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Streets of San Francisco: Brunswik's Lens Model Applied to Urban Inference and Assessment

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Brunswik's probabilistic functionalism and the lens model offers a conceptual framework for linking environmental assessment with environmental perception and cognition in the study of such urban problems as inference and action regarding crime opportunity and crime vulnerability. An adaptation of Brunswik's lens model is applied to analysis of inferences about urban conditions. The ecological validity of cues generated by technical and observational assessments of residential streets in San Francisco is gauged for three conditions: traffic volume, average family income and residents' concern about crime. The functional validity of estimates of these conditions by expert judges is also appraised, and policy capturing is illustrated.

To understand urban behavior, we must understand how people interpret attributes of the urban scene as cues associated with socially significant conditions and outcomes, and we must be able to gauge the actual validity of these cues as predictions of such conditions and outcomes.

Concern about crime, for example, is one pressing aspect of urban reality. What environmental attributes of settings do urban residents associate with the differential incidence of crime? How do they combine and weight multiple cues to make inferences about the risk of crime? We know rather little about these forms of inference about urban settings, despite their obvious implica-

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tions for human action in the city. We do have some evidence, though. For example, in a study of judgments made by West Baltimore inhabitants on the basis of the visual features of neighborhood streetfront scenes, Taylor, Brower and Stough (1976) found that the presence of residents outdoors in the scenes was negatively associated with the judged likelihood of burglary, while the presence of occupant-generated decorations (e.g., flowerboxes, ornaments, outdoor furniture) was positively associated with judged safety of the areas at night.

Such a strategy for examining systematically the relation between urban features and inferences about urban conditions warrants broader application. In addition to the study of inferences made by the general public, those made by special subgroups deserve attention. How do burglars associate urban features with crime opportunity? How do police experts diagnose urban settings for vulnerability to crime? How do urban planners and designers associate urban features not only with the actual incidence of crime, but with the residents' concern about crime? The assumption underlying this approach to urban perception and behavior holds that city residents constantly "read" or interpret urban features as cues to other conditions and contingencies. These inferential processes serve to guide everyday behavior for citizens at large, and also characterize the professional performance of others, such as police officers, urban criminals, and urban planners.

An important functional question here is the accuracy of these interpretations of the city. To appraise the veridicality of urban inferences, we must determine the actual intercorrelations among cues and urban conditions. Unfortunately, we know rather little about the structure of these environmental probabilities. The required analyses are straightforward. For example, Pablant and Baxter (1975) examined a sample of 32 public schools in Houston and identified physical features empirically related to differential vandalism rates. What we lack are systematic findings on an array of urban cases and conditions.

Studying these questions involves two distinct kinds of research: research on environmental perception and cognition, on the one hand, and studies of environmental assessment, on the other. Environmental perception and cognition refer to efforts to analyze the features of the city that laypersons and experts associate with important conditions or outcomes (e.g., differential incidence of crime); to examine the processes involved in these inferences, and to gauge their accuracy. Environmental assessment refers to

systematic attempts to identify attributes of urban settings that are empirically related to such socially significant criteria as the differential incidence of types of crimes (e.g., the features that distinguish liquor stores that are robbed frequently from those that are not) (Duffala, 1978).

Unfortunately, these traditions of investigation have developed quite independently within environmental psychology (Craik, 1973, 1977; Stokols, 1978). A conceptual framework that integrates these two forms of research is offered by Brunswik's lens model and his orientation of probabilistic functionalism.

The role of Egon Brunswik's work as inspiration and influence in the development of environmental psychology is generally acknowledged (Barker, 1968; Craik, 1970; Ittelson, Proshansky, Rivlin & Winkel, 1974; Smith, 1977; Stokols, 1978). His formulation of the notion of representative design holds that classical experimental research often artifically ties or unties independent variables in ways that do not characterize the conditions prevailing in the organism's natural environment (Brunswik, 1943, 1955, 1956). Brunswik argues that we must study the organism in its own settings, with representative sampling along the variables of interest, or else contrive experimental settings that accurately capture the probabilistic relations between environmental cues and veridical object perceptions.

