"Discomfort glare from daylighting: study of factors influencing discomfort glare perception and validation of a universal discomfort glare index"

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ABSTRACT

Nowadays, no current index can properly explain the high variability existing between individuals' discomfort glare perception. The mechanism behind the discomfort glare phenomenon is not well understood as some of the factors influencing this phenomenon are still unknown. A large literature review has shown that in addition to the physical quantities currently used in discomfort glare indices, other variables such as contextual, physiological, or even psychological factors, could influence the degree of perceived discomfort glare. The aim of this research project is therefore to determine which factors, whether physiological, psychological, contextual or physical, have a real and significant influence on discomfort glare perception in daylighting. Subsequently, these factors can be compiled in a new discomfort glare model or included in the Daylight Glare Probability, which is the most accurate index at present. During the first stage of the project, potential factors were identif...
DISCOMFORT GLARE FROM DAYLIGHTING

STUDY OF FACTORS INFLUENCING DISCOMFORT GLARE PERCEPTION AND VALIDATION OF A UNIVERSAL DISCOMFORT GLARE INDEX

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Nowadays, NO index can explain the great variability existing between subjects' discomfort glare perception! However, automatic systems (that manage visual comfort) and European standards are being developed based on discomfort glare indices.

→ Which factors affect discomfort glare perception in daylighting and how to compile these factors in a formula so that discomfort glare from daylighting can be more accurately and universally predicted?

From literature, 30 potential factors identified:

- Lighting-related factors
  - Luminance of the glare source
  - Adaptation level
  - Contrast effect
  - Saturation effect
  - Size of the glare source as seen by the observer
  - Position of the glare source as seen by the observer

- Subject-related factors
  - Gender
  - Age
  - Culture
  - Chronotype
  - Self-assessed glare sensitivity
  - Vision correction
  - Iris pigmentation
  - Macular pigment optical density
  - Cortical hyperexcitability
  - Contrast sensitivity
  - Previous luminous environment
  - Physical state
  - Emotional state
  - Caffeine ingestion
  - Fatigue

→ Determine whether these factors have an influence on discomfort glare perception

- Attractiveness of the view through the window
- Room temperature
- Time of the day
- Season
- Gender
- Culture
- Chronotype

* self-assessed glare sensitivity
* vision correction
* iris pigmentation
* physical state
* emotional state
* caffeine ingestion
* fatigue

→ Determine the influence of culture

→ Suggest a modified DGP index, which includes newly found factor(s)

METHODOLOGY

In-situ discomfort glare experiment

<table>
<thead>
<tr>
<th>Action</th>
<th>START: Arrival in the office</th>
<th>Consent form</th>
<th>1st subjective glare evaluation</th>
<th>1st objective glare evaluation</th>
<th>Blinds opening</th>
<th>2nd subjective glare evaluation</th>
<th>2nd objective glare evaluation</th>
<th>END: Departure from the office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>0 (min.)</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>15</td>
<td>17</td>
</tr>
</tbody>
</table>

Where and when?

- Chile
  03/2017 (summer) 85 subjects
- Belgium
  08/2017 (summer) 155 subjects
- Japan
  07/2018 (summer) 60 subjects
- Total
  300 subjects

Subjective glare evaluation with a questionnaire

Objective glare evaluation with HDR images

Statistical analyses

Comparison between subcategories of each studied factor* to detect influential ones:

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* variables related to the lighting related to the subject related to the context

Modification of a discomfort glare index:

\[
\text{Discomfort Glare Perception} = f(L_s \cdot \omega, P_1, V_1, V_2, \ldots)
\]

with

- \(L_s\) = luminance of the glare source [cd/m²]
- \(\omega\) = solid angle of the glare source [°]
- \(L_b\) = luminance of the background [cd/m²]
- \(P_1\) = position index of the glare source [°]
- \(V_1, V_2, \ldots\) = other variables influencing discomfort glare perception

\[\text{DGP}_S\]