Assessing Perceptions of Environments for Active Living

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Background: Substantial research has been done on the relationship of physical environments to active living, much of it using observational measures of physical properties. Although this research is important, it produces an incomplete picture. Perceptions of environmental factors may affect physical activity. There is particular value in learning about people's perceptions of environmental factors that are associated with increased or decreased likelihood of physical activity.

Methods: The present paper surveys and evaluates various options for measuring perceptions of specific environments and alternatives for study designs and methods. Referring to the relevant studies and concepts in environmental psychology, environmental perception, and related disciplines, it identifies and evaluates the measurement methods.

Results: The measurement of environmental perceptions must take into consideration the selection of respondents, measurement of environmental variables, sampling and mode of presentation of the environmental stimuli, and response measures.

Conclusions: Research can build on current knowledge of environmental perception to explore measures and methods of particular relevance to understanding people's likelihood of using places for physical activity.

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Background

New urbanists, design professionals, and others have proposed many physical attributes of places that they expect to affect outcomes such as comfort, interest, safety, activity for recreation or transportation, sociability, and sense of community. Studies have examined the links among environmental attributes, physical activity, body weight, and health.[1–6] Environmental perception and evaluation probably mediate many of the behavioral effects, but not all of them. People may tend to walk more in an area they assess as safe or pleasant,[7] but someone living in a mixed-use area may walk more whether or not the area feels safe or pleasing. The perception of pleasantness also depends on the context. Various groups (such as adults and children; walkers and joggers; rural, suburban, and urban residents) may differ in the aspects of the environment they consider pleasant. Ideally, communities should create places that for their context have positive effects on physical activity and on their evaluations and connotative meanings. This involves crafting design guidelines for how to attract people to places that support physical activity and how to make such places feel safe, convenient, and attractive.

Researchers of active living often conduct impartial assessments of places to characterize the extent to which they support activity, having participants rate various qualities of those places to examine which physical attributes seem to be stimulating both positive and negative meanings and evaluations. Knowing a wide range of effects would be valuable for designers. The physical and the perceived attributes of environments are likely to provide complementary information about the influence of environments on physical activity and other outcomes. Perceptions may mediate the effects of the built environment.

Environmental assessments that differ by gender, age, economic status, race, or ethnicity may provide clues about designing activity-friendly environments for each group. Identifying environmental attributes that are both related to physical activity and evaluated favorably can provide a strong case for policy change. To explore any of these issues, high-quality measures of environmental perceptions and evaluations are needed, and appropriate study designs must be used.

For background and guidance on the measurement of environmental perception and evaluation for active living research, this paper covers three topics: (1) the relevance of environmental-perception research to active living research, (2) the methods for measuring

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environmental perceptions, and (3) the identification of what to measure in the environment and in human evaluative appraisals of it.

Active living research deals with both physical activity (the burning of calories) and exercise (a planned, structured, and repetitive physical activity). The health benefits of both are well-documented, and include the prevention of cardiovascular disease, some cancers, type 2 diabetes, osteoporosis, injurious falls, premature mortality, and mental disorders.[8] In a nation of increasingly obese people, an emphasis on physical activity is an important public policy issue.

A simple model summarizes concepts about the role of environmental perceptions in active living and health research. Attributes of the physical environment interact with various human characteristics (such as sociodemographics and people's perceptions of the environment) to affect physical activity; this in turn influences health outcomes. Research on active living has developed a variety of rigorous methods for measuring the physical environment, physical activity, and health outcomes. Research is less advanced, however, in assessing human perceptions of the environment. While recognizing the potential effects of noise, smell, touch, and kinesthetic experience, this review centers on vision, the dominant human sense.

