Soundscapes and human restoration in green urban areas

Irene van Kamp, Elise van Kempen, Hanneke Kruize, Wim Swart
Points of Departure and Key Question

- Worldwide revival of interest in the positive effect of landscapes, green and blue space, open countryside on human well-being, quality of life, and health especially for urban dwellers.

- CAVE: Professionals tend to value green and quiet higher than lay observers do.

- Most studies do not account for the influence of the acoustic environment in green spaces both in a negative and positive way.

- Green environments (urban and rural) with high sound quality can intrinsically provide restoration through spending time there.

- But also merely the knowledge that such quiet and green places are available seems to work as a buffer effect between stress and health.
More Focus on Positive Aspects

- Mortality
- Disease (sleep disturbance, cardiovascular)
- Stress indicators (blood pressure, cholesterol, blood clotting, glucose)
- Feelings of discomfort (annoyance, disturbance)

Well-being

STRESS → restoration

Number of people affected

Source: Babisch, 2002 (WHO 1992 - modified)

interpretation

Physiological reactions to

To pleasant sound
Four Mechanisms at work:

Nature and Health

- Natural environment (at different scale levels)
- Restoration: stress and attentional fatigue
- Physical activity
- Social contacts
- Development: Child & Adult
  - Health, restoration, quality of life, mental and social well being
  - But also: Reduction environmental exposures

And: What is restoration?

- Dictionary: The act of restoring or bringing back to a former place, state, station, or condition; the fact of being restored; renewed, reestablished.

- Pederson & Persson Waye: the degree in which an environment can aid recovery from mental fatigue and attentional capacities.


- Gidlöf et al. Psychological restoration is access to places where one can relax, unwind, feel content and undisturbed.

* Important factors: Perceived Control /and Noise Sensitivity
Definition

- Attention restoration theory (see e.g. Kaplan & Kaplan, Hartig, Staats, Brosschot)

  Distinguishes four necessary components of restoration:
  1. being away: psychological distance from the demands and routines in which people use the directed attention capacity
  2. fascination: attention is captured by aspects of flora and fauna
  3. extent: degree and scope of exploration on the environment
  4. compatibility: match between what the person wants to do and must do

these elements are seen as the mediators of the relation between the physical environment and restoration.
EU Framework project PHENOTYPE

- Positive Health Effects of the Natural Outdoor Environment in Typical Populations in Different Regions in Europe
- Coordinator: CREAL – Centre for Research in Environmental Epidemiology (Barcelona):
  Prof. Mark Nieuwenhuijsen
- Primarily aimed at Health effects of Green Space
- RIVM: Survey + squeezing in the role of noise!
Noise as context

Figure 6: The Conceptual Model formulated during the PHENOTYPE project. The legend
Aim of Phenotype

Explaining mechanisms for the beneficial effects of green space to human health and well-being?

How does access size, use, perception and importance affect the association between:

- The natural environment and physical exercise,
- The natural environment and social contacts,
- The natural environment and restoration of stress and mental fatigue,
- The natural environment and environmental factors (air pollution and noise).
Method of Workpackage 2:

1. Selection
   Neighbourhoods based on SES and GREEN

2. Selection
   Subpopulation per city (N=1000)

3. GPS data + diary (N=100)

4. In depth Interviews (N=20)
Where?

Design: Crossectional

Method: Questionnaire

4000 persons 2014

4 cities

N= Approx. 100 Per city

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## Participating Cities

<table>
<thead>
<tr>
<th>City (type of spatial unit)</th>
<th>Total number spatial units</th>
<th>Mean size (km²)</th>
<th>Mean density (people/km²)</th>
<th>Study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doetinchem (neighbourhoods)</td>
<td>83</td>
<td>0.96</td>
<td>1986</td>
<td>33,500</td>
</tr>
<tr>
<td>Stoke-on-Trent (Lower level Super Output Area’s)</td>
<td>241</td>
<td>1.26</td>
<td>3361</td>
<td>214,000</td>
</tr>
<tr>
<td>Barcelona (census areas)</td>
<td>1061</td>
<td>0.11</td>
<td>42,832</td>
<td>&gt;1,000,000</td>
</tr>
<tr>
<td>Kaunas (voting districts)</td>
<td>??</td>
<td>1.34</td>
<td>8695</td>
<td>230,000</td>
</tr>
</tbody>
</table>
Example: Mental Health Per Type of Neighbourhood
Restoration Model

PREDICTORS:
• **Availability** green space
• **Frequency and duration** visits favorite area
• **Importance**

OUTCOMES:
• Restoration
  • General Health
  • Symptoms
  • Mental health
  • Mental Fatigue

POTENTIAL effect modifiers or confounders: gender, age, level of education, ethnicity, perceived quality, Soundscape Perceptions

Soundscape → Outcomes
Green Indicators
Soundscape Questions (translated from Berglund et al.)

