

AESTHETICS OF STREETSCAPES: INFLUENCE OF FUNDAMENTAL PROPERTIES ON AESTHETIC JUDGMENTS OF URBAN SPACE^{1,2}

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Summary.—This experiment was designed to investigate the relationship between the fundamental visual, spatial properties of existing complex streetscapes and aesthetic judgments. Participants performed aesthetic judgments over 35 photographs of typical spatial situations taken along the Meißner Straße in Radebeul, Germany. In a modified Q-Sort procedure, the participants assigned the pictures to five categories, including 1 (beautiful) and 5 (not beautiful). Vegetation, Stylistic Uniformity, Homogeneity of Scale, and Symmetry were identified as primary components of aesthetic judgment by using principal component analysis. Stimuli, photographically edited according to these factors, were then tested using the same Q-Sort procedure, which confirmed these determinants. These results are intended to help the development of the theoretical understanding of the link between the influence of selected spatial properties and the aesthetic judgment of the visual quality of urban spaces.

Contemporary urban space is in permanent flux: streets are adapted to conform to the changing demands of traffic; old buildings are replaced by new ones better suited to meet changing functional and commercial needs; advertising has tainted the visual appearance of streetscapes and a clutter of artifacts of public life furnishes urban spaces.

In recent years, it has become evident that not only functional and infrastructural qualities influence the affective, evaluative response to a city, but its aesthetic qualities play a crucial role as well. Ward and Russell (1981) viewed the evaluative aesthetic dimension (pleasantness) together with the nonevaluative dimension of arousal as the two bipolar orthogonal dimensions describing the affective quality of a place. Carp, Zawadsky, and Shokrin (1976) identified aesthetic quality as the influential dimension of peoples' perception of their surroundings. According to Oostendorp and Berlyne (1978), evaluative judgments of the aesthetic quality account for 44.7% of the variance. For Horayangkura (1978) affective evaluative judgments (interesting-boring, good-bad, dislike-like, pleasant-unpleasant, exciting-dull) are responsible for 23.7% of the variance.

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Thus, for planning departments it has become increasingly important to know and understand which parameters influence judgments about the perceived visual quality of urban spaces. Which are the fundamental properties of a specific urban situation that are responsible for judgment of its beauty?

This question ties into present-day psychological aesthetics. Following Fechner's tradition of an "aesthetics from below," modern psychological terminology is used in investigating aesthetic processing, which establishes a complex realm of issues. Aesthetic judgments are governed by a host of factors, for instance, stimulus symmetry, complexity, novelty, familiarity, artistic style, appeal to social status, and individual preferences (Fechner, 1876; Berlyne, 1971; Martindale, 1988; Jacobsen, 2004). Aesthetic processing can be usefully considered from evolutionary, historical, cultural, educational, or instructional, cognitive, (neuro)biological, individual personality, emotional, situational, and probably more perspectives. As a whole, human aesthetics appears to be best viewed from a number of different perspectives at several different levels of analysis (Jacobsen, 2006). For an introduction and overview of the field of aesthetic perception of the built environment, see Kaplan and Kaplan (1978), Altman and Zube (1989), Nasar (1988, 1998), Gifford (1997), and Stamps (2000).

A principal component defining the character of urban spaces are streetscapes. As paths they are an important element in creating legibility of a city (Lynch, 1960), and their character has a major effect on the quality of life (Appleyard, 1981).

The description of visual qualities of urban streetscapes has had a long tradition in 19th and 20th century architectural theory. Examples are Stübben (1890) or Sitte (1965), whose works described qualities of beautiful streets through the analysis of famous historical examples and advanced recommendations for urban design in an empirical fashion. Books like these assumed the character of rulebooks, which became influential for planning the layouts of city extensions during the end of the 19th century until the mid 20th century. With the triumph of modernist doctrines in city planning after the Second World War, attention to urban space as an entity in its own right, as a visible space with bounded perceptual properties, became marginalized. So-called "urban landscapes" dominated the discussion, and building ordinances which regulated the appearances of public spaces were increasingly seen as a means of curtailing the individual architects' creativity as well as the developers' right to maximize return through build-out.

With the onset of postmodern planning ideologies, many authors, like Jacobs (1961), Appleyard (1981), or Trancik (1986), expressed a strong discomfort about the loss of public space and with the appearance of heterogeneous, faceless suburban developments and inner city renewal projects by means of "tabula rasa" rebuilding characteristic to many examples of mod-

ernist postwar planning ideology. Consequently, interest in research on functional and visual qualities of public spaces was rising as well. Examples are Appleyard (1981) and Lynch (1981) who concentrated on the quality of urban spaces and Bruns and Schmidt (1997) whose research focused on quality growth in urban design. Other examples, which have become sources of inspiration for planners and architects, are Cullen (1961), Jacobs (1993), and Weber (1995), showing dimensions and spatial characteristics of great public spaces all over the world.

Yet, the theoretical understanding of possible causalities between properties and the complex processes of judgment is not developed sufficiently to yield a set of general design recommendations, although there have been a number of empirically based approaches. For example, Stamps' investigations (1994) showed how the perceived quality of streets changes when geometric parameters are altered. Order appears to enhance the evaluative quality of the built environment (Nasar, 1998). The interrelation of order and complexity is, according to Kaplan and Kaplan (1982), the product of the human need for involvement and comprehension. This notion is supported by the results of a study on signscapes by Nasar and Hong (1999), which documented a preference for moderate complexity and, therefore, for a balance of order and complexity. Compatibility with neighboring buildings or contextual fit is regarded positively (Groat, 1984) perhaps because it seems to be one possibility to establish the perception of order in an urban situation. Berlyne (1972) described novelty as a dimension for visual preference. In contrast, Nasar (1980) found a preference for the familiar. A balance between novelty and familiarity seems to be desirable. Vegetation or naturalness has been identified as an important dimension creating aesthetic value as well as having beneficial restorative effects on humans (Kaplan & Kaplan, 1982; Cackowski & Nasar, 2003). Openness or spaciousness as a factor has been documented by Horayangkura (1978), Ward and Russell (1981), and Nasar (1983).

