Urban Space and Architectural Scale - Two Examples of Empirical Research in Architectural Aesthetics

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Introduction

As one of the oldest schools of architecture in Germany, Dresden has a long and continuous tradition in the field of architectural aesthetics and building composition. Architects such as Fritz Schumacher initiated research and teaching in the field in the 1920s, and this was revitalised during the 1950s by Otto Schubert who laid the foundations for a scientific description of the correlation between optics and architectural design, and also worked towards a comprehensive theory of architectural composition. As a result of the architectural ideology of the East German regime, such studies were consigned to near oblivion and the main concern became interior decoration. With the appointment of Professor Ralf Weber, the institute was re-established in 1994 under its original name, the Institute of Spatial Design (Raumgestaltung). Its new research agenda originated from Weber's book "On the Aesthetics of Architectural Form - A Psychological Approach to the Structure and the Order of Perceived Architectural Space" (Ashgate 1994). In order to verify some of the hypotheses advanced in the book empirically, members of the institute have been carrying out a number of studies in the areas of oculomotor research and the perceptual foundations of design, and have been addressing issues that would help formulate principles of good architectural form and space applicable to the everyday practice of architectural design.

Currently, the Institute of Spatial Design focuses on the further development of the psychological bases of experiencing architecture, as well as on theories of aesthetics and their application in practice. Specifically, attention is paid, on the one hand, to the perception and experience of architecture, i.e. aesthetics, and on the other, to the assemblage of various parts into an overall whole in a building, city or landscape – in other words, architectural composition. These two aspects are naturally inextricably intertwined: the one concerns the reception of architecture, the other, its production. Under these headings, various other areas of interest, such as architectural tectonics, systems of order and proportions, or the issue of scale in architecture, are tackled through dissertations, research projects and seminars. The institute has been cooperating on several studies with the Cognitive & Biological Psychology Unit at the University of Leipzig and the intention is eventually to establish an interdisciplinary research unit for architectural aesthetics.

This address will discuss some of the more recent studies, present their results and discuss the potentials and limitations of various methods of research using different representations of space and architectural form. Two of the studies concentrate on the influence that the essential spatial properties of urban spaces have on aesthetic judgments; the third concerns the issue of architectural scale in facades of buildings. Each of these experiments used different kinds of simulation techniques, ranging from three-dimensional computer imaging to photographic representation.
These inquiries are intended to advance the understanding of the relationship between the physical qualities of architecture and the aesthetic judgments they invoke. These kinds of study are not only useful in developing design recommendations for specific urban spaces, but also contribute to the development of urban design principles as such. The procedures used in these studies can therefore be further developed and provide useful tools for planners in their decision making processes.

Urban Spaces: Aesthetic Judgment and Physical Properties
A comparison between abstract simulations and pictorial representations of urban spaces

Background

Contemporary urban space is in permanent flux: streets are adapted to conform to the changing demands of traffic, buildings are replaced by others customised to altering functional and commercial requirements, advertising leaves its imprint, and urban spaces become cluttered by the artifacts of public life. More than ever, diverse and disparate interests determine the appearance of public spaces, whereas, up to the beginning of the Twentieth Century, it was the will of a community as a whole that left its mark on the scenic beauty of these spaces through the application of correspondingly appropriate design ordinances.
In recent years, it has become evident that functional and infrastructural qualities alone do not determine the attractiveness of a city: its visual configuration is at least equally important and plays a crucial role in fostering its citizens' identification with place. Public planning departments are

under pressure to respond to this (re-discovered) perspective and develop instruments to evaluate its implications in functional, social and aesthetic terms. It has become increasingly important to know and understand the spatial parameters that influence peoples' judgments about the visual quality of urban spaces. What are the cardinal spatial properties that are responsible for judgments about beauty? Which spatial parameters can be varied without altering the identity of a public urban place? Are there parameters independent from the influence of personality or individual difference?

