Zürcher Hochschule
für Angewandte Wissenschaften

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aw

Institute of Facility Management
Workplace Research & Management

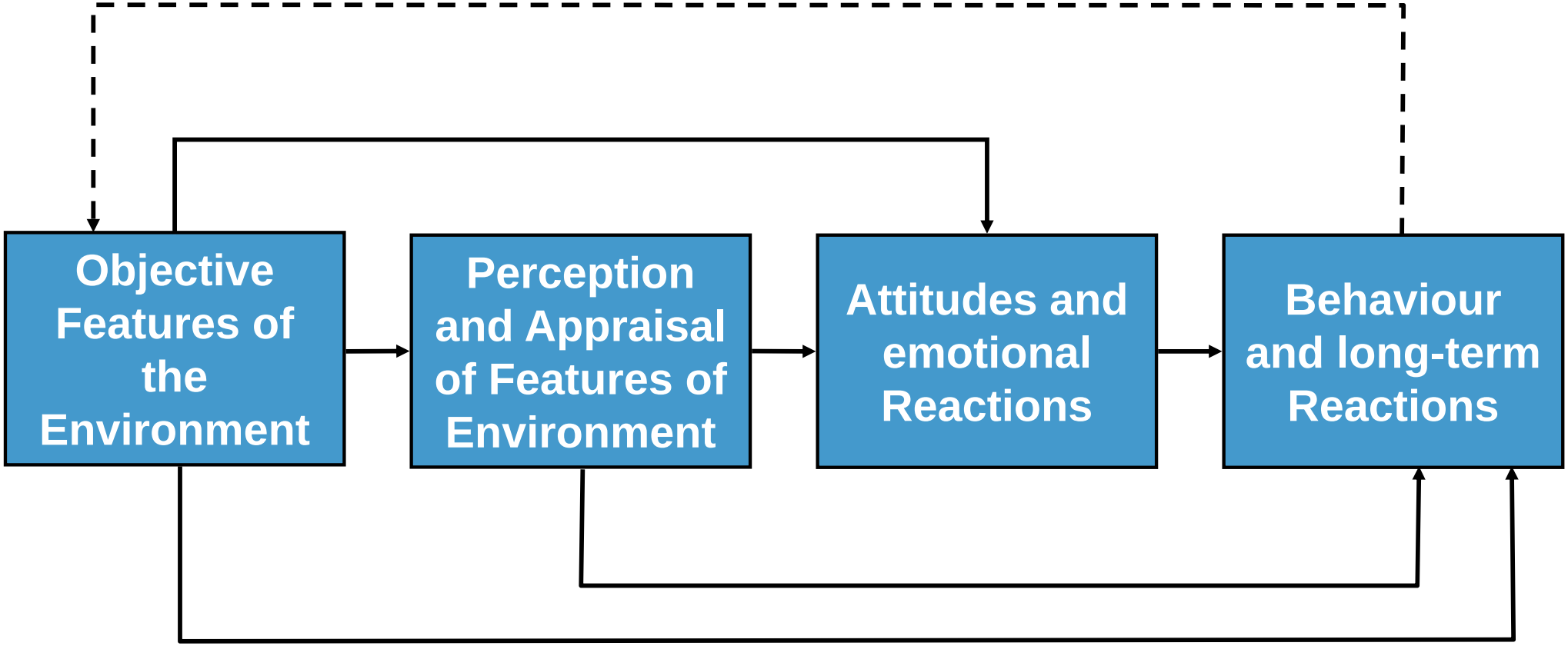
OFFICE NOISE IN REAL-WORLD OFFICES

SAFE (Sound acoustics for employees), November 2015, Dortmund

Introduction

1

Conceptual model of environment-behaviour relationship (Marans & Spreckelmeyer, 1981, p. 22, modified)



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Study I: Multilevel analysis of building/design parameters, perceptions, job characteristics, and employee-level outcomes

Goals and characteristics of study I

Goals of the study

- Analysis of relative effects of (perceived) office environment and (perceived) job characteristics on (perceived) user-level outcomes
- Analysis of office users' perceptions and building/design parameters on user-level outcomes

Characteristics of study

- Cross-sectional field study
- 24 organisations (financial services, telecom, construction, public administration, technology, pharmaceutical industry)
- 39 buildings (3-155 years old; median size: 104 workplaces; 21 owned, 18 leased; median social density: 7)
- 1373 employees completed survey (46% female, 54% male, mean age: 40.1)
- Predominant office type per building:
  - Cell office (1-2 employees): 11
  - Small group office (3-15 employees): 11
  - Large group office (16-50 employees): 14
  - Open space (> 50 employees): 2
  - Combi office:1

Measures: assessment of work environment

Measure	Source
Environmental Features Rating	Veitch et al., 2003
Work and storage space	Brennan et al., 2002
Workspace quality	Lee & Brand, 2005
Distractions	Lee & Brand, 2005
Office noise	Leather et al., 2002
Privacy	Oldham, 1988
Crowding	May et al., 2005; Oldham, 1988
Control over the individual work environment	Lee & Brand, 2005

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Measures: outcomes, work characteristics, social stressors

