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STRUCTURE OF ATTENTION AND THE LOGIC OF VISUAL COMPOSITION

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Abstract

We began with the general hypothesis that the compositional structure of a building façade is the means by which a designer can guide and manipulate imaginative attention. Making selective changes to the composition of a building façade should produce corresponding changes in the distribution of attention across the façade, so that the prominent parts or aspects of the composition may now be suppressed and vice-versa.

Two groups of 12 subjects—all of comparable educational background and age groups—were given two successive tasks. After having been shown a building façade and once familiarized with its design, they were asked to first reproduce the façade design from memory and to secondly copy it in a limited amount of time. The task was repeated twice—once with the façade of the Atlanta Public Library (the designed by Marcel Breuer) and then with an altered design of the library to increase its visual order and predictability. Our interest was in checking if altering the design would make a difference in the subjects' ability to recall or copy it.

Our findings indicate that the more simply ordered altered design was easier to remember. The number of its elements recalled correctly was significantly higher than those of the original one ($t(32)=3.669$, $p=0.0009$). But when copying, an exercise that requires subjects to first create a conceptual organizing framework of the façade in their mind, there was no difference in the overall recall ($t(32)=-0.956$, $p=0.34$). Instead, the distribution of errors showed us that the subjects' attention was more broadly focused across the original façade, and that they were attentive to depth cues in the original façade.

These findings support the thesis that altering the composition of a façade can reorient attention to different aspects or parts of it. The paper discusses the implication of these findings, arguing that differing attention can alter the reading and imaginative understanding of the composed artifact, and so provide a partial basis for systematic functional analysis of the visual forms of buildings.

Keywords: *visual composition, attention, schema, imaginative function*

Theme: *Spatial Cognition and Behaviours*

The Issue

Recent years have seen a re-emergence of interest within the space syntax community on developing systematic procedures for describing formal features of buildings such as visual composition, language, and style – those features that often embody architectural concerns but are not included in descriptions focusing on the organization of space (Bafna et al. 2009, Holanda 2009, Koch 2009, Psarra 2009). This paper describes an ongoing set of experiments whose results make specific contributions to this line of research.

The ultimate goal in this paper is to begin to establish certain general principles by which the role of imaginative function in the shaping of buildings may be understood. The study presented here tests the hypothesis that altering a composition can reorient attention to different aspects or parts of it, and that doing so alters the reading and imaginative understanding of the composition.

Imaginative Attention and Visual Parsing

We began with the premise that the architects' purpose in creating deliberate visual design in a building is to direct a viewer's attention to it in specific ways. Whatever the explicitly stated and motivating intent, whether it is formulated as the requirement for dressing the building to give it an appropriate social status (Alberti [1404-72] 1991), or to create a sense of public presence (Fergusson 1874), or of using the form to train the eye to contemporary conditions (Kepes 1948), the underlying rationale is the necessity of responding correctly to a discerning viewer. The necessity arises from a combination of a generic visual function fulfilled by buildings and of specific characteristics of human vision that are brought into play in achieving the design intent.

Human vision is fundamentally inferential; one encounters variation of light intensities on the retina and uses those to develop a useable image of the environment. One first identifies contours, fills them in to create surfaces, and then puts them together to construct individual larger objects as fusions or assemblies of these surfaces (Hoffman and Singh 2003). This "parsing" operation relies on visual cues to guide the construction at every step. Because this is an inferential process that operates simultaneously through both bottom-up and top-down processes, parsing makes selective use of visual information available, using what fits the inferential model and discarding what does not. The significance is that much of this process is not in one's conscious control – as the early gestalt psychologists have noted, we cannot help what we see, nor guide it towards pre-specified ends, although we may control what is in our field of view and use attention to select from within it (Hochberg 1998).