Study

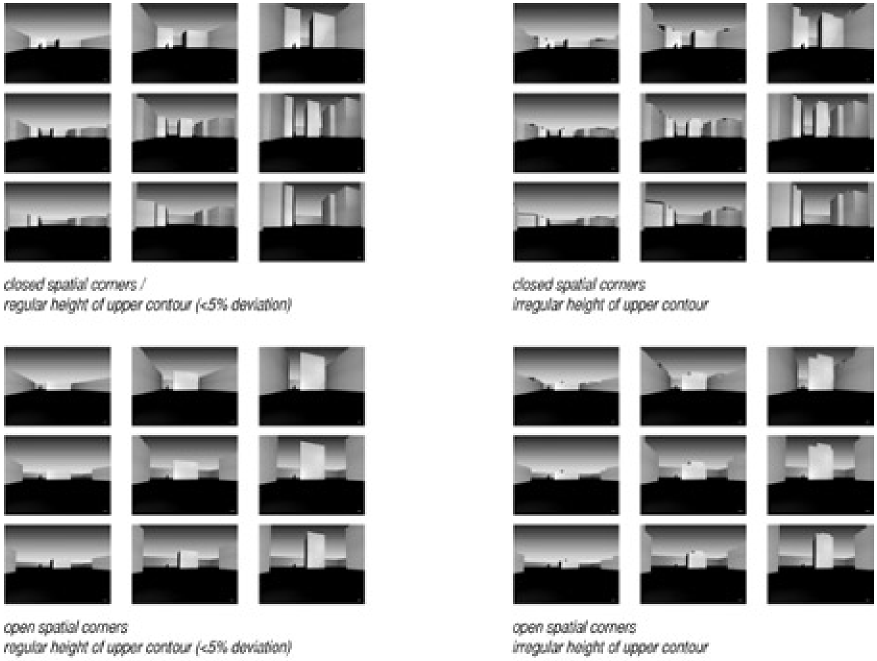
Both urban-space studies aimed to further the understanding of the relationship between the physical qualities of urban spaces and resulting judgments of them by applying and testing a number of assessment procedures on the one hand, and by developing planning tools that help guide the planning processes by which long-term design decisions are made on the other. The objective of both studies was to identify formal parameters that would influence aesthetic judgments. Amongst the host of key concepts commonly used in architectural design theory, four were selected as parameters - closure of spatial corners, spatial enclosure, format of width and height, and regular continuation of contours. In the first experiment, these parameters were systematically varied using computer generated prototypical spaces. In the second study, photographs of actually existing urban spaces exemplifying different ranges of these parameters were selected and tested.

Test I: Prototypical Urban Spaces

Variables

Closure of Spatial Corners	closed and open corners of spaces	2 alternatives
Spatial Enclosure	50%, 50-90%, >90% closure	3 alternatives
Format of Width and Height w:h	w>4h, 4h>w>h (unclear), w<h	3 alternatives
Regular Continuation of Contours	even contour; irregularities ca. 30%	2 alternatives

Correlation 2 x 3 x 3 x 2 = 36 alternatives



Matrix of Stimuli

Procedure

52 students of architecture (3. semester, Dresden University)
50 students of various humanities (Leipzig University)
36 black - white images printed on postcards 10 cm x 15 cm, individually randomized
modified Q-Sort procedure
students were asked to sort pictures into 5 stacks (rating procedure), with a minimum of 3 pictures per stack
no time limit average sorting time. ca. 20 minutes
Repeated-measures analysis of variance of rating data

The study used a Ranking-Rating-Procedure, with 36 computer generated simulations of an urban square, which were systematically grouped according to four variables. On the basis of previous research, four primary spatial parameters thought to influence aesthetic judgments of the visual quality of urban space were selected (as mentioned earlier): closure of spatial corners, spatial enclosure, format of width and height and regularity of upper spatial contour. Variations provided 10 different alternatives. These alternatives consisted of: closure or openness of spatial corners; low, medium or high enclosure of spatial boundaries; low, medium or high width to height format; and regular or irregular upper spatial contour. The 36 different computer simulations were based on the dimensions of the market square in Weimar, Germany. All material was printed as black-white images on postcards (10 x 15 cm).

The material was ranked by two different groups of participants. One group consisted of 52 second year students from the faculty of architecture at Dresden University; the other group was made up of 50 students from humanity faculties at Leipzig University. In both parts of the experiment, participants were asked to make aesthetic judgments. The two groups ranked the material separately. Participants were asked to sort their choice of images into five categories ranging from (1) beautiful to (5) not beautiful (the rating system, 1 – 5, corresponds to the common grading scale in German schools). A minimum of three images per category was required. No time limit was given.

