Health related quality of life & Environmental QoL in soundscape research and implementation

Peter Lercher
Medical University Innsbruck
Division of Social Medicine

Soundscape of European Cities and Landscapes

cost
TUD Action TD0804

- Rationale and Policy perspectives
- Health related QoL
- Results: (H)RQoL
- Environmental QoL
- Results: (E)QoL
- (H+E)QoL vs Satisfaction
- Summary/Conclusions

My (selected) background

Lercher P, Schulte-Fortkamp B. The relevance of soundscape research to the assessment of noise annoyance at the community level.
In: de Jong RG, Houtgast T, Franssen E & Hofman W. (Eds). ICBEN proceedings, 2003, Schiedam, Netherlands: pp 225-231 (also on CD-ROM)

Lercher P. Which health outcomes should be measured in health related environmental quality of life studies? Landscape and Urban Planning 2003; 65:63-72.

Lercher P. Environmental noise: A contextual public health perspective. In: L. Luxon & D. Prasher (eds) Noise and its effects: pp 345-377.
London: Wiley, London 2007.

De Coensel B, Botteldooren D, De Muer T, Berglund B, Nilsson ME, Lercher P. A model for the perception of environmental sound based on notice-events. J Acoust Soc Am 2009, 126 (2):656-665.

Lercher P (ed). Noise & Quality of life: Special issue in Int. J. Environ. Res. Public Health

Lercher P (Issue editor: noise & health). Encyclopedia of Environmental Health. Elsevier Feb 2011.

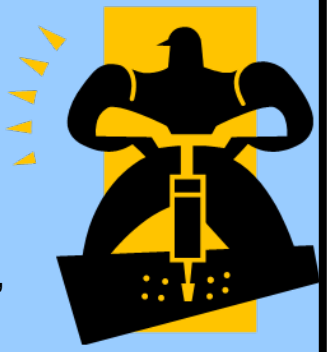
WG-3-summary of Edinburgh meeting

Soundscape: Type I

Individually derived

By

-Personal experience
-Preferences
-Type of activity
-Matching with: intentions, expectations, purposes
-Place related aspects



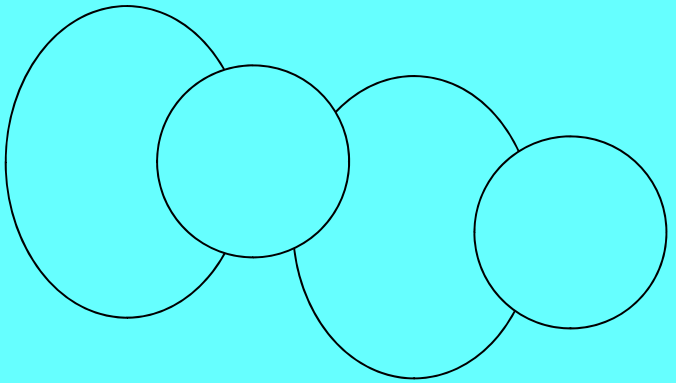
User
Artists
Scientists
(Psychoacoustitian, psychologist, linguist, acoustic ecologist etc.)

Acoustitians, social scientists, epidemiologists, public health departments, community administrations etc.

Soundscape: Type II

Derived by group level

Based on aggregated judgements



Soundscape: Type III

Derived by higher level concerns

Place related (conservation, heritage etc.)

Planning derived (zoning, limits, reshaping areas etc.)

Policy derived (quiet area by END, sustainability, EHIA etc.)

Planning
&
Policy
administration

Constraints
Derived by
-Costs
-Benefits
-Evidence

Policy rationale: HRQoL in soundscape studies

General policy (OECD, WHO, EC)

- Sustainable development and local assessment (Agenda 21)
- Precautionary principle

CALM-Network paper: „Research for a quieter Europe“

- To support the Environmental noise directive (END) based on „perception related research“
- Specifically contribute to Annex III: „harmful effects“ according to the scientific progress

Environmental noise directive (END)

- Protection of quiet areas („restorative health perspective“)

Environmental health risk assessment	Sound level	Prevention
Established increase of health risks	>65 dBA	Protection against adverse effects
Health risks cannot be ruled out with certainty Percentage of highy annoyed >25%	55-64 dBA	
Percentage of highy annoyed increases	45-54 dBA	Protection of life quality
Quiet residential areas	35-44 dBA	
Quietness	<35 dBA	Permits and promotes restoration
Silence	<25 dBA	Promotion

55 dBA: Quiet area in urban agglomerations

40 dBA: Quiet area in rural settlements

Example: EHIA for aircraft noise: state of the art

Scientific rationale to use quality of life related health endpoints in environmental assessments

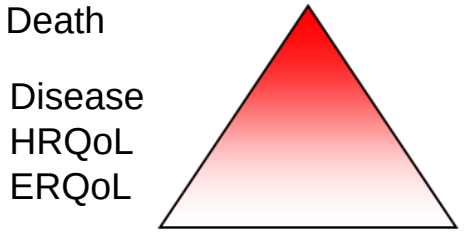
After the epidemiological transition the (good or bad) experience of health while alive requires more attention

The demographic shift to „older societies“ requires supportive and restorative environments to stay healthy

Latency time: The longer people live with suboptimal exposure conditions (even such of „low toxicity“) the more likely an impact will show up later in life and increase morbidity and decrease functional health

We need to know more about how positive health is created by quiet areas or optimised soundscapes (health promotion)

More people are affected at the lower end of the morbidy pyramide

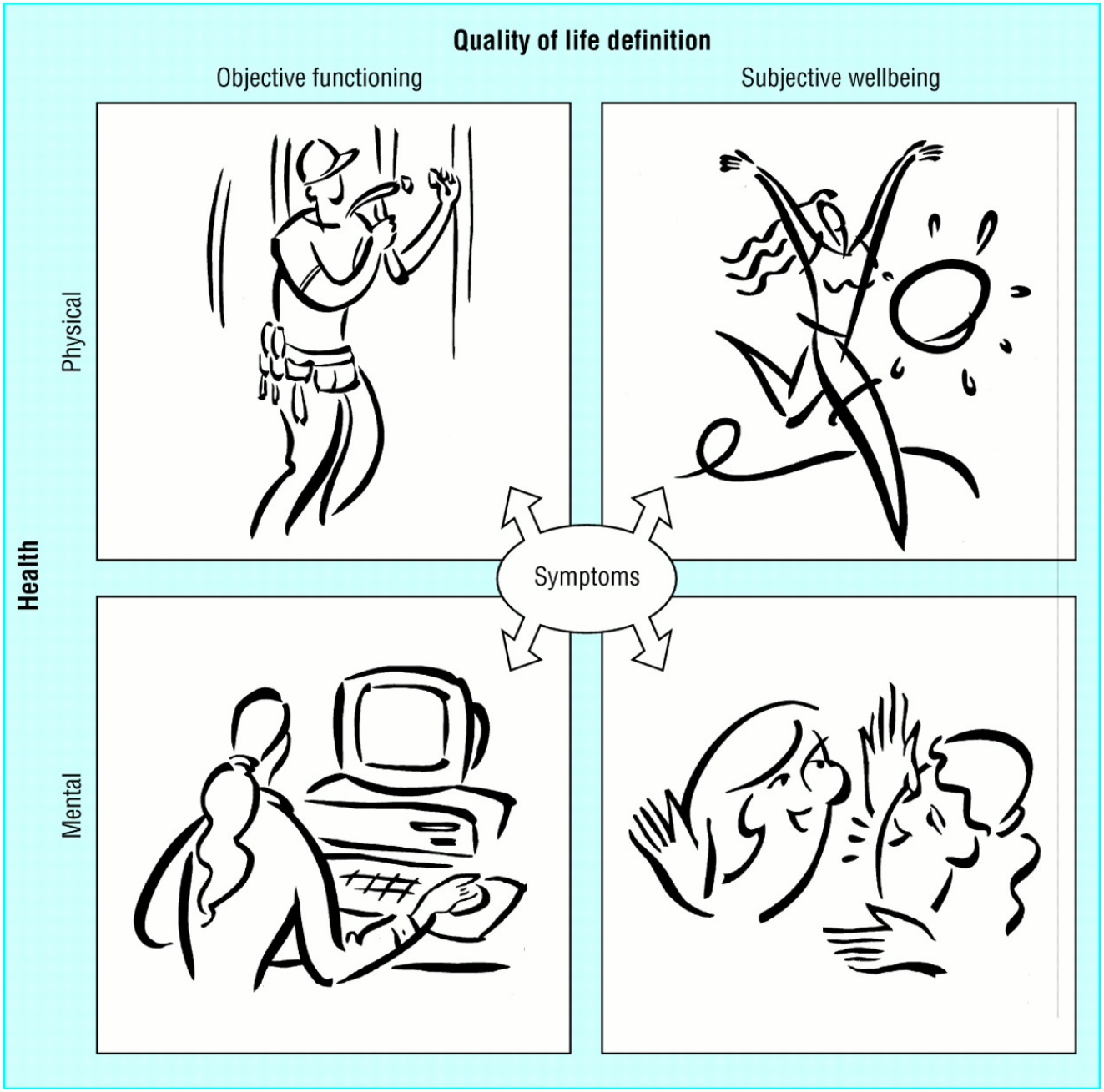


Involved theoretical concepts

	Stress Perspective	Coping Perspective	Restoration Perspective
Theoretical Premise	Heavy demands can undermine adaptation.	Readily available resources support adaptation.	Adaptation requires periodic restoration.
Practical Premise	Interventions can eliminate or mitigate demands.	Interventions can ensure the availability of resources.	Interventions can enhance opportunities for restoration.

From Hartig, Bringslimark & Patil (2008); Hartig (2008)

Clinical perspective of health related quality of life (HRQoL)



Muldoon MF et al. BMJ 1998

Perceived health status: measurement I

Simple one-item measurement without reference

- Classical English question (e.g. Whitehall cohort)
  „Over the past 12 months would you say your health has been—very good, good, average, poor or very poor”
- Gazel cohort: „How would you judge the state of your general health?’’
  1 = ’’very good’’ to 8 = ’’very bad’’
- German “school grade” version (Microcensus, our surveys)
  “Wenn Sie an die letzten 12 Monate denken, wie würden Sie Ihren Gesundheitszustand insgesamt beurteilen?

1 sehr gut	2 gut	3 zufriedenstellend	4 weniger gut	5 schlecht
☐	☐	☐	☐	☐

- USA: “Would you say your health in general is excellent, very good, good, fair, or poor?”
  or “Would you say that in general your health is….”

Perceived health status: measurement II

Formats with reference: to same age or earlier own health

- RAND general health perception question: Current health
  1. I am somewhat ill. (R)
  2. I am as healthy as anybody I know.
  3. My health is excellent.
  4. I have been feeling bad lately. (R)
- Longitudinal aging study Amsterdam

  ‘‘How is your health in general compared with your age peers ?
  1 much better ……. 5 much poorer

  ‘‘How is your health in general compared to your health 10 yrs ago ?
  1 much better ……. 5 much poorer

Why measuring health status ?

Questions widely used in large surveys

- Eurobarometer/HIS, ECHI, US-NHIS, US-NHANES, SF-1
- National micro-census surveys

Established predictor of future mortality

after adjusting for traditional risk factors, sociodemographics, and objective measures of health status

- Meta-analysis poor vs excellent health: 1.92 (1.64-2.25) (DeSalvo et al 2006)
- provides different and additional information, compared with objective measures of health (Benyamini et al 2003, Idler et al 2004)
- Better in respondents with preexisting circulatory diseases (Idler et al 2004)
- Better in short-term than long-term (Deeg-Kriegsman 2003, Singh-Manoux et al 2007)
- Gender difference (predictive for men) at older age (Deeg-Kriegsman 2003)
- Inconsistent predictive power by SES (stronger for higher education or income quartile: Beam et al 2007, Huisman et al 2007), (stronger for lower SES: Singh-Manoux et al 2007), (equal power: Burstrom & Fredlund JECH 2001)