Measure	Source
Work area satisfaction	May et al., 2005, Charles et al., 2003
Job satisfaction	Baillod & Semmer, 1994
Health symptoms	Mohr, 1986, 1991
Self-assessed work performance	Brennan et al., 2002; Oldham, 1988; Settoon & Mossholder, 2002
Work engagement (dedication, vigour)	Demerouti, 1999
Screening of work characteristics	Prümper et al., 1995
Social stressors	Frese & Zapf, 1987

Effective workplaces: spatial environments and job design

Office environment

Spatial organisation of offices
- Layout
- Spatial Density
- Workspace quality
- Work and storage spaces
- Workplace appropriateness

Indoor environmental conditions
- Office noise
- Indoor climate
- Lighting
- Control over environment

Socio-spatial environment
- Social density
- Privacy
- Crowding
- Distractions

Employee-level outcomes
- Satisfaction
- Health
- Work performance

Job design

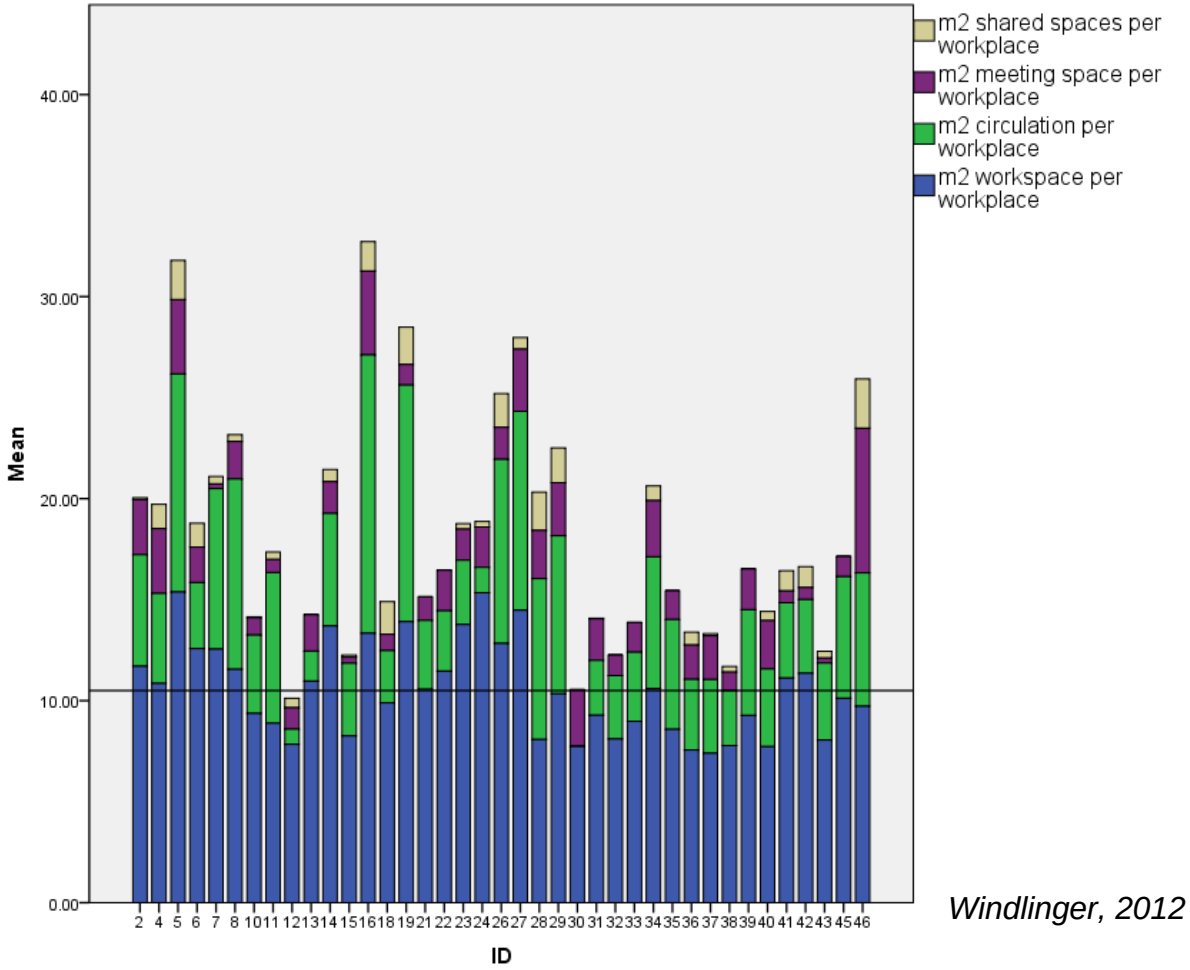
Scope of action
decision possibilities with regard to procedures, equipment, time frame, and sequence of actions

Variety
degree to which skills and abilities can be applied for dealing with work tasks, deciding, and learning new things on the job

Overload
- Quantitative overload (time pressure, high workload)
- qualitative overload (overtaxing information processing)

