**Experimental Design**

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<tr>
<th>Original</th>
<th>Original mirrored</th>
<th>Original altered</th>
<th>Altered version mirrored</th>
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<tbody>
<tr>
<td>Robert van 't Hoff: Villa Nora</td>
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<td>Louis Hermann de Koninck: Villa Berteaux</td>
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<td>Léon Wolffage Wernik: Office Building Berlin</td>
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<td>Rafael Moneo: City Hall Murcia</td>
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<td>Residential Building Radsbeul</td>
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1. Summary

Concepts of visual balance and stability play a major role in many theories of the visual arts and architecture. It is still one of the cornerstones of aesthetics that works of art are judged intuitively according to visual harmony, balance, dynamics or stability. More than in the arts, where critical theory has focused in recent decades on conceptual issues, such terms are still part of the standard repertoire of the evaluation of buildings and spaces. The making of architecture incorporates a manifold of diverse aspects, spanning from the function which a building has to fulfill, via the technical aspects to the formal qualities, that is, those which immediately address the viewer's senses. While many of the professions in the disciplines of engineering and planning master selected aspects, often even more thoroughly than architects, competence in the design of spatial and corporeal form is the only field of expertise remaining for the architect. For architects, designing the visible form of buildings is usually an intuitive, but sometimes rationally based exercise in arranging forms and masses into a balanced, yet dynamic whole. These design aspects are often summarized under the term architectural tectonics. While the term has been widely used in different ways since classical antiquity, it has remained a somewhat nebulous notion that demands a systematic attempt toward its elucidation.

Many of the most fundamental planning and design decisions in architecture require aesthetic judgments to be made. One that is very common concerns the balance of a facade’s composition. Architectural balance may be achieved through weighting compositional architectural elements in order to produce stable, holistic patterns. Does this consequently mean that the balance of a facade’s composition has an important impact on the assessment of a building’s beauty? A study was conducted to test if judgments of beauty and judgments of balance on facades correlate to some extent. The question is, whether balance is really experienced and incorporated when judging the aesthetic value of a building, and if there are differences in judgement between architects and non-architects. In order to understand how people experience buildings, and how that experience informs the process of evaluation, an eye-movement experiment was conducted, thus elaborating the issue of balance in a facade by measurably relating it to specific architectural design alternatives and their perception and evaluation of the beholder.
2. Theoretical and empirical background

This paper will address some of the issues in tectonics as they might appeal to psychologists and architects alike, and it will likely raise more questions than it will be able to answer. But what we hope to achieve with this paper, is to stir the interest for a number of issues that might prepare the ground for a research agenda that is of interest to both architects and psychologists.

Our theoretical and empirical background comprises the concept of balance in architecture by differentiating the concept of compositional balance and the concept of visual balance. In addition, two aspects of balance are described in more detail, i.e. the aspect of visual centers and spatial locations of compositional elements, i.e. the anisotropy of space. Subsequently, our research focus is outlined and questions are derived.

2.1 The Concept of Compositional Balance in Architecture

When the art historian Heinrich Wölfflin (1984) defined architecture as the art of arranging corporeal masses, he refers to the architect as a designer who arranges diverse visual masses together to form a state of compositional equilibrium. In this vein, he defined architecture as being “the art of arranging corporeal masses”. August Schmarsow (1905) broadens this definition by defining architecture as “the art of designing space”. He speaks of tectonics in the third dimension, that is through depth of space. Fritz Schumacher (1938), a German architect and educator, defines Architecture as design of space by means of form. And at least Leo Adler (1926), an architectural theorist in the 1920, defined “Architecture is the making of spaces for human activities by means of surfaces and solids”.

In summarizing these definitions, it is obvious that they all incorporate in one form or another architectural mass or the solids that make architecture as well as the void between these solids the elements of architecture. That is, the arrangement of solids and spaces is described as being the constituent base of architecture. Consequently, architectural composition can be seen as art of balancing individual architectural parts within an overall whole of a building.