Considered as indicator of health related quality of life

Also used as indicator of health care needs

Other suitable HRQoL measures

SF-36 and SF-12

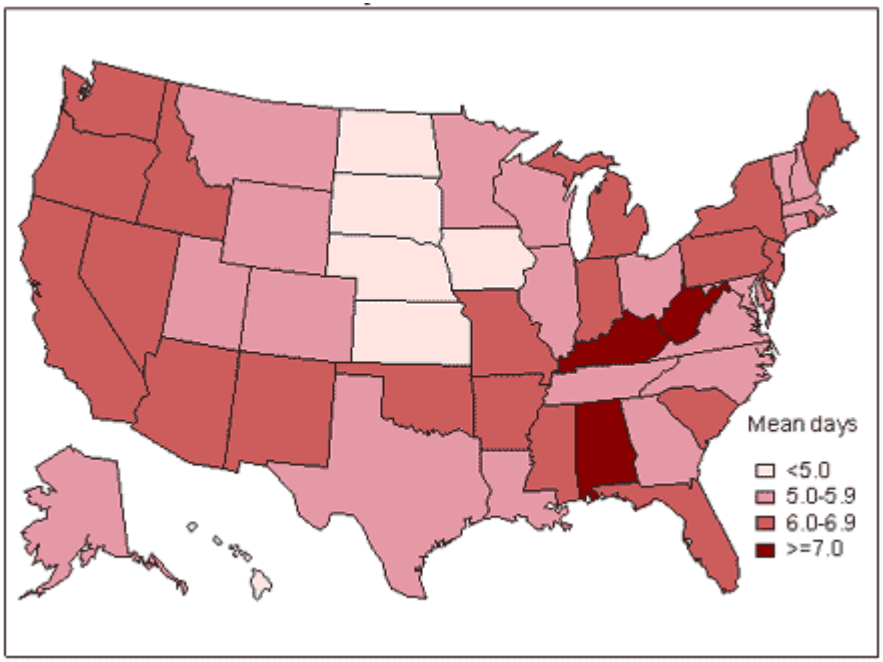
(Ware & Sherbourne 1992; Ware 2000; Ware et al. 1996; deVet et al. 2005, Contopoulos-Ioannidis et al. 2009)

GHQ (Goldberg & Hillier 1979; Stansfeld & Marmot 1992; Goldberg et al. 1998; Kishikawa et al. 2009)

WHOQoL and WHOQoL-Brev (The WHOQOL Group, 1998+1999; Lercher 2003)

Healthy Days Symptoms Module from CDC HRQOL-14

http://www.cdc.gov/hrqol/hrqol14_measure.htm



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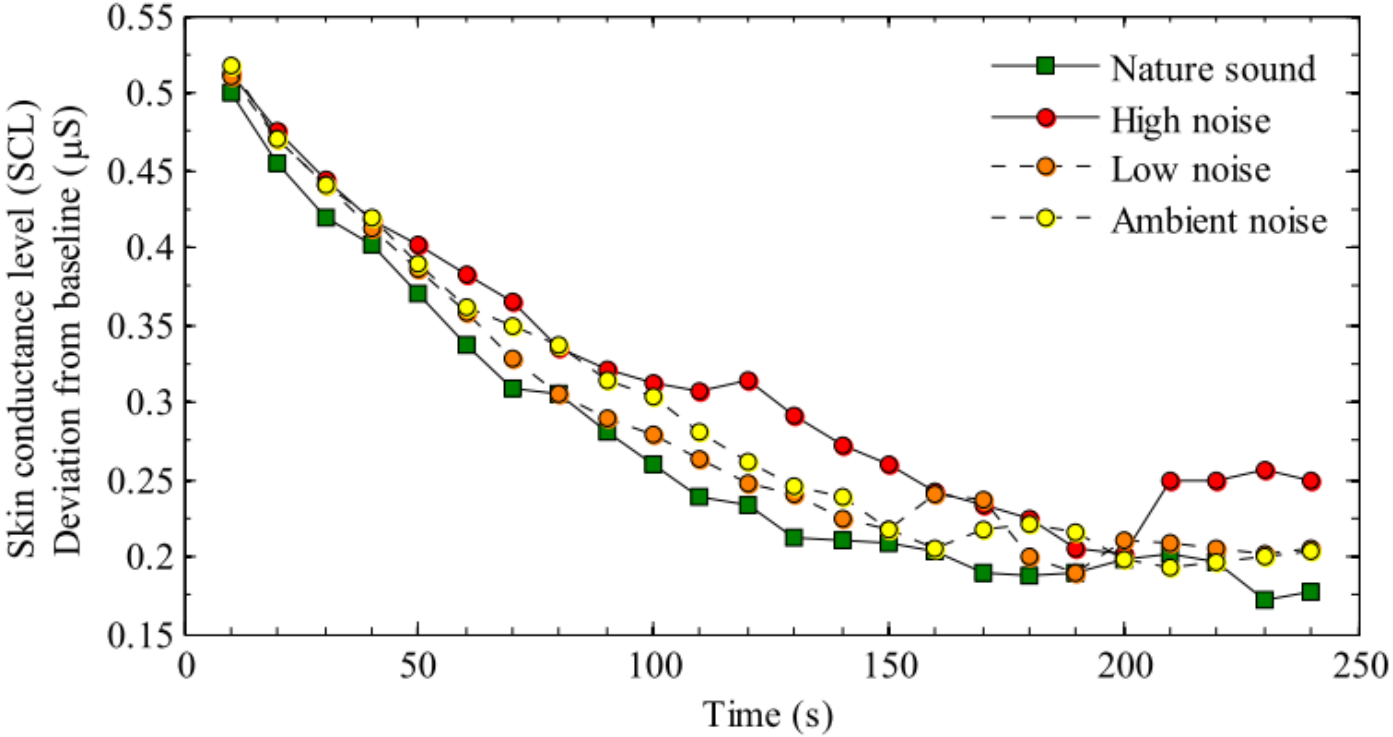
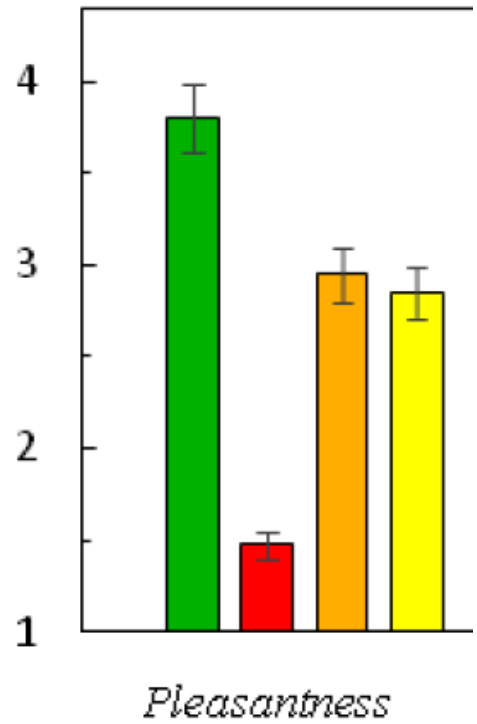
Sound related examples

- Experiments with subjective and sound assessments
- Field studies with subjective assessments
- Field studies with subjective and sound indicator assessments

Experimental studies

Alvarsson et al. (2010) observed a slightly faster recovery of skin conductance level during natural sound than in noisy environments. This is the first sound study to demonstrate similar effects as reported earlier from visual impressions of natural vs urban environments





Woods et al. (2010) found evidence for three different effects of background noise on food perception.

i. Food saltiness and sweetness diminished when eaten in the presence of loud compared to quiet background noise (Experiment 1 below).

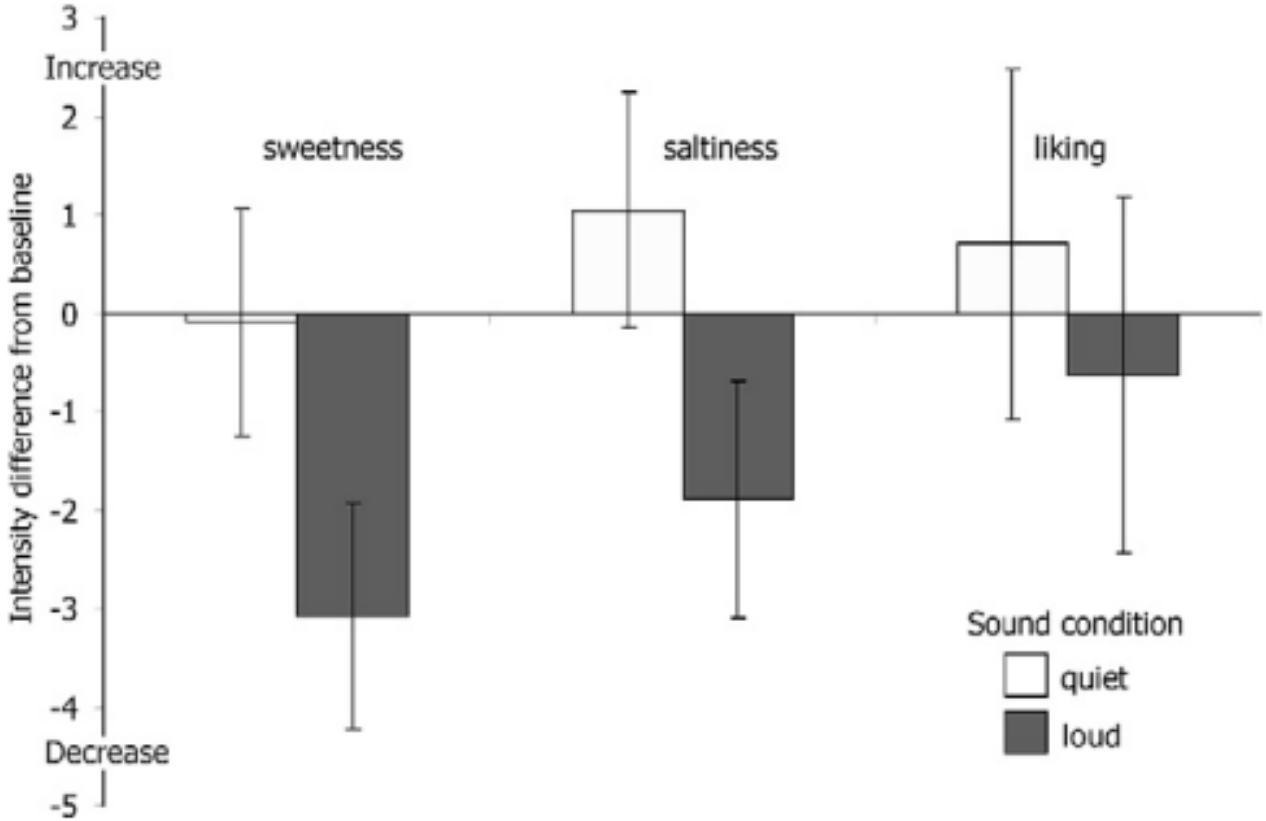


Figure 2. The effect of quiet and loud background sound level on sugar, salt and liking intensity in Experiment 1, relative to the baseline condition

Woods et al. (2010) cont.

ii. food was reported to taste crunchier in the presence of background noise (Experiment 2 below).

iii. background noise liking and food liking were found to interact: effect of noise on the liking of the food correlated with the liking of noise itself

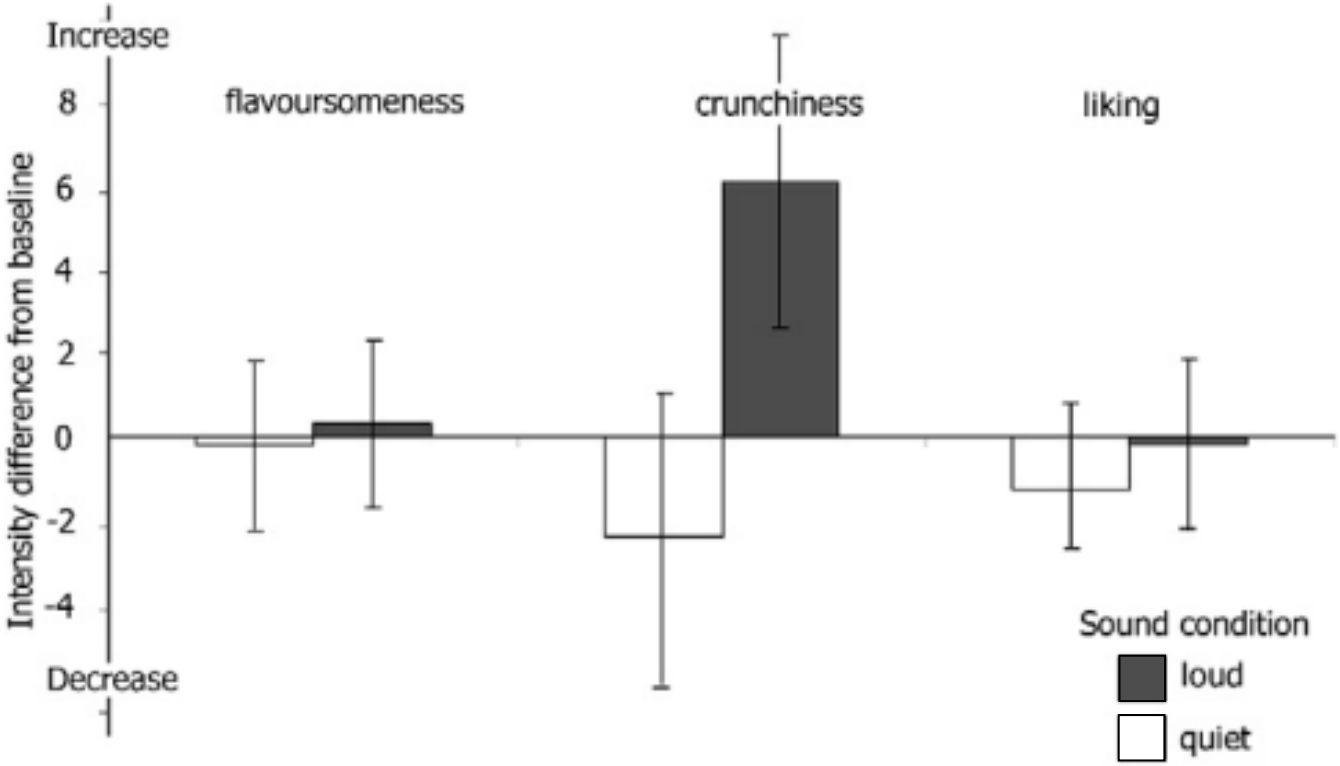


Figure 3. The effect of quiet and loud background sound on flavour-somer crunchiness and liking intensity ratings in Experiment 2, relative to the baseline condition.