Multi-level Analysis

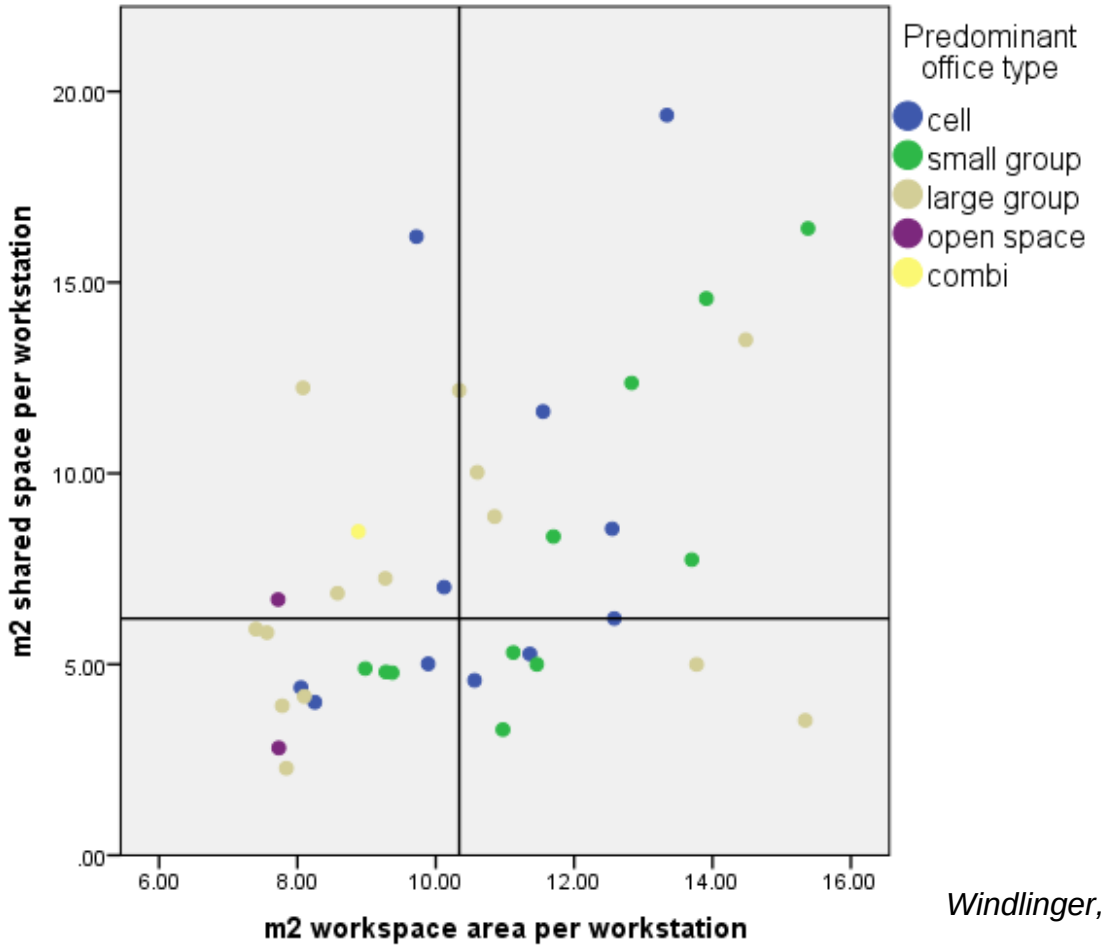
Floor space per workplace per building



Windlinger, 2012

→ Amount of floor space is not statistically related to employee-level outcomes (satisfaction, health, work performance)