Compositional balance can be achieved in different ways. The traditional way of making a composition balanced is through symmetric arrangements. An example of a classic traditional symmetrical building is the Palazzo Farnese (Sangallo,
Michelangelo, Rome, 1546), an example of a classic modern symmetrical building is Haus Bubanek (Bienefeld H.). Another form of balance can be achieved through asymmetrical arrangements within compositions. An example of a balanced interplay between horizontal and vertical elements, between solids and planes as well as between different textured surfaces is the Kaufmann House (Wright F. L. Bear Run, 1935). This interplay produces balance without symmetry. An example of asymmetrical balance of larger masses is Notre Dame du Haut (Le Corbusier, Ronchamp, 1950-55). Here, balance is achieved through equally weighting elements of openness and closure.

2.2 Balance Center

Rudolf Arnheim’s writings such as the Dynamics of Architectural Form (1977) or the Power of the Center (1982) refer to the perceptual image as a result of dynamic properties of the perceived thing, such as the position of the parts and their visual masses. Arnheim propagates the notion of perceptual centers, compositional fulcrums in which so-called perceptual forces are in equilibrium. The preference for the middle, the preference for an emphasis of the center in simple pattern was shown in an example in Metzger’s (1975) book on Perception, where he shows that children tend to emphasize the center in simple grid-like patterns.

On this note, Arnheim (1982) describes shapes as fields of perceptual forces with different intensities. For example, a square possesses a clear center and centers of smaller intensity at the four corners. And it possesses latently existing axes, the vertical and the horizontal and – comparable to trusses in a building – the diagonals.

In addition, oculomotor research reveals which areas of a visual field attract the eye in particular (see for example Fig. 7 and 8). On the one hand, it is the center of the visual field itself. On the other hand, the properties of the perceived elements within the composition determine the main focus of the gaze. In this example, the rosette attracts the eye mostly due to its concise form and due to its size. According to Arnheim (1982), both properties contribute to the weight of a compositional element and might therefore attract the eye.

One can abstract theses findings and claim that visual centers exist at certain parts of shapes just as Arnheim showed in his diagram describing the structure of a square. Certainly the eye
does not fixate at all the centers and subcenters because of redundancies, but eye movement studies seem to support the general notion of visual centers.

The question remains open: How sensible are eye movements with regard to compositional balance, especially with regard to the disturbance of compositional balance? When compositional balance is disturbed through shifts of compositional centers, would eye movements react to that? And after all this, would the beholder judge the composition less balanced and thereby less beauty?

### 2.3 Anisotropy of Visual Space

Visual space is anisotropic. That is, left and right as well as top and bottom are perceived differently. According to the concept of visual masses after Arnheim, left and right as well as top and bottom produce different perceptual weights, i.e. they provide the same object with different perceptual weights in dependence of its location. While the left and bottom side of a spatial arrangement produce “lighter” perceptual weights, the right and bottom side produce “heavier” perceptual weights. Consequently, more compositional mass – for example a circle – can be tolerated on the left side of a spatial arrangement without producing an overall less balanced composition (see Fig. 9). A circle stands for a very concise form with high compositional weight which is in Fig. 9 heightened through the isolation of the circle from the other compositional elements. The other two forms in this diagram are less concise in comparison to the circle. In diagram 1 the left side with its property to lower perceptual weights compensates for
the high compositional weight of the concise form of the circle, and the right side with its property to raise perceptual weights compensates for the lower compositional weight of the less concise compositional elements. Thus, the overall composition remains balanced. The opposite is the case with Diagram 2 where spatial weights coincidence with weights of compositional elements in a way that makes the overall composition less balanced.

2.4 Hypotheses

First of all, we asked the question: Why should balance of facade composition have an effect on aesthetic judgements of balance and beauty of the facade? (Question 1)

Based on theories and findings from empirical aesthetics it is suggested that the more fluently an aesthetic object can be perceived and processed the more favorable is its evaluation (Leder, Belke, Oeberst & Augustin, 2004). That is, an easy mode of processing should have a positive impact on the evaluation of the processed object. Furthermore, there is a consensus that the path from stimulus to response falls apart into two stages (Locher & Nodine, 1987). The first stage is believed to comprise a fast and preattentive process: It picks up information from a stimulus, and it yields a representation of that stimulus. This preattentive process is assumed not to be influenced by knowledge. In contrast, the second stage is assumed to be more top-down driven, that is, more influenced by the subject himself. This second stage aims at finding an interpretation of what is seen, and the subject uses associations, knowledge and expertise in order to interpret the object. Balance is suggested to influence the first stage of processing by enhancing the fluency of perceptual processing. Thereby, balance should enhance appreciation of the stimuli. Consequently, we hypothesize:

Hypothesis 1: Differences in balance of facade composition show an effect on aesthetic judgements of balance and beauty.