This is because we require attention to see (Mack and Rock 2000); just training our eye on the object of vision is not sufficient. Attention may be essential to our ability to assemble independently observed attributes and features into specific objects and scenes (Triesman and Gelade 1980). Attention usually has a focus, which leads to selectively seeing only some aspects of what is in our field of vision. The focus can vary in size and in interest as we choose to either scrutinize something closely using high acuity foveal vision, or to survey an area without any pre-specified goal, maintaining general awareness (Hochberg 1999, Styles 2006). Attention itself is task-oriented; to maintain attention on a specific object, we need to be engaged in a visual task concerning the object (James 1890). So in the end, our seeing is task-driven, limited to seeing with specific purposes in mind.

Seeing also has an imaginative dimension. The objects or assemblies constructed may not actually be present, such as when we see a three-dimensional object in marks on a surface and create notional groupings. At other times, constructions made an also trigger associations. The importance of this imaginative seeing is to direct thoughts and attention away from what is

directly in our field of vision to entities or worlds not immediately present (McGinn 2004).

Given this, we can argue that the manipulation of visual form through composition is not just a simple aesthetic activity – where a designer manipulates the visual form in order to create designs that feel harmonic or pleasing or right (Scruton 1973) – but rather a means to guide the viewer's attention and, therefore, thoughts in specific directions (Bafna 2012). This study was designed to test one aspect of this argument: that altering the visual design of a building in particular ways alters a viewer's attention to it and makes different parts salient, or in other words, buildings with even small differences in visual composition would be parsed differently.

The façade as a case: Marcel Breuer's Atlanta Public Library

The hypothesis was tested using a façade of a building. The relationship of buildings to their viewers is complex - often designed for viewing by moving visitors, from different angles, and in different environmental conditions. The façade of a building, however, can be safely considered a two-dimensional composition with three-dimensional attributes – something comparable to a relief rather than a sculpture in the round. Movement for such objects may help discern the shape, but is not essential to understanding it. Moreover, it would be relative easy to find a façade that was treated as a stand-alone composition in its own right, over and above how it contributed to the visual design of the entire building. The choice of the façade as a case thus simplified many issues for us without compromising the basic idea to be tested.

The façade selected is the entrance front of the Atlanta Public Library, constructed in 1981 [Figure 01]. The architect in charge of construction was Hamilton Smith of MBA Architects, however much of the basic façade design was actually produced under the direction of Marcel Breuer prior to his retirement from the firm in 1974. The façade is a dull gray, monochrome composition of pre-cast concrete panels and glass, which is both severe and uncompromising in its Brutalist aesthetic. Simultaneously the façade is a very sophisticated composition, providing an unexpectedly apt illustration of a visual composition designed not just to please the eye, but also to engage the mind (Bafna 2013).

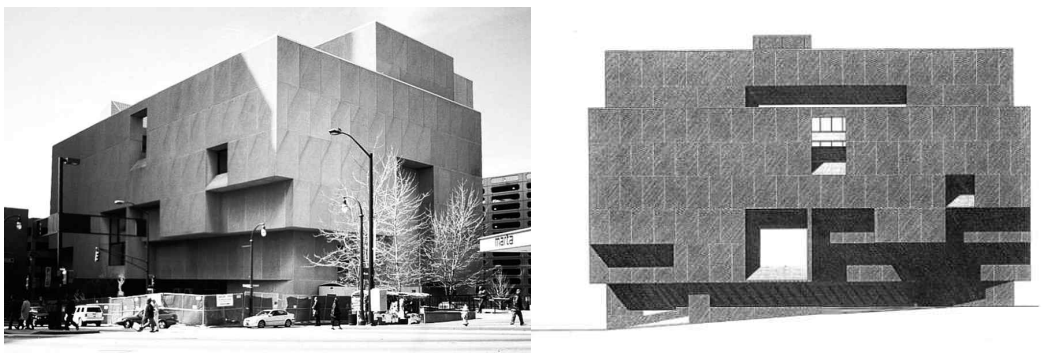

Figure 01: Atlanta Public Library

Breuer was trained at the Bauhaus under a very particular design philosophy. The core element of design was to create a new set of visual forms that would help contemporary man overcome the fragmented and dissociative experiences that the modern world had created and "reform [him] into an integrated being." (Kepes 1948, 13) To achieve a "dynamic integration", visual forms had to meet certain criteria: they would have to be plastic (i.e. produce a unified and balanced experience), but one that was dynamic rather than static. The characteristics of such dynamic forms included 1) asymmetric, yet 2) balanced composition, which could be resolved into 3) a small set of elementary figures against a ground, but in such a way that 4) the consistency of one reading would be constantly challenged by another, and 5) the identification of the figures against a ground and their inter-relationship would be consistently open to

