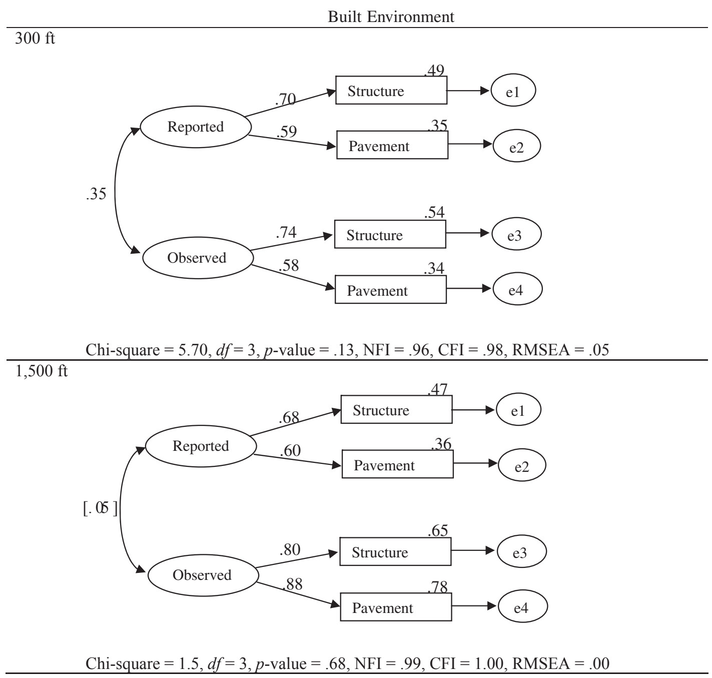

Figure 3: Structural Equation Models for the Built Environment Using Home (300 ft) or Neighborhood (1,500 ft) Distances

NOTE: NFI = Normed Fit Index, CFI = Comparative Fit Index, RMSEA = root mean square error of approximation.

is significantly larger than agreement within 1,500 ft for both natural and built environments.

Content effect. There is also some evidence that content (nature vs. built) affects the agreement between self-reported and observed measures. Natural environments include trees/shrubs, groundcovers, and water, whereas built environments include structure and pavement. As shown in Figures 2 and 3, we found that the content of the physical environment influences the strength of the relationship between self-reported and objectively measured physical environments. The relationship is stronger for natural environments than for built environments. The structural equation correlations between the self-reported and observed variables are .84 for natural environments and .35 for built environments within 300 ft. A similar trend exists within 1,500 ft. The correlations between the self-reported and observed variables for these models are .62 for natural environments and .05 for the built environments. In other words, agreement between self-reported and objective measurements for natural environments is larger than agreement for built environments for both 300 ft and 1,500 ft.

In summary, four sets of structural equation models revealed that the overlap between self-reported and objective environments is influenced by distance and content. The overlap between self-reported and objective measurements within 300 ft is significantly stronger than agreement within 1,500 ft for both natural and built environments. Also the overlap is stronger for natural environments than built environments for both 300 ft and 1,500 ft.

DISCUSSION

Our first hypothesis focused on the relationship between self-reported and objectively measured environments. Based on the relationships between all variables, factor analysis separated self-reported and objectively measured environments into different dimensions. This is consistent with previous findings (Appleyard, 1976; Brunswik, 1956; Cuff & Hooper, 1979; Ittleson, 1974; S. Kaplan & Kaplan, 1982). Brunswik (1956) indicated that perceptions of an environment are not always consistent with the actual environment. S. Kaplan and Kaplan (1982) said that cognitive maps connect Place A and Place B but have many gaps or discontinuities between A and B. Our finding confirmed that self-reported and objectively measured environments are two different dimensions for both natural and built environments.

Factor analysis also separated self-reported environmental knowledge into two different dimensions: knowledge of natural environments and knowledge of built environments. This is consistent with R. Kaplan and Kaplan (1995) who categorized environmental contents as *nature* and *non-natural* scenes. It is interesting to note the similar results between this study and those of the previous work represented by photographs (R. Kaplan & Kaplan, 1995). They also indicated that each category could be seen as many different subcategories (e.g., prairie, woods, meadow, etc.), but our study did not differentiate among these subcategories. Ulrich (1993) argued that human preference for natural environments is genetically based. Others claim that these are common cultural and personal responses (Tuan, 1974). Our findings suggest that perceptions of natural and built contents are not opposite ends of the same scale but rather that people perceived them as different things.