Yet, there have been no sufficient technical and statistical resources for the practice oriented evaluation of complex architectural structures and for a comparative analysis of alternative design solutions.

The Present Study

This study, at a general level, aimed at furthering the development of a theoretical understanding of the influence of selected properties on judgments of visual qualities of urban spaces. At this, a methodology was used that provides a possibility to involve laymen in the planning process, enabling them to evaluate different design alternatives on an intuitive basis. Findings would be important for developing design recommendations for specific urban situations and aim to help planners understand some of the ingredients of making places more beautiful. The results would be important

for teaching because they would help raise consciousness for the vocabularies of spatial design and in the end would help to answer the question of how one improves the perceived quality of public spaces.

At a practical level, this study intended to develop an inexpensive, robust, and easy-to-use procedure suitable for identifying and evaluating fundamental properties affecting aesthetic judgments of specific urban spaces.

To recognize the salient dimensions in the aesthetic perception of particular, already existing streetscapes, the present approach started deliberately without preconceived notions or the use of criteria established in previous research. Each scene or streetscape may be influenced by a multitude of factors. Therefore, an experimental control of the complex constellation of features present in a scene was not possible and not intended. Rather, the method used extracts the factors underlying judgmental variance, while abstracting from extraneous influences. As a streetscape example, the Meißner Straße in Radebeul, a mid-size German city in the metropolitan area of Dresden, was used. The city grew from the fusion of 12 small cities and villages, each forming centers of their own without creating an overall center for the city as a whole. The Meißner Straße is characterized by a multitude of different urban situations, ranging from small-scale rural neighborhoods to urban areas with large multistory buildings.

Visual representation of the environment through photographs and photographically realistic stimuli was chosen since it represents a common language to which everybody can relate (e.g., King, Merinda, Latimer, & Ferrari, 1989). Using color photographs of locations to test environmental perception has been empirically successful in producing the same responses as those obtained from participants in situ (Stamps, 1990). Although findings by Heft and Nasar (2000) indicate some differences in the participants' reactions to dynamic vs static displays, preference was given to using 9- × 13-cm color photographs. These are probably the most common everyday format of representing environmental situations and can be intuitively handled by every participant without posing a technical barrier. This quick and easy test procedure facilitated efficient gathering of data in the field from participants of all age groups and with a wide variety of demographic backgrounds.

A modified Q-Sort procedure was used to generate hypotheses about the dimensions responsible for judgmental variance. Subjects were asked to judge the beauty of 35 photographs of typical spatial situations taken along Meißner Straße. Principal component analysis was applied to elicit the primary determinants of aesthetic judgment solely from the rating of the environmental representations. To test the found hypothetical determinants a number of stimuli were systematically altered to emphasize or de-emphasize a single determinant per photograph in the scene using a photographic editing software.

A retest followed in which new participants were asked to rank the images using the same Q-Sort procedure.

PART I

Method

Participants.—Of 103 volunteers who participated 41 (40%) were men. The median age category was 20 to 30 years, ranging from under 20 to over 50 years of age. There were 60 (58%) residents of the area who knew the Meißner Straße in Radebeul. Also, 33 (33%) were professionals in architecture, urban planning, and related areas or undergraduates in these fields at the University of Technology, Dresden. An additional 12 participants had to be excluded from further analysis given their violations of instructions or high error rates in filling out the form.

Material.—A photographic sequence of the images of the Meißner Straße in Radebeul, which extends over 9 km, was taken every 100 m starting at the eastern border of the city. To exclude the factor of asymmetrical illumination by the sun, the pictures were taken on an overcast morning in November 1999 between 9:00 a.m. and 1:00 p.m. The photographer stood in the middle of the street facing west along the middle axis of the street. Three photographs were taken from a slightly altered position to avoid only partial capturing of significant buildings. Color prints (9 × 13 cm) were made (see Fig. 1 for examples, and Stimulus Overview 2 filed with the Archive for Psychological Data for the complete set of stimuli).³

Because a large number of the images showed redundant scenery, many pictures showed only trees on either side of the street, and others similar kinds of buildings again and again, the total number of pictures was reduced to 35 representative spatial situations which were selected by four independent expert judges. The numbers of the photographs were printed on the reverse sides.

Apparatus.—Photographs were taken using a 35-mm Nikon FM2 SLR camera with a 50-mm lens and 200ASA Fuji print film.

Procedure.—The order of the 35 photographs was randomized. Participants received the stimuli in a stack and were instructed to rate them according to the beauty of the depicted streetscape (cf. Jacobsen, Buchta, Köhler, & Schröger, 2004), using anchors of 1: Very beautiful (sehr schön) and 5: Not beautiful (Nicht schön). The five ratings corresponded to the common grading scale in German schools. A minimum of two items per category was required to generate variance within the data set.

³Data are on file in Document APD2008-003. Remit \$12.00 for photocopy to the Archive for Psychological Data, P.O. Box 7922, Missoula, MT 59807-7922, for recipients in the USA. Contact APD for shipping rates outside the USA.