In a pilot study, Davies et al. (2009) evaluated brain responses to different soundscape stimuli by functional Magnetic Resonance Imaging (FMRI). Image (a) shows the activation of the left and right auditory cortex elicited by a change from silence to soundscape presentation

Image (b) demonstrates the difference between soundscapes rated neutral and high or low on factor 1 (calmness/pleasantness/valence) showing activity in the left and right amygdala (a brain region known to process emotions)

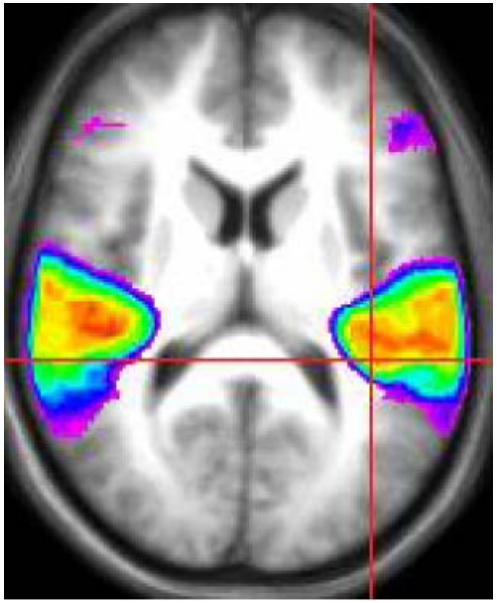


Image (a)

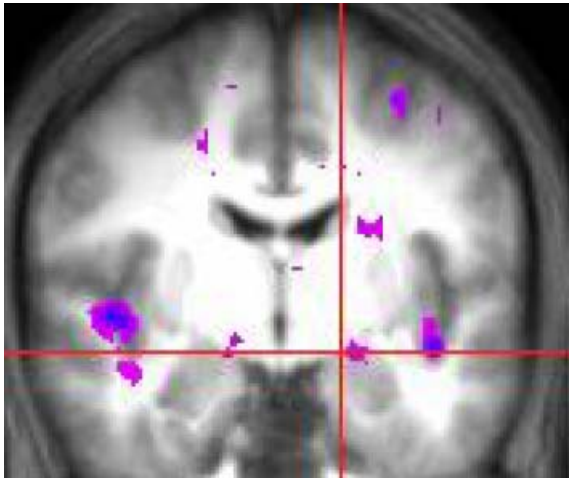
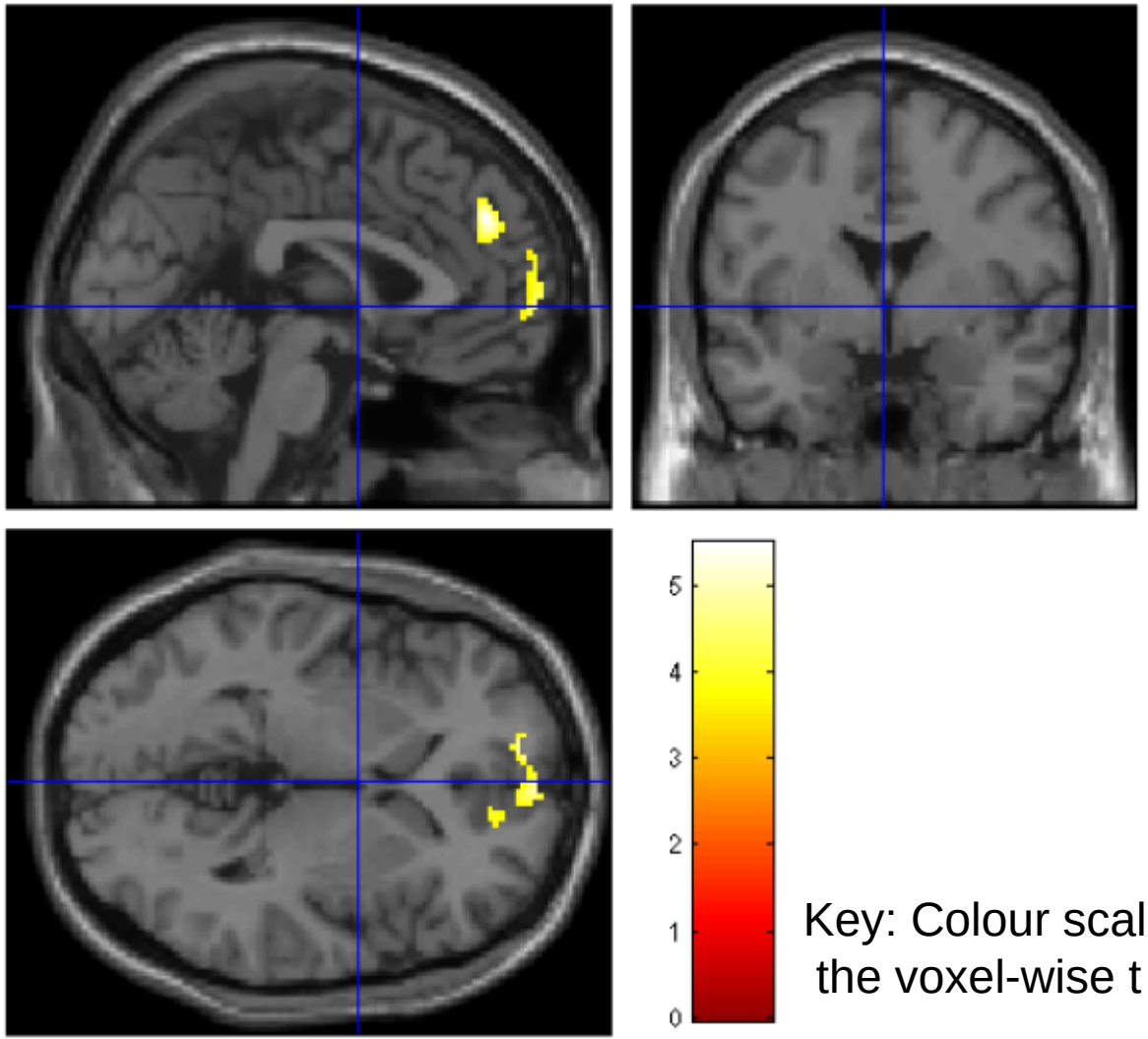


Image (b)

Watts et al. 2009 utilized an experimental design by which it has been possible to isolate visual (landscape) effects in modulating the response to auditory inputs. The A-weighted levels in both cases is exactly 65 dB(A)
Specifically it has been shown that responses in the medial prefrontal cortex are linked directly to activity in the auditory cortex under tranquil conditions (beach) but not under non-tranquil conditions (motorway).



Key: Colour scale represents the voxel-wise t statistic

In a related study to Davies, Irwin et al. (2009) provide further support for the hypothesis that soundscapes evoke differential responses in the brain, even when they are presented at the same sound level. They found evidence for a U-shaped response

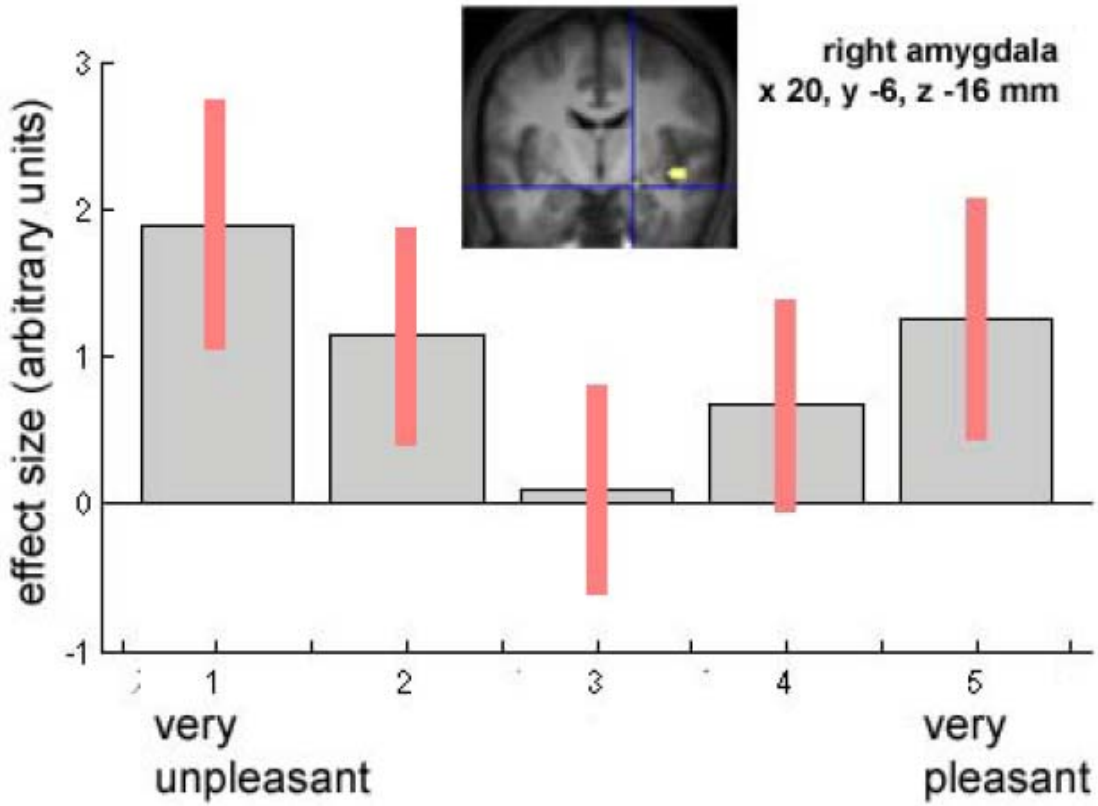
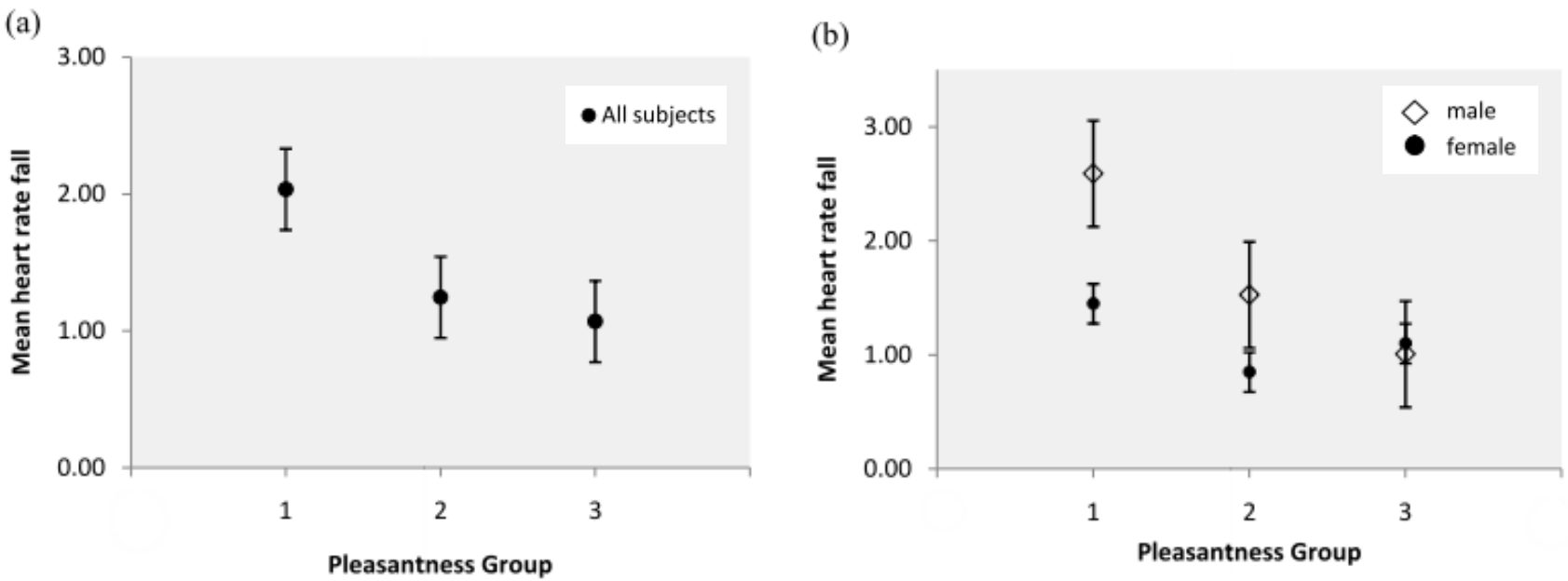


Figure 2: From the group analysis the peak u-shaped response for the pleasantness dimension occurred at the voxel co-ordinate 20 -6 -16.
This figure shows the size of the response across the five ratings of pleasantness for this peak voxel. The error bars depict 90% confidence interval.