What role does research on environmental perception have in relation to physical activity such as walking? First, how places look affects people in powerful ways. Humans have a rapid emotional response to places.[9] "Aesthetics" is one of the most important aspects of people's experience of their surroundings,[10,11] and is an important quality associated with physical activity.[12–19] People are more likely to visit and walk in places they judge as pleasant, and to avoid places they perceive as unpleasant. Studies of environmental experience and physical activity operationalize aesthetics as favorable affect and connotative meanings (inferences about the quality of the environment and users) experienced by users and inhabitants in relation to the environment.[10,20] For example, although results have been inconsistent, studies have found that perceived crime and traffic safety affect walking, with people less likely to walk in environments they perceive as unsafe.[7,13,15,19,21,22]

Next, to enhance physical activity through the physical environment, the physical attributes of the environment that relate to affect and meaning must be measured, and this involves questions of perception. Some direct physical measures of the environment do not translate into people's perception of the environment,[23] and some perceptions may have independent associations with physical activity. This suggests a need for physical and perceptual measures. An understanding of environment perceptions may also suggest relevant environmental attributes for study (i.e., those that stand out in human perception and evaluation).

Finally, research has consistently found distortions in perceived distance that affect spatial behavior. For example, one study found that people (unknowingly) parked farther away from their offices due to perceived distance distortions related to physical characteristics of the routes from the garages to the destinations.[24] Other research confirms the effects of perceived distance on activity, finding, for example, that the perceived convenience or distance to recreation facilities affects use of the facilities.[12,13] Knowing the environmental characteristics that make a place appear closer allows designers to employ those characteristics and thus make a place more likely to attract walkers.

Knowledge of perceived environmental qualities can further the understanding of how the environment affects active living, and this can allow better evaluation and planning of places that encourage physical activity.

Methods

To measure environmental perception, four aspects of the study must be addressed: (1) the selection and measurement of environmental attributes, (2) the selection and presentation of environmental stimuli, (3) the selection of response measures, and (4) the selection of respondents.

The following sections describe these choices and evaluate them in relation to trade-offs among practicality (time, resources, and convenience), internal validity, and external validity.

Selection and Measurement of Environmental Attributes

Physical measures can be obtained of certain concrete attributes of the environment such as block length, lot sizes, setbacks, or number of trees on a block. Some attributes of relevance to evaluative perceptions and behavior may involve a more abstract perceived integration of various properties. For example, a physical measure of the number and size of trees and shrubs on a block may miss people's perception of the block's naturalness, because that perception may depend on such factors as the spatial arrangement of the trees relative to developed elements. Eventually, the study of physical and perceptual measures may reveal the physical bases underlying the perceptions.

Until then, human observers are necessary to assess abstract properties of the environment (such as order) that are relevant to human affect and behavior; these abstract properties, while having referents to concrete physical attributes of the environment, depend more on the observer's integration of the environment's attributes, and therefore are more difficult to measure directly. The degree to which a physical measure of an attribute matches people's perception of it also needs to be known. If environments are manipulated or selected for variation of a physical attribute (such as the amount of vegetation present), an independent measure may be needed to check if people perceive the environments as hypothesized. Do the environments vary as expected in people's perception of their naturalness?

It makes sense, then, to supplement physical measures with judgmental measures in which humans rate various physical

Table 1. Prospect, refuge, and escape, and likely fear of crime

Attribute	Level	Perceived safety
Prospect	Blocked view	Less safe
	Open, unobstructed view	More safe
Refuge	Hiding place/concealment ahead	Less safe
	No hiding place/concealment ahead	More safe
Escape	Bounded, blocking escape	Less safe
	Open, no obstacles to escape	More safe

properties of the environment. For example, a study of fear of crime[25] had as stimuli eight areas selected for their physical differences on attributes expected to relate to fear (Table 1). To find out if people's perceptions of the areas varied as expected on those attributes, independent ratings were obtained on each attribute for each area.

Although such ratings appear subjective, judgmental approaches tend to obtain consistent and accurate measure of environmental attributes, especially if the measures refer to physical attributes of the environment such as complexity, order, enclosure, and naturalness, and are clearly defined.[26] The marginal increase in inter-observer reliability decreases as raters are added; 15 raters should be adequate,[27] but inter-observer reliability should still be assessed.