re-evaluation.[1] The relationships between forms could be described in standard compositional terms – repetition, balance, symmetry, rhythm, contrast, opposition – but the key to a successful composition was to create an object that could be resolved into a number of different figures depending upon where the observer's eye was focused, but in such way that the resolved forms always presented a visual balance. Kepes and others argued that such dynamism was essential for the maintenance of the observer's attention (Kepes 1948, 59).

Breuer's façade maintains these qualities [Figure 02]. In order to test our hypothesis; we decided to work with two derivative qualities. The first quality is called plastic experience, i.e. the ability of the façade to resolve itself into a composition of three-dimensional forms arranged in a layered space, rather than a pattern of two-dimensional shapes arranged only in a plane. The second quality is overall dynamism, i.e. the ability of the façade to distribute the observer's visual attention evenly over the entire façade rather than focusing more strongly on a local area. The façade of the Atlanta library, we argued implicitly, produces, for an interested and discerning viewer a strong plastic experience and motivates the viewer to attend to and scrutinize elements over the entire façade. In order to test this, we developed an alternative version of the façade and designed a simple experiment to compare the original façade against the altered facade. This is described below.

Figure 02: Atlanta Public Library

Methods

Two groups of 12 subjects were given two successive tasks. The subjects were shown a façade in several images, first presented successively, then simultaneously, and then were asked to take their time and memorize a frontal view of it [Figure 03]. Following this they were given two successive tasks, the first to draw from memory the learned view and the second to copy it rapidly from a projected view in a very limited amount of time. The short time was expected to force subjects to prioritize and select features to include and so give clues to their mental organization of the façade. Subjects drew these features on a drawing similar to the

[1] This description, although using our own words, is characteristic of writing of this period. A typically illustrative example can be found in Kepes (1948) from which much of our description is drawn. Kepes was a close contemporary of Breuer, like him a Bauhaus graduate, and instrumental in developing what was to be the standard curriculum for architecture students in visual studies.

orthographic drawings shown below with front façade removed. The first set of subjects worked on the façade of Marcel Breuer's Atlanta Public Library and the second set on an altered version of the façade.

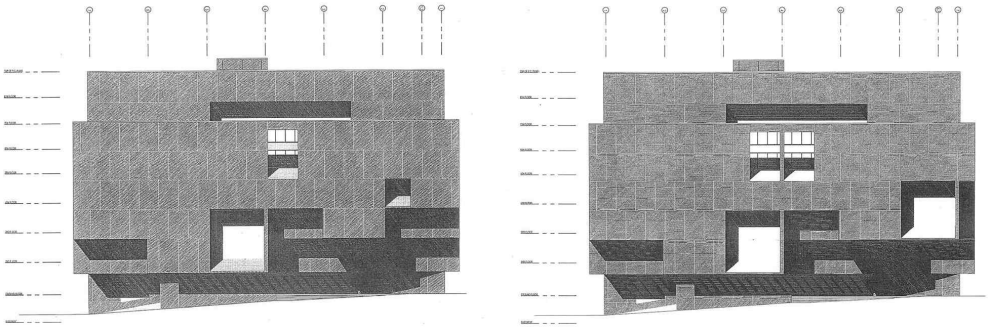

Figure 03: Orthographic Atlanta Public Library façade drawings used for the experiment: (left) design by Marcel Breuer, (right) design composition altered by research team

The first task, a memory exercise, was chosen to help us retrieve where the subject's attention was being paid while looking at the images, giving us clues to how the composition moves the eye. The inferential, attention driven, process also guides what is encoded in short term memory and what is remembered; we are selective not just about what we see in our visual environment, but also about what is entered into our long-term memory (Styles 2006, Hasher and Zacks 1979). This implies that if we recall something that was seen, we must have been attending to it when we saw it.