In a related study to Davies, Hume et al. (2009) evaluated heart rate responses to different soundscape stimuli

Image (a) shows the degree to which the HR fell depending on the mean estimate of pleasantness

Image (b) shows that the more unpleasantly scored sound-clips give the largest HR falls – but gender differences exist



Group 1 is the most unpleasant and group 3 is the most pleasant

Field studies without regular noise assessment

Dratva et al. (2010) report an inverse relationship between traffic-related noise annoyance (highly annoyed vs not annoyed) and all SF36 domains excluding general health, especially for individuals who had lived in their homes for six years or less.
Significant effect modification by gender and chronic disease status was present in specific SF-36 domains. Results were properly adjusted in multivariate regression.
-> no sound assessment

Shepherd et al. (2010) reported a negative association between a multi-item general annoyance measure and HRQOL domains (from the WHOQOL-BREF) and between general annoyance and self-rated health in a population that was exposed to a comparable amount of aircraft noise.
-> sampling of respondents from areas with similar noise exposure based on airport noise contours

Studies including regular noise assessment

Schreckenberg et al. (2010) found variables to be associated with aircraft noise annoyance as well as with the individual noise sensitivity. The more annoyed residents were by aircraft noise the poorer was their HQoL - particularly among higher noise-sensitive residents.

A significant association between aircraft noise and HQoL indicators was not observed. Rather a weak significant relation was found with EQoL (single item and total residential satisfaction score).

Eventually, within the group of multi-morbid residents (with more than one illness) an association between aircraft sound level and HQoL-indicators was observed.

Also the morbidity*aircraft noise interaction term was significant for SF36 mental health+vitality+SF12 physical health but not for the GSCL-24 total health complaints or PSQI total sleep quality score.

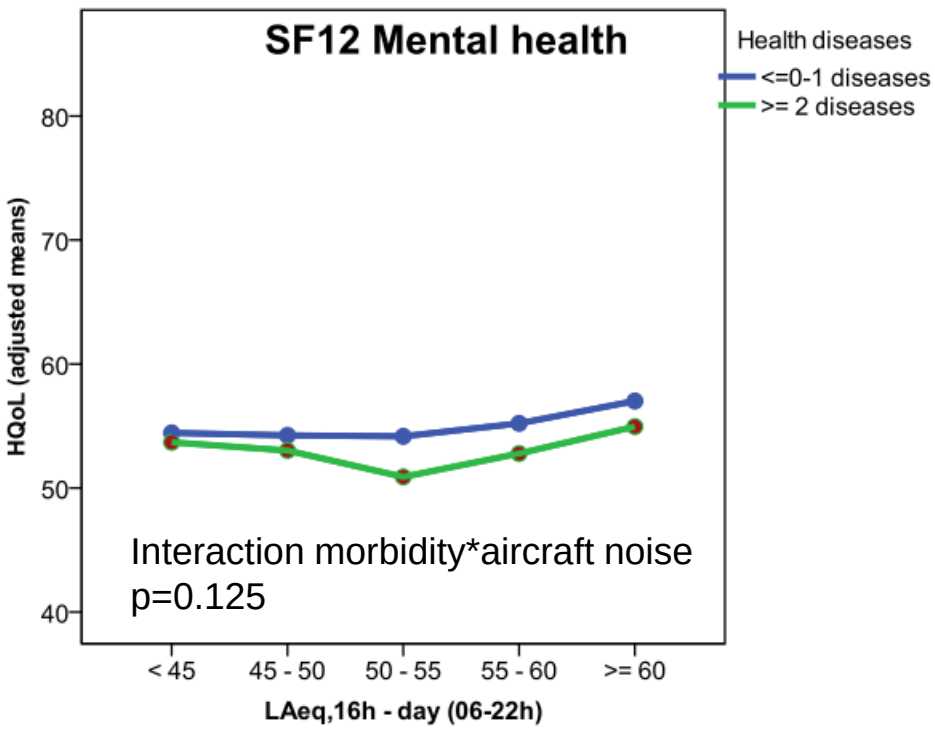
Table 8. Associations between aircraft noise exposure at daytime (L Aeq,16h), aircraft noise annoyance, noise sensitivity, and health variables (Odds ratios [OR] per unit and ±95% confidence interval [CI]).

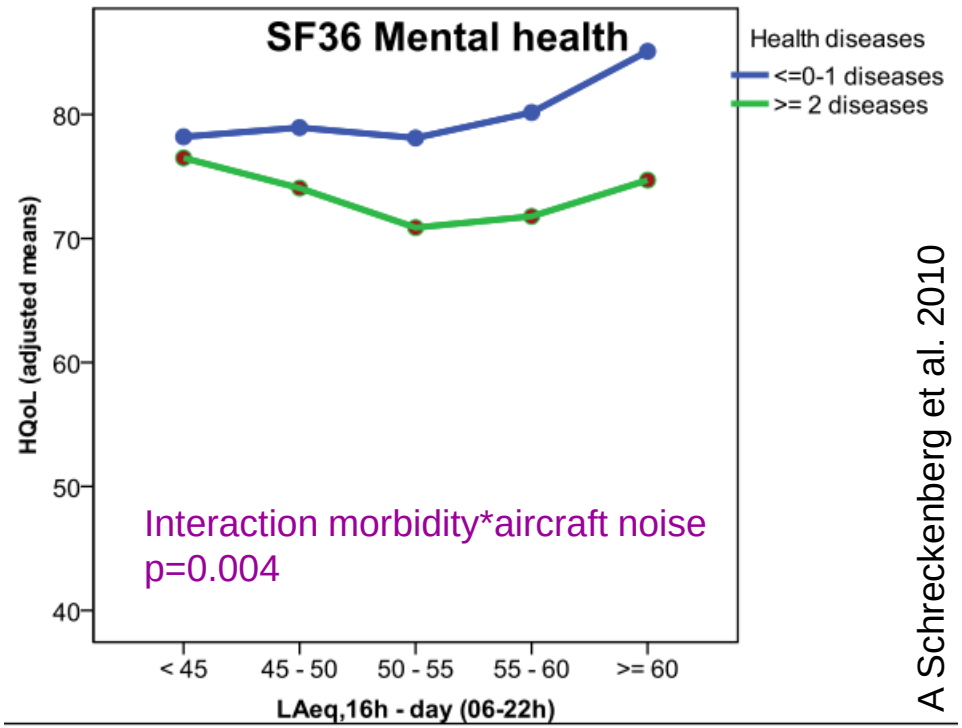
Health variables	Aircraft sound level $L_{Aeq,16h/8h}$ #			Aircraft noise annoyance			Noise sensitivity		
	OR	CI–	CR+	OR	CI–	CR+	OR	CI–	CR+
Health-related quality of life (SF36/12 scores < median)									
Vitality (SF36)	**0.95**	0.93	0.97	**1.25**	1.13	1.37	**1.13**	1.02	1.26
Mental health (SF36)	**0.96**	0.94	0.98	**1.13**	1.03	1.24	**1.40**	1.26	1.55
Mental health (SF12)	**0.96**	0.94	0.98	1.06	0.97	1.17	**1.22**	1.10	1.36
Physical health (SF12)	**0.97**	0.95	0.99	**1.13**	1.01	1.26	**1.19**	1.06	1.34
GSCL-24 health complaints (above 50% = average of population in Germany)									
Exhaustion	**0.98**	0.96	1.00	**1.36**	1.23	1.51	**1.40**	1.26	1.56
Stomach complaints	0.99	0.97	1.01	**1.12**	1.02	1.24	**1.18**	1.06	1.30
Limb complaints	**0.96**	0.94	0.98	**1.22**	1.10	1.34	**1.48**	1.33	1.65
Cardiac complaints	**0.96**	0.94	0.98	**1.32**	1.19	1.47	**1.35**	1.21	1.50
Total score	**0.96**	0.94	0.98	**1.41**	1.27	1.56	**1.53**	1.37	1.71
Sleep quality (bad sleep quality: PSQI score > 5))									
Bad sleep quality	**0.95**	0.93	0.97	**1.45**	1.29	1.63	**1.42**	1.25	1.61

Adjusted for railway and road traffic sound level, age, gender, socio-economical status, home ownership, residential satisfaction, usual window position in the sleeping room at night, number of hours away from home

A Schreckenberg et al. 2010

Figure 4. Results of multi-factor GLM: Adjusted means of HQoL (SF12/36 scores) by aircraft sound level classes (L Aeq,16h/8h) and morbidity





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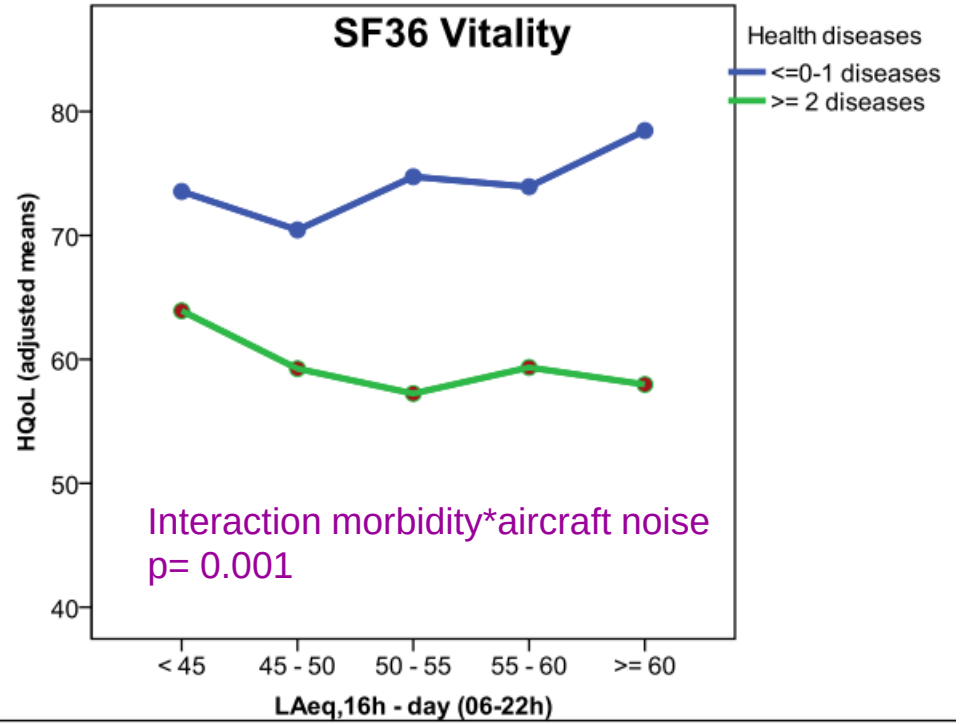