Do such judgments agree with residents' perceptions of their block or neighborhood? Research suggests they probably do. A meta-analysis from which a correlation could be gleaned examined 40 studies of environmental preferences by different groups. The 40 studies covered 1001 environments, 5301 respondents from 432 samples, 21 countries, and 13 demographic groups. The meta-analysis found a high level of consensus ($r = 0.82$) across all demographic groups (including tests by ethnicity, political affiliation, gender, culture, student versus nonstudent, and expert versus non-expert).[28] Further comparisons of four experiments examining variations in respondents and environments suggest that variation in preference relates more to characteristics of the environment than to differences among people.[29] Nevertheless, because familiarity and adaptation may affect judgments of the environment,[30–33] they could be tested directly for the panel of judges.

Studies are also needed to determine if judgments of environmental attributes by an outside panel are associated with evaluations and behavior among residents. While the panel judgments may predict likely responses among a group of residents, given some variability in response, measures of central tendency may not predict any individual resident's response. Obtaining one resident's response on a street or area cannot provide much useful information for design or planning. Although that resident's perception of the environment may relate to walking, it is difficult to separate the personal from the environmental bases for the rating. One resident's rating of the attributes of his or her block, or their desirability, may not generalize to other residents. Consider naturalness: To understand the perceived naturalness of an area or its desirability, the research would need to obtain ratings of the naturalness or its desirability from several residents. This would allow a test of the inter-observer reliability of those ratings, which could give a better sense of the degree to which the ratings derive from characteristics of the environment.

Having residents judge the attributes of the physical environment (as independent measures) can introduce a bias if the same residents also rate their evaluation of the environment (as a dependent measure). To explain the functional relationships between the perceived characteristics of places and people's evaluations of them, independent and separate measures of the two kinds of variables should be obtained. For example, to gauge the desirability of a block in relation to its perceived naturalness, the perceived naturalness should be measured separately from either the evaluation of the naturalness or the block. The study should have one group of people assess the naturalness and another group assess the desirability of the environments. When the same person rates both kinds of variables, the rating of one might affect the rating of the other independent of the property being rated, and, as a result, such studies may reveal more about semantic relationships among words than about the way people respond to the environment.[20] This could be supplemented with independent observations of pedestrian behavior vis a vis the environments.

If a study must obtain residents' assessments of their environment, it is best to have some residents on a block judge the environmental attributes and others rate their evaluation of the environment. Alternatively the order of the two kinds of ratings could be varied and possibly obtained on different days. This would allow testing for order effects to identify effects of each kind of measure on the other.

Ratings from residents after a change in their environment, and behavior associated with them, may have a bias either from an implicit comparison to the previous conditions or from the residents' knowledge of community investment in the neighborhood. That the change in the environment, and not some artifact, caused a different response to the environment is what must be determined. Achieving this, particularly when implementing and testing a change, requires careful consideration of quasi-experimental designs. Controlled walk-through simulations, discussed later, offer one technique to establish the likely responses and behavior.

Selection and Presentation of Environmental Stimuli

Investigators must decide how to sample the environment and must choose the mode of presentation of the selected environment.

Sampling the environment. The objective is to obtain information on the effects of certain specified attributes of places without sacrificing external validity.[34] In one approach, scenes along attributes of interest are systematically manipulated. This allows the systematic varying of selected environmental attributes and the control of others, thus potentially improving internal validity, as it is more likely that effects found would relate to the selected attributes. For example, one study created nine signscapes that varied in the complexity (number and amount of variability across the signs) and obtrusiveness (size, brightness of color, and contrast) of the signs.[35] Ratings by a panel of judges confirmed that the signscapes varied as expected on some aspects of perceived complexity and obtrusiveness.

People familiar with an environment may, due more to personal feelings, judge its characteristics and evaluate it

Table 2. Salient physical attributes of environments

- **Naturalness** refers either to the individual's perception of an area as natural or to the predominance of natural elements (vegetation, water, mountains) over developed elements. Some "natural" settings (such as manicured lawns or a farm field) depend on human intervention, have developed elements, or exist in developed contexts.
- **Upkeep (civilities)** refers to the perceived maintenance (and lack of signs of decay) of areas. The negative pole of this attribute is sometimes referred to as physical incivilities,[56] which function as cues to social disorder.
- **Openness** refers to the perceived vista, visual scope, and related attributes (such as spaciousness, building density, and defined space). Another spatial attribute is deflected vistas (also called "mystery"), which in safe situations people may like and in unsafe ones they may fear and avoid.
- **Complexity** refers to the amount of structural information in a scene, the number of different noticeable elements, and the distinctiveness among those elements. **Order** refers to the degree to which people see an environment as unified, coherent, congruous, legible, or clear.
- **Historic significance** rests on the observer's perception. An environment could either have authentic historic significance or simply look historic to the observer.