Floor space ratios per workplace per building



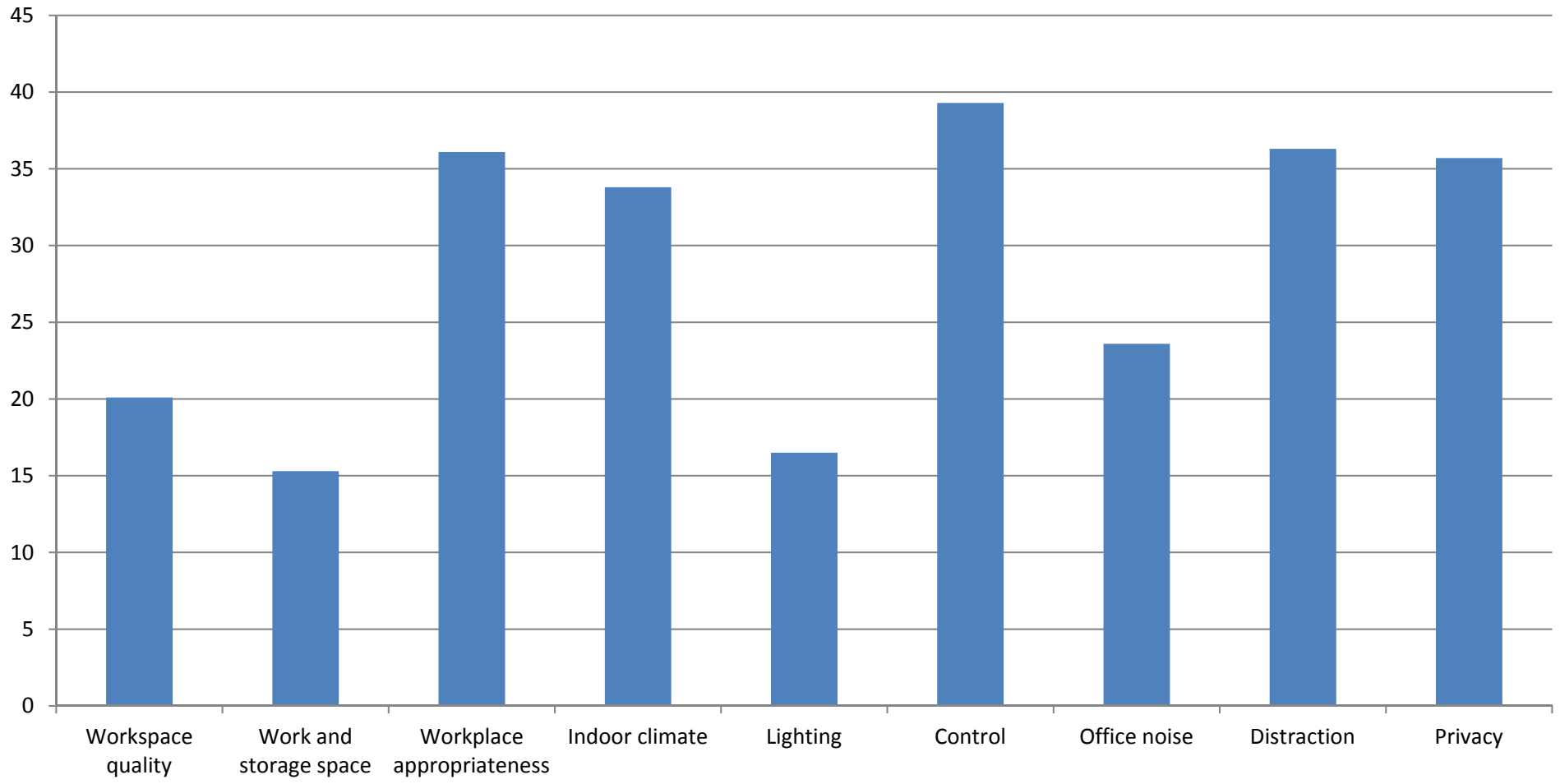
Windlinger, 2012

→ Ratios of floor space / office type are not statistically related to employee-level outcomes (satisfaction, health, work performance)

Office quality lies in the eyes of the beholder

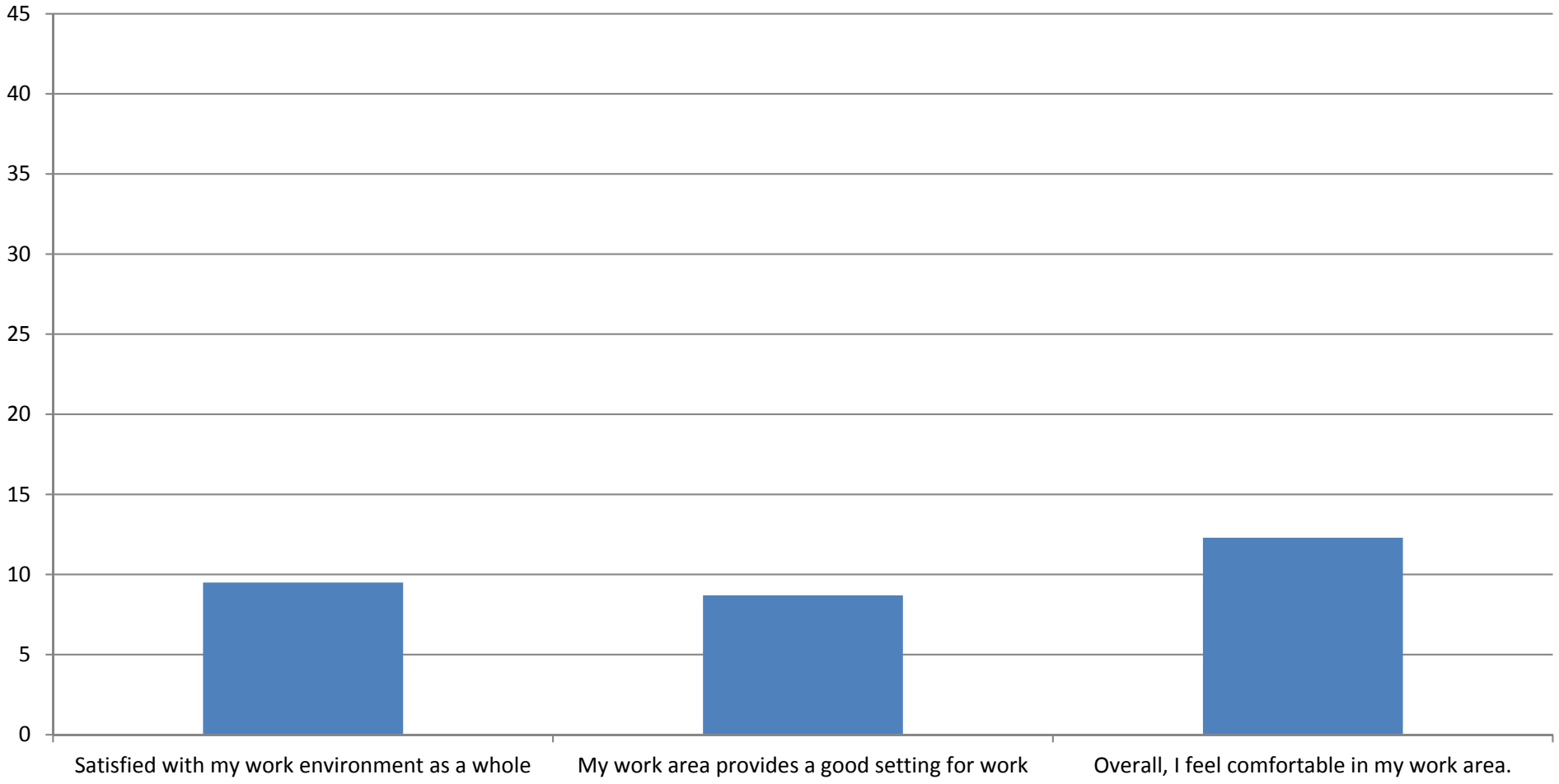
→ Satisfaction, health, and work performance cannot be explained by spatial building parameters but depend on users' perceptions