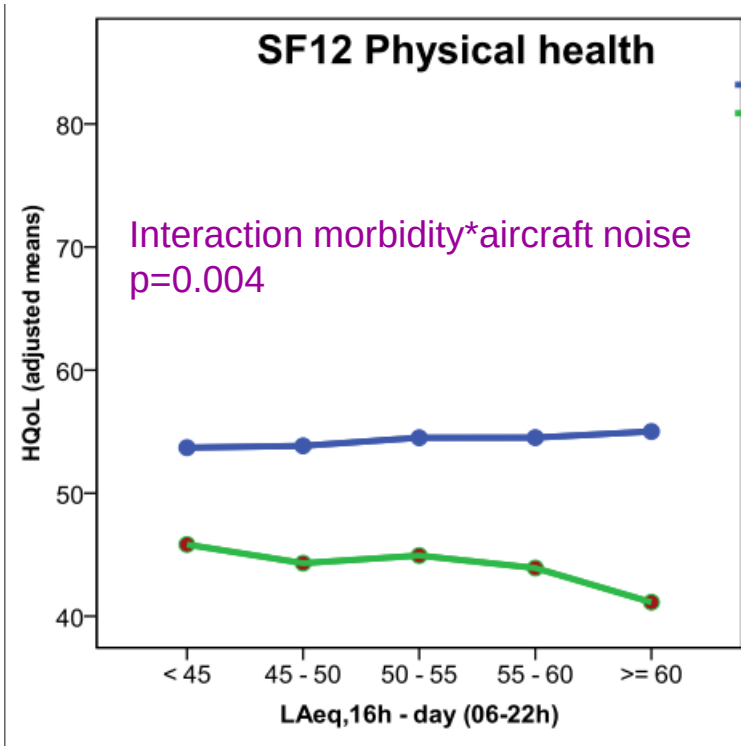

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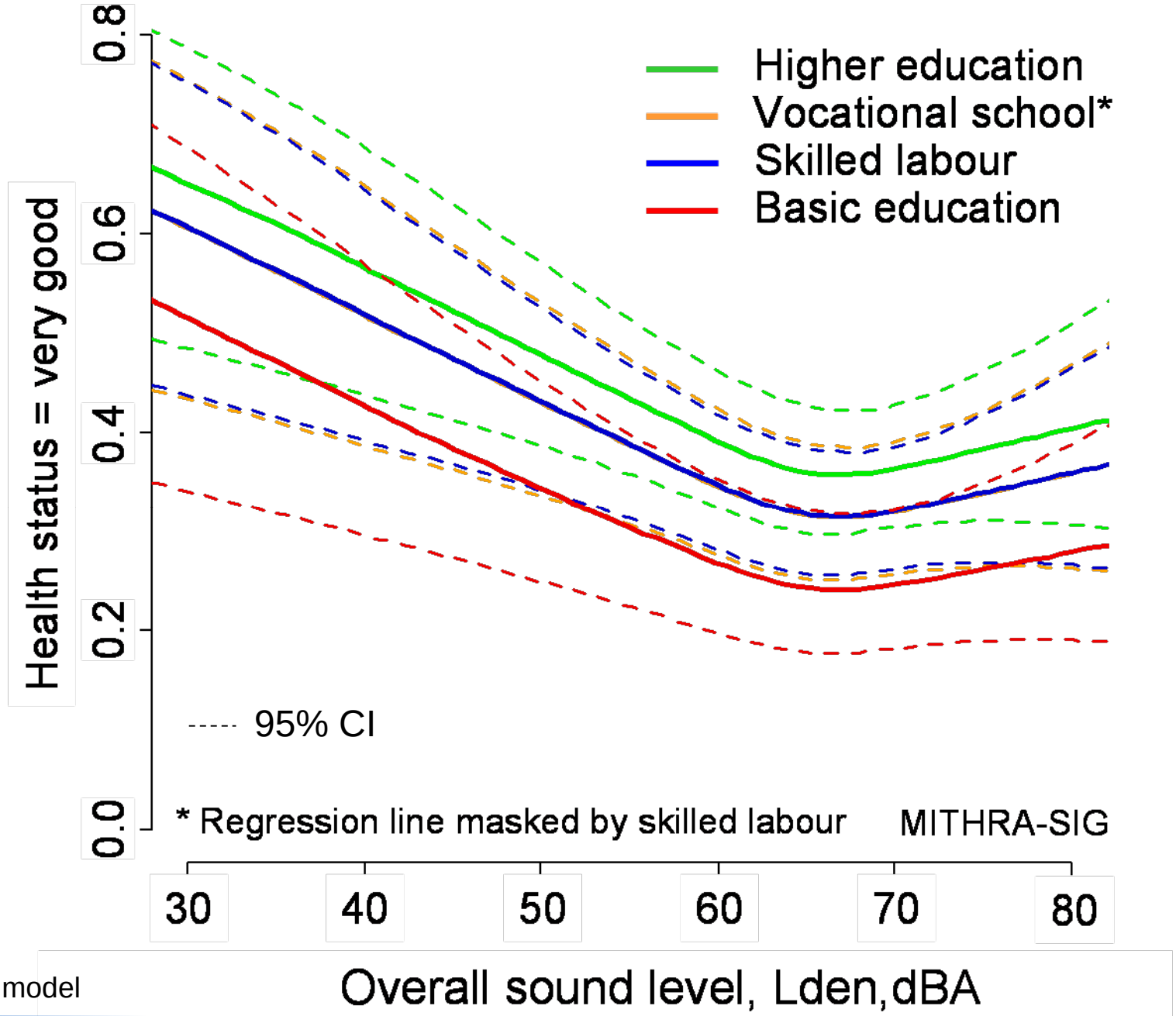

Lercher,ICBEN proceeding 2008

Adjusted model

- ✓ Introduction and Policy perspectives
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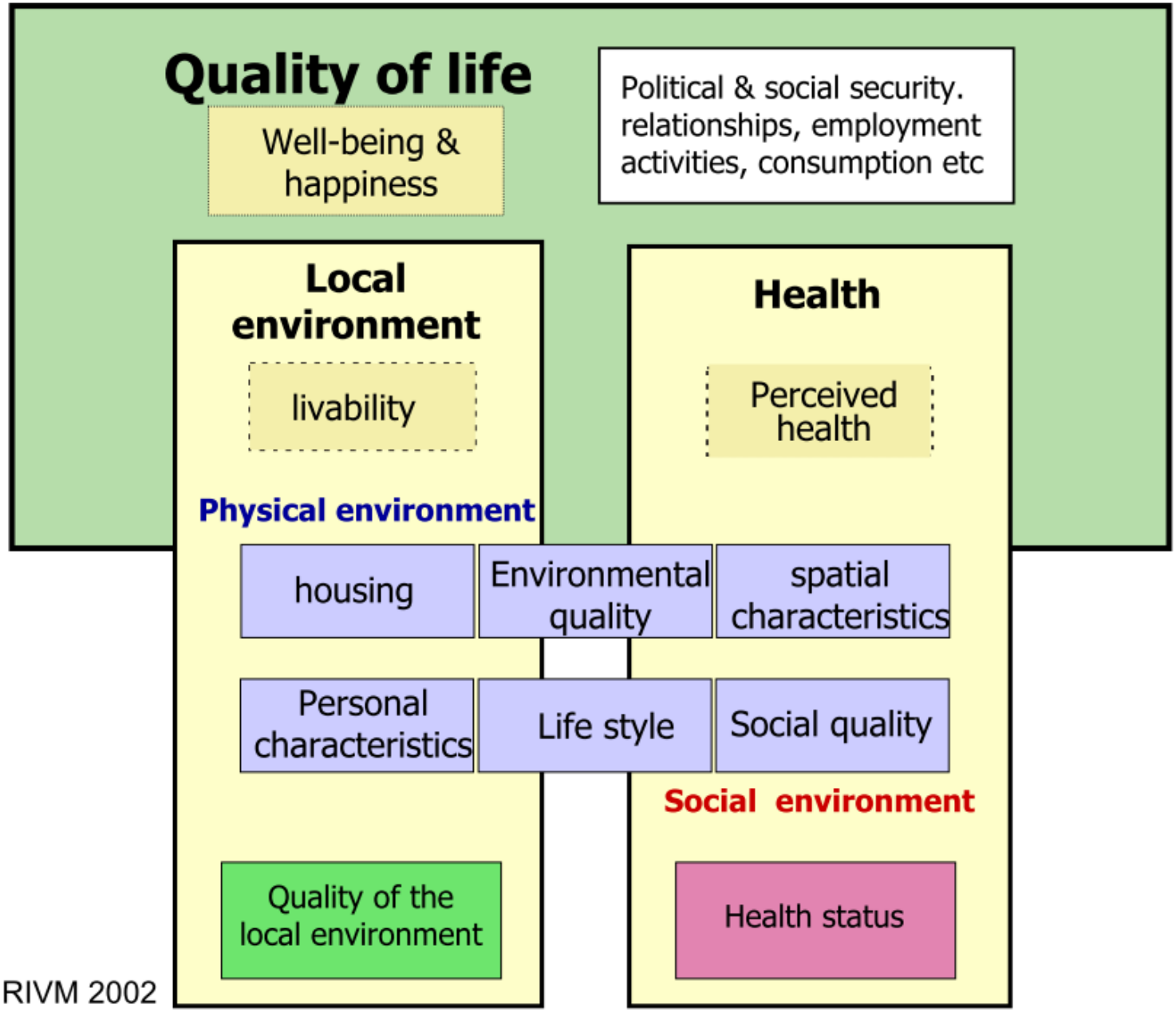
Health related Environmental quality

Core Question

Does the quality of the environment affect health condition and well-being

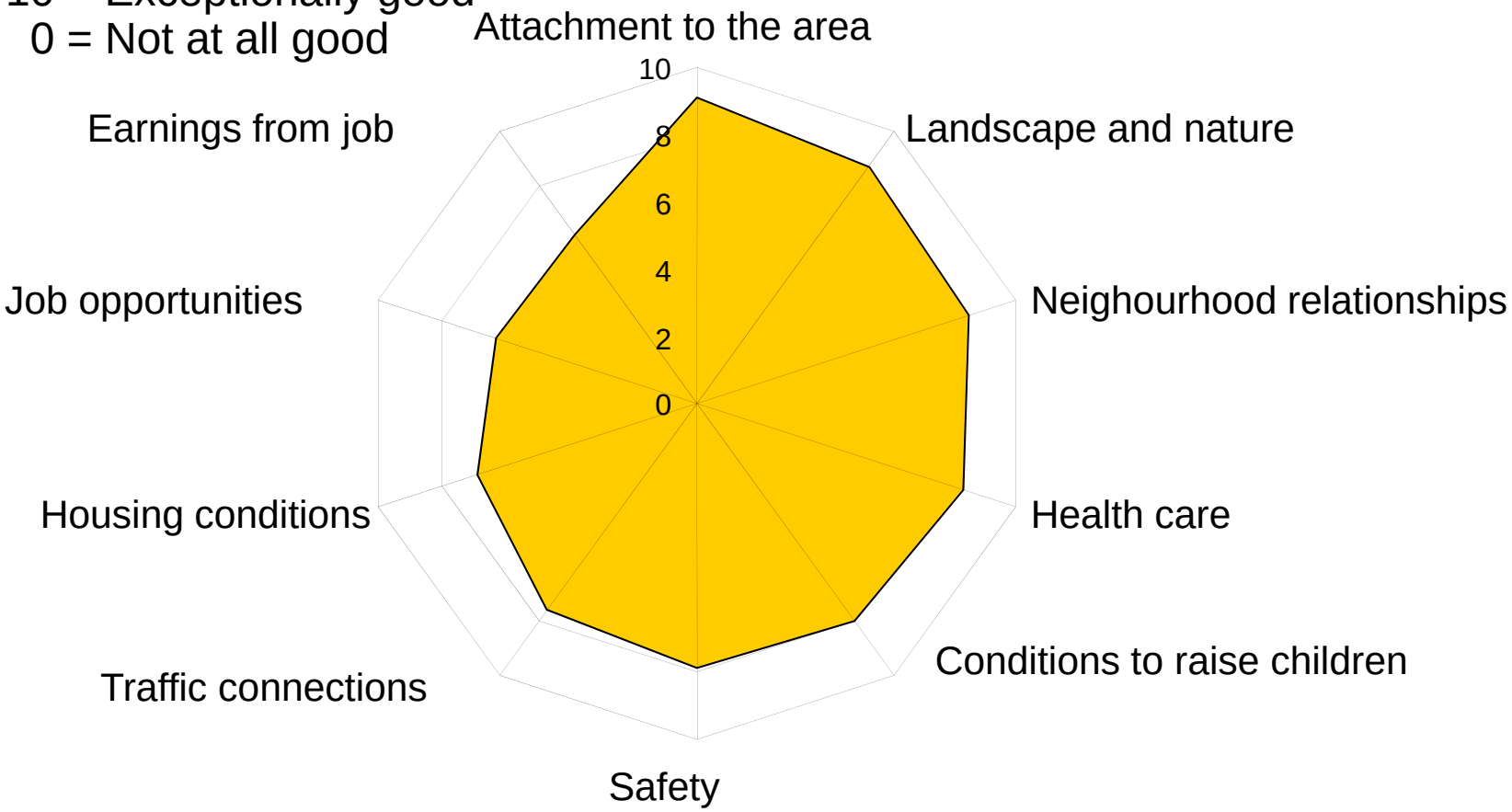
Utility

Ranking the relative contribution of the environment on health & well-being for planning & resource allocation …