The façade was designed to exhibit a very specific visual organization, which relied on standard compositional moves [Figure 02]. The second task, an exercise in copying, is paired with the memory exercise to give us clues to how the eye selectively parses the composition according to its sets of elemental relationships. In order to copy the façade under a time pressure, the subject would have to organize what was in front of him and prioritize what to draw.

The two facades were studied by different subject groups—necessary to avoid memory of one façade influencing the other—internal validity established by 1) subjects all of comparable educational background and age groups, balanced by sex, and 2) two experiments that acted as mutual cross-controls.

The building was presented to subjects through the viewing of multiple images of the building façade successively and then simultaneously. Subjects were limited to viewing only the façade seen through viewing pictures and not in a real-life setting.

Coding

The experiment was designed such that the compositions of both facades could be analyzed into an integral number of discretized elements.

The coding listed not only basic elements, and some basic emergent elements, but also secondary elements like shadows and supporting graphic elements like the panel-grid that subjects sometimes used to locate the elements. It should be noted that there was no a-priori standard of correctness imposed upon the elements. For instance, a number of subjects tended to interpret some of the shadows as figural features of the façade, and we included such shadows in our list of elements characterizing the façade. As our results will show, such emergent but actually false elements could be important data indicative of the type of reading induced by the façades.

In the list of elements produced for analysis, most elements remained the same in the two compositions, and where the compositions differed, the differences could be mapped to corresponding elements. This meant that matched pair t-tests could be run to compare differences between the elements recorded for the original façades and those for the altered one. Figure 04 clarifies the hierarchy between elements and contour lines, bringing forth simple and emergent overlapping figures and relationships.

We classified and discretized elements into categories that contribute to two overall experiences: 1. Plastic Experience: surface, depth, ambiguous; 2. Dynamism – attentional focus (2D): central, peripheral, and distributed elements.