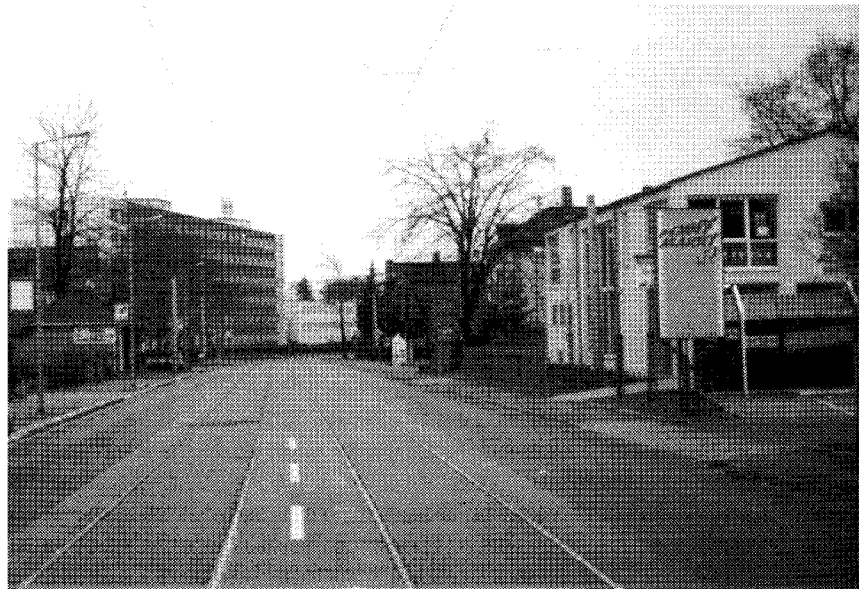
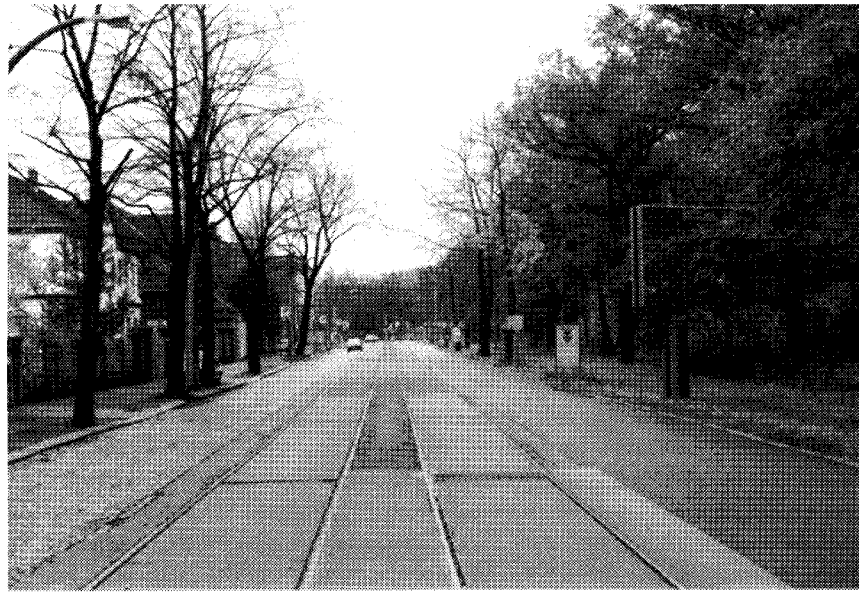


FIG. 1. Stimulus examples of Part I (photographs of prototypical situations of the Meißner Straße in Radebeul). Picture 1 (upper) was rated most beautiful; Picture 13 (lower) least beautiful.

Data analysis.—The rating data were analyzed using analyses of variance. Throughout this paper, Greenhouse-Geisser-corrected error percentages are reported where applicable. For the extraction of the dimensions of fundamental spatial properties influencing aesthetic judgments of street-scapes (using the example of the present scenes), the pictures' ratings were subjected to a principal component analysis with subsequent varimax rotation, a statistical procedure commonly used for data reduction and hypothesis generation.

Results

For each of the 35 pictures, mean ratings (second column) and standard deviations (third column) are given in Table 1. Ratings ranged from 1 to 5 for each individual photograph (exceptions: Picture 1, range 1 to 4; Picture 27, 2 to 5). The streetscape considered most beautiful by far shows a broad street laterally bounded by trees with only a few buildings visible (Picture 1); the other pictures ranking highest showed similar characteristics. The streetscape considered to be the least beautiful (Picture 13) shows a situation with an extreme heterogeneous architectural typology; namely, a church, an office building from the 1960s, a supermarket from the 90s, and several turn-of-the-20th-century buildings, all drastically differing in scale and articulation (see Fig. 1).

An analysis of variance with the between-group factors of sex (men, women), knowledge of the Meißner Straße (knowledge: yes, no), and profession (professional architect, urban planner, etc.: yes, no), and the repeated-measures factor of picture (Pictures 1 to 35) was conducted. There was a significant main effect of the within-subjects variable picture ($F_{34,3230} = 36.34$, $MSE = .99$, $p < .001$). This effect confirms that the pictures were rated differently with respect to their beauty, even though the range of the ratings was very broad and hardly differed between pictures. None of the between-subject main effects or any of their interactions were substantial. Sex ($F_{1,95} = 1.23$, $MSE = 4,290$, $p = .27$), knowledge ($F_{1,95} < 1.00$), profession ($F_{1,95} = 1.76$, $p = .19$). These results indicated that sex, knowledge of the street, and profession had no general effect on the aesthetic judgment of the stimuli [sex \times knowledge ($F_{1,95} = 1.06$, $p = .30$), sex \times profession ($F_{1,95} = 2.13$, $p = .15$), knowledge \times profession ($F_{1,195} < 1.00$), three-way interaction ($F_{1,95} = 1.97$, $p = .16$)]. Interactions involving the within-subject effect picture yielded a significant effect for picture \times profession ($F_{34,3230} = 1.84$, $MSE = .99$, $p = .02$), suggesting that professionals rated certain pictures differently from nonprofessionals. Given the large number of contrasts, this interaction was not resolved. No other interaction approached significance (picture \times sex \times profession: $F_{34,3230} = 1.16$, $p = .29$; the four-way interaction: $F_{34,3230} = 1.25$, $p = .22$; all other F s < 1.00).