differently from others unfamiliar with it.[30–32] Familiarity can color their judgment of its physical characteristics. For example, people rating environments in or near their neighborhoods might rate the naturalness or desirability of that naturalness more favorably than someone unfamiliar with those same environments. The use of a panel unfamiliar with the environment can mitigate those potential biases. However, if the systematically manipulated stimuli do not represent a realistic range of actual environments, the results may not generalize to actual places.

A second approach involves the selection of real environments that vary on the attributes of interest. While this can yield a more realistic sample, it may do so by sacrificing control and internal validity. Other naturally occurring environmental attributes may co-vary in the scenes, which makes it impossible to distinguish the effects of individual characteristics. For example, if environments that varied in naturalness were selected, those scenes might also tend to vary on density, openness, upkeep, or some other attribute. This kind of pre-selection of attributes by the investigator presents another problem. Relevant attributes may be missed, and the selected attributes may not be relevant to ordinary experience. If so, the differences may not stand out for people in their daily experience, and differences found in response to the environments may not generalize. To avoid this problem, attributes should be selected that research has identified as salient in people's perception of the environment (Table 2).

In a third approach, investigators could sample a broad variety of environments relevant to the kind of environment studied (e.g., single-family residential, or parks), without attempting to select places for the presence of an environmental attribute of interest. Some controls in the presentation of the environments are needed to obtain comparable and typical views and to reduce bias from photographic quality and viewing angle. For example, consistent lighting conditions, weather, and eye-level viewing angles would be required to avoid variations in conditions extraneous to the study, biasing the results. This approach could achieve strong ecologic validity, but the presence of so many attributes, some interrelated, makes it difficult to rule out rival hypotheses and establish independent associations. Still, research has used this kind of approach to identify patterns of preference.[36] Use of multiple methods, each with unique biases, can allow for triangulation of convergent and divergent validity tests on the results.

Mode of presentation. The dilemma of the choice between internal and external validity can be alleviated through choosing an appropriate mode of presentation (Table 3).

The difficulty of taking each participant in a panel to a site or to a variety of sites can be overcome through the use of color slides, photos, or real-time virtual reality simulations. Studies indicate that responses to color slides or photos reflect on-site experience more accurately than responses to drawings or black-and-white photos.[10,37] A meta-analysis of 1215 stimuli and 4200 respondents[38] confirmed the validity of responses to color photos in relation to on-site responses ($r = 0.83$). Live images can be scanned, and, with programs such as Adobe Photoshop, used to create controlled and realistic manipulations indistinguishable from color slides or photos of real environments,[39] which should generalize well to on-site experience. The computer allows the changing of attributes such as street width, length, amount and type of vegetation, sidewalks, litter, upkeep, and type of houses and their distance from the street.

The lack of movement may present a limitation.[40] In addition, what people notice in the environment varies with their speed of travel through it.[41] As the speed of movement increases, the level of detail noticed and the extent of view

Table 3. Strengths and weakness of various modes of presentation

Mode of presentation	Similarity to on-site experience: external validity	Experimental control: internal validity	Ease of use
On-site exposure	Most realistic	Less control	Difficult to take panel to site(s) for ratings
Color video or film	Realistic	Hard to control	Easy to have panel rate attributes of many places
Virtual reality walk-through	Realistic	Allows control	Easy
Color slides/photos*	Realistic	Allows control	Easy
Color slides/photos of models	Less realistic	Allows control	Easy
Black-and-white photos, and models	Least realistic	Allows control	Easy

Note: Computer manipulations of color photos and virtual reality environments can yield realistic controlled images.

decreases. These differences might produce differences in response for people walking at different speeds, joggers, bikers, or people in automobiles. Computer-generated virtual walk-through environments can address these possible limitations. Virtual environments allow both experimental control and movement, and research indicates that behavior in virtual environments does generalize to behavior in actual environments.[42] Eye level can also be varied, from that of a child or person in a wheelchair to that of a typical adult.