Percentage Dissatisfied with aspects of the office environment (n=1373)



Windlinger, 2012

Percentage Dissatisfied with the office environment as a whole (n=1373)



Windlinger, 2012

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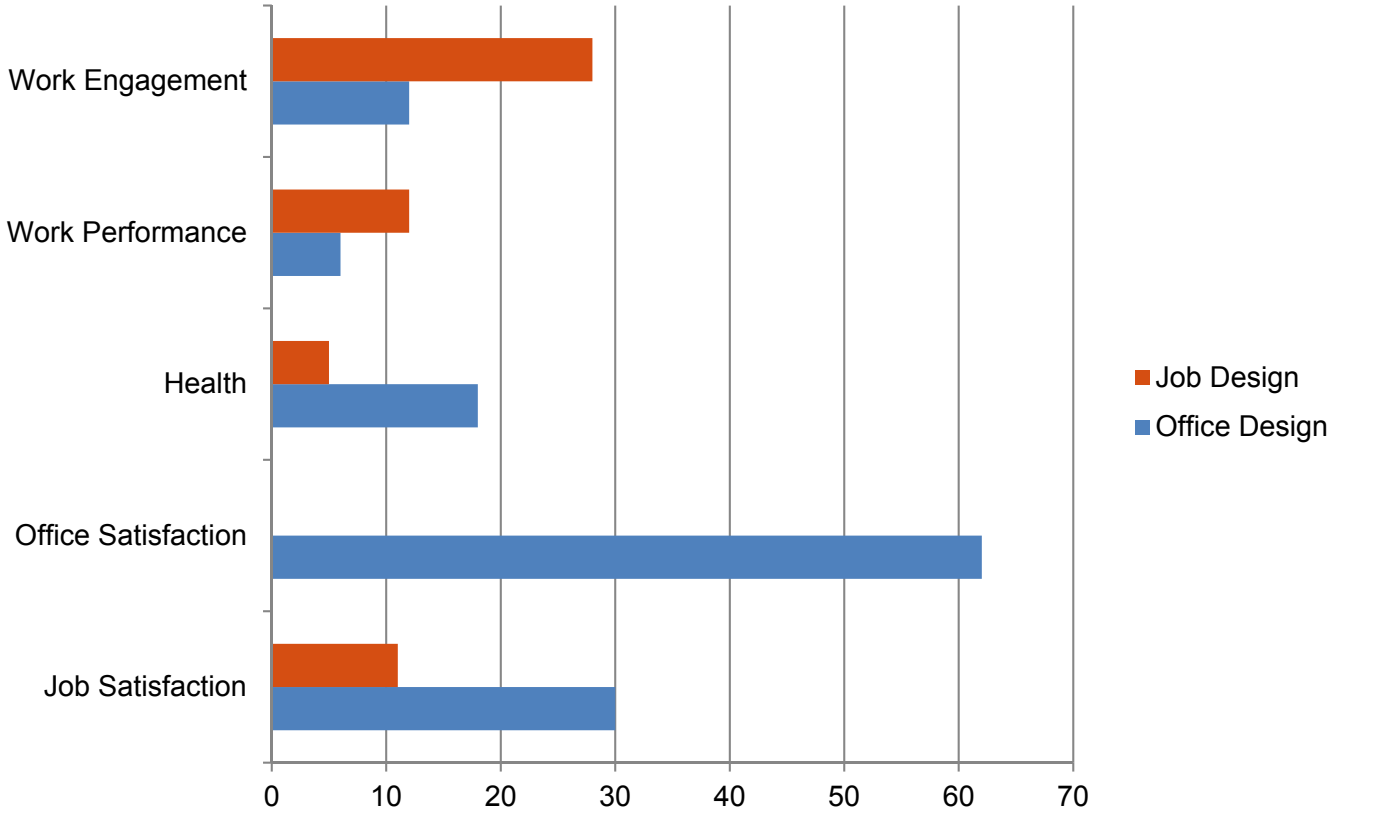
Ranking of job characteristics and office design effects on employee-level outcomes (MLM)