The pattern of results was rather homogeneous with respect to knowledge, sex, and profession. Interestingly, prior knowledge of the Meißner

TABLE 1
RATINGS OF BEAUTY FOR ORIGINAL AND MODIFIED PICTURES WITH RESULTS OF ANOVAS

Picture	<i>M</i>	<i>SD</i>	Picture	Experimental Manipulation	<i>M</i>	<i>SD</i>	Cohen <i>d</i>	<i>F</i> _{1,246}	<i>p</i>
1	1.54	.78	1A	Vegetation: trees replaced	2.40	1.09	0.89	24.00	.001
2	3.24	1.06							
3	3.34	1.17	3B1	Symmetry: building replaced	2.59	1.06	0.68	36.74	.001
			3B2	Symmetry: building replaced	2.61	0.94	0.70	40.50	<.001
			3A	Vegetation: building replaced by trees of equal height	1.78	0.97	1.48	126.70	<.001
			3C	Vegetation: trees replaced by buildings of equal height	3.80	1.28	0.37	2.82	.1
4	3.08	1.04							
5	3.49	1.07							
6	4.08	.96	6A	Scale: part of building replaced	4.14	0.92	0.06	<1.00	.37
7	3.96	.92	7	No manipulation	4.27	0.85	0.35		
8	3.52	1.14	8A	Style: building replaced	3.18	1.28	0.28	11.04	<.001
9	2.92	.89	9A	Vegetation: trees placed	2.74	1.07	0.18	7.20	.008
10	3.27	1.09							
11	3.48	.95							
12	3.50	.96	12A	Vegetation: trees placed	2.46	1.16	0.97	58.94	<.001
13	4.54	.70	13A	Scale: large building removed	4.39	0.93	0.18	8.35	.004
			13B	Scale: large building removed	3.30	1.14	1.27	101.49	<.001
				Vegetation: trees placed					
			13C	Vegetation: trees placed	3.77	1.14	0.79	45.25	<.001
14	4.28	.97	14A	Scale: large building replaced	3.54	1.03	0.74	43.25	<.001
15	3.55	1.21							
16	3.65	.94							
17	3.95	.96	17A	Vegetation: trees placed	3.55	1.04	0.40	18.22	<.001
18	2.67	1.10							
19	2.03	1.10							
20	3.73	1.01							

(continued on next page)

TABLE 1 (CONT'D)
RATINGS OF BEAUTY FOR ORIGINAL AND MODIFIED PICTURES WITH RESULTS OF ANOVAS

Picture	<i>M</i>	<i>SD</i>	Picture	Experimental Manipulation	<i>M</i>	<i>SD</i>	Cohen <i>d</i>	<i>F</i> _{1,246}	<i>p</i>
21	2.99	1.00							
22	3.31	.90	22	No manipulation	3.52	1.07	0.21		
23	1.85	.89	23A	Symmetry: larger trees removed	2.12	1.06	0.27	< 1.00	.56
24	2.10	1.11	24	No manipulation	2.14	0.88	0.04		ns
25	2.91	1.28	25A	Style: building replaced	2.52	1.17	0.32	12.28	< .001
26	2.20	1.13							
27	3.50	.79							
28	2.50	1.09							
29	2.99	1.07	29A	Vegetation: trees placed	2.68	1.10	0.29	11.63	< .001
30	2.62	1.27							
31	3.27	1.01							
32	2.64	1.21							
33	4.24	1.18							
34	2.14	1.29	34A	Vegetation: trees placed	2.27	1.14	0.08	< 1.00	.75
35	2.46	1.27	35A	Vegetation: trees placed	1.83	0.94	0.54	25.86	< .001

Note.—No manipulation: reference stimulus.

Straße did not have a strong influence on participants' judgments. Judgments of both groups show strong similarities, which suggest that judgments were not motivated by familiarity with the place but rather by spatial geometric properties of the streetscapes presented on the photographs.

Factor analysis.—Eleven factors showing an eigenvalue larger than 1.00 were extracted, explaining 66.5% of the variance. A scree test was used to specify four substantial factors, explaining a total 38.8% of the variance. After that, these four factors were interpreted and labeled by an independent expert group. This group included two professors, three research associates of the Department of Architecture of the University of Technology, Dresden, and one professor of Urban Design of the University of Essen. The only woman among these experts was one of the research associates. To simplify the classification all labels used the positive form exclusively, while the negative form is implied. For example, Factor 1, Vegetation—absence of vegetation is labeled Vegetation only.

Factor 1, labeled Vegetation, had an eigenvalue of 4.49 and explained 13.8% of the variance. Pictures in this group show vegetation as the dominant lateral spatial boundaries. Pictures which show vegetation in a homogeneous appearance of height, color, and tone rank generally higher. Here, the vegetation on both sides of the street showed similar height, similar texture, i.e., similar kinds of trees, and a similarity in color saturation and tone, so the scenery appeared largely symmetrical with the field of open sky in the upper region of the vertical symmetry axis. The highest factor loadings were observed for Pictures 24 (.77), 32 (.76), 30 (.74), 26 (.67), and 23 (.60).

Factor 2, labeled Stylistic Uniformity, had an eigenvalue of 3.93 and explained 11.2% of the variance (cumulated explained variance 24.0%). Images loading on this factor showed either old or new buildings similar in terms of style and period, articulation of the facades, as well as color and tone. The highest factor loadings were observed for Pictures 25 (.79), 35 (−.71), 15 (.66), and 34 (−.60).

Factor 3, labeled Homogeneity of Scale, had an eigenvalue of 2.92 and explained 8.4% of the variance (cumulated explained variance 32.4%). The scale of the buildings on the pictures of this group differs very much, e.g., a large high-rise office building on one side of the street dominating smaller buildings on the opposite side. Highest factor loadings were observed for Pictures 14 (.76) and 5 (.68).

Finally, Factor 4, labeled Symmetry, had an eigenvalue of 2.52 and explained an additional 6.4% of the variance (cumulated explained variance 38.8%). Dominant in this group was the asymmetry of images, which was manifested, for example, by buildings on one side and trees on the other side, or trees of different height on each side, or buildings of different size and color saturation on each side of the street. The highest factor loadings were observed for Pictures 12 (.81), 6 (.64), and 20 (.62).

Based on the above reported picture by profession interaction, a second, separate principal component analysis was computed for the subgroup of nonprofessionals for control purposes (the subgroup of professionals was too small to conduct a second control principle component analysis). This yielded an identical result for the first three factors and a comparable, but slightly different, result for the fourth factor (Symmetry). This difference is taken to indicate that visuospatial symmetry and asymmetry are of differential importance for professionals and nonprofessionals. Overall, however, the results were highly comparable. As a consequence, hypothesis generation for Part II of the study was based on the overall principal component analysis reported above. Here, the four factors, Vegetation, Stylistic Uniformity, Homogeneity of Scale, and Symmetry were experimentally varied.