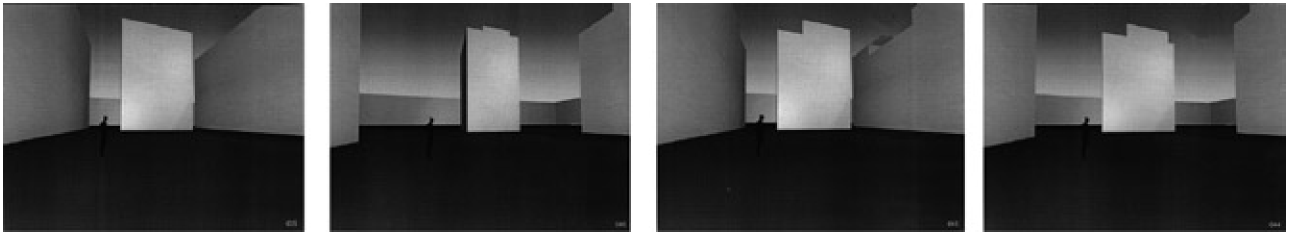
The initial hypotheses of the study were: (1) the selected parameters influence aesthetic judgments; (2) closure of spatial corners in particular, will result in a higher aesthetic ranking; (3) the combination of closed spatial corners and a regular upper spatial contour will be ranked as more beautiful than the combination of open spatial corners and an irregular upper spatial contour.

Results of the ranking of computer generated images using Anova Statistical Analysis of Variance:

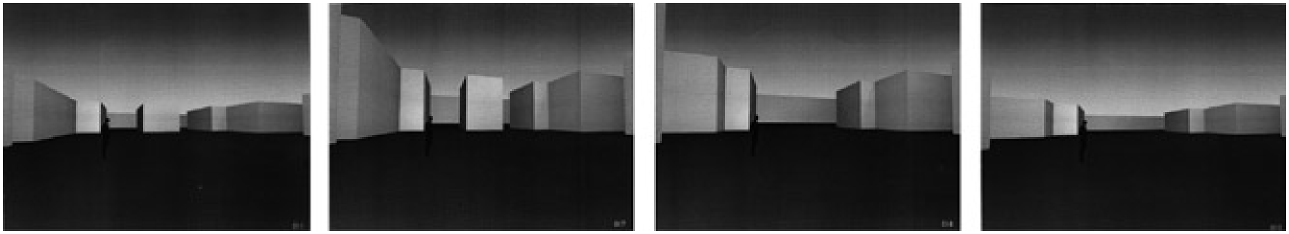
(1) Regularly shaped upper spatial contours with little height variation (less than 5% variation in height) appear to be more beautiful than irregularly shaped ones (more than 5% variation in height).
(2) Closed spatial corners appear to be more beautiful.
(3) Variations of width to height format had no effect.
(4) Overall spatial enclosure of/at the lateral boundaries had no effect.

(4; this is not particularly clear; do my suggestions fit the meaning here?) The following interactions between the variables were noticeable:

(1) Open spatial corners and strong vertical formats enhance each other's "less beautiful" ranking.
(2) Width-height format has an effect only in interaction with closed spatial corners.



Examples of high ranking images



Examples of low ranking images

Test II: Photographic Representations of Urban Squares

Matrix of Stimuli

Procedure: The second experiment used the same procedure as the first. Results: Of the original variables, only closure of spatial corners had a significant effect: the variables width to height format, overall spatial enclosure and regularity of upper contour had little* effect. There were, however, some noticeable differences between architects and non-architects. Whilst a strong vertical format had a distinctively negative effect on non-architects, it had no influence on architects' ranking. The variable of spatial enclosure produced differing responses: architects considered enclosed spaces more beautiful, whereas non-architects considered them less beautiful. Several architectural features that were not originally included as parameters effecting judgments of beauty, turned out to have a positive impact on the ranking: these were the occurrence of arcades and isolated vertical

Examples of low ranking images

Examples of low ranking images

elements such as obelisks, towers or fountains. However, a lack of ornamentation in the facades surrounding the urban spaces had a negative effect on non-architects' ranking.