Response measures. Many studies use verbal rating scales without efforts to deal with response biases and the reactivity inherent in them.[43–45] To record environmental perceptions and evaluations, research needs such verbal ratings, but these can be supplemented with physiological and behavioral measures. For evaluative appraisals (such as preference), reliance on verbal measures alone may identify cold cognitions that may lack emotional involvement.[46] Behavioral and physiological measures may help establish the level of involvement. Behavioral measures might involve observing how long individuals look at an environment, or which of two environments they choose to look at, or, in the case of virtual reality, which they choose to enter. Psychophysiological measures might assess pulse, heart rate, graduated skin response, brain waves, pupil dilation, or patterns of eye movement. In the absence of behavioral and physiological measures, verbal measures can be crafted that indirectly tap likely behavior or physiological response by asking about expected behavior or feelings in realistic situations. For example, a study of house exteriors had respondents imagine winning a dream-house lottery and then selecting the house they wanted; a study of commercial strips asked respondents to indicate which they would most likely visit to shop.[35,47] Other research has developed a verbal measure that correlates with physiological measures of restorativeness.[48]

Verbal measures for active living research can measure two distinct categories of response that might affect physical activity: (1) judgments of physical attributes of the environment, and (2) affective appraisals of and likely behavior in the environment. Each has ties to broader theoretical positions with relevance to physical activity. In theory, certain aspects of environments should increase their pleasantness or interestingness,[10,37] and pleasant or interesting places should attract people more than unpleasant or boring ones. For example, one study found that commuters traveled out of their way to drive through a natural environment.[49]

As with the environmental attributes, the measures of affective appraisals should reflect the dimensions relevant to people and to active living behavior. Those dimensions might include both evaluative responses such as pleasantness, excitement, and calmness, and connotative meanings such as perceived status or friendliness. Verbal measures can be administered to large numbers of people, thereby allowing the evaluation of large numbers of environments relatively quickly. Readers should consult texts on psychological measurement for details on scale wording, order, context effects, response format, scales, and procedures.[44,50]

What to measure. The study of active living seeks to know which attributes of the environment stand out in human perception, because those attributes would more likely affect behavior. The salient dimensions of evaluative appraisals of environments are also of interest, as they also would more likely affect behavior. Although a comprehensive review of the research seeking to identify the salient environmental attributes and salient dimensions of response is beyond the scope of this paper, the following paragraphs briefly summarize some factors to consider for environmental perception and evaluation.[51]

Research has found five kinds of attributes that stand out in people's perceptions and affective appraisals of environments (Table 2). Directly or through their impact on aesthetics, they may influence pedestrian activity. Other constructs, such as the perceived effort and perceived connectivity, could also affect activity. Beyond these attributes, research could have adults and children identify attributes that would affect their willingness to be physically active in a place; and have adults identify attributes that would affect whether they would allow their children to be active in a place. Affective appraisals may vary with the activity (such as walking for recreation, to work, to a destination, or jogging) and the context. Context refers to characteristics of the environment (such as urban, suburban, or rural) and the person (such as age, gender, and socioeconomic characteristics) in the environment. Investigators would do well to consider the context, activity, and both the aesthetic and functional constructs.

Emotional responses in relation to the environment include affective appraisals and emotional reactions.[52,53] An affective appraisal refers to an individual's attribution of an emotional quality to the environment, such as liking it, as well as inferences about (or connotative meanings for) the place or people in it, such as judging it as friendly. An emotional reaction refers to an internal state (such as pleasure) that a person feels in relation to the environment. For active living research, affective appraisals probably have more relevance to patterns of use. Research indicates two orthogonal dimensions of affective appraisals to the environment: evaluation (from pleasant to unpleasant) and arousing (from sleepy to arousing), and mixes of them to create two additional aspects of environmental evaluation: excitement (from dull to exciting) and relaxing (from distressing to relaxing).[33,53] Exciting places are more pleasant and arousing than boring ones. Relaxing places are more pleasant but less arousing than distressing places.