The Lens Model and Probabilistic Functionalism

Brunswik's lens model offers a useful device for joint consideration of research on environmental assessment and environmental inference. Its value can be illustrated by findings drawn specifically from psychological studies in an urban context. Let us suppose that a panel of observers has been presented with color photo-slides of 21 street scenes in San Francisco and asked to estimate the status of each street regarding an important socio-environmental condition, in this case, the residents' degree of concern about crime in their neighborhood. To establish the accuracy of each judge's estimate, some criterion index of this environmental condition for the sample of streets must be established—in this case, from a survey of residents. The correlation between the judge's estimates for the sample of streets and the criterion index gauges the *functional validity* or *achievement* of each judge. If an independent operation is used to provide a descriptive assessment of the sample of streets on an array of

environmental attributes (e.g., length of block, number of trees, incidence of graffiti), two additional sets of relations can be considered. First, each environmental attribute can be correlated with the criterion index for the environmental condition, gauging the *ecological validity* of each cue—that is, its probabilistic relation to the attribute measured by the criterion index. Second, each environmental attribute can be correlated with each judge's estimates of the environmental condition for the sample of streets, gauging the pattern of *cue utilization* displayed by that judge. Finally, the intercorrelations among the environmental attributes provides information about the causal texture, or structure, of the environmental setting under analysis (e.g., the probabilistic relation of number of trees to incidence of graffiti).

The lens model is based on some underlying assumptions of probabilistic functionalism. First, the relation of cues to criterion conditions (their ecological validities) is probabilistic rather than certain in nature. Second, since cues have limited though varying ecological validities, the organism can be viewed as following a probabilistic strategy in combining and weighting cues in the inferential processes. Third, the adaptive level achieved by the organism is itself probabilistic rather than perfect, and the attained functional validity depends in part upon the match between utilization of different cues and their differential ecological validities.

The San Francisco Street Study

The implications of the lens model for enviromental psychology can best be seen through an illustrative application of it. Such an illustration is offered by a study of judgments of socio-environmental conditions in residential streets of San Francisco.

To what extent do the residential streets of San Francisco offer ecologically valid cues for such socio-environmental conditions as traffic volume, socio-economic status of residents, or the degree of residents' concern about crime? Given that useful cues are available, can environmental professionals "read" or interpret urban features accurately? The three criterion conditions are represented by three distinct classes of measures that have been emphasized within urban planning and design: a physical variable—traffic volume; a sociological variable—socio-economic status; and a social psychological variable—residents' concern about crime.

A sample of two-block streetfronts was selected, and their standing on the criterion variables was established through archival

records (traffic volume) and survey interviews (family income; concern about crime). Systematic measurement of an array of urban features was conducted, using both technical and observational assessments. Correlations of the three criterion indices with measures of those urban features provide a basis for identifying the ecological validity of the cues for each criterion condition.

The functional validity of judgments regarding the three criterion conditions was studied by having environmental professionals make inferences on the basis of photo-slide presentations of the streetscenes. This phase of the study also yielded case studies of cue utilization by environmental professionals, based upon correlations of their judgments of criterion conditions with the assessed or objective criterion measures. This procedure has been termed policy capturing; it identifies the differential use of cues and their relative weighting by individual judges (Slovic, Fischhoff & Lichtenstein, 1977).

The use of physical, sociological and social psychological criterion conditions serves to underscore the point that the lens model need not be restricted to the analysis of physical environmental variables. Brunswik initially applied his analytic strategy to judgments of physical size, but later expanded it to social perceptions such as judgments of personal traits based upon facial features (Brunswik, 1956). Subsequently, research on policy capturing has focused upon expert inferences, such as radiologists judging gastric ulcer conditions (Slovic, Rorer & Hoffman, 1971), stock brokers judging the potential capital appreciation of business firms (Slovic, Fleissner & Bauman, 1972), city council members judging budget allocations (Stewart & Gelbard, 1976), resource managers judging trout stream quality (Louviere, 1974) and psychodiagnosticians judging neurotic versus psychotic conditions (Dawes & Corrigan, 1974; Hammond, 1955; Hammond, Hursch & Todd, 1964; Hoffman, 1960).