Arnheim suggested the „anisotropy of the room“ with different parts of the room weighting differently. Given a plane (Ebene) the top is heavier than the bottom and the right side is heavier than the left side. The same elements that are placed into the right or top side become heavier than when placed into the left or bottom. This is, according to Arnheim, due to the fact that different parts of an area or room weight differently themselves. It could be speculated that given different parts of the room
consisting of different weights, a composition with elements that are shifted towards the right side of the composition should lead to a shift of eye movements to the right side. This could imply that eye movements leave the anisotropy of the room that they are used to and could therefore be associated with ease of processing for them. This shift of eye movements might lead to decreasing ratings of beauty. On this note, we further hypothesize:

Hypothesis 2: Differences in balance of facade composition show an effect on perceptual processes.

3. Method

We conducted two experiments. The first experiment (experiment 1) was carried out with a large sample of subjects (101 participants) that evaluated balance and beauty of façade compositions and their manipulated less balanced counterparts.

The second experiment (experiment 2) was carried out with 30 participants that evaluated beauty and balance of façade compositions as well, while during the evaluation process eye movements were recorded.

The following chapter includes the description of both experiments 1 and 2.

3.1 Experiment 1

25 facades (practice trial images included) were presented 12 sec. per facade with a beamer presentation. Participants rated beauty and balance of every facade on a 6 point scale. The sample of subjects consisted of 101 students (psychology, economics, linguistics) that were non-architects, 23% men, 71% women (6%), age M=23 (s=3.1, max=35, min=18). In addition, the same A quarter of the 25 facades reflected original facade compositions, whereas the other quarter consisted of altered facade compositions through manipulation of compositional balance organization. Manipulations were developed with the help of experts (architects) who changed one feature of the original facade composition. Results were evaluated by other experts to make sure that manipulations reflected variations in balance through the eyes of a representative group of architects. All stimulus material consisted of arranged facade photographs with the aim to make facades comparable. All facades appear in the front, background and other surroundings were retouched and
replaced by a blue background. A flat black area served as building ground. The left two quarters consisted of mirrored compositions, that is, the original facade compositions were mirrored as well as the altered composition. The design was a 4x5 Design, that is, 5 facades in 4 versions with additional four facades used for practice trials (making 25 facades as a whole).

3.2 Experiment 2

14 facade stimuli were used for the beauty and for the balance judgment in this experiment (6 for the practice trials, 8 in the main experiment). Half of the 14 facades reflected original facade compositions, whereas the other half consisted of altered facade compositions through manipulation of the symmetrical organization of the facade. Manipulations were carried out as in Experiment 1. As for eye-movement analysis, fixation areas, fixation durations and saccade amplitudes were determined. Understanding where the fixation areas of a facade are help us to understand the variables that contribute to the judging processes undertaken by the observer of the building.

The program Eye Gaze was used to investigate the eye movement correlates of aesthetic judgments of (beauty of) facades. Participants performed evaluative aesthetic judgements of beauty and of balance on the same stimulus material. Participants were divided in two groups based on their level of expertise in architecture, i.e. architects were distinguished from non-architects. The experiment was conducted in two phases. In Phase 1 presentation duration of the facades was 500 ms, whereas in Phase 2 presentation duration was 5 s. Participants judged beauty and balance on the same stimulus material in both trials.

In order to count for the well-known effect of expertise on aesthetic judgements, we distinguished architects, students of architecture and non-architects as test-subjects. (Finally, the effect of length of processing on judgements was of interest. Because mode of processing, perceptual or cognitive, can be inferred from length of processing. The length of processing was varied by different presentation times.)