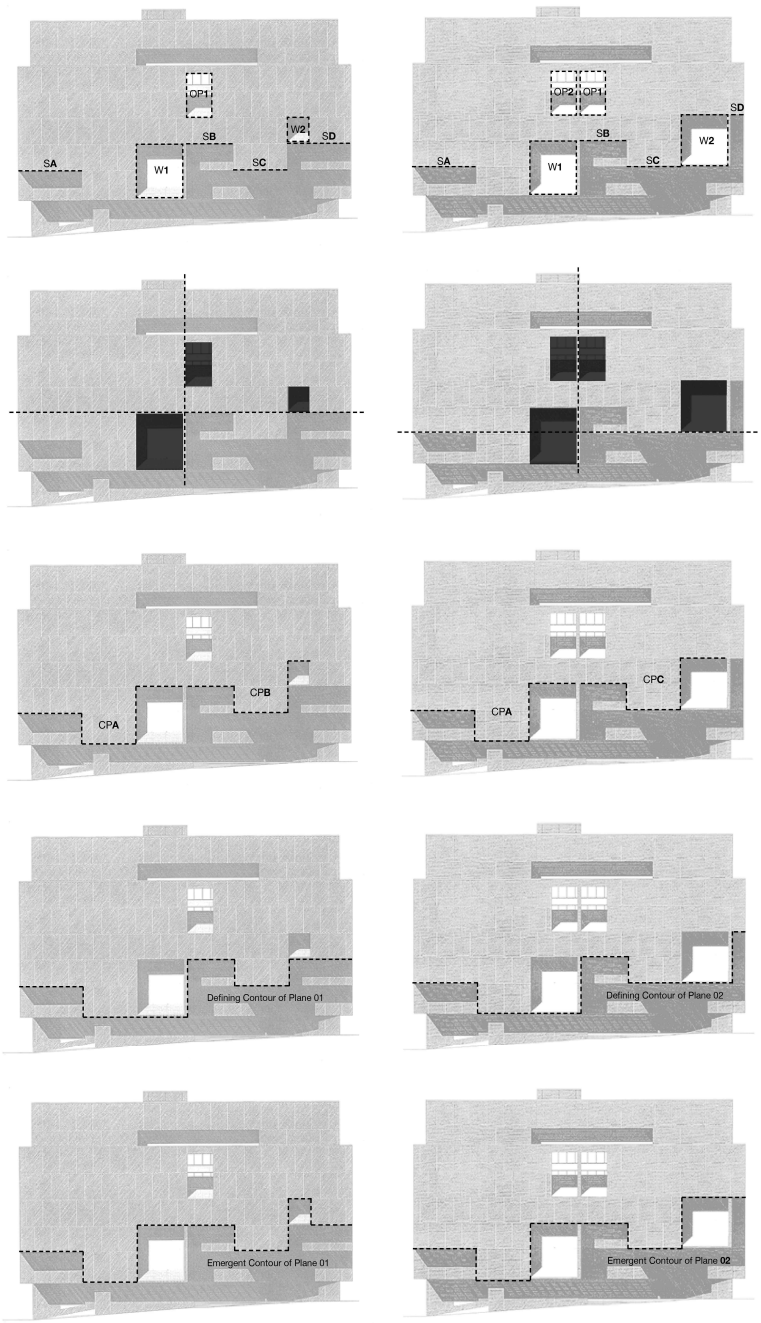

Figure 04: (left column) Original Design, (right column) Altered Design

In the original façade design by Marcel Breuer [left column of Figure 04], the façade is characterized by a composition of floating uninterrupted planes with undulating edges that wrap the library's rectangular form. These planes appear "punched out" by a lyrical balance of apertures. There is an underlying Line of Vertical Symmetry present that runs vertically along the façade's outer plane between window W1 and opening OP1. As the front face/plane of the façade is pulled upward like a skirt, more planes appear and step back, creating a "stepped" sequencing of planes creating the entry space to the library. Steps SA, SB, SC, and SD create gentle alignments with one another. Step SA aligns along an emergent horizontal line with step SC. Similarly, a second emergent horizontal line relates step SB and step SD. The two pairs create a rhythm as they undulate past one another creating new alignments with the three apertures: window W1, window W2, and opening OP1. The edge boundaries of window W1, step SB, window W2, and step SD create an emergent horizontal "middle".

Patterning emerges as contours form with bounding edge relationships nested against the two windows. The two primary contour profiles CPA and CPB are defined by the edges of the steps and the new edges that window W1 and window W2 create. The contour profile line is an emerging line made from segment lines at the façade's edge creating two contour profile lines and a repeating relationship. Relationship R1 is defined by contour profile CPA and window W1. The contour profile CPB and window W2 define relationship R2. As noted in Figure 05 D, the contour profile lines follow the lines of the steps and then snake around the left and top edge lines of the windows. All segment lines to the contour profile lines of contour profile CPA repeat identically with contour profile CPB except for the top edge line length of window W2. This underlying repetition of edge lines with a corresponding element creates a subtle complexity to visually understanding the organization of the façade.

The façade front plane contains two contour profile edges simultaneously. The first, Defining Contour of Plane 01, is the enveloping edge boundary. The Emergent Contour of Plane 01 is a secondary contour edge that is an emergent figure, lifting the Defining Contour of Plan 01 up around the edges of window W1 and window W2.

As noted earlier, the aim of altering the façade composition was to exaggerate figural relationships, clearly directing the subject's visual attention by playing with visual rules. In order to determine if basic discrete parsing of elements and edges affect the way we perceive, organize and retrieve the design, the Atlanta Public Library's entry facade was altered to increase repetition and emphasize symmetry. In the Altered Drawing relationship R2 is replaced with relationship R1. This alteration creates a new identical repetition of relationships between relationship R3 and relationship R4. In order to repeat this relationship, window W2 grew in size to mimic window W1 and the bottom edge was dropped to align with step SC. Step SD was brought up to align with the top edge of window W2. While increasing the repetition of elements, a strong sense of symmetry emerged. To increase the symmetry further, a second opening, OP2, was added straddling the Vertical Line of Symmetry.[2] The alternate design lessens plastic experience and decreases overall dynamism.