Water was the only factor that combined both self-reported and objectively measured variables. Water has been regarded as a powerful element in landscape architecture research. Water was highly preferred and people show positive response to water (R. Kaplan & Kaplan, 1995; Orians & Heerwagen, 1992; Ulrich, 1984, 1993). People are willing to pay a higher price for water views from their residence as well as active and passive water activities for recreational purposes (R. Kaplan & Kaplan, 1995). Our findings show that objective and self-reported measurements of water belong to the same dimension. This may be because of the strength of water as a preferred environmental element. It may also be because of the fact that waterbodies alter our spatial behavior as we move about in our environment (around lakes, over streams, etc.). Consequently, our knowledge or understanding of water may be strengthened in part by our behavioral response to its existence.

Our second hypothesis focused on the effect of distance on the relationship between self-reported and objective measurements. Although the strength of the correlations for both the direct and the content comparisons tended to be higher within 300 ft than 1,500 ft, the correlation table by itself did not provide clear and convincing evidence of a distance effect. In addition, distance did not emerge as a distinct dimension in the factor analysis. However, when the variables are simultaneously grouped in terms of content and distance using structural equation modeling, a significant distance effect emerged for both natural and built environments separately. We found that a longer distance significantly reduced the correlations between self-reported and objectively measured environments. This finding is similar to those reported by Gibson (1979) and Kirtland et al. (2003). Gibson suggested that perception of size becomes less definite with distance. Also, Kirtland et al. concluded that perception of the environment may be most accurate close to home. They found that the agreement between objectively measured environments and perception of those environments is higher within neighborhood distance (0.5 mile) than community distance (10 miles; Kirtland et al., 2003). The distances in our study included 1,500 ft (0.28 miles) for neighborhood environments and 300 ft (0.06 miles) for home environments. The scale differences among the studies did not affect the congruency of the findings.

Our third hypothesis focused on the effect of content (natural vs. built features) on the relationship between self-reported and objectively measured environments. The correlation table suggested that stronger relationships existed among the natural content variables than among the built variables, but the evidence was not compelling. The structural equation models clearly revealed that a stronger agreement existed between self-reported and objective measurements for natural content than for built content. This effect on the different measures is a new finding. It may be explained in part by existing preference research. Settings that contain nature have been consistently preferred over settings that do not contain nature (Chokor & Mene, 1992; Getz et al., 1982; Herzog et al., 1976; Sullivan, 1994; Ulrich, 1993). It is possible that people pay more attention to the preferred contents (i.e., natural) than other contents in their environment. The agreement between self-reported and objective measures may be enhanced when people are most attentive to the environmental contents involved. The finding might also be explained by the measurement differences. The transparent character of the natural environment may allow people to see through, whereas built elements may interfere with the perception of distant objects.

CONCLUSION

This study examined the relationships between objective and self-reported measures of the natural and built environment within 300 ft and 1,500 ft of respondents' homes. It hypothesized that these measures were significantly different overall but that the strength of the relationships would be affected by both distance and content (natural vs. built). Each of these hypotheses was supported by the results. In addition, knowledge of natural content was found to be different (oblique) from knowledge of built environments, whereas water appeared to be measuring the same thing regardless of how it was measured.

Environmental planners and designers are asked to make decisions affecting the environment using both kinds of data examined in this study. By better understanding the relationship between self-reported and objective measurements of the environment, planners and designers can choose the most appropriate data type for analyzing decisions, thereby reducing the chances of making costly errors. In general, objective data should not be substituted for self-reported data when making decisions that may be value laden. Conversely, self-reported data should not substitute for objective data when absolute measurements are needed. However, when making decisions that concern nature near residents' homes (300 ft), substitution bears less risk. Landscape design and planning decisions can be expensive to implement and difficult to overcome once completed.

Future studies should be undertaken to provide a more detailed examination of content effects including content of the natural and built environment. This study provides some evidence that such effects exist but fall short of identifying a complete list of the content types that may carry such an effect. In addition, more studies are needed that examine the distance effect. This effect appears to hold for different scales (home, neighborhood, community), but it is not known whether the effect is linear or nonlinear or if a consistent threshold exists beyond which self-reported and objective measures show no significant relationship at all. The results of this study hold little possibility for generalizing to the wide variety of municipalities that exist in the world. A useful approach to generalizing might include enlarging the scope of the municipalities studied (from fast-growing small towns to megalopolitan areas) and varying the eco-regions (forested, plains, mountainous, coastal, etc). Finally, it would be particularly helpful to examine how objective and self-reported measurements of the environment are related to quality of life and human behavior. This knowledge would be most useful to professionals involved in community development activities including landscape architects, planners, and engineers.

NOTE

1. Normalized Difference Vegetation Index Formula is a radiometric measure of the amount, structure, and condition of vegetation (Huete, 1988). The formula obtains the grid cell values in the red (RED) and near infrared (NIR) image bands to calculate a vegetation cover image using the formula (NIR–RED)/(NIR + RED).

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