Source: RIVM 2002

10 = Exceptionally good
0 = Not at all good



Lercher, 2006 BBT-study, unpublished

General judgement of environmental living conditions by category: means

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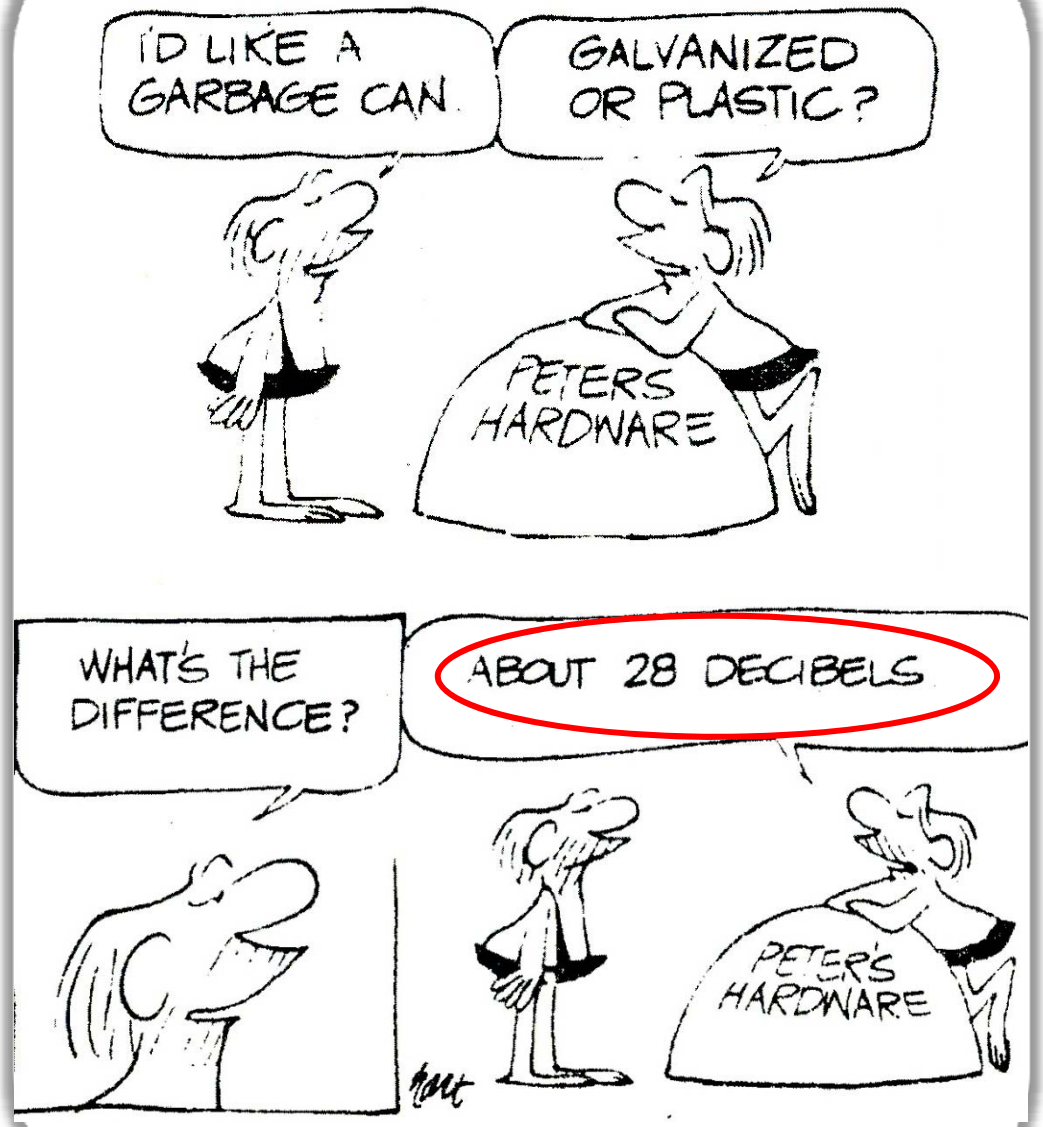
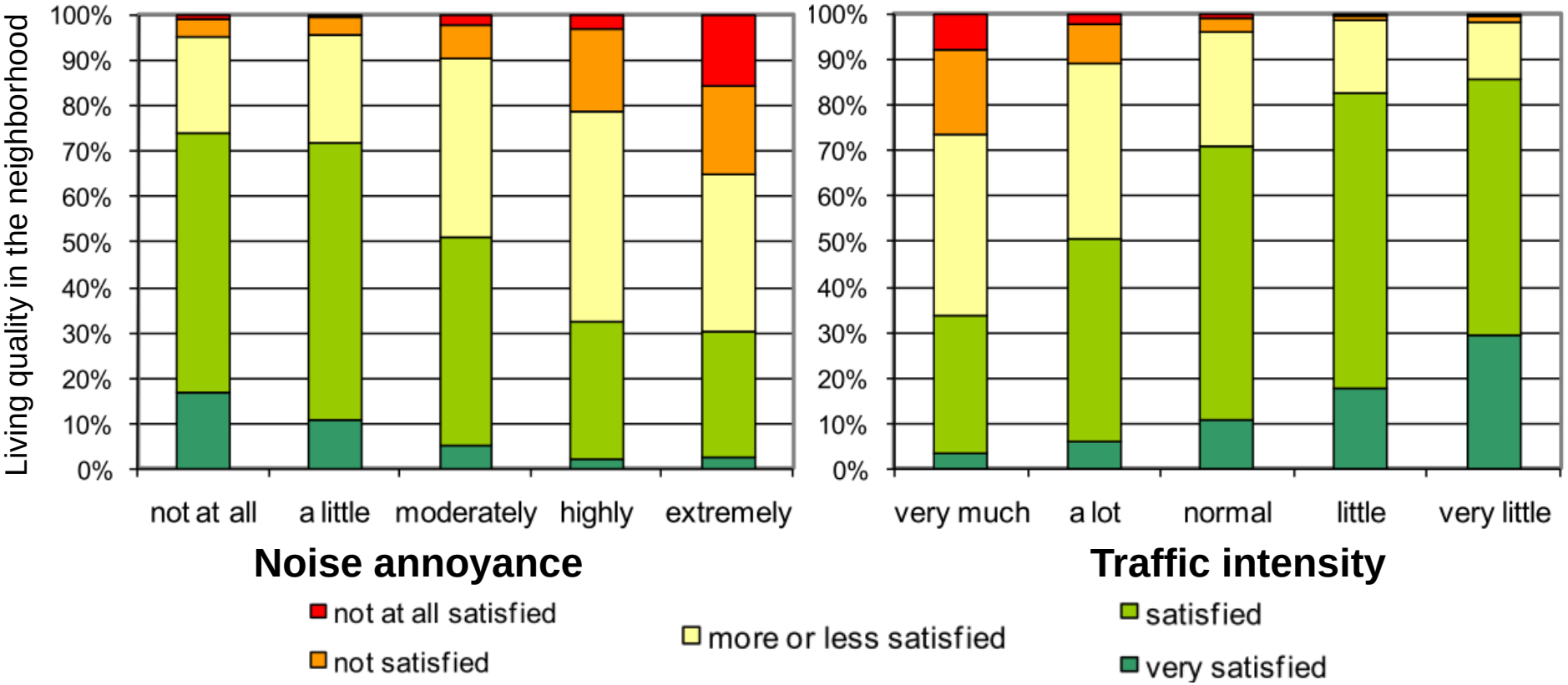
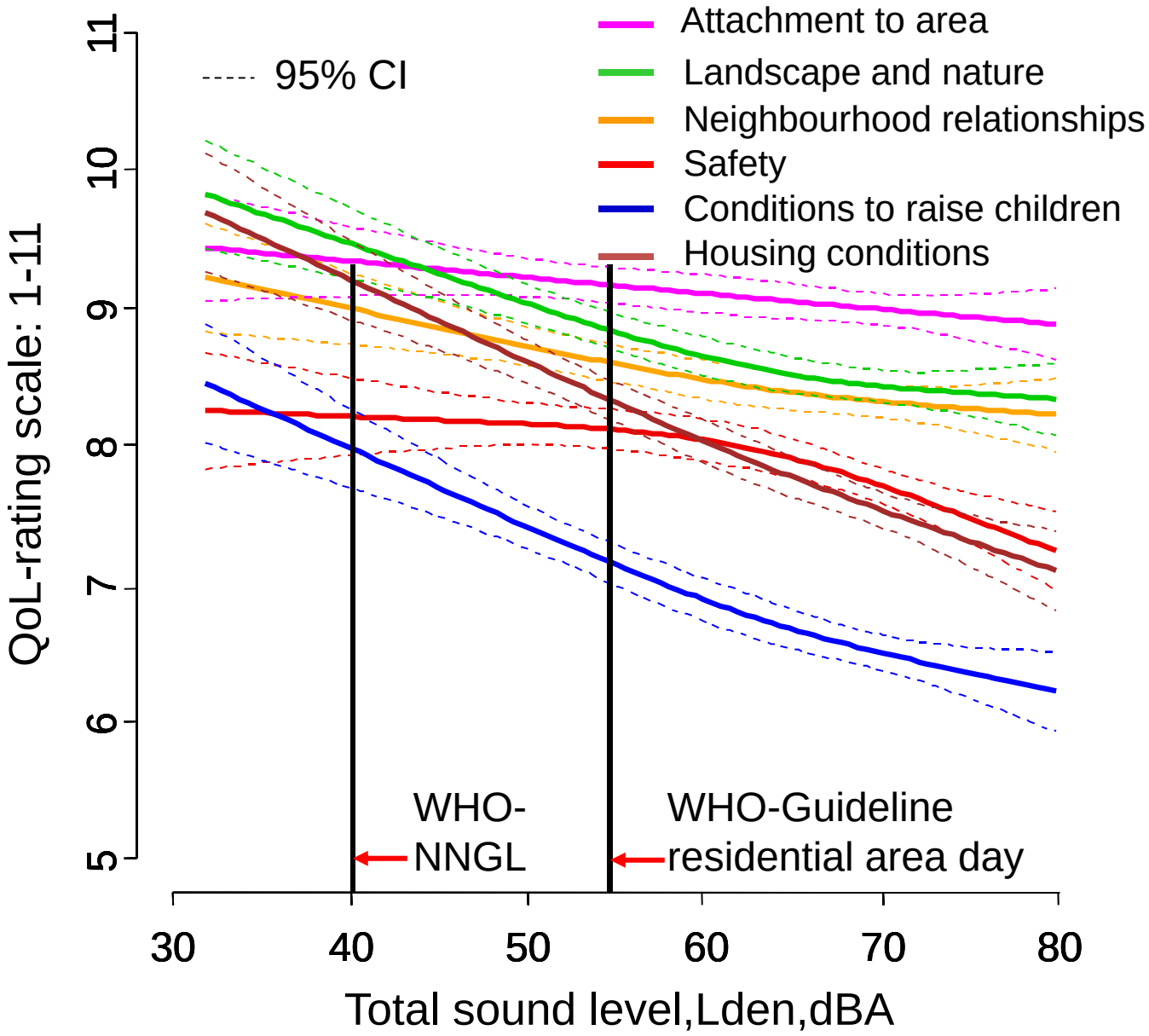


Botteldooren et al 2011 concluded that the relation between traffic intensity and quality of life in the neighborhood could be generated through street traffic noise annoyance or through other negative or positive aspects of traffic such as safety, exhaust smell, or even accessibility.

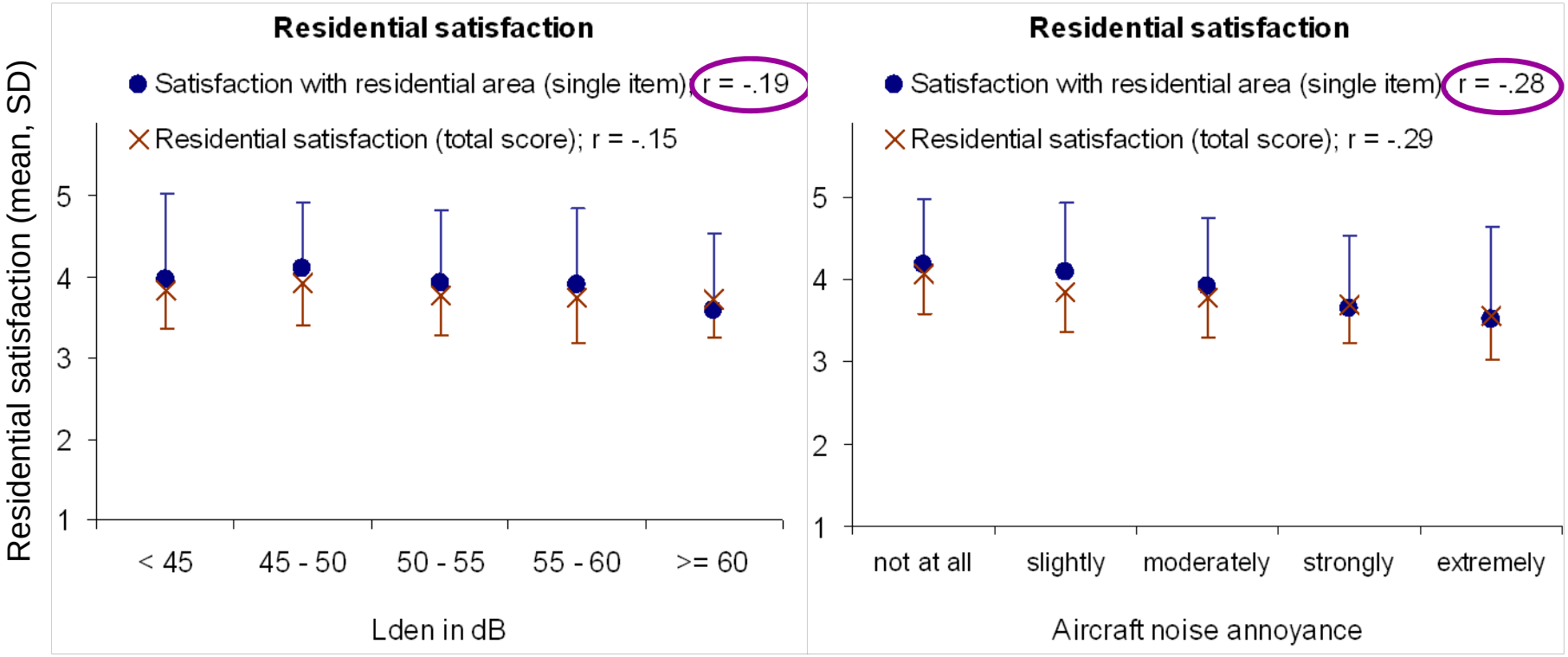
Combining this analysis with a question on traffic intensity in the neighborhood further suggests that the pathway from traffic through noise to quality of life in the neighborhood accounts for the strongest relationship between traffic and quality of life.