Discussion

In Part I, clear results, yielding four factors that account for 38.8% of the variance, were obtained despite the fact that photographs of an existing streetscape were used as stimulus material. The sheer magnitude of visual information in these photographs makes it difficult to isolate unequivocal causalities between specific stimulus qualities and response, respectively, because there is 'visual noise' in these pictures. The scenes are furnished with quite a number of visual elements, such as cars, signage, overhead wiring, different types of vegetation, light traffic signs, etc. All these elements might contribute to the remaining 61.2% residual variance because they skew the aesthetic judgment, as demonstrated, for instance, by Nasar and Hong (1999), who investigated the influence of signage on the perception of beauty. Homogeneity of stimulus material would, of course, be possible under controlled conditions with computer-produced images. Yet, since the reduction of the visual complexity that could be achieved using computer-generated stimuli implies preselection of possible factors, the present study deliberately used photographs of existing streetscapes. The results support this approach of extracting the fundamental properties influencing the aesthetic judgments from existing, variable material.

Analysis of variance yielded an interaction between rating and profession for a number of images. Because there were no overall effects for the expert laymen, this has not been investigated further in the present study. However, the investigation of differences in the assessment of architecture by experts vs laymen is an important issue. For example Groat (1979) and Wilson (1996) suggested a process of socialization within architectural education that leads to the development of judgment standards, which may differ from laypeople's judgments. Since architects are concerned with design decisions that at least partially shape the built environment of the general public, their difficulties in predicting what nonarchitects might find desir-

able (Hershberger & Cass, 1988; Brown & Gifford, 2001) might sometimes lead to designs that do not work and require extensive redesign.

The above findings can be condensed by formulation of a number of hypotheses about the fundamental spatial parameters responsible for influencing judgments about the beauty of urban space. These were put to test in the second part of the study.

The factor analysis showed which dimensions explained most judgmental variance. The presence or absence of vegetation clearly had the strongest influence. Especially scenes with the combined presence of the factors Symmetry and Vegetation were strongly judged toward the beautiful, whereas the asymmetrical arrangement of, e.g., buildings on one and trees on the other side were ranked as not beautiful.

Also obvious were the influences of homogeneity of the visual elements forming a scene, for example, in style, color, tone and texture of the buildings or vegetation. Especially in the pictures in Groups 4 and 5 (not beautiful), there was a noticeable difference in the scale of buildings.

PART II

To test the four hypothetical factors Vegetation, Stylistic Uniformity, Homogeneity of Scale, and Symmetry, a subset of the original picture material was selected for photorealistic manipulation by the same expert judges as in Part I. Since not all photographs were equally suited to carry out the experimental manipulations, and not all factors could sensibly be instantiated on any random choice of stimuli, a complete factorial experimental design was deliberately not used. Instead, pictures and respective manipulations were selected according to the expected efficacy of the alteration. The manipulations aimed at realistic changes. However, a fully-crossed design would be an interesting possibility for research. Each picture with the exception of Picture 13B was altered to test only one of the four hypothetical factors. Only in Picture 13B, two factors (Homogeneity of Scale and Vegetation) were altered to test possible combined effects. All manipulations are specified in Table 1. Added features stem from the original set of the 35 photographs and were selected according to their potentially achieving photorealistic alterations of the original stimuli. In Pictures 12A, 13B, 13C, 17A, 29A, and 35A, one tree was added in multiples of approximately equal distances along the street to turn it into a parkway. Participants could not distinguish between altered and unaltered items (see Fig. 2 for examples).

If the method of extracting the fundamental property dimensions by means of factor analysis, as proposed in Part I, worked suitably, then the alterations of the photographic material should yield effects on aesthetic judgment ratings in the directions predicted on the basis of Part I. The three images that produced the smallest mean deviation in Part I were included unaltered as reference stimuli in Part II.

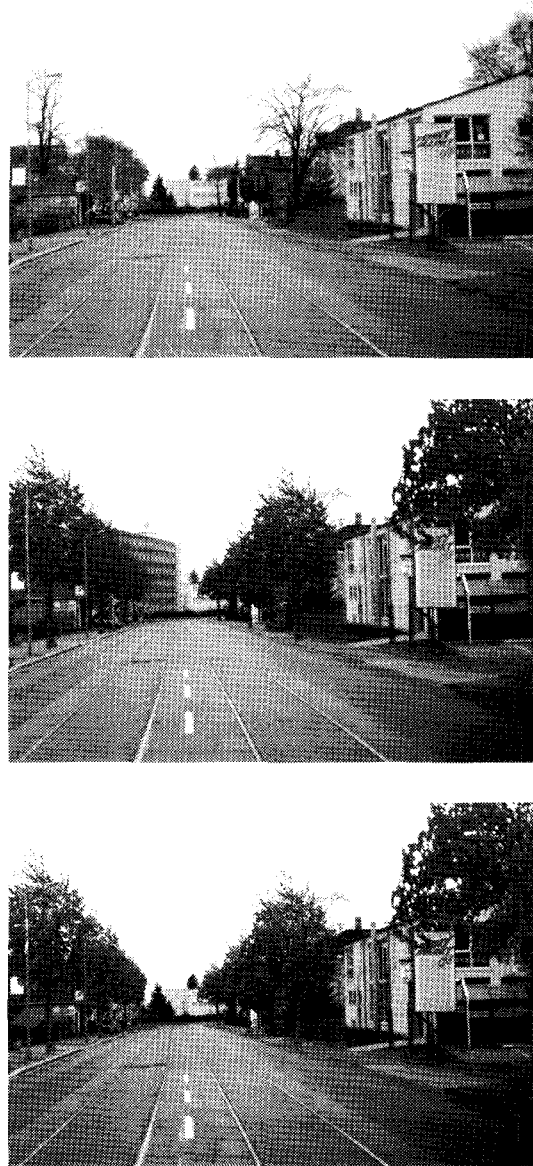


FIG. 2. Stimulus examples of Part II. The photographs are altered versions of Picture 13 (see Fig. 1). In Picture 13A (top), the large blue office building was removed to improve the dimension Homogeneity of Scale. In Picture 13C (middle), trees were placed on both sides of the street to improve the dimension Vegetation. Picture 13B (bottom), the only picture with a combined alteration of two dimensions, Vegetation and Homogeneity of Scale, showed the most dramatic improvement in rank.