The four dimensions apply to emotional reactions (pleasure, arousal, excitement, calmness).They also echo planners' discussion of interest (i.e., excitement), comfort, and safety (i.e., relaxing). People may walk out of their way to a place such as Times Square for its interest and excitement; they might also walk out of their way to a place such as a park for its relaxation; and they may avoid places they judge as unsafe. An intense aesthetic response may involve a mix of intense pleasure, excitement, and relaxation. While a measure of preference or enjoyment may be sufficient, measuring pleasantness, excitement, and peacefulness could provide richer data. As each involves an evaluation, they might co-vary. If an aesthetic experience can be conceptualized as relaxed but also exciting pleasure, then the combination of the three items could become an aesthetic scale. Table 4 shows items from tested lexicons of environmental descriptors[54,55] that can be used to construct scales for pleasantness, excitement, or relaxation.

Selection of respondents. For evaluations of the environment, the individuals likely to experience the places under

Table 4. Items for use in assessing salient aspects of emotional appraisals

Response category	Items
Pleasantness	Appealing—unappealing
	Attractive—unattractive
	Beautiful—ugly
	Pleasant—unpleasant
	Inviting—repelling
Excitement	Unexciting—exciting
	Lively—dull
	Unstimulating—stimulating
	Interesting—uninteresting
Relaxation	Unexciting—exciting
	Upsetting—calming
	Refreshing—wearying
	Restful—disturbing
	Threatening—safe
	Distracting—soothing

consideration represent the population to whom the assessment should apply. That population might include residents, passersby, and occasional visitors. For example, for existing neighborhoods, residents would be the relevant population. For a school, it might be students who attend the school and their parents. In such cases, if a list of the population can be assembled, a census should be used (for a small population), or a random, stratified, or cluster sample to obtain a sample representative of the population. Passersby, occasional visitors, and surrogates for them (i.e., similar groups) could be identified for new or proposed projects that lack actual residents. Then a census could be taken for a relatively small population, or a sampling procedure used—probability or nonprobability sampling—to select respondents from the population.

A caveat applies to the standard wisdom on the benefits of random, stratified, or cluster sampling: In some cases an opportunity sample (where the investigator reaches out for cases that are readily available) makes sense. For example, a correctly selected opportunity sample makes the most sense to find out how passersby evaluate a park. It would be impossible to create a list from which to draw a probability sample for the population of interest (passersby), but an opportunity sample of passersby can be drawn. To avoid potential biases in selection, a systematic sampling procedure should be used. In the study of fear of crime in relation to the eight areas around a building,[25] for example, passersby were sampled. Because of higher levels of fear after dark and among women, the sample was drawn from female passersby after dark. Locations for sampling were selected in advance. A decision rule dictated the selection of the n-th female passerby for an interview until the desired sample size was obtained. Such an approach could be broadened to draw the sample on different days and times. Using a systematic process averts unintentional bias in selecting passersby.

Conclusion

Assessing perceptions of environmental attributes and affective appraisals of environments has relevance to understanding active living through the environment. With appropriate choices of environmental stimuli, measures, and respondents, an accurate picture of environmental perceptions and evaluations can be gained—a finding relevant to spatial behavior, and usable in models of such behavior.

Future work could use technologies such as PDAs or hand-held computers to code responses to environments on-site. With some programming, a meter could be created to allow a person to continuously rate a particular dimension as he or she walked. It would somehow need to link that rating to the particular place in the environment being rated, much like an integrated GPS. Dials can also be used (or computers programmed to create dials) to get ratings. Online survey technologies such as Surveymonkey and Zoomerang have great potential in that they allow the inexpensive use of color photos, and they offer gains in efficiency and accuracy because they can send output directly to a database. Having even a small group of judges rate the character of environments through an online tool can improve timeliness and accuracy. Groups of people can use wireless, handheld voting units, allowing each person to rate the stimuli; these provide instantaneous results.

Research can build on current knowledge of environmental perception to explore measures and methods of particular relevance to understanding people's likelihood of using places for physical activity. Digital simulations have promise, as they can identify environmental modifications that would likely improve appraisals and people's willingness to be active in places.

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