Physical and affective correlates to perceived order in open-plan architectural space

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While experiential qualities of rectangular architectural spaces can be effectively predicted from properties like room proportions or area (Franz, von der Heyde, & Bülthoff, 2003), these factors from normative architectural knowledge obviously cannot be directly transfered on open-plan indoor spaces. Phenomenologically as well as in empirical aesthetics, nontrivial forms are often compared by collative variables (e.g., complexity, regularity, cf. Berlyne, 1960, 1972) that are introspective assessment criteria of structural properties of a stimulus array (Wohlwill, 1976) and have proven to allow predictions mainly on the arousal dimension of affective experience (Stamps, 2000). In the following, we introduce a novel approach that relates affective and collative qualities of arbitrarily shaped architectural spaces to directly measurable parameters. The concept of isovists (i. e. viewshed polygons, cf. Benedict, 1979) is used to generically describe spatial properties of architectural spaces from a perceptually-oriented viewer-centered perspective.

In a psychological experiment, we compared numerical factors describing isovists and their derivatives (Turner, Doxa, O'Sullivan, & Penn, 2001; Psarra & Grajewski, 2001) of virtual reality (VR) simulated rooms with their experiential qualities, quantified with a semantic differential scaling in six principal categories (pleasure, interestingness, beauty, spaciousness, complexity, and clarity). Since VR offers a high degree of perceptual realism, control, and flexibility, properties of spaces can be individually varied, allowing to ascribe observed variances in the measured experience to particular differences between the stimuli. The study consisted of two stages comprising 18 and 16 scenes from a fictive art gallery and was conducted with 2 groups of eight participants. The stimuli were presented as radiosity-rendered spherical panorama images on a 130x90 degree wide-angle projection system.

The original analysis (Franz, von der Heyde, & Bülthoff, 2004), correlating averaged ratings with 28 characteristic values derived from the isovists, was focused on automatically detectable measurands mainly related to complexity. Isovist area, density of wall edges, and enclosure ratio turned out to be the most effective predictor variables. Extending the initial scope, an additional exploratory correlation analysis of the second scene set concentrated on manually evaluated aspects commonly related to order, as symmetry or self-similarity. Particularly the number of symmetries turned out to be a relevant factor explaining additional variance in the ratings (e.g., correlation coefficient with rated pleasure r=-0.75, $p<0.001$). Beside symmetry, from the tested factors

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also the relative number of unique polygon sections was significantly correlated to rating results (e.g., pleasure r=0.66, p=0.01, clarity r=0.63, p=0.01).

For an empirical validation of the initially subjectively induced factors characterizing visual order, eight additional participants sorted printed cards showing the 16 isovist polygon contours from the second scene set by the criterion of regularity. Afterwards, they were asked to mark a potential aesthetic tendency within their sequence. The subsequent analysis showed a wide consistency within the rankings. Again, the same two main factors became apparent: The average ranking could be almost perfectly (r=0.94, p<0.001) described by the simple formula

$$polygon\ regularity = -\frac{n_{unique\ polygon\ sections}}{n_{symmetry\ axes} + 1}. \quad (1)$$

Surprisingly, the marked aesthetic tendency was opposite to the beauty ratings of the corresponding virtual reality scenes: Consistently regular polygons were estimated to be tendentially more pleasing, whereas the polygon regularity ranking was negatively correlated with rated room beauty (r=-0.49, p=0.05). This at first glance puzzling finding may be explained by the obvious differences in experiential intensity between seeing a small outline and being placed in the focus of a highly centralized visual architectural space. So the result might indicate a considerable dependency of experiential qualities from the observers' standpoint. A currently planned study will allow for free observer movements in the virtual scenes and may help to answer this question.

The presented studies strongly suggest that perceived visual order can be related to plausible measurable properties that are important factors for the experience of architectural spaces. Both, visual order and experiential qualities proved to be normal intersubjective psychological phenomena open for quantitative research. While due to the small number of scenes the measured numerical values certainly do not claim quantitative validity, the observed main effects likely indicate generally relevant factors. We assume the empirical investigation of relations between physical and perceptual properties of architecture to be a feasible way towards a better consideration of experiential qualities during the architectural design process.

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