	Work area satisfaction	*Job satisfaction*	*Health*	*Self-assessed job performance*	*Self-assessed job performance based on feedback*	*Situational work performance*	*Dedication*	*Vigour*
1	**Workspace quality**	**Variety**	**Gender**	**Variety**	**Variety**	**Variety**	**Variety**	**Overload**
2	**Work and storage spaces**	**Workspace quality**	**Overload**	Workspace quality	**Scope of action**	**Privacy**	Office noise	**Variety**
3	**Distractions**	**Overload**	**Social density**	Gender	**Overload**	**Scope of action**	Workspace quality	**Work and storage spaces**
4	**Privacy**	**Distractions**	**Scope of action**	Distractions	Gender	**Workplace appropriateness**	Workplace appropriateness	**Social density**
5	**Control**	**Control**	**Distractions**	Age		**Gender**	Scope of action	Distractions
6	Indoor climate	Indoor climate	Workplace appropriateness			**Overload**	Overload	Scope of action
7	Gender		Workspace quality			Workspace quality	Lighting	Workplace appropriateness
8	Variety		Office noise			Distractions	Age	Privacy
9			Indoor climate			Age		

Note: Ranking is based on significant γ-values in Multilevel Analysis; coefficients for factors printed in bold are >.10

Windlinger, 2012

Explained variance: relative effects of office environment and job characteristics



Windlinger, 2012

→ **Substantial effects of office design variables on all outcome dimension**

Summary from perspective of Job Demands-Resources model

- Overload
- Noise
- Crowding
- Distractions
- Environmental stressors
- Social stress

- Scope of action
- Variety of job tasks
- Holistic job
- Social support
- Control over physical environment
- Privacy
- Workspace design
- Workplace appropriateness
- Indoor climate
- Lighting
- Social density

Study II: Quality of sustainable office buildings

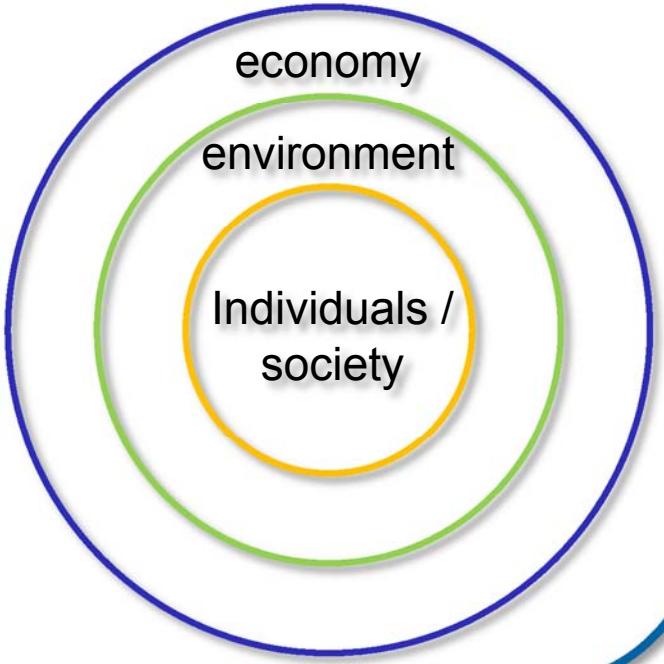
Goals and characteristics of study II

Goals of the study

- What are the benefits and disadvantages of sustainable office buildings for the user?
- How do occupants deal with sustainable office buildings and what are the consequences of their behavior on ecological aspects of sustainability?

Characteristics of study

- Cross-sectional field study
- 10 organisations (financial services, energy provision, engineering, IT)
- 26 buildings (built between 1915 and 2011; 7 with sustainability certificates; 18 owned, 8 leased; 91-2100 workplaces, median 363)
- 6092 employees completed survey (38% female, 62% male; mean age: 39.9)
- Average social density: 44