Results

The results confirmed our general hypotheses. A matched-pair t-test showed that subjects tended to recall elements of the altered drawing significantly better than they did corresponding elements of the original ($t(32)=3.669$, $p=0.0009$). The matched-pair t-test comparing the subjects' performance during the copying exercise showed the opposite result—subjects tested on the original façade reported marginally greater number of elements than those tested on the

[2] Mention how the alternate design lessens plastic experience and decreases overall dynamism; also describe how the discrete elements can be classed into categories (surface, depth, ambiguous) that contribute to plastic experience, and those that contribute to overall dynamism (central, peripheral, and distributed elements).

altered façade. However, the difference did not reach statistical significance (t(32)=-0.956, p=0.34), and we cannot discount that the result was not entirely a matter of chance [Table 01].

Overall Recalls: Memory Exercise

Recall_Alt	0.61212	t-Ratio	3.669395
Recall_Orig	0.47389	DF	32
Mean Difference	0.13823	Prob > |t|	0.0009*
Std Error	0.03767	Prob > t	0.0004*
Upper 95%	0.21496	Prob < t	0.9996
Lower 95%	0.0615		
N	33		
Correlation	0.66121		

Overall Reproductions: Copy Exercise

Reprod_Alt	0.56667	t-Ratio	-0.95591
Reprod_Orig	0.60191	DF	32
Mean Difference	-0.0352	Prob > |t|	0.3463
Std Error	0.03687	Prob > t	0.8269
Upper 95%	0.03986	Prob < t	0.1731
Lower 95%	-0.1103		
N	33		
Correlation	0.77558		

Table 01: (Left) Matched Pairs Comparison on Memory Exercise: Overall recalls in Original verses Altered Drawings, (Right) Matched Pairs Comparison on Copy Exercise: Overall reproductions in Original verses Altered Drawings

In other words, alterations made to the façade did allow subjects to remember it better than the original one, and this advantage was lost in the copying exercise.

Finer analysis of the data revealed more interesting findings regarding our subsidiary hypotheses. We had expected the altered composition to lose some of the original's plastic quality—in terms of our data, this would imply that the subjects given the original façade would report elements related to depth perception in greater numbers, and they would report elements on the periphery of the façade in greater numbers, indicating a more varied and multi-focal attentional span. This turned out to be partially validated by the results obtained in the copying exercise. Grouping the data by elements recording attentional focus, and running a matched pair analysis, we found that peripheral elements were recorded in greater numbers on the original drawings, and the central ones on the altered drawings, and the differences between them significant. Grouping elements by plastic characteristics, the differences in either the surface or the depth elements between the altered and original drawings were not significant, though the expected bias towards the depth elements in the original drawing did show up [Figure 05]. However, as the F-test of Mean means in Figure 05 shows, ambiguous elements were recorded in significantly greater numbers overall, in both drawings, as compared to the surface and depth elements. When we excluded these ambiguously plastic elements from the data, and ran the matched pair analysis on elements grouped only into surface and depth qualities, we found that the differences between the mean differences recorded for the depth and surface elements was significant [Table 02 and Figure 06].

Plastic Values:

Across Groups

PlasticValues	Count	Mean Difference	Mean Mean
Surface	9	0.0776	0.4056
Depth	6	-0.152	0.475
Ambiguous	18	-0.053	0.7097

Test Across Groups	F Ratio	Prob>F		
Mean Difference	2.4540	0.1030	Within Pairs	Y Axis
Mean Mean	4.3742	0.0215*	Among Pairs	X Axis

Attentional Focus:

Across Groups

AttentionalFocus	Count	Mean Difference	Mean Mean
Peripheral	12	-0.166	0.568
Central	11	0.0929	0.6444
Distributed	10	0.0047	0.3177

Test Across Groups	F Ratio	Prob>F		
Mean Difference	7.2901	0.0026*	Within Pairs	Y Axis
Mean Mean	15.8556	<.0001*	Among Pairs	X Axis