3.3 Definition of the term „balance“ given to the participants of the experiment

The following definition was given to the participants making sure that all of them share the same meaning of balance.
4. Results

Firstly, results concerning judgements of balance and beauty in dependence of balance manipulation of a façade manipulation are reported. In doing so, the effect of expertise on balance and beauty ratings is shown. Secondly, the effect of manipulation of balance on perceptual processes was of interest. Eye movements served as relevant correlates of perceptual processes. We analysed eye movements qualitatively and quantitatively and therefore introduce our results respectively.

4.1 Effect of balance on judgements of balance and beauty

Regarding balance judgements, the more symmetric the façade composition was, the more balanced it was judged. This could be shown for the facades Villa Nora and Leon Wohlhage Wernicke Architekten (see figure below).

Regarding judgements of beauty, the façade versions of Villa Nora and the house of Leon Wohlhage Wernicke Architekten

Figure 12: Experimental procedure

Experiment 2
showed no significant effect. That is, the versions, if original, manipulated or mirrored, make no difference regarding their beautiful judgements. Instead of that, Villa Berteaux and house Radebeul produced different beautiful rating regarding their versions.

A correlation between the judgments of beauty and balance could not be corroborated.

4.2 Qualitative analysis of eye movements

The next issue that was of interest concerned eye movements in dependence of different balance versions of façade compositions. Distributions of fixations served as correlates of attention distribution. Attention distribution can, from a psychological point of view, be taken into account for deriving interest of a person in different aspects of a picture or composition. First qualitative analyses of eye movements suggest that in the case of an asymmetrical distribution of openings within a facade, fixations are directed at the figures of these openings, while in the case of symmetrical arrangements the gaze is more obviously directed at the principal compositional center of the facade or along the vertical symmetry axis (see figure below). In other words, fixations on an asymmetrical composition primarily fall in the areas of windows that determine the pattern of balance in the facade. In the symmetrical version, there is an emphasis on the overall middle of the shape, regardless of the existence of windows.

![Figure 13: Significant differences of judgements of balance and beauty](image-url)
4.3 Quantitative analyses of eye movements

As for preliminary analyses, fixation patterns and judgments of balance were combined. It was found that fixation distributions vary in dependence of balance judgments. Facades that were judged to be more balanced evoked more fixations on the left and bottom side of the facade composition whereas facades that were judged to be less balanced evoked more fixations on the right and top side of the composition. Arnheim (1974) suggested the „anisotropy of space“ with different parts of the space weighting differently. Given a plane the top is heavier than the bottom and the right side is heavier than the left side. The same elements that are placed into the right or top side become heavier than when placed into the left or bottom. This is, according to Arnheim (1974), due to the fact that different parts of an area or room weight differently themselves. It could be speculated that given different parts of the room consisting of different weights, a composition with elements that are shifted towards the right side of the composition should lead to a shift of eye movements to the right side.

5. Conclusions

Effect of balance on judgment seems to be dependent on viewing time and expertise. Eye movements correlate with judgement of balance. A correlation between the judgments of beauty and balance could not be corroborated.

First qualitative analyses of eye movements suggest that in the case of an asymmetrical distribution of openings within a facade, fixations are directed at the figures of these openings, while in the case of symmetrical arrangements the gaze is more obviously directed at the principal compositional center of the facade or along the vertical symmetry axis. It was further found that fixation distributions vary in dependence of balance judgments. Facades that were judged to be more balanced evoked more fixations on the left and bottom side of facade composition whereas facades that were judged to be less balanced evoked more fixations on the right and top side of the composition. The results can be interpreted by referring to Arnheim’s theory of the „anisotropy of space“ with different parts of the space weighting differently. It could be speculated that given different parts of the space consisting of different weights, a composition with
elements that are shifted towards the right side of the composition should lead to a shift of eye movements to the right side. This could imply that eye movements leave the anisotropy of the space that they are used to and could therefore be associated with ease of processing for them. This shift of eye movements might lead to decreasing ratings of beauty.

References