Please indicate to what extent the following words describe the sounds in your living environment when you are outdoors:

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Very much so</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Loud</td>
<td>1. Loud</td>
</tr>
<tr>
<td>2. Thrilling</td>
<td>2. Sharp</td>
</tr>
<tr>
<td>3. Sharp</td>
<td>3. Noisy</td>
</tr>
<tr>
<td>4. Light</td>
<td>4. Disturbing</td>
</tr>
<tr>
<td>5. Noisy</td>
<td>5. Light</td>
</tr>
<tr>
<td>6. dull</td>
<td>6. Exciting</td>
</tr>
<tr>
<td>7. Exciting</td>
<td>7. Pleasant</td>
</tr>
<tr>
<td>8. Intruding</td>
<td>8. Calming</td>
</tr>
<tr>
<td>9. Pleasant</td>
<td></td>
</tr>
<tr>
<td>10. Stressful</td>
<td></td>
</tr>
<tr>
<td>11. Disturbing</td>
<td></td>
</tr>
<tr>
<td>12. Calming</td>
<td></td>
</tr>
</tbody>
</table>

Acoustic environment – a New York City Park – with potential restorative outcomes (Photo: A.L. Brown)
## Score per country

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean Score (SD) Positive (0-16)</th>
<th>Mean Score (SD) Negative (0-16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain (851)</td>
<td>7.21 (2.69)</td>
<td>2.69 (3.24)</td>
</tr>
<tr>
<td>UK (701)</td>
<td>8.37 (3.38)</td>
<td>2.82 (3.55)</td>
</tr>
<tr>
<td>Netherlands (833)</td>
<td>7.73 (2.98)</td>
<td>1.65 (2.55)</td>
</tr>
<tr>
<td>Lithuania (731)</td>
<td>8.40 (3.78)</td>
<td>2.68 (3.22)</td>
</tr>
<tr>
<td>Pooled data set</td>
<td>7.89 (3.52)</td>
<td>2.68 (3.22)</td>
</tr>
<tr>
<td>F value</td>
<td>21.061***</td>
<td>54.449****</td>
</tr>
</tbody>
</table>

Internal Consistency moderate to high for Positive scale (.66-.87) and high for Negative scale (.82-.87)
During or after a visit:

I feel calmer.
My concentration and alertness clearly increase.
I get new enthusiasm and energy for my every day routine.
I feel restored and relaxed.
I forget every day worries.
My thoughts are cleared and clarified.
My self confidence improves.
I gain vitality.
I get trust for each new day
### Correlations

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restoration</td>
<td>.08</td>
<td>.01</td>
<td>-.07</td>
<td>-.02</td>
</tr>
<tr>
<td>1. General Health (Rand 36)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>.31</td>
<td>.38</td>
<td>.27</td>
</tr>
<tr>
<td>2. Mental Health (Rand 36)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>.34</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>3. Symptoms</td>
<td></td>
<td></td>
<td></td>
<td>.13</td>
</tr>
<tr>
<td>4. Social Cohesion</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
Models: Multilevel

- Outcome = Soundscape\text{Pos} Soundscape\text{Neg}

- Outcome = Soundscape\text{Pos} Soundscape\text{Neg}^+ \ (\text{City})(\text{Type neighbourhood})

- Outcome = + determinants

- Outcome = + determinants and explaining variables

Restricted to Restoration, Symptoms and Mental Health
### Multilevel analysis: ESTIMATES

**All cities**

**N = 3092**

1. Unadjusted model with a random intercept (neighbourhood)
2. Adjusted for age, gender, education level, ethnicity, availability, use, and importance of green, Quality Green, with data for all four cities pooled also adjusted for city. Mental Health and Symptoms: also adjusted for ROS and social Cohesion.

<table>
<thead>
<tr>
<th></th>
<th>POSITIVE</th>
<th>NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude model&lt;sup&gt;1&lt;/sup&gt;</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Adjusted Model&lt;sup&gt;2&lt;/sup&gt;</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td><strong>SYMPTOMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude model&lt;sup&gt;1&lt;/sup&gt;</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Adjusted model&lt;sup&gt;2&lt;/sup&gt;</td>
<td>(ns)</td>
<td>***</td>
</tr>
<tr>
<td><strong>MENTAL HEALTH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude model&lt;sup&gt;1&lt;/sup&gt;</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Adjusted model&lt;sup&gt;2&lt;/sup&gt;</td>
<td>ns</td>
<td>***</td>
</tr>
</tbody>
</table>

p < 0.01 - < 0.05; **p < 0.001***
Outcome per city in broad line comparable (some fluctuations)
Determinants and explaining variables

ROS

City
Exposure (freqxduration)
Quality green
Importance green
Education
Ethnicity

Symptoms

City
Exposure
Quality green
Importance green
Gender
Education
ROS

Not significant: Age, Gender, available green (100, 300 & 500 meter)

Not significant: Age, ethnicity, available green (100, 300 & 500 meter)
Determinants and explaining variables Mental Health

Exposure (freq x duration)
Quality
Importance
Education
Gender
Social Cohesion

Not significant: City, Exposure, Age, Gender, available green (100, 300 & 500 meter), ethnicity, ROS

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Appleyard revisited?

Social Interactions on Three Streets - Neighboring and Visiting

HEAVY TRAFFIC  MODERATE TRAFFIC  LIGHT TRAFFIC

Where people have friends
Where people gather
Conclusions

- Perceived soundscapes (positive and negative) are strong predictors of restoration at favorite green areas after controlling for city, neighbourhood, demographics, green space indicators (availability, use, importance and perceived quality).
- The pattern is also found for other (subjective) health outcomes, although the role of negative and positive soundscapes only significant for restoration and disappears after adjustment.
- Social cohesion: Also linked to perceived soundscapes and an important predictor of health outcomes.
- Other mechanisms to be addressed in future by others are: physical activity, and social contacts.
- Findings on pooled data as well as in separate cities.
- Limitation: cross sectional data.
Way ahead

- Add Noise estimates to the models
- Add Interaction between SOUNDSCAPES and RESTORATION on HEALTH + Social Cohesion

- Analyse the three different mechanisms in more depth:
  › Via physical exercise
  › Social Contacts
  › Stress and Restoration

Follow Progress via :
- http://www.phenotype.eu/en/about/beneficiaries/creal
Thank you for your attention!

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