In the retest new participants were asked to rank the 19 altered stimuli and three reference stimuli using the same Q-sort procedure previously employed in Part I.

Method

Participants.—In all, of 145 volunteers who participated 59 (41%) were men. The median age category was 20 to 30 years, ranging from under 20 to over 50 years of age. There were 67 participants (46%) who were residents of the area or knew the Meißner Straße in Radebeul. Also, 42 (29%) were professionals in the fields of architecture, urban planning and related areas or undergraduates in these fields at the University of Technology, Dresden. Additional participants ($n=9$) had to be excluded from further analysis given their violation of instructions or high error rates. A maximum of 10% of the subjects participated in the test and retest of the study.

Material.—Based on the results of Part I, 22 photographs were selected according to the hypothesis generated above. Alterations were done using elements of the initial set of photographs exclusively (see Stimulus Overview II filed with the Archive for Psychological Data). Three representative items were not altered and were included for reference. All photographs were printed on glossy paper and mounted on heavy paper. Examples of the altered stimuli are given in Fig. 1.

Apparatus.—The color prints were digitized using a scanner (Epson-GT 7000, Epson Twain Rev. 3.1a software). Images were altered using photographic editing software (Adobe Photoshop 5.5). The stimuli were printed on an Epson Stylus 740.

Procedure.—The procedure of Part II was identical to that of Part I.

Data analysis.—Analyses of variance were conducted. Effect sizes were computed as Cohen d . Effects of .20 are considered weak, .50 middle, and .80 strong (Cohen, 1987).

Results

For each of the 22 pictures, mean ratings (sixth column) and standard deviations (seventh column) are given in Table 1. Ratings ranged from 1 to 5 for each individual stimulus. As in Part I, an analysis of variance with the between-group factors of sex (men, women), knowledge of the Meißner Straße (knowledge: yes, no), and profession (professional architect, urban planner, etc.: yes, no), and the repeated-measures factor picture (Pictures 1 to 22) was conducted. As expected, there was a significant main effect for the within-subjects variable of picture ($F_{21,2877} = 62.70$, $MSE = 1.07$, $p < .001$). There was a significant effect of profession ($F_{1,137} = 5.58$, $MSE = 2.20$, $p = .02$), indicating that professionals and nonprofessionals differed in their overall judgment policy. None of the other between-subject main effects or any of their interactions were substantial [knowledge ($F_{1,137} = 1.12$, $p = .30$), knowl-

edge \times profession ($F_{1,137} = 1.16$, $p = .28$), all other F s < 1.00]. As in Part I, these results indicate that neither sex nor knowledge of the street had a general effect on the aesthetic judgment of the stimuli in Part II. None of the interactions involving the within-subject effect picture gave a significant effect [picture \times profession ($F_{21,2877} = 1.50$, $p = .11$), picture \times sex ($F_{21,2877} = 1.16$, $p = .30$), picture \times knowledge \times profession ($F_{21,2877} = 1.15$, $p = .31$), the four-way interaction ($F_{21,2877} = 1.44$, $p = .13$), all other F s < 1.00]. In sum, the analysis of variance was clear-cut: pictures differed in their ratings and professionals and nonprofessionals adopted different overall judgment policies. There was no other effect.

To compare ratings across both parts of the study, three pictures of Part I (Nos. 7, 22, 24) were included unaltered in Part II. An analysis of variance with the repeated-measures factor pictures and the group factor gave no significant interaction [$(F_{2,246} = 1.17$, $p = .31)$, effects of group ($F_{1,246} = 7.18$, $p = .008$), or picture]. Thus it can be argued that the relative position of the reference pictures among the rank-ordered ratings remained unaltered, although overall ratings as well as judgment policies changed between parts as indicated by the substantial main effects. The latter were predicted on the basis of the results of Part I and the fact that a large number of new, i.e., altered, stimuli was introduced in Part II. The absence of the interaction allowed for aggregating the three reference pictures into a single reference value. Effects of experimental manipulation were assessed in terms of a significant interaction in a 2×2 analysis of variance with the variable manipulated picture (pre- and postmanipulation), and the variable reference picture (Part I and Part II). Therefore, if the difference in mean ratings between both parts was descriptively larger for the experimental than for the reference stimuli and the interaction was significant, then the experimental manipulation was considered to have a substantial effect. For additional control purposes, the stimulus' ratings were also checked against the single reference picture closest to them in the rank-ordered ratings, using the same 2×2 analysis of variance procedure. Given the multiple comparison nature of the subsequent analyses, the threshold of the probability of making an alpha error was set to $p = .01$ for the following analyses. Reference Picture 1 (Picture 7) showed a difference in rating for both parts ($t = 2.7$, $p = .007$). Both remaining reference pictures showed no difference [Picture 22 ($t = 1.6$, $p = .11$) and Picture 24 ($t < 1.00$)]. The only comparisons which yielded significant effects, i.e., interaction of the factors picture and group with $p < .01$, in both analyses were accepted as substantial. For reasons of brevity, analyses of variance for the interaction term only are reported subsequently.