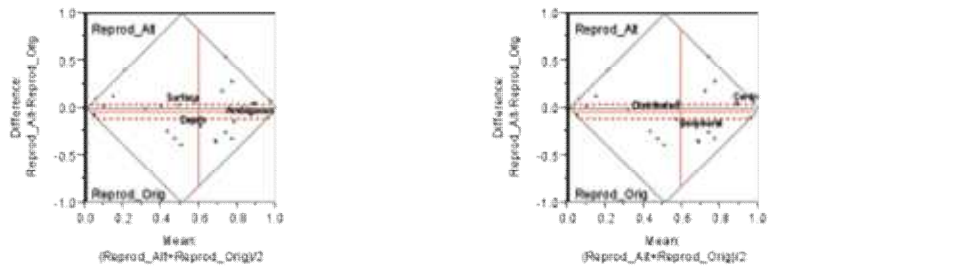

Figure 05: Matched Pairs Comparison on Copy Exercise: (Left) Reproductions in Original verses Altered Drawings grouped by Plastic Values, (Right) Reproductions in Original verses Altered Drawings grouped by Attentional Focus

Overall Reproductions with Ambiguous Excluded: Copy Exercise

Reprod_Alt	0.42667	t-Ratio	-0.29419
Reprod_Orig	0.44087	DF	14
Mean Difference	-0.0142	Prob > |t|	0.7729
Std Error	0.04829	Prob > t	0.6135
Upper 95%	0.08936	Prob < t	0.3865
Lower 95%	-0.1178		
N	15		
Correlation	0.86404		

Table 01: (Alt.) Matched Pairs Comparison on Copy Exercise: Reproductions in Original verses Altered Drawings grouped by Plastic Values Ambiguous Excluded

Plastic Values:

Across Groups

PlasticValues	Count	Mean Difference	Mean Mean
Surface	9	0.0778	0.4056
Depth	6	-0.152	0.476

Test Across Groups	F Ratio	Prob>F		
Mean Difference	8.2201	0.0132*	Within Pairs	Y Axis
Mean Mean	0.1502	0.7046	Among Pairs	X Axis

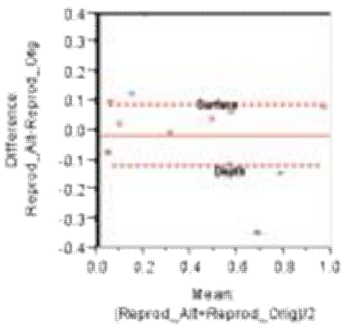

Figure 06: (Alt.) Matched Pairs Comparison on Copy Exercise: Reproductions in Original verses Altered Drawings grouped by Plastic Values Ambiguous Excluded

The drawing from memory exercise did not produce significant differences; the mean difference by groups showed that the mean differences between original and altered drawings was lower for the peripheral elements as compared to the surface ones [Figure 06] but the difference between the two groups was not significant. Grouping by plastic characteristics produced similar results: the direction of the results was according to our hypotheses, but the results failed to reach an acceptable level of significance [Figure 07].

Plastic Values:

Across Groups

PlasticValues	Count	Mean Difference	Mean Mean
Surface	9	0.1052	0.4469
Depth	6	0.0377	0.4812
Ambiguous	18	0.1878	0.6117

Test Across Groups	F Ratio	Prob>F		
Mean Difference	1.2362	0.3049	Within Pairs	Y Axis
Mean Mean	1.7950	0.1835	Among Pairs	X Axis

Attentional Focus:

Across Groups

AttentionalFocus	Count	Mean Difference	Mean Mean
Peripheral	12	0.1103	0.4782
Central	11	0.255	0.7088
Distributed	10	0.0433	0.4383

Test Across Groups	F Ratio	Prob>F		
Mean Difference	2.9973	0.0651	Within Pairs	Y Axis
Mean Mean	5.2405	0.0112*	Among Pairs	X Axis