Conclusions

At this stage of the investigation, the experiments largely confirm some of the original hypotheses, but they show differences between judgments based on abstract simulations and pictorial (i.e. photographic) representations. Further tests will focus on this aspect more closely. In a next stage we plan to use a new compilation of images derived from a modified and refined set of variables. Computer generated simulations are to show less abstract and more differentiated facades with the principal elements divided into horizontals and verticals. Furthermore, the professions, genders and ages of the participants are to be identified.

Architectural Scale: empirical support of a key architectural concept

Background

Architectural scale is one of the most commonly used notions in architectural discourses. One speaks of buildings that lack scale, of architecture with a human scale, of a monumental or an intimately scaled space or facade. However, the idea of scale is one of the most elusive in the field. What is the meaning of the word? Is it to do with aesthetics or ethics, does it pertain to quantity or quality, to size, to the viewer's perception, to psychological impact or all of these simultaneously? While the everyday experience of buildings provides a host of clues that allow us to judge a building's size somewhat correctly, there are few of these real life indicators present during the process of design. Better knowledge about the effects of a building's scale may help to overcome this problem and help students and practitioners by making design a more conscious process. In the scientific discourse on the subject, scale is usually defined as the perceived or apparent size of a building. The impact of architectural scale is usually analyzed in relation to people (human scale), to the context of the building in question (contextual or outer scale) or to the relation between a building's individual architectural elements and its whole (inner scale). A series of experiments at the Institute recently addressed some of these issues. Two of these are discussed here.
In the experiments, scale is understood as a concept of size: viewers were shown images of buildings of different styles, types and sizes, in isolation from their contexts, and were asked to estimate or rank how big the buildings were. By comparing real against estimated sizes, conclusions could be drawn about the geometrical factors influencing the judgment of size.

Study

The principal issue underlying this study was how the geometrical properties of a facade influence the apparent size of a building. Prior to the study, we formulated the following hypotheses based on our teaching experiences in the field of architecture:
(1) Facades with many subdivisions tend to appear larger; buildings with few subdivisions tend to appear smaller.
(2) Buildings with elements whose sizes are known due to their functions

[steps, heights of door handles, handrails etc.] are more likely to be judged correctly.
(3) Horizontal divisions in a facade are taken as clues to judge heights.
(4) The size of vertically oriented buildings tends to be overestimated.

Stimuli

We prepared 35 black and white pictures of buildings of different types, styles, heights and functions. Each image showed a building from two sides and the surrounding contexts were replaced by a neutral gray tone. Anything that would help indicate the building's height, e.g. cars, people, vegetation, was eliminated from the images.

Matrix of Stimuli

Test Procedure

Test I: Estimation of Heights

198 students of architecture [4th semester]
53 students of various humanities
35 black-white images of buildings
shown via beamer projection,
11 seconds per picture,
overall time ca. 7 minutes

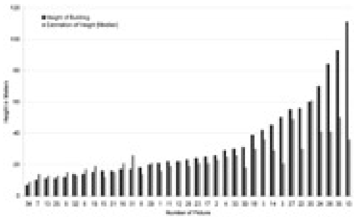
students were asked to estimate the heights
of the buildings shown

Test II: Q-sort test

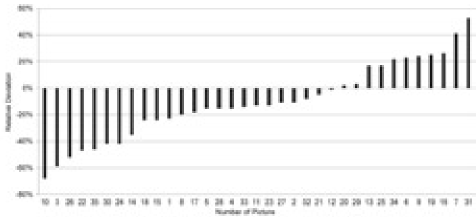
198 students of architecture [4th semester]
53 students of various humanities
35 black-white images of buildings
printed on postcards 10 cm x 15 cm, individually randomized

students were asked to sort the images into 5 stacks (according to their estimates of small to large buildings),
with a minimum of 3 pictures per stack;
they were then asked to sort the images in each stack:
no time limit was given; the average sorting time was ca. 20 minutes

Results:



Comparison of Real and Estimated Heights [Median]



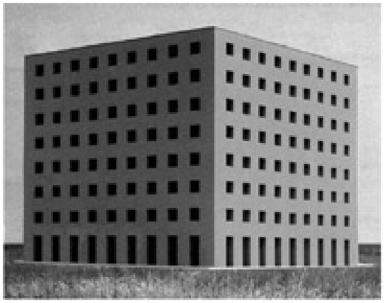
Relative Deviation of Estimated from Actual Height [Median]

Test I: Estimation of Heights

Dimensions were estimated relatively accurately for buildings between 20 and 30 m high. Buildings less than 20m high were estimated more or less correctly, although smaller buildings in this range were usually slightly underestimated. Deviations between actual and estimated size increase drastically for buildings higher than 30m, and their heights were generally considerably underestimated. In short, smaller buildings tended to be over-estimated, whilst large ones tended to be underestimated.