Lercher, 2006 BBT-study, unpublished

Figure 3. Means and standard deviation of residential satisfaction (single item, total score) by aircraft noise exposure (left) and by aircraft noise annoyance (right side)



A Schreckenberg et al. 2010

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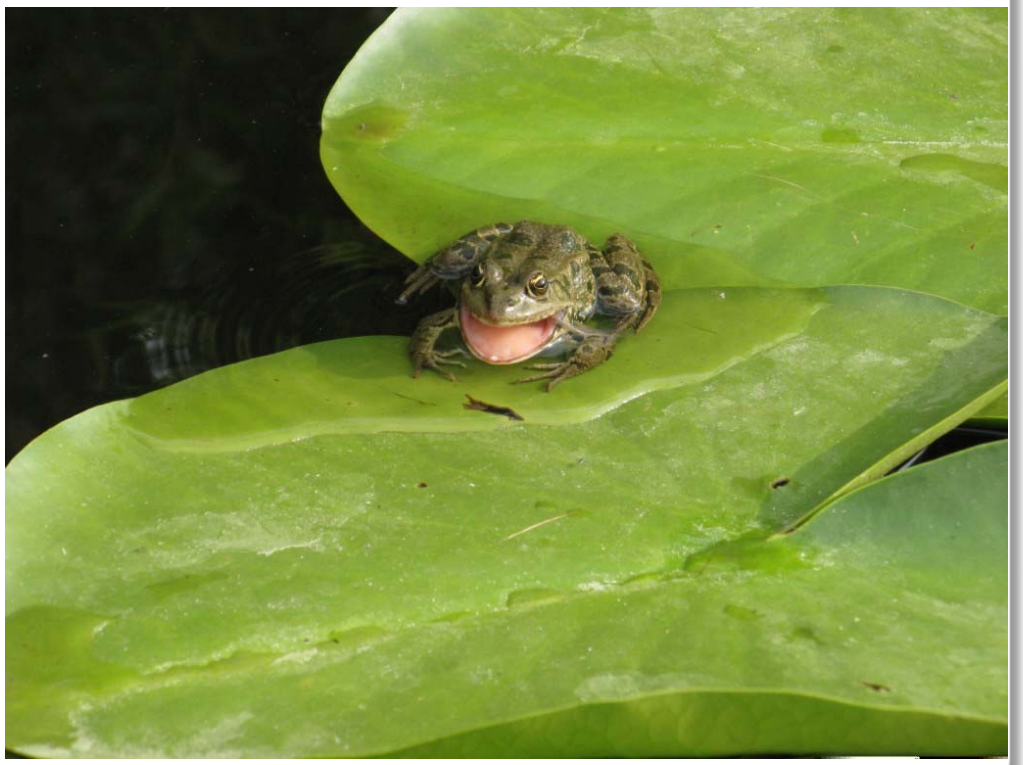
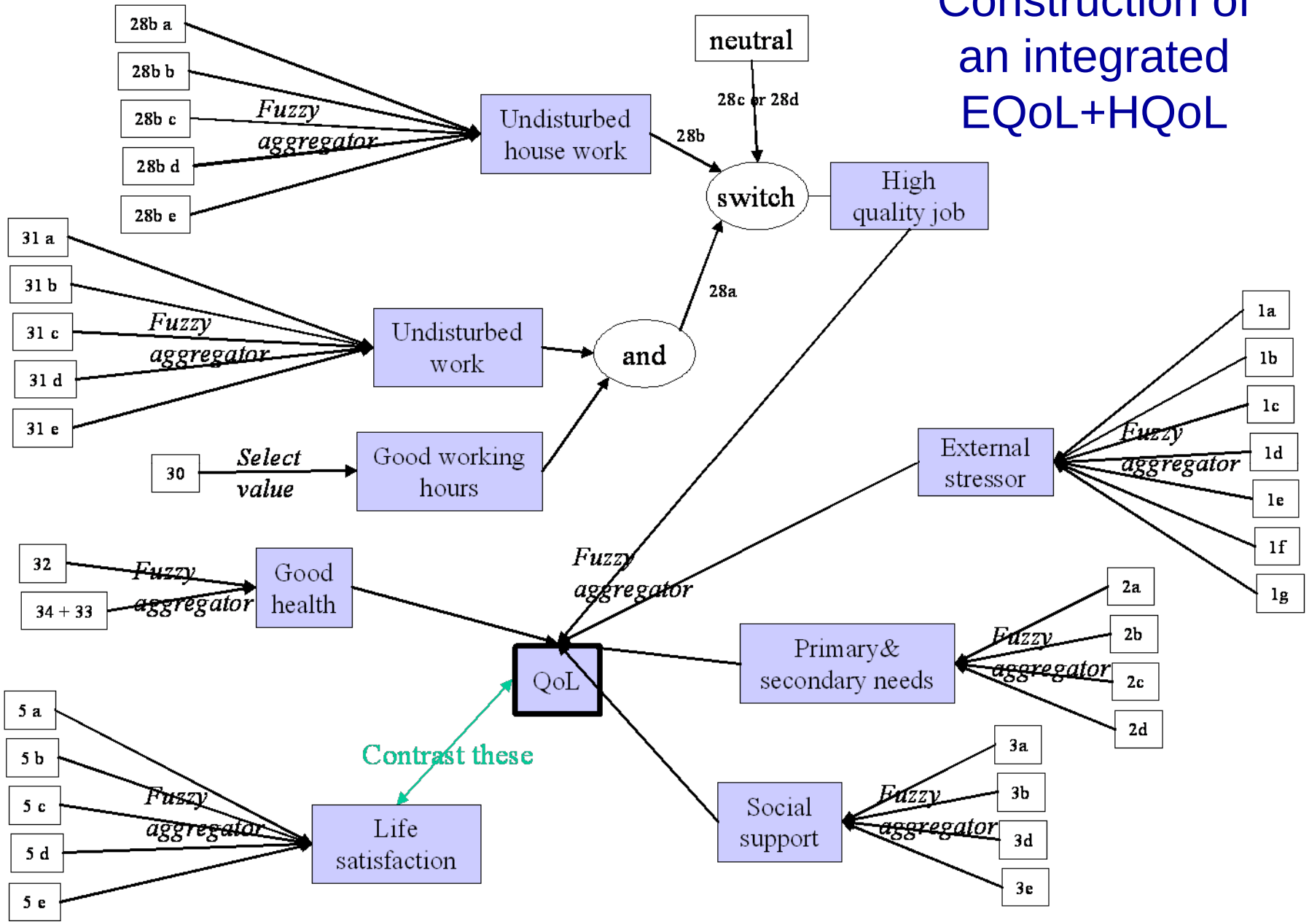