Measures

The sample of 21 street segments (2 block lengths each) was selected from throughout the city of San Francisco. Stratified sampling devised to meet the requirements of a related research project was employed (Appleyard, Gerson & Lintell, 1976), yielding an array of settings diverse in terms of traffic volume, amount of landscaping, average family income and geographical location. Three criterion indices were used. One index was derived from archival data: traffic volume (number of vehicles per day). Two indices were based upon survey interviews with a sample of 20

randomly selected residential units per street segment: average family income and concern about crime. Across the sample of 21 street sites, residents' concern about crime is significantly related to mean family income (−.42); but neither is significantly related to traffic volume (+.18 and −.15).

The descriptive environmental assessments included technical assessments and observational assessments. Technical assessments refer to those based upon technical-scientific systems of measurement (measures of length, counts per unit time, etc.). Observational assessments refer to those based upon consensual impressions recorded by on-site observers (Craik, 1980). The technical measures include length of blocks, presence and incidence of illegally parked cars, sidewalk activities, and the like. Observational assessments were made by an interdisciplinary team of six faculty and advanced graduate students in environmental psychology and environmental planning who walked the length of each street site and independently recorded ratings on nine environmental attributes. The composite reliabilities of these ratings estimate the level of agreement that could be expected with ratings made by another comparably constituted assessment team (Block, 1961; Horowitz, Inouye & Siegelman, 1979). The rating dimensions and their reliabilities are presented in Table 1.

TABLE 1
COMPOSITE RELIABILITIES AND ECOLOGICAL VALIDITIES OF OBSERVER-BASED ENVIRONMENTAL ASSESSMENTS*

Attributes	Composite Reliabilities (N: 6 observers)	Environmental Conditions		
		traffic volume	family income	crime concern
	r	*r*	*r*	*r*
Architectural quality and integrity of street as a unit(high vs low)	73	−57	40	−24
Attractive vs unattractive	92	−63	46	−34
Busy vs quiet	91	88	−33	38
Colorful vs drab	65	−41	−07	−10
Diversity: varied vs similar	85	00	10	35
Greenery (high vs low)	94	−32	56	−37
Ornate/detailed vs plain	88	−44	04	13
Upkeep: private area (excellent vs poor)	90	−51	62	−57
Upkeep: public areas (excellent vs poor)	90	−35	64	−50

*Entries are correlation coefficients with decimals omitted
r of .41 or greater, significant beyond .05 level

Color photo-slides, one per street site, were presented to a sample of 18 environmental professionals who recorded their judgments of the three conditions for which criterion indices were also available. The judges were faculty and advanced graduate students in environmental planning and environmental psychology. The photo-slides typically were taken midway into the length of the street segment, with the viewing point from one sidewalk looking up the street and across toward a distant point on the opposite sidewalk. Those judgments provided the basis for policy capturing analysis.

Results

Table 2 presents correlations which represent the ecological validity of selected technically-assessed environmental attributes for two environmental conditions: traffic volume and family income. The left-hand column of Table 3 presents similar information for the third condition, residents' concern about crime.

TABLE 2
Ecological Validities of Selected Environmental Cues*

Environmental Cues/ Attributes	Environmental Conditions	
	traffic volume *r*	family income *r*
Estimated percent of the time that conversation with moderately raised voices can be carried on across street (morning and afternoon)	–87	32
Number of moving lanes of traffic	81	–10
Air odor quality (1-no odor to 5-strong odor, gas fumes, etc.)	69	–52
Block on truck route	68	–17
Soot accumulation on streetside, buildings, front surfaces (1-clean surfaces to 5-thick soot)	49	–41
Sidewalk activity: incidence of people talking	–43	–26
Number of trees	–25	72
Exterior decoration of windows and doors: incidence	–17	64
Unit separation (width of separation)	–22	54
Street alignment: sloped	11	52
Number of green setbacks	–26	51
Evidence of auto repair activities	–27	–48
Average setback of dwelling unit from curb	–32	46
Distance to nearest commercial area	00	41
Opaque fencing streetside: incidence	07	–40

*Entries are correlation coefficients with decimals omitted
r of .41 or greater, significant beyond .05 level

Ecological validities for observer-assessed environmental attributes are presented in Table 1.

