Perceiving Livelihood through Objective Technology

Müjdat Deniz
Şükür
AR4U100
MSc graduation project
introduction

Why this research?
Generic design characteristics are ill-defined and unstructured or untamed and hard to evaluate in advance.
Based on Ching (1979), and von Meiss (1992)
but.., there is a common language
and a mental image
Evaluation relates to people’s **perception**

“the human scale”
But the problem is...
it is complex
it is biased

presumed livability
(e.g. leefbarometer)
perceived livability
(e.g. questionnaire)
is it possible with objective technology..?
Better understand how we visually perceive urban environments (evidence based, rather than presumed expert/picturesque approach)

Explore cross-disciplinary methods (EEG & eye-tracking) in environmental psychology & urban design

Centralize human perception, and make it more explicit in urban design

Develop a visual-perceptual urban design guideline that helps designing harmonious urban environments

Illustrate how these guidelines can be expressed in urban design
outline

PART I

Research question & definitions
Theoretical framework

PART II

Exploring methods
Analysis & results

PART III

Express results in design: example cases
Conclusions
research question

Which spatial elements are essential in influencing our visual perception of urban environments, and how can we explicate and express these elements in urban design?

Let’s define the question...
theoretical framework
spatial elements
SEE’s

OBJECT

SCREEN

SURFACE

Thiel (1997)
space - in space
**Perception** (derived from Latin words perceptio or percipio) is the *organisation, identification, and interpretation* of *sensory information* in order to *represent* and *understand* the environment (Schacter et al., 2011)

---

**Perceptual cycle**

**Common research**

<table>
<thead>
<tr>
<th>Relationship</th>
<th>How studied?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Stimulus → Perception</td>
<td>Psychophisically. Present a stimulus and determine the person's response.</td>
</tr>
<tr>
<td>B. Stimulus → Physiology</td>
<td>Physiologically. Present a stimulus and measure the electrical response in the nervous system; also look for connections between anatomy and perception.</td>
</tr>
<tr>
<td>C. Physiology → Perception</td>
<td>Physiologically and psychophysically. Measure physiological and perceptual responses to the same stimuli.</td>
</tr>
</tbody>
</table>
perceptual cycle

Goldstein (2002), edited
Keplerian layout - ecological approach
sensory stimulation
sensory information

perception cannot occur with sole stimulation
gradation of sensory information

Mitnick; in von Meiss (1992)
optic flow

in theory

in robotics/ computer/ AI vision

affordances

surfaces that “afford” information in relation to behaviour; it is up to us how we perceive it
Arousal affects performance, which is best at an optimum level. This is often referred to as the Yerkes-Dodson Law, proposed by Yerkes & Dodson in 1908. Lower levels of arousal can lead to boredom, while higher levels can cause stress or panic. The ideal state is where interest is at its peak, and anxiety is minimal.
methodology

How to approach this?
hypothetical variables
derived from arch. urb. design - env. psychology - & perception theory
variables & relations in the basic env. psychology model

- **SETTING**
  - **arch.ens**
    - time/era
    - arch. style
    - location
  - **phys.space**
    - see’s
    - pqa’s
    - mh’s
  - **dsgn.prncpl**
    - axis
    - hierarchy
    - contrast
    - rhythm
    - datum
    - complexity
    - transformation
  - **ptrn.languag**
    - 14-15
    - 28-40
    - 48,60,61
    - 49-57
    - 96-128

- **socio.phys**
  - function
  - use
  - territorial zoning
  - income
  - age
  - ethnicity
  - household size
  - safety
  - etc. (leafbarometer)

- **socio.spat**

- **micr.climate**
  - temperature
  - (sun)light
  - wind
  - precipitation
  - motor vehicles
  - cyclists
  - pedestrians

- **trfc.flow**

- **psmd.livbty**

- **pcvd.livbty**

- **PERSON**
  - **expertise**
    - urban/ arch.
    - landsc. designer
    - non- designer
  - **age**
    - children (5-7, 10-12)
    - adults (22-45)
    - seniors (65+)
  - **env.knwlg**
    - resident/ non-resident
    - familiar/ unfamiliar
    - biased/ non- biased

- **visl.afdnc**
  - sensory
  - information
  - interaction

- **att.stimuli**

- **arousal**
  - tracked focus-points
  - measured
  - brainwaves
  - $\alpha$, $\beta$, $\gamma$

- **appraisal**
  - remembered emotions
  - unconscious/ conscious
  - perception
  - instantaneous excitement
  - long-term excitement
  - stress
  - relaxation
  - interest/ affinity
  - focus