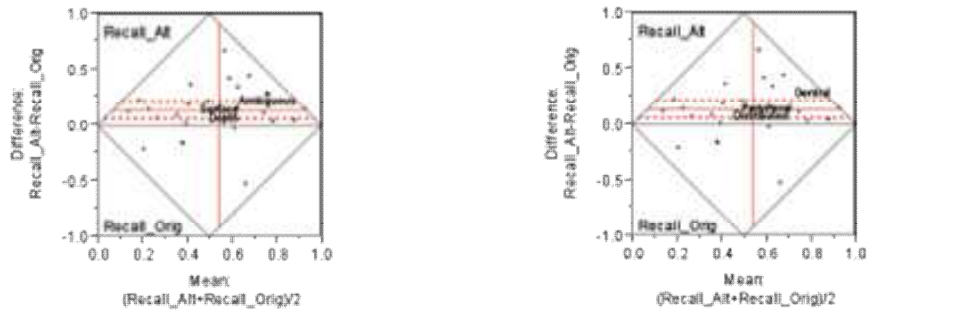

Figure 07: Matched Pairs Comparison on Memory Exercise: (Left) Recalls in Original verses Altered Drawings grouped by Plastic Values, (Right) Recalls in Original verses Altered Drawings grouped by Attentional Focus

Summing up, the altered drawing was easier to recall, but not to reproduce; when reproducing the altered drawings the subjects tended to reproduce elements related to surface composition and those which were centrally located in far greater numbers than the subjects who worked on the original drawings. When recalling the façades, similar differences, although observed, were not reliably large.

Discussion

In this experiment we confirmed our hypothesis: altering a composition can reorient attention to different aspects or parts of a design, and that doing so alters the reading and imaginative understanding of the composition. We found that the façade designed by Marcel Breuer has both a plastic quality and overall dynamism – a result of his design intentions. Changing the composition altered the way viewers parsed the design. In architectural design the architect is constantly entertaining alternate compositional relationships of building elements throughout the design phase at both a macro (building form) and micro (building details) level.

Prior to this experiment we assumed such parsing was primarily a bottom-up cognitive process dependent upon the shape of the seen object. The results lead us to believe that there is an active top-down component happening as well. We observed that subjects constructed schemas as a procedure for organizing the visual data needed to complete the drawing task. We use the word “schema” to describe this framework that has been constructed by the participant in order to cognitively organize the visual data into a new representation for completing the task. Schema, as defined by cognitive psychologist George Mandler, is a “bounded, distinct, and unitary representation” and a method of “organizing experience” (D’Andrade 1995: 122). The level of schema development is dependent upon the level of attention paid to the details of the building and the ability to recognize surfaces and relationships between edges and figures. Two types of schemas were identified.

In the first schema, the Organizational Schema, the organization of elements and relationships between contours and elements are parsed into groups. First subjects recognized the white rectangle as a surface, second, they carved away the contours of the surface in simple rectangular geometries, and lastly they placed architectural elements in the form of simple

rectilinear objects in the surface. The second step of the organizational schema describes the way in which participants created the contours of the surface. Contours were created either by carving away the edges of the surface through re-describing them as simple squares or multiple rectilinear geometries that created a more complex contour profile. The advanced organizational schemas show more attention paid to the shape complexity of the contour profile. The carved corners of the less advanced schema are rectangular chunked figures in all cases. Elements are drawn as simple figures and are placed with no relationship to the edges of the contour line. In the advanced instantiations of the organizational schema participants synthesize the anchoring relationships between elements and contour lines. Here the contour edge of the surface is sculpted away, showing attention paid to the contour line as the undulating boundary edge of the surface, in effect creating the Defining Contour Profile. Elements are placed along this contour line, highlighting the relationship between the contour and the element. The contour profile edges and Vertical Line of symmetry are used as anchors to locate the elements.

In the second schema, the Surface Schema, patterns and underlying marks are drawn as a way to divide the surface – an approach to the parsing of the surface into zones. Students use construction lines in creating surfaces, parsing zones, and aligning elements. Several light primary markings are seen underneath heavier strokes, indicating that the participants use the elevation and column line markers to emulate the texture of the surface, align contour lines, and place elements along the surface edges and the line of symmetry.

The schemas employed in this experiment demonstrate a top-down processing influenced by the compositional organization of the architectural design. By correlating schema type to architectural compositional design rules, we can begin to establish certain general principles by which the role of the imaginative function shapes understanding of building design. We intend to further explore developing systematic procedures for describing architectural design.

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