Experimental effects.—Analyses of variance are given in detail in Table 1. A detailed description of the experimental effects has been filed with the Archive for Psychological Data and is available upon request.³

Strong effects were obtained by the experimental manipulation of vegetation in the streetscapes (Factor 1: Vegetation). Drastic changes in ranking were caused by the addition of trees, partially covering buildings left and right of the street, so the primary spatial boundaries are formed by vegetation. Equally effective was the removal of vegetation: here the modified images without vegetation dropped markedly in their ranking. Modification of the homogeneity of style had small effects (Factor 2: Stylistic Uniformity). Improvements were only slight when the spatial boundaries were stylistically homogenized on both sides. A strong positive effect could be observed for the removal of a large, out-of-scale office building (Factor 3: Homogeneity of Scale). Thus the boundaries appeared to be more unified in height, and the rating of the picture improved. Manipulations of scale, however, were not generally successful. Manipulations of symmetry resulted in middle to strong effects (Factor 4: Symmetry). Even if the boundaries on both sides of the street were not of the same type, e.g., when there were buildings on one and trees on the other, a picture would improve in rating when the boundaries were of equal height and thus the spatial figure inbetween the two was symmetrical.

Discussion

The hypotheses tested in Part II were generated on the basis of the results of Part I. Controlled manipulations of the photographic stimulus material by diminishing or enhancing the presence or absence of the four dimensions were carried out and affected the aesthetic judgments of the streetscapes.

The results were clear-cut. The majority of the manipulated images were rated according to the outcome predicted in the respective hypotheses. Thus the hypothesized fundamental factors responsible for aesthetic judgments of streetscapes were confirmed. Several pictorial manipulations seemed to taint the clarity of the presence of the factors, e.g., alterations in color of the replacement buildings or vegetation were not always carefully controlled.

GENERAL DISCUSSION

General Remarks

Fundamental properties affecting aesthetic judgments of streetscapes were investigated by having participants rate photographs of real situations. A factor analysis of the data obtained in Part I gave a set of four dimensions affecting aesthetic judgments of streetscapes. This procedure appears to function independently of the individual character of a streetscape, for the Meißner Straße in Radebeul is largely spatially inhomogeneous and may thus, given the multiplicity of characters, represent different prototypical streetscapes. However, further testing of this procedure using a different street preferably in a different cultural setting would be beneficial.

While the general approach of using photographs to evaluate environmental situations is not new, results have shown that the test is a suitable tool (a) for the analysis of aesthetic judgment of streetscape properties, i.e., the generation of hypotheses about the fundamental factors that influence these judgments, and (b) for testing the effects of different design alternatives on the aesthetic judgment.

The advantages of this method are the quick and easy production of the visual stimuli for which no special hardware is needed. Photographs and photorealistic images as part of most participants' everyday experience are in contrast to most architectural graphic standards like plans and elevations equally readable by experts and laymen. They do not represent a technical barrier which might influence the test results. The entire procedure is independent of laboratory equipment and extensive computer modeling. It is cheap, flexible, and robust. Therefore, the present method can be used to identify the important fundamental spatial properties of a situation under investigation. As a consequence, this kind of test can be put to use in any given environmental situation as a tool for developing design recommendations for urban streets but also for the development of urban design principles as such. In this particular test, recommendations for specific sections of the street could clearly be drawn from the drastically changed ratings of manipulated images. The alterations of images used show plainly which specific parameters could be changed to increase the rated visual beauty of specific locations along the Meißner Straße in Radebeul.

Not surprisingly, the most influential dimension in aesthetic environmental perception in this study is Factor 1: Vegetation. Various positive effects of vegetation like the reduction of fear and crime rates in a number of settings (Kuo & Sullivan, 2001) and aiding recovery from stress and fatigue (Cackowski & Nasar, 2003) have been reported. The findings on effects of the dimension Uniformity of Style dovetail with the results of Groat (1984) about contextual fit and Stamps (2000) about matching design features. The importance of Homogeneity of Scale and Symmetry has been stressed by Alexander (2002), Stamps (2000), and Weber (1995).

Further studies should be done to address a number of questions ignored or neglected in the present study. For example, even if acoustical and all other nonvisual sensory information is dominated by visual cues as shown by Gifford and Ng (1982), Craik (1983), Hershberger and Cass (1988), and Oostendorp and Berlyne (1978) and excluding their influence avoids effects that might reduce the overall influence of the visual information, acoustic stimuli do have some influence on environmental perception (Gifford & Ng, 1982). Another example is the effect of the height-width ratio of the street: is the relation of street width to the height of the spatial boundaries a factor which would alter the results of this study significantly? Furthermore, the effects of variables of color, tone, and texture were not accounted for.

In short, the variables used should be less widely different, while the images should exhibit photorealistic properties. These might be created entirely artificially from a finite number of visual elements. This would allow better control of seemingly secondary but nevertheless impacting visual elements, e.g., wires, signage, sprigs of grass, and cracks in the pavement. While this test showed few significant examples of differences between experts' and laymen's judgment, this issue may also warrant further attention as well as whether differences in general intelligence, cognitive style, urban experience, or preference for detail of imagery affect individuals' judgments.

Conclusion

The results for the present tests can be summarized in simple conclusions. The strongest spatial parameters affecting aesthetic judgments of urban spaces are symmetrical and uniform arrangement of the lateral spatial boundaries, preferably formed by vegetation or stylistically uniform building types. These characteristics correspond to the kind of properties of figure formation originally developed in Gestalt psychology and later adapted to three-dimensional architectural spaces by Weber (1995). In short, visual regularity is a primary factor in the judgment of beauty.