Ecological Validities of Assessed Environmental Attributes

The useful cues for traffic volume on residential streets, as shown by the ecological validities in Table 1 and 2, do little violence to common-sense intuition. High traffic volume is indicated by such attributes as: Number of traffic lanes available; hindrance to conversation and low incidence of persons conversing on the sidewalks; air odor and soot accumulation; and a busy versus quiet character. The poor maintenance of front yards associated with high traffic volume is compatible with previous research, suggesting a shift in attention from front to rear areas under conditions of heavy residential traffic (Appleyard & Lintell, 1972).

The environmental cues for more versus less well-to-do resi-

TABLE 3
ESTIMATES OF RESIDENTS' CONCERN ABOUT CRIME: COMPARISON OF TWO JUDGES*

Criterion Variable *r*	Judge A Estimates *r*	Judge B Estimates *r*	Environmental Cues/Attributes
73	29	−14	Incidence of defensive signs
52	44	23	Number of grilles on windows and doors
51	23	35	Sidewalk activity: pedestrians walking through
50	34	03	Soot accumulation on streetside, buildings, front surfaces ("1"-clean surfaces to "5"-thick soot)
−50	−23	21	Length of block
−49	−41	−18	Number of trees
−49	−32	−23	Exterior decoration of windows and doors: incidence
48	43	32	Incidence of illegal parking
47	46	17	Number of bus stops
−47	−22	−08	Number of green setbacks
44	50	−06	Graffiti: incidence
42	38	−08	Width of sidewalk
02	18	61	On-street parking permitted
03	05	57	Sidewalk activity: bike riding
01	15	53	Sidewalk benches present
−11	−01	−53	Number of resident-used garages
02	14	42	Opaque fencing streetside: incidence

*Entries are correlation coefficients with decimals omitted
r of .41 or greater, significant beyond .05 level

dential areas also offer no surprises. They include evidence of attractive exterior decoration; ample vegetation and landscaping; careful maintenance; and spatial separation of units (Tables 1 and 2).

The ecologically valid cues for residents' concern about crime appear to include: 1) manifestations of the concern, such as incidence of defensive signs (e.g., "keep out," "beware of dog,") and number of grilles on windows and doors; 2) signs of instances of asocial behavior (e.g., graffiti, illegally parked cars); 3) hints of an excessively public and difficult to defend residential setting (e.g., width of sidewalks, pedestrians walking through, number of bus stops); 4) poor maintenance of public and private areas; and 5) lack of attributes indicative of relative affluence (e.g., number of trees, exterior decoration) (Tables 1 and 3).

Functional Validities for Judged Environmental Conditions

When the estimates by the 18 expert judges are considered in relation to the criterion indices for the three socio-environmental conditions, the median correlations are: traffic volume (+.66), average family income (+.62) and concern about crime (+.41) (each is statistically significant at the .05 level of confidence). The magnitude of the functional validities follows a continuum from the relatively overt (traffic volume) to covert (residents' concern about crime) criteria. The expert judges' estimates of another relatively covert criterion variable, residents' rated residential satisfaction, was non-significant (+.21).

Variation Among Expert Judges: Policy Capturing

While the median functional validity correlations are relatively high for all three attributes, the range among expert judges is considerable; for the three attributes, the range is: +.28 to +.84; +.30 to +.80; and −.16 to +.67; respectively. Judges attaining high functional validity must be selecting and weighting those attributes that actually are ecologically valid cues for the given socio-environmental condition, while judges not attaining high functional validity in their estimates are doing otherwise.