- **emotion**

Gifford (2002), edited
so... how to measure perception?
basic anatomy of the human Brain
Dorsal or “where” stream

Spatial processing

location
movement
spatial
transformations
spatial
relations

Ventral or “what” stream

Object processing

color
texture
pictorial detail
shape
size
equipment

Pupil-Labs® mobile eye-tracker

Emotiv Insight® 5 Channel Wireless EEG Headset

Pupil-Labs Capture software interface

Emotiv Pure EEG software interface
understanding electroencephalography
brain waves
α β γ θ δ

**Gamma:** higher processing tasks & cognitive functioning

**Beta:** normal waking consciousness & heightened state of alertness

**Alpha:** quietly flowing thoughts, daydream or light meditation

**Theta:** in a dream, vivid imagery, intuition and information beyond normal consciousness

**Delta:** deep dreamless sleep & in deep transcendental meditation

**understanding electroencephalography**
Which **spatial elements** are essential in influencing our visual **perception** of **urban environments**, and how can we explicate and express these elements in **urban design**?

*Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?*

*What specific attributes do they have in common?*

*How can we express these attributes in urban design?*
spatial analysis

First of all, let’s define the urban environment
two cases
with a different pattern language

#95 Building complex
A building represents a manifestation of a social group or social institution and therefore should be, like the group or institution itself, devised into visible smaller entities to make it more interactive with humans. The image shows buildings and their rate of identifiable parts.

#108 Connected buildings
Isolated buildings are symptoms of a disconnected society. Referring to psychosocial disintegration at the emotional level, a town with disconnected buildings would depict a society made up with disconnected and isolated selves.
#114 Hierarchy of open spaces
People always try to find a spot with their backs protected and with a view to a larger opening, beyond the immediate space in front of them. It is therefore essential to create smaller spaces that form a natural back, with openings and views towards at least one larger space.

#120 Paths and goals
The process of walking is crucial for the layout of paths. As we walk, we scan the landscape for intermediate destinations and try to walk in a straight line towards these. We arrange our walking paths in a way that we pick a temporary goal — a clearly visible landmark — which is more or less in the same direction. As we get closer, we pick another goal so in the meantime we can think or daydream, without thinking about our walking direction every minute. If there aren’t enough intermediate goals, the process of walking consumes unnecessary emotional energy.
Building set-backs from the late 20th century were aimed at creating more light and air, while they also destroyed the street as a social space. It is essential to create building fronts with the mindset that they also create streets and spaces in front of them. On no account should there be set-backs. Buildings should face the street directly, preferably with a slightly uneven angles emphasize the shape of the street.
and different SEE’s - PQA’s

SEE’s
X-typed vague or suggests

SEE’s
O-typed and volumetric

PQA’s
Scattered & not “human interfered”
Large spaces result in unclarity if object or PQA

PQA’s
Complex & “human interfered”, but more coherent in composition
scenes

Westerkwartier

- spatially more coherent, with very complex and personalized objects
- humanly interfered PQA's along the façades
- vistas with a clear vanishing point are present
- elements such as window frames, doors or rain pipes create rhythmic patterns, while corners of buildings, slim trees, blind façades, overhangs or dormers create certain datum
Poptahof

- generally defined by X-shaped spaces with vagues
- impossible to create internal representations of space within these kinds of scenes (Prak, 1969)
- spaces lack foreclosure and create dispersed and messy visual arrays
- the sequence with a clear view of the park creates a *serial view*, which emphasizes the SEE surface on the UNDER-side, ultimately creating a more coherent picture
data analysis
equipment

Pupil-Labs® mobile eye-tracker

Emotiv Insight® 5 Channel Wireless EEG Headset

Pupil-Labs Capture software interface

Emotiv Pure EEG software interface
Method 1: Field runs

- Direct sunlight & overexposure
- Rain and wind
- Head motion and FOV influence
- Hardware specifications
- Retinal image stabilization
- Locomotion, scanning, and motor function

Method 2: Video tracking

- Scanning surfaces and objects
- Vestibulo-ocular reflex
- Frame-freeze
- EEG dynamics
- Comparing validity
- Fake encounters

Method 3: Randomized scenes with chin rest

- Pre-attended cognition
- Validation by comparison
- Shaky video stabilization
- More comfortable
data analysis methods & tools