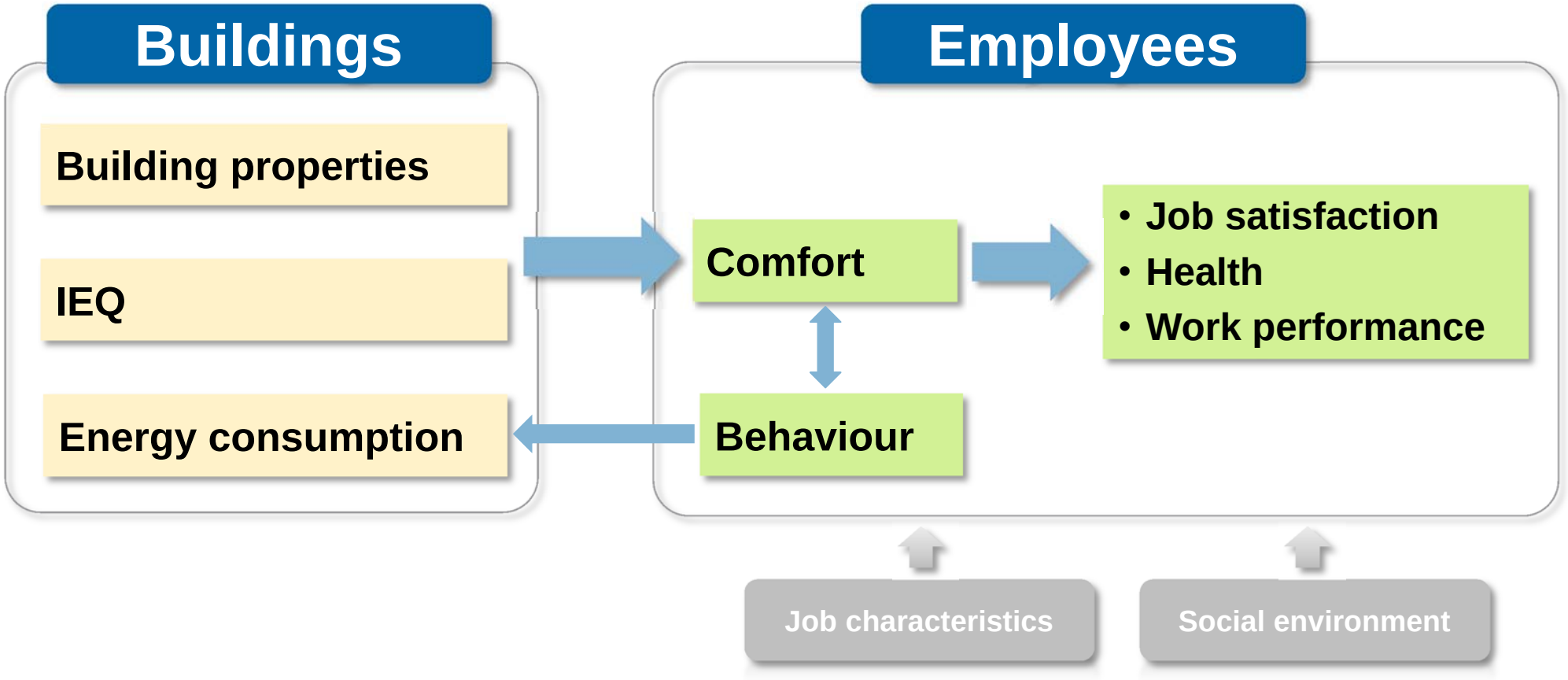


Measures

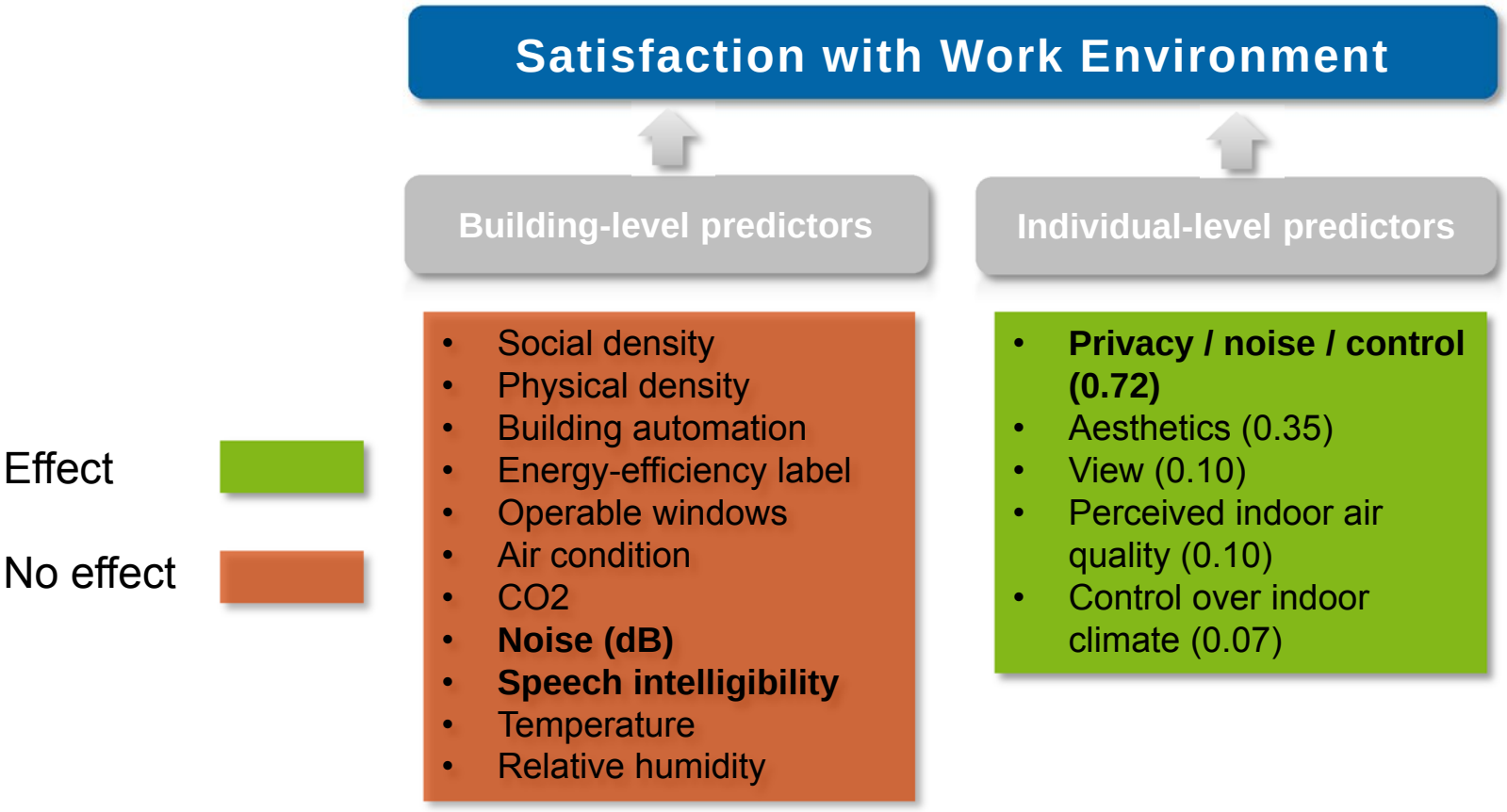
Measure	Source
Environmental Features Rating	Veitch et al., 2003
Indoor climate work environment, MM 040 EA	Andersson, 1998
Self-assessed work performance	Brennan et al., 2002; Oldham, 1988; Settoon & Mossholder, 2002
Work engagement	Schaufeli & Bakker, 2003
Screening of work characteristics	Prümper et al., 1995
Social stressors	Frese & Zapf, 1987