For illustrative purposes, the pattern of cue utilization for two judges is presented in Table 3. Judge A had achieved a functional validity of +.62 for his estimates of residents' concern about crime, across the 21 street sites, while Judge B displayed a non-significant functional validity of +.22. Regarding the attributes that possess ecological validity, Judge A demonstrates an appropriate pattern of cue use, although he underweights some and

overweights others. Judge B makes use of fewer ecologically valid cues (e.g., illegal parking; number of grilles on windows and doors), while weighting a series of streetside factors (e.g., onstreet parking; bike riding) that have little value in predicting or inferring residents' concern about crime. Two qualifications must be noted. First, this analysis is restricted to first-order correlations; in other contexts, various multivariate statistical techniques would be appropriate (Dawes, 1979; Hammond, Steward, Brehmer & Steinmann, 1975). Second, the task set for the expert judges was to estimate the average level of residents' concern about crime, not the actual incidence of crime. Some of the invalid cues used by Judge B for this purpose (e.g., on-street parking; bike riding) might prove ecologically valid for forecasting the actual rate of offenses.

Discussion

Substantial progress has been made in developing techniques affording technical and observational assessments of environmental attributes (Craik, 1971, 1980). Such environmental assessments permit the systematic examination of the differential ecological validity of assessed attributes in their role as cues for important socio-environmental conditions. Systematic environmental assessment also can assist in capturing judges' inferential policies through examination of their cue utilization. The lens model is especially valuable to environmental psychology in demonstrating the coherence and interrelatedness of what may seem to be disparate research undertakings.

The present analysis examined expert judgments regarding one socio-environmental condition: residents' concern about crime. But we could also have taken the actual crime rate as the criterion variable of interest. Recent studies have sought to establish the ecological validity of physical cues (e.g., architectural distinctiveness, lighting, proximity to major transportation routes) for differential rates of school vandalism (Pablant & Baxter, 1975) and armed robbery of convenience stores (Duffala, 1978). Also, Newman (1972) has asserted that certain urban design features afford "defensible space" for residents of multi-family projects and that these factors reduce actual crime rates and residents' fear of crime, although empirical evidence in support of these hypothesized relations remains insufficient or contradictory (Altman, 1975; Mawby, 1977; Repetto, 1976).

If specific offense rates had been available for our street

sites, a second form of the lens model could be applied. The survey of residents' concern about crime would shift to the status of providing judgment variables, and the actual crime rate would serve as the criterion variable. Present evidence on the functional validity of judgments regarding crime made by laypersons is mixed (Fowler, McCalla & Mangione, 1979; Weinstein, Note 1). In the more generalized use of this particular lens model, study of the functional validity and judgment policies of samples of experts, such as urban planners, police officials and criminals, also warrants attention. Analysis of criminal inferences regarding the vulnerability of settings is underway (Carter & Hill, 1976). One drawback to this approach, however, is that the 'expert' criminal informants would almost necessarily be practitioners who had failed at least once and become identified through the criminal justice system. Thus, their inference processes may not represent those of more effective criminals.

The important point is that the lens model demonstrates how the two strands of research, environmental perception and environmental assessment, can be combined to form a broader, more coherent fabric. Previous investigations of urban perception and cognition have dealt primarily with the role of cognitive sets as influences upon the subjective experience of urban scenes (Leff, Gordon & Ferguson, 1974) and with the achievement of cognitive representations of the spatial properties of large-scale urban environments (Downs & Stea, 1973; Moore & Golledge, 1976). The lens model offers a framework for systematic analysis of inferential judgments about many kinds of environmental conditions. Gauging the interior characteristics of restaurants (e.g., length of menu, price of steak) from their exterior features (e.g., presence of neon sign; interior visible from exterior) represents a typical urban task. Krampen has initiated studies of cue utilization in inferences about the function or purpose of buildings based upon facade features (Krampen, 1979). In this context, the lens model and its related analytic techniques of social judgment theory (Hammond, et al., 1975; Dawes, 1979) can provide a systematic approach to environmental semiotics, which seeks to clarify how meaning is conveyed by the built environment (Eco, 1973; Krampen, 1979).

Analyses of human action in the city typically acknowledge the crucial role of perception and cognition (Appleyard, 1973; Ittelson, 1978) but scientific study of these urban processes has proceeded in a halting and fragmented manner. The general concepts of Brunswik's probabilistic functionalism and his method-

ological orientation (Petrinovich, 1979; Sjoberg, 1971) are well suited to guiding the specific tasks of understanding how urbanites interpret the city and appraising the validity of their inferences about the situations they encounter within it.

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