REFERENCES

- ALEXANDER, C. (2002) *The luminous ground: an essay on the art of building and the nature of the universe*. Vol. 12. Berkeley, Ca: Center of Environmental Structure Series.
- ALTMAN, I., & ZUBE, E. H. (1989) *Public places and spaces: human behavior and environment*. Vol. 10. New York: Plenum.
- APPLEYARD, D. (1981) *Liveable streets, protected neighborhoods*. Berkeley, CA: Univer. of California Press.
- BERLYNE, D. E. (1971) *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts.
- BERLYNE, D. E. (1972) Ends and means of experimental aesthetics. *Canadian Journal of Psychology*, 26, 303-325.
- BROWN, G., & GIFFORD, R. (2001) Architects predict lay evaluations of large contemporary buildings: whose conceptual preferences? *Journal for Environmental Psychology*, 21, 93-99.
- BRUNS, D. F. W., & SCHMIDT, J. A. (1997) City edges in Germany: quality growth and urban design. *Landscape and Urban Planning*, 36, 347-356.
- CACKOWSKI, J. M., & NASAR, J. L. (2003) The restorative effects of roadside vegetation: implications for automobile driver anger and frustration. *Environment and Behavior*, 35, 736-751.
- CARP, F., ZAWADSKY, R., & SHOKRIN, H. (1976) Dimensions of urban quality. *Environment and Behavior*, 4, 3-32.
- COHEN, J. (1987) *Statistical power analysis for the behavioral sciences*. (Rev. ed.) Hillsdale, NJ: Erlbaum.
- CRAIK, K. H. (1983) The psychology of the large scale environment. In N. R. Feimer & E. S. Geller (Eds.), *Environmental psychology: directions and perspectives*. New York: Praeger. Pp. 67-105.
- CULLEN, G. (1961) *Townscape*. New York: Reinhold.
- FECHNER, G. T. (1876) *Vorschule der Aesthetik* [Experimental aesthetics; "pre-school" of aesthetics]. Leipzig: Breitkopf & Härtel.
- GIFFORD, R. (1997) *Environmental psychology: principles and practice*. Boston, MA: Allyn & Bacon.
- GIFFORD, R., & NG, C. F. (1982) The relative contribution of visual and auditory cues to environmental perception. *Journal of Environmental Psychology*, 2, 275-284.
- GROAT, L. (1979) Does post-modernism communicate? *Progressive Architecture*, 12, 84-87.

- GROAT, L. (1984) Public opinions of contextual fit. *Architecture*, 23, 72-75.
- HEFT, H., & NASAR, J. L. (2000) Evaluating environmental scenes using dynamic versus static displays. *Environment and Behavior*, 23, 301-322.
- HERSHBERGER, R. G., & CASS, R. (1988) Predicting user responses to buildings. In J. L. Nasar (Ed.), *Environmental aesthetics: theory, research and application*. New York: Cambridge Univer. Press. Pp. 195-211.
- HORAYANGKURA, V. (1978) Semantic dimensional structures: a methodological approach. *Environment and Behavior*, 10, 555-584.
- JACOBS, A. B. (1993) *Great streets*. Cambridge, MA: MIT Press.
- JACOBS, J. (1961) *The life and death of great American cities*. New York: Random House.
- JACOBSEN, T. (2004) Individual and group modeling of aesthetic judgment strategies. *British Journal of Psychology*, 95, 41-56.
- JACOBSEN, T. (2006) Bridging the arts and sciences: a framework for the psychology of aesthetics. *Leonardo*, 39, 155-162.
- JACOBSEN, T., BUCHTA, K., KÖHLER, M., & SCHRÖGER, E. (2004) The primacy of beauty in judging the aesthetics of objects. *Psychological Reports*, 94, 1253-1260.
- KAPLAN, S., & KAPLAN, R. (1978) *Humanscape: environments for people*. Belmont, CA: Wadsworth.
- KAPLAN, S., & KAPLAN, R. (1982) *Cognition and environment: functioning in an uncertain world*. New York: Praeger.
- KING, S., MERINDA, C., LATIMER, B., & FERRARI, D. (1989) *Co-design: a process of design participation*. New York: Van Nostrand Reinhold.
- KUO, F. E., & SULLIVAN, W. C. (2001) Environment and crime in the inner city: does vegetation reduce crime? *Environment and Behavior*, 33, 343-367.
- LYNCH, K. (1960) *The image of the city*. Cambridge, MA: MIT Press.
- LYNCH, K. (1981) *A theory of good city form*. Cambridge, MA: MIT Press.
- MARTINDALE, C. (1988) Aesthetics, psychobiology, and cognition. In F. H. Farley & R. W. Neperud (Eds.), *The foundations of aesthetics, art and art education*. New York: Praeger.
- NASAR, J. L. (1980) The influence of familiarity on responses to visual qualities of neighborhoods. *Perceptual and Motor Skills*, 51, 635-642.
- NASAR, J. L. (1983) Adult viewer preferences in residential scenes. *Environment and Behavior*, 15, 589-614.
- NASAR, J. L. (1988) *Environmental aesthetics: theory, research and applications*. New York: Cambridge Univer. Press.
- NASAR, J. L. (1998) *The evaluative image of the city*. Thousand Oaks, CA: Sage.
- NASAR, J. L., & HONG, X. (1999) Visual preferences in urban signscapes. *Environment and Behavior*, 31, 671-691.
- OOSTENDORP, A., & BERLYNE, D. E. (1978) Dimensions in the perception of architecture: identification and interpretation of dimensions of similarity. *Scandinavian Journal of Psychology*, 19, 73-82.
- SITTE, C. (1965) *City planning to artistic principles*. New York: Random House.
- STAMPS, A. E. III. (1990) Use of photographs to simulate environments: a meta-analysis. *Perception and Motor Skills*, 71, 907-913.
- STAMPS, A. E. III. (1994) A study in scale and character: contextual effects on environmental preferences. *Journal of Environmental Management*, 42, 225-245.
- STAMPS, A. E. III. (2000) *Psychology and the aesthetics of the built environment*. New York: Plenum.
- STÜBBEN, H. J. (1890) *Der Städtebau*. Darmstadt: Bergsträsser.
- TRANCIK, R. (1986) *Finding lost space: theories of urban design*. New York: Van Nostrand Reinhold.
- WARD, L. M., & RUSSELL, J. A. (1981) The psychological representation of molar physical environments. *Journal of Experimental Psychology: General*, 110, 121-152.
- WEBER, R. (1995) *On the aesthetics of architecture: a psychological approach to the structure and the order of perceived architectural space*. Aldershot, Eng.: Avebury.
- WILSON, M. A. (1996) The socialization of architectural preference. *Journal of Environmental Psychology*, 16, 33-44.