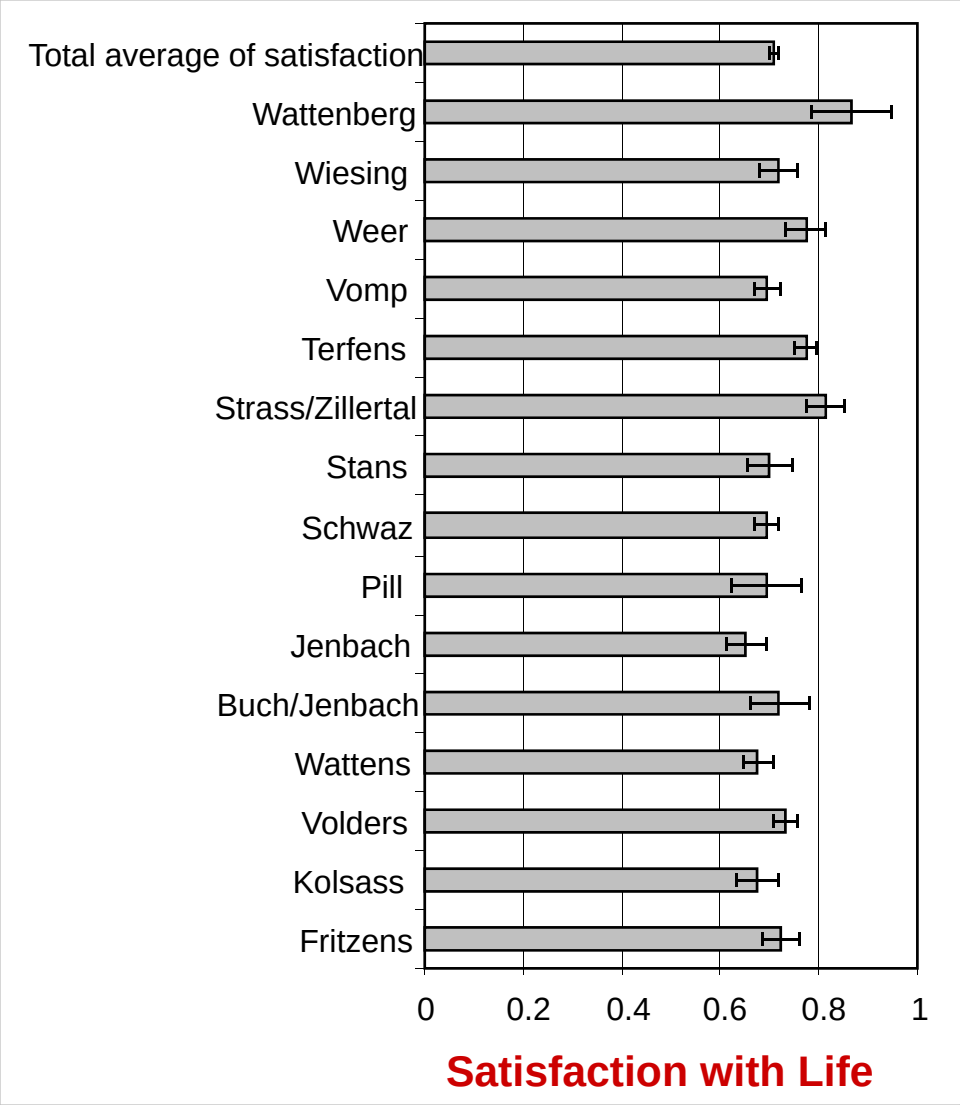
Construction of an integrated EQoL+HQoL

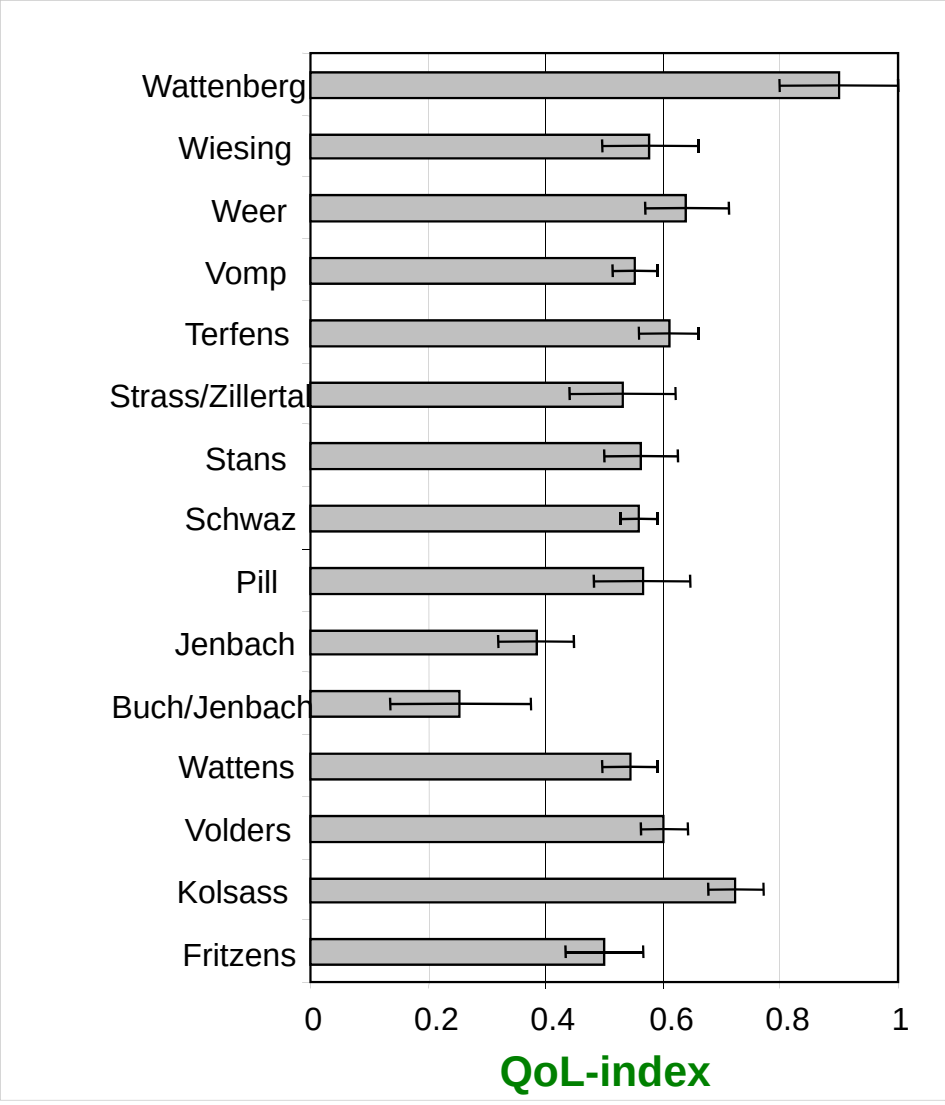


Botteldooren & Lercher Internoise 2006

Satisfaction with Life versus Quality of Life

Quite different variations between communities

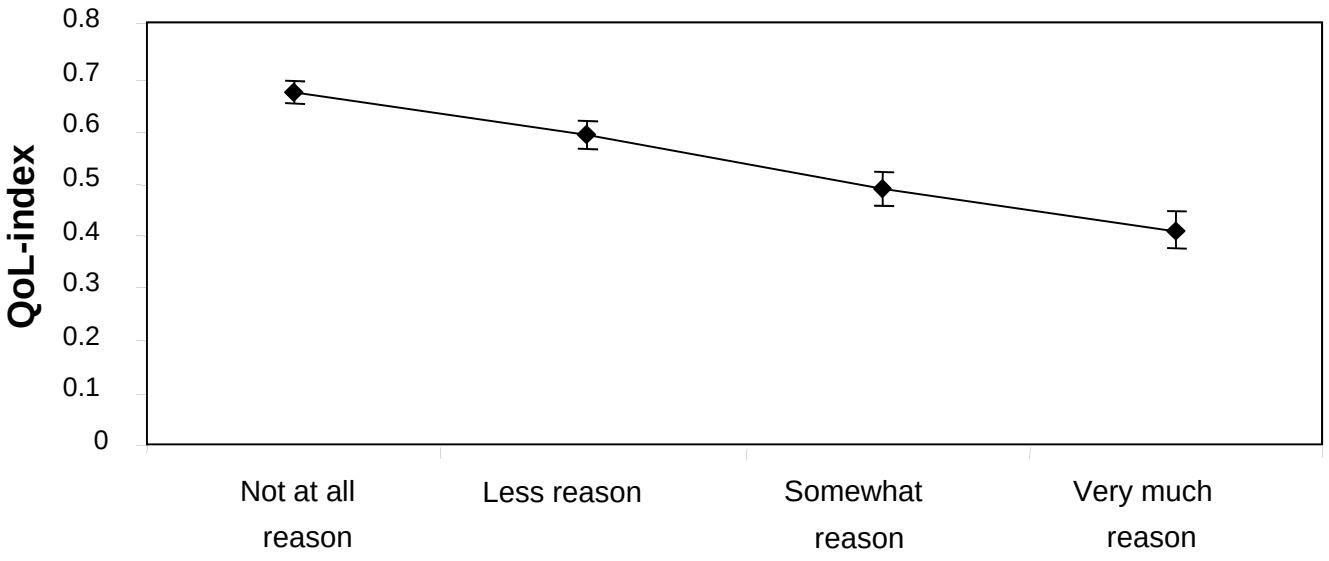




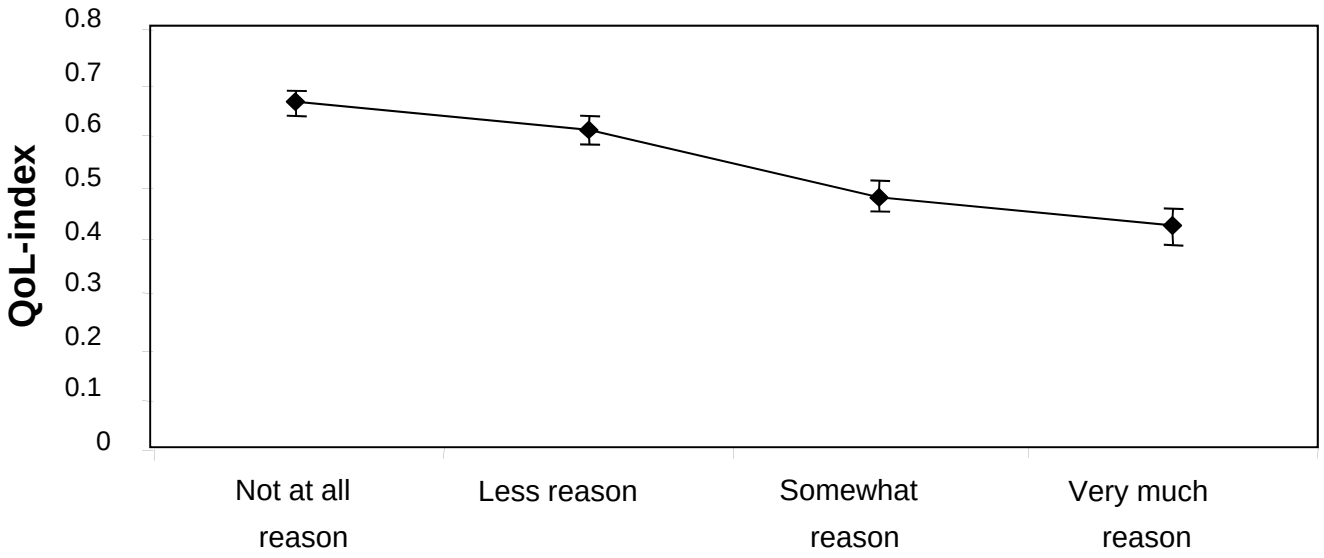
Botteldooren & Lercher Internoise 2006

Quality of Life Index

The relation with perception of noise and air pollution



Reasons to complain about noise exposure*



Reasons to complain about air pollution*

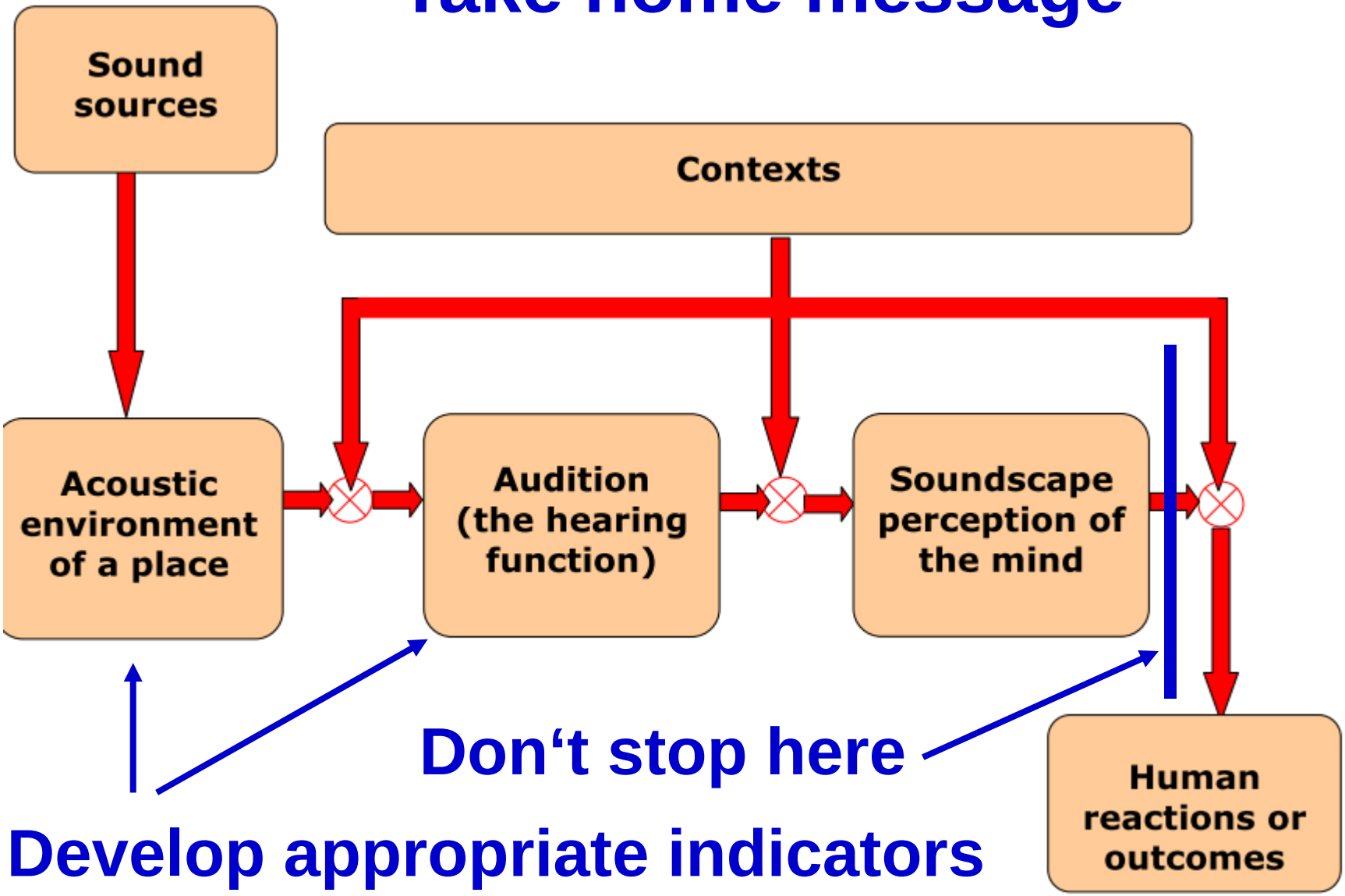
Botteldooren & Lercher Internoise 2006

* Eurobarometer question - environmental module

- Introduction and Policy perspectives
- Health related QoL
- Results: Health status
- Environmental QoL
- Results: (E)QoL
- (H+E)QoL vs Satisfaction
- Summary/Conclusions

- Health related quality of life indicators should be more often utilized in all soundscape studies (Type I+II+III)
- The different facettes of Environmental quality of life needs to be included in a perspective that addresses sustainability and positive health
- A mono-sensoric approach is not appropriate – a multi-sensoric (vision, odour, noise, vibration) view is required
- In Environmental health assessment an extended view includes combined and cumulative positive or negative effects
- Combining Health and Environmental Quality of life approaches are more suitable to detect differences between small areas and communities – interventions can be optimised

Take home message



Don‘t stop here

Develop appropriate indicators

Graph from Schomer et al. Internoise 2010

Noise & Quality of life
Special issue in Int. J. Environ. Research and Public Health

Anita Gidlöf-Gunnarsson and Evy Öhrström Article: Attractive "Quiet" Courtyards: A Potential Modifier of Urban Residents' Responses to Road Traffic Noise? Int. J. Environ. Res. Public Health 2010, 7(9), 3359-3375;

Pamela Woolner and Elaine Hall Article: Noise in Schools: A Holistic Approach to the Issue Int. J. Environ. Res. Public Health 2010, 7(8), 3255-3269;

Jesper J. Alvarsson, Stefan Wiens and Mats E. Nilsson Article: Stress Recovery during Exposure to Nature Sound and Environmental Noise Int. J. Environ. Res. Public Health 2010, 7(3), 1036-1046;

Dirk Schreckenberg, Markus Meis, Cara Kahl, Christin Peschel and Thomas Eikmann Article: Aircraft Noise and Quality of Life around Frankfurt Airport Int. J. Environ. Res. Public Health 2010, 7(9), 3382-3405;

Stephen J. Lepore, Bhaskar Shejwal, Bang Hyun Kim and Gary W. Evans Article: Associations between Chronic Community Noise Exposure and Blood Pressure at Rest and during Acute Noise and Non-Noise Stressors among Urban School Children in India Int. J. Environ. Res. Public Health 2010, 7(9), 3457-3466;

Birgit Mazurek, Heidi Olze, Heidemarie Haupt and Agnieszka J. Szczepek Article: The More the Worse: the Grade of Noise-Induced Hearing Loss Associates with the Severity of Tinnitus Int. J. Environ. Res. Public Health 2010, 7(8), 3071-3079;

Daniel Shepherd et al. The Relationship between Noise Sensitivity, Annoyance and Health-Related Quality of Life in a Sample of Adults Exposed to Environmental Noise. Int. J. Environ. Res. Public Health 2010, 7, 3579-3594;

Norun H Krog et al. Effects of changed Aircraft Noise Exposure on the Use of Outdoor Recreational Areas. Int. J. Environ. Res. Public Health 2010, 7, 3890-3915;

Norun H Krog et al. Effects of Changed Aircraft Noise Exposure on Experiential Qualities of Outdoor Recreational Areas. Int. J. Environ. Res. Public Health 2010, 7, 3739-3759;

Dick Botteldooren et al. The Influence of Traffic Noise on Appreciation of the Living Quality of a Neighborhood. Int. J. Environ. Res. Public Health 2011, 8, 777-798;