Eye-tracking video of Westerkwartier

EMOTIV ‘Xavier pure EEG’ interface

EEG Lab’s scroll function

\[ F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-i\omega t} dt \]

\[ f(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(\omega)e^{i\omega t} d\omega \]

Fourier transform

Event-related Spectral Perturbation (ERSP). (Makeig, 1993)

ERSP analysis in EEG Lab (author)
results
q 1:

Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?
**Gaze Behaviour**

**Enclosed Spaces**
(suggests & o-type volumes)
- Building edges / v-points / path / rooflines / left-right
- Grouped detailed surfaces / objects adjacent / objects behind each other / chamfered corners / diversiform shapes

**Open Spaces**
(x/o-type vagues)
- Distant building shapes / paths / large tree-crowns / scattered (vert. objects)
- Grouped objects / objects-surfaces behind each other / moving objects

**Gaze**
- People / distant objects / signs
eeg frequency - SEE

SPACE ESTABLISHING ELEMENTS (SEE's)

SCENE TRANSITION

ENTRANCES, VISUAL PORTALS

NEW SHAPE CONTOURS

CHANGING PRIMARY SPACES

HEIGHT & SLOPE

CORNERS

FIGURE-GROUND COMPOSITION

SYMMETRIC SIGHTLINES

VANTAGE POINTS

LANDMARKS & HIGH POINTS

ASYMMETRIC SHAPES

SCREENS & BACKGROUNDS

alertness

α β γ
eeg frequency - PQA

OBJECT (RE)COGNITION

OBJECTS AS OBSTACLES

UNUSUAL OBJECTS & ART

SOCIAL TRACES

TERRITORIAL OBJECTS & ZONES

OBJECTS AS OBSTACLES

UNUSUAL OBJECTS & ART

SURFACE INFORMATION / OBSERVATION

PATHS & ZONES

NATURAL SURFACES

ODD & UNUSUAL SURFACES

TEXTURE & COLOR

DYNAMIC FAÇADE UNITS

TRANSPARENT & REFLECTIVE SURFACES

SIGNS, NUMBERS & TEXT

alertness

α

β

γ
eeg frequency - occasions

HUMAN ENCOUNTER SITUATION

CHILDREN, ANIMALS & PETS

PRECAUTIONARY

FACE-TO-FACE

GROUPS

SURPRISE

TRAFFIC ENCOUNTER SITUATION

CROSSING

MOVING CYCLISTS

MOVING CARS

alertness

α  β  γ
q 2:

What specific attributes do these elements have in common?
complexity of sensory information:

information potency vs. information redundancy
visual deprivation vs. cognitive overload

Under-stimulation raises orienting response... What is it?
Over-stimulation causes information redundancy. You try to avoid collision.
From low information to complex. What is it?

Complex information rather than volumes
Architectural complexity: Volume and details

Complexity in visual sensory information on the level of a single building.

The complexity scale is rather relative to the building size and our distance from the building:

the larger the building, the more effort is needed to create complexity, and, the greater our distance from the building, the less information in detail can be perceived.

E.g. at a greater distance texture can become redundant, while articulation can replace its complexity-increasing function.

Too little = easy & quick perceived
Too much = overwhelmed (sexy, postcard architecture)
**Plasticity:** The extent of three-dimensional deviation of a prismatic building form.

**Articulation:** Three-dimensional division of the total building appearance into recognizable parts that retain a certain relation with each other.

**Height difference:** Difference in building height that is expressed through the roofline.
**Difference in direction:** Difference in the horizontal plane of the building (except for corner joints).

**Special elements:** Added elements that are not living quarters (staircases, entrances, portals, etc.).

**Oblique lines:** Oblique lines that visibly differ from the orthogonal (both horizontal and vertical) axes of the building.
Arch_details

*Texture*: Variety of applied materials in the façade, ordered by surface structure.

*Colour (and brightness)*: Variety of applied materials in the façade, ordered by colour and brightness.

*Plasticity*: The extent of deviation from the basic flat surface, both horizontal and vertical.
Articulation: Surface division of the façade into recognizable parts that retain a certain relation with each other.
Complexity in urban design: Spaciousness, buildings, and details.

Relation with the surrounding urban context, multiple buildings, or building blocks is even more relevant in psycho-perceptual design.

It relates to complexity of perceived *scenes* of our field of views.

It can make or break the complexity composition:

- Too little = visually poor
- Too much = visual overload
**Urb_spaciousness**

*Variety in sequential spaces:* Extent in which different urban spaces alternately occur on a route.

*Variety in urban spaces:* Extent in which different urban spaces simultaneously occur in the area.