Indoor environmental quality was measured at 6-9 typical workstations in each building (indoor air quality: temperature, relative humidity, CO2, air movement, VOC, dust; lighting, dB, STIPA)

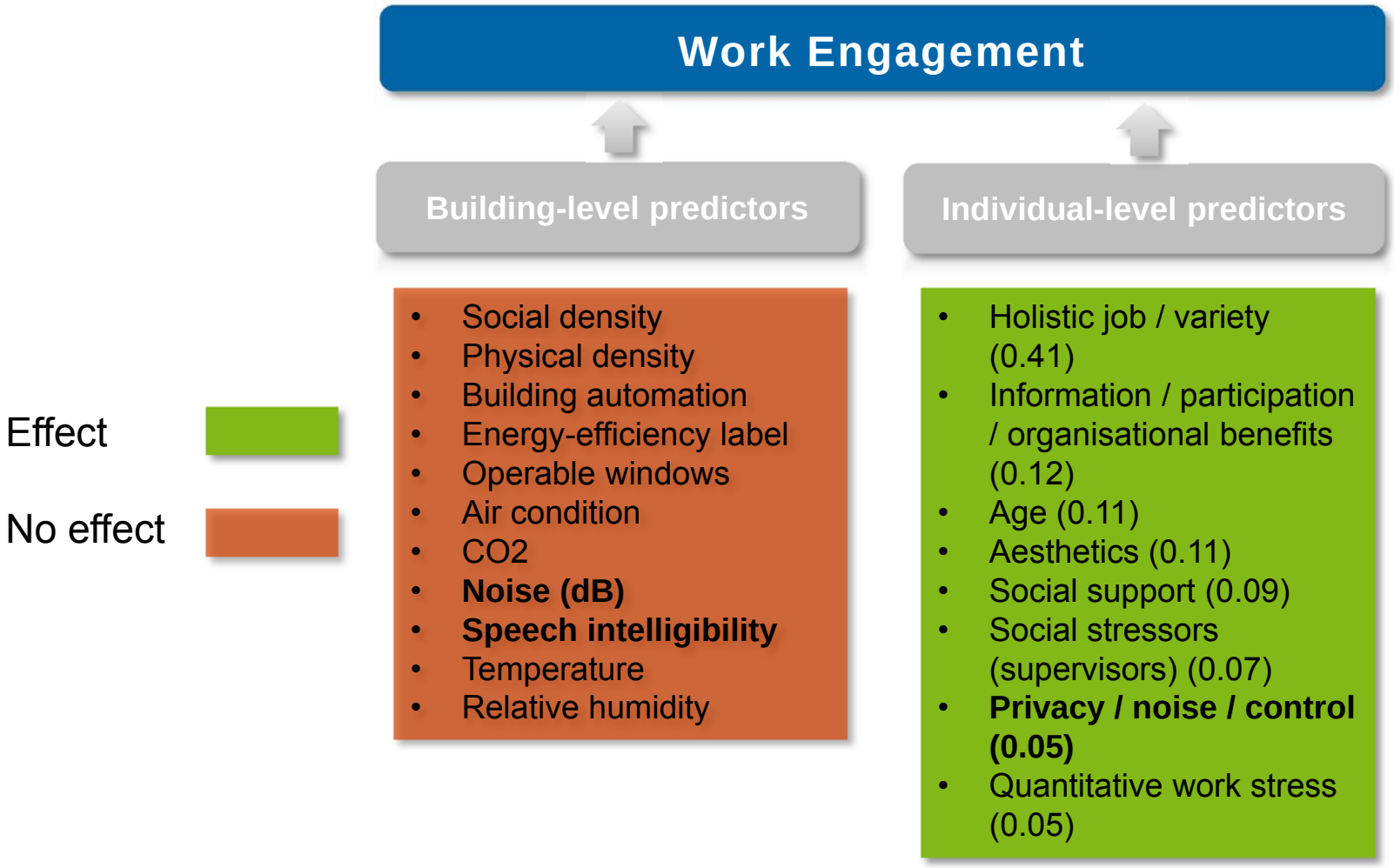
Theoretical framework



