Light, architecture, and our experience of space: human responses to façade and daylight composition

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Can the *composition of daylight* change how we *experience* a space?


Source: Archdaily.com

Source: milicabalubdzic.com
Façade patterns in contemporary architecture

Can the façade geometry and the resulting daylight patterns impact human responses?

Influence of the expected space function
[Butler and Biner, 1987, 1989; Boyce 2003; Wang and Boubekri 2010]

Influence of regional differences
Subjective experiments with different conditions of façade and daylight patterns.

VARIATION OF DAYLIGHT

VARIATION OF VIEW

Immersive virtual reality as an experimental tool.

Source: iva.velux.com
Is virtual reality an adequate surrogate for experiments in real spaces?
VR scenes using physically-based renderings: suitable to investigate perception of daylit scenes

High perceptual accuracy, minimal physical symptoms (sore eyes), high perceived presence

Can façade and daylight pattern geometry impact our subjective and physiological responses?
<table>
<thead>
<tr>
<th>Experimental factors</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Façade geometry*</td>
<td>3 (Irregular, Regular, Stripes)</td>
</tr>
<tr>
<td>Spatial context scenario</td>
<td>2 (socializing, working)</td>
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<tr>
<td>*Within-subject factor</td>
<td></td>
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<table>
<thead>
<tr>
<th>Participants</th>
<th>Gender distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>71*</td>
<td>36 men, 35 women</td>
</tr>
<tr>
<td>*58 for physiological responses</td>
<td>(30 men, 28 women)</td>
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What is the participants’ heart rate and skin conductance while immersed in the different scenes in VR?

Measured with an Empatica E4 bracelet, first 28 seconds of exposure

How pleasant interesting exciting is this space?

Rating scale: 1 (Not at all) – 10 (Very)
**Effect of façade geometry** on impressions of pleasantness, interest, excitement

- **Irregular geometry** perceived more positively independently of context scenario
- Façade and daylight variations affected both the appraisal of space and the participants' heart rate

Do subjective responses to façade and daylight patterns change across latitudes?
Do subjective responses to façade and daylight patterns change across latitudes?
Experimental design

Experimental factors

<table>
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<tr>
<th>Façade geometry*</th>
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<tbody>
<tr>
<td>Sky type</td>
</tr>
<tr>
<td>Spatial context</td>
</tr>
<tr>
<td>Country</td>
</tr>
</tbody>
</table>

*Within-subject factor

Participants

- 120 in Switzerland
- 138 in Greece
Experimental factors

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Spatial context
Country

*Within-subject factor

Participants
120 in Switzerland
138 in Greece

Experimental design

clear sky with high sun angle
clear sky with low sun angle
overcast sky
Experimental design

Experimental factors
- Façade geometry*
- Sky type

Spatial context
- Country
  - *Within-subject factor

Participants
- 120 in Switzerland
- 138 in Greece

working context
social context
Experimental design

Experimental factors
- Façade geometry*
- Sky type
- Spatial context
- **Country**
  *Within-subject factor

Participants
- 120 in Switzerland
- 138 in Greece
Each participant is shown all six façade variations.
How is this space?

- pleasant
- interesting
- exciting
- calming

How is this space?

- complex
- spacious
- bright

How satisfied are you with the amount of view in this space?

Rating scale: 0 (Not at all) – 10 (Very)
Results

Significant effects of façade geometry for all studied attributes
Results

- No effect of sky type
- No effect of spatial context
- No regional differences
How **pleasant** is this space?
How **calming** is this space?
How *interesting* is this space?
How *exciting* is this space?
How **spacious** is this space?

How **bright** is this space?

How **satisfied** are you with the **amount of view** in this space?
Percentage of positive (>5) responses

Straight versus slightly skewed vertical elements

How **pleasant** is this space?

How **interesting** is this space?

How **exciting** is this space?

How **calming** is this space?
Façade geometry is shown to be the main driver of spatial experience, inducing robust perceptual effects that do not differ between different sky types, spaces, window sizes, or latitudes.
Key outcomes

► Development and validation of a novel experimental method that combines photometrically accurate images with immersive virtual reality

► Demonstrated for the first time that façade elements and their interplay with light can have a quantifiable physiological effect on humans

► Even seemingly small changes in the façade geometry can have a strong effect on perception
Future research directions

» Replication of experiments in real space

» Can the light pattern alone influence human responses?

» Static and kinetic façades, applications in dynamic lighting

Source: vimeo.com
Source: officesnapshots.com
Source: commons.wikimedia.com (edited)

Dappled Light, Jody Verser, 2015
Qiyou Interactive Entertainment Company Offices, Joe Ho Associates, Guangzhou, China, 2017
Thank you!