*Special spaces:* Spaces that differ in both form and function from the usual residential spaces in the area.
Urb_buildings

*Variety in appearance:* Variety and distinctiveness in the occurrence of building appearances in the area.

*Corners:* The extent of corner connectedness of buildings, and their appearances.

*Variety in type:* Extent in which different building types occur.
Transition building- surrounding: The way the building is situated in- and transitions to its surroundings.

Special buildings: Occurrence of special buildings such as shops, libraries, schools, churches, etc.
Our visual system is set to track and detect changes in the visual field.

Apparent pattern of motion, which is referred to as the optical flow.

Change of this flow, rhythm & datum, is essential, but often neglected.
Enclosure: Extent to which the scene deviates from an enclosed (convex) overview.

Expectation and surprise: Variety in which the composition of architectural- and/or urban design elements (the scene) provides occlusion and revelation.

Vanishing point: Extent to which the scene deviates from a clear vanishing point, where lines seem to converge.
**Object placement:** The variety in type and rhythm of object placement in relation to the background.

**Direction of flow:** Extent to which longitudinal flow deviates with the occurrence of lateral (or radial flows) architectural- and/or urban design elements (the scene) provides occlusion and revelation.

**Flow interruption:** Variety in rapid changes of continuous flow
Affordances

*Affordances:* Variety and clarity in surface or object interaction
spatial-perceptual complexity layers

To summarize:
spatial-perceptual tension field

Arch_volume
- Arch_details
  - var. in appearance
  - var. in type
  - transition surrounding
- special buildings
- special spaces
- var. sequential spaces
- var. urban spaces
- planting
- pavement
- affordances
- Urb_details
- Urb_spaciousness
- Urb_buildings

Spc_motion
- vanishing point
- expectation & surprise
- enclosure

Fig_ground_motion
- plasticity
- obj. placement
- direction of flow
- flow interruption
- height diff.
- diff. direction
- special elmts.
- oblique lines
- colour & brightness
- texture
- plasticity
- articulation

Urb_spaciousness
- Urb_details
- Urb_buildings
subquestion 3:

How can we express the findings in design?
Example case: Mastbos Amsterdam Noord
tension field balance

- low in every attribute
- moderate in planting
- moderate - low in texture
concept
From steady optic flow to datum & disruptive flow
minimum intervention
medium intervention

- urb.space
- mesh objects
- bldg. articulation
- opt.flow direction
- pavement/planting
- pavement

Legend:
- fig_gr motion
- spc_motion
- urb_details
- urb_spaciousness
- urb_buildings
- arch_complexity
- arch_details
rigid intervention
Example case: De Kamp
tension field balance

- oblique lines
- complex vanishing points
- high disruptive direction of flow
- low var. in urb. spaces
concept
From visual messy
to coherent flow
minimum intervention

- planting
- enclosure
- expect. & surprise
- pavement

Legend:
- fig_gr: motion
- spc: motion
- urb: details
- urb: spaciousness
- urb: buildings
- arch: complexity
- arch: details
medium intervention
rigid intervention

var. seq. spaces

affordances
conclusions
Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?

- **SEE’s - low alertness** involve quick-scanning coherent (enclosed o-type, vanishing points, occlusions, and contours.
- **SEE’s - high alertness** involve irregulation and change
- **PQA’s - low alertness** involve paths and natural surfaces
- **PQA’s - high alertness** involve more complex agents

What specific attributes do they have in common?

- **Dynamic spatial events** in relation to SEE’s, PQA’s, and occasions, rather than static spatial elements
- **Complexity of information potency** (architectural and urban complexity)
- **Complexity of relative motion** (Optical flow)

How can we express it in urban design?

- Use guidelines to determine which scenes score low/high in the coherence - complexity tension field
- Depending on the context & strived goal, increase or decrease information potency of within the tension field
Which spatial elements are essential in influencing our visual perception of urban environments, and how can we explicate and express these elements in urban design?
• Commercial grade equipment vs. medical equipment and methods
• Eventually used data is based on videos, not the visual world
• Generalizability (low n, applicability to other urban environments)
• Focus is on influencing visual perception. Actual design requires design thinking in combination with other urban design layers, e.g. the, urban context, social context, ecology, etc.
potential

- Different approach to urban design (see the environment as affordances & sensory information)
- Can be used as design input and evaluation method
- This approach sees the environment as sets of complexity sensory information and the balance between the tension field, however beauty remains subjective:

“Mooi is anders”
Thank you