REFLECTION

As human beings we are always (sub)consciously perceiving and interacting with our environment. As designers therefore, we try to design healthy environments that not only look good aesthetically, but also function in a technical and sustainable way. Consequently we discuss social behavior and centralize the "human scale" in our designs, but we somehow tend to neglect the important fact in *how* we actually perceive our environment in cognitive and psychological terms. By making this perceptive process, what we see, hear, smell, feel and more importantly, what our mind makes of it, more tangible, we can achieve a better understanding how the built environment affects the body and mind.

From biased methods to objective perceptions

The current existing methods to study liveable environments however are based on two biased methods (van Dorst, 2005). The first is measuring perceived liveability. The problem with this method is the cognitive bias of every individual and the sub-conscience influence of the physical environment on well-being. A simple example; users of a shopping street are not always aware of the trees present, yet benefit by the stress reducing effect of green (Kaplan & Kaplan, 1989). The second method is called presumed liveability; here we presume all kind of influences on the well-being of people by qualities of the environment, although we can not measure any cause-effect relations. Cleaner streets were presumed to be more liveable; the correlation is *there*, and yet no cause-effect relation is proven (van Dijk & Oppenhuis, 1998). New technology can help us here to measure perceptions more objectively in relation to physical well-being. By relating this data to the built and natural environment we can evolve from a biased way of measuring liveability to a more inter-subjective way of measuring. On societal level, this dichotomy can lead to a negative spiral of a neighbourhood its image, which in turn can lead to segregation, promoting a biased perceived liveability.

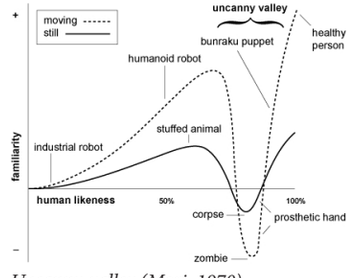
Using eye-tracking and EEG sensors therefore seemed a valid combination to initiate objective research on design, and how we perceive our environments. However, even though recent studies within the field of urbanism or environmental psychology exist, the analysis methods were not clear. Therefore, the initial phase of this research contained a series of methodological experiments and test-runs to get familiar with the acquired gear, to establish an adequate workflow, and most importantly, to know what the possibilities and limits are, and how to interpret collected data. Similar research (using EEG) had already showed results (Mavros et al, 2016), but were more about general findings rather than specific spatial or design elements. Nevertheless it motivated to try new approaches combined with qualitative research methods.

Existing research, replicability & generalizability

A substantial drawback in the research is that (commercially) available EEG devices are used to collect data. EEG research is usually done in labs, using clinical tools, with a team of expert lab technicians and data-analysts. Even though, there were studies available that showed correlation with insights, and showed positive results in the field of brain-computer interface, initially the data was interpreted with a pinch of salt. After adjusting the initial data collection and analysis methods, results were more trustworthy, indicating interesting patterns of tracked gaze positions and EEG frequencies.

Commercial-grade equipment

A second limit of this research is that, after adjusting to a workable method, data consisted of the visual perception of 2D videos rather than the perception of real environments, or in Gibson's terms, the visual world. Even if we would do the same experiments in a VR-setting, the "uncanny valley" effect (Mori, 1970) variant of environments could evoke very different outcomes. In order to have meaningful results, the VR setting needs to be hyper-realistic to capture the more detailed information complexity (such as texture).



Uncanny-valley (Mori, 1970)

As is mentioned before, the low n, and two urban environments account the research to be non-generalizable to different user-groups or urban environments. In this extent further research needs to be done with different target groups, and different urban environments.

The outcomes are generally in line with the body of knowledge and theory on visual perception. However, the interesting potential in this research method is that it can provide substantial proof for more nuanced differences of objects and complex PQA's in relation to their spatial-, or visual context; objects and shapes and what we make of them e.g. slim trees as a shape that raises alertness vs. large trees with big green crowns that provide calming reactions; or the perception of gestalt principles in the visual world, however in order to achieve better validity, extended research is needed, replacing the commercial grade equipment with clinical or medical gear and research methods.

Analytical or evaluative guideline, rather than linear tool

The research focuses solely on visual perception, meaning that the spatial-perceptual complexity tension field is primarily based on visual perception. In urban design however the design goals or objectives are far more "wicked", comprising multiple other (physical, social, or economic) factors and layers, and require complex lateral design thinking. In this sense, the complexity tension field cannot be used as a linear design tool to achieve good design, but should rather be referred to as an analytical (from the start) or evaluative (in the process) guideline in *addition* to keep the design in balance and avoid visual deprivation or visual nuisance.

While the outcome allows urban designers to distance from a conventional technical, social, or picturesque approach, and see the environment differently in terms of affordances, sensory information complexity, and optical flow, the aesthetic quality of good design, or, beauty, still remains subjective and a responsibility of designers to incorporate it as a function in design.

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