111 m
Est. 36 m

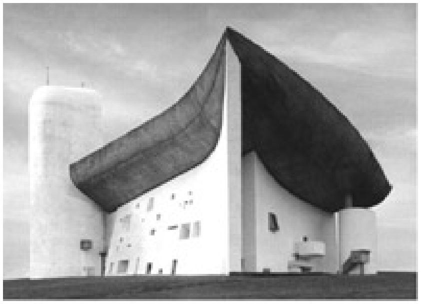
50 m
Est. 21 m



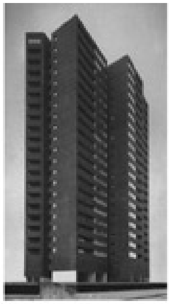
17 m
Est. 26 m

10 m
Est. 14 m

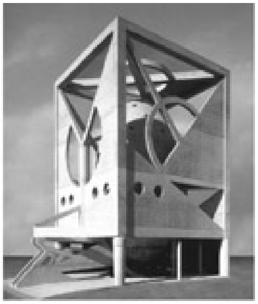
Lowest Degree of Accuracy



22 m
Est. 22 m



60 m
Est. 61 m



16 m
Est. 15 m

20 m
Est. 21 m

Highest degree of accuracy

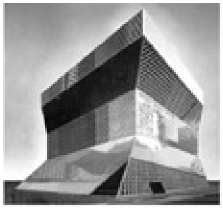
Differences between architects and non-architects were less significant compared to some of the differences between actual and estimated heights. For example, both participating groups grossly underestimated the Grand Arch in Paris. Much like the Seattle Library by OMA, it lacks a variety of levels of subdivision indicating the human scale, and has no clues that relate to everyday human experience, e.g. steps, height of railings, windows, doors etc.
Two building whose sizes were considerably underestimated, were the Hofkirche and the Frauenkirche in Dresden, although those buildings were well known to most of the participants. Both facades are decorated with elements, such as windows and doors that are also frequently seen in many secular buildings of that historical period, but usually in smaller sizes. Because the two buildings in question use such elements at a much larger scale, it can be assumed that estimates of the sizes of these buildings were influenced by participants' familiarity with the more usual sizes of these elements. Hence, the underestimation.
Results also show that buildings with few levels of subdivision are estimated to be smaller, whereas buildings with small subdivisions are judged to be larger.

Test II: Ranking of Buildings According to Height

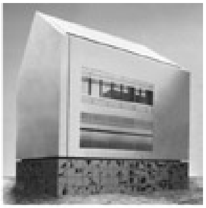
Buildings with many levels of subdivision and with small subdivisions are generally overestimated in size. As in Test I, a lack of small size clues result in an underestimation. A comparison reveals some interesting curiosities: for instance, the residential building on the top left is about as high as the Einstein Tower, top right. However the estimates differ considerably, since the floor heights of each building are different. The same observation can be made in the comparison of the Palazzo Strozzi, Florence, and the multi-storey housing project shown next to it. Three storeys compared to eight! Thus, regardless of their actual floor heights, buildings appear to be judged by some sort of assumed typical floor height.

The pair at the bottom again shows two buildings of the same height, but they were estimated to be considerably different in size. The library on the left was judged to be smaller, perhaps because of the lack of any subdivisions that would indicate the height of a floor.

Size: 111 m Rank: 35
Est.: 36 m Est.: 30



Size: 56 m Rank: 30
Est.: 30 m Est.: 27



Size: 18 m Rank: 13
Est.: 14 m Est.: 06

Size: 93 m Rank: 34
Est.: 50 m Est.: 31

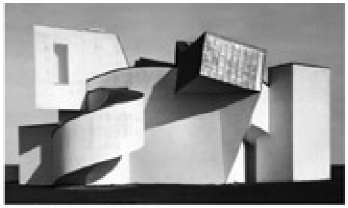
Size: 50 m Rank: 28
Est.: 21 m Est.: 18

Size: 31 m Rank: 24
Est.: 18 m Est.: 14

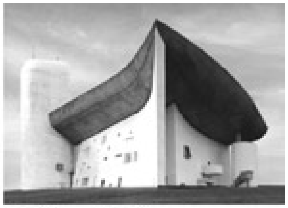
Underestimated buildings

These six images are examples of buildings that were underestimated in both tests. They illustrate two major reasons for underestimation, as initially hypothesized. The buildings pictured on the left are characterized by large, relatively simple forms with very little microstuctural subdivision -- here, the buildings macrostructure dominates. As in Test I, a lack of subdivision at the microstructural level appears to lead to underestimations of size. The images on the right show architectural elements that are much larger than the viewer is accustomed to. For example, the windows of the Palazzo Strozzi are about 5m high, yet look the same as windows frequently seen in other buildings in Florence, which have a typical height of ca. 2m. This effect is the same as that seen with the Frauenkirche in Dresden, whose elements use the same architectural vocabulary as the surrounding secular buildings, yet at a larger size, as described earlier.

Size: 42 m Rank: 26
Est.: 36 m Est.: 28



Size: 14 m Rank: 07
Est.: 13 m Est.: 06



Size: 22 m Rank: 16
Est.: 22 m Est.: 18

Size: 30 m Rank: 23
Est.: 26 m Est.: 24

Size: 22 m Rank: 16
Est.: 19 m Est.: 14

Size: 26 m Rank: 21
Est.: 23 m Est.: 20

Accurately estimated buildings

The accurate ranking of specific buildings corroborated several principal hypotheses. Horizontal divisions seem to indicate floor heights and are used as dimensional clues. Common architectural elements, e.g., windows, doors, stairs etc., which are familiar and are assumed to have a particular size, indicate how big a building is, in these cases accurately.
While it is known from perceptual psychology that vertically oriented geometric figures are usually overestimated by up to one third, the hypothesis that vertically oriented buildings are overestimated in height was not corroborated in the case of buildings.

Conclusions

The study confirmed that the estimated size of buildings depends in part on the geometric properties of the buildings' facades. The hypothesis that facades with many subdivisions tend to appear larger and that buildings with few subdivisions tend to appear smaller, was confirmed. The hypothesis that buildings with elements whose sizes are known due to their functions (steps, heights of doorknobs, handrails, windows, doors etc.) are more likely to be judged correctly was confirmed (so long as the dimensions of these elements are within the usual range of a familiar architectural style). The hypothesis that horizontal divisions are used as a tool to judge heights was confirmed. The hypothesis that vertically oriented buildings are overestimated was not confirmed. The study revealed no significant differences between architects and non-architects, except when the sample building was known to the subjects (the architects tended to know more of the buildings used in this test).

Further Work

New and revised stimulus material will be selected in accordance with the hypotheses that have been confirmed so far. Original images will be modified in order to strengthen or weaken those specific geometric features held responsible for the estimation of size. We also plan eventually to investigate the differences between exposures to real as against laboratory stimuli.
A further study will look at the role played by a facade's subdivision, i.e. its hierarchies of scale, in influencing judgments on the size of a building. In this test, the apparent sizes of differently subdivided computer-generated prototype facades are to be estimated. The aim is to find which degree of subdivision suggests merely a pattern or texture as apart from a collection of shapes or parts, and how the subdivision of a facade relates to the apparent size assigned to it by the viewer. Finally, in another part of the planned study, the question will be asked as to whether the imagined size of a building is affected by its context: can the presence of a particular building be amplified or reduced by controlling the scale of its contextual constituents?
Eventually, the results of these experiments, and those of further studies in this area, could provide useful tools not only for establishing design recommendations for specific urban spaces and facades, but also in the development of design principles in general. They can therefore offer planners an essential orientation in their decision-making processes.

** The first two studies were carried out with Birgit Wolter of the Institute for Spatial Design, Dresden University, and Thomas Jacobsen of the University of Leipzig; the third, with Silke Vosskoetter of the Institute for Spatial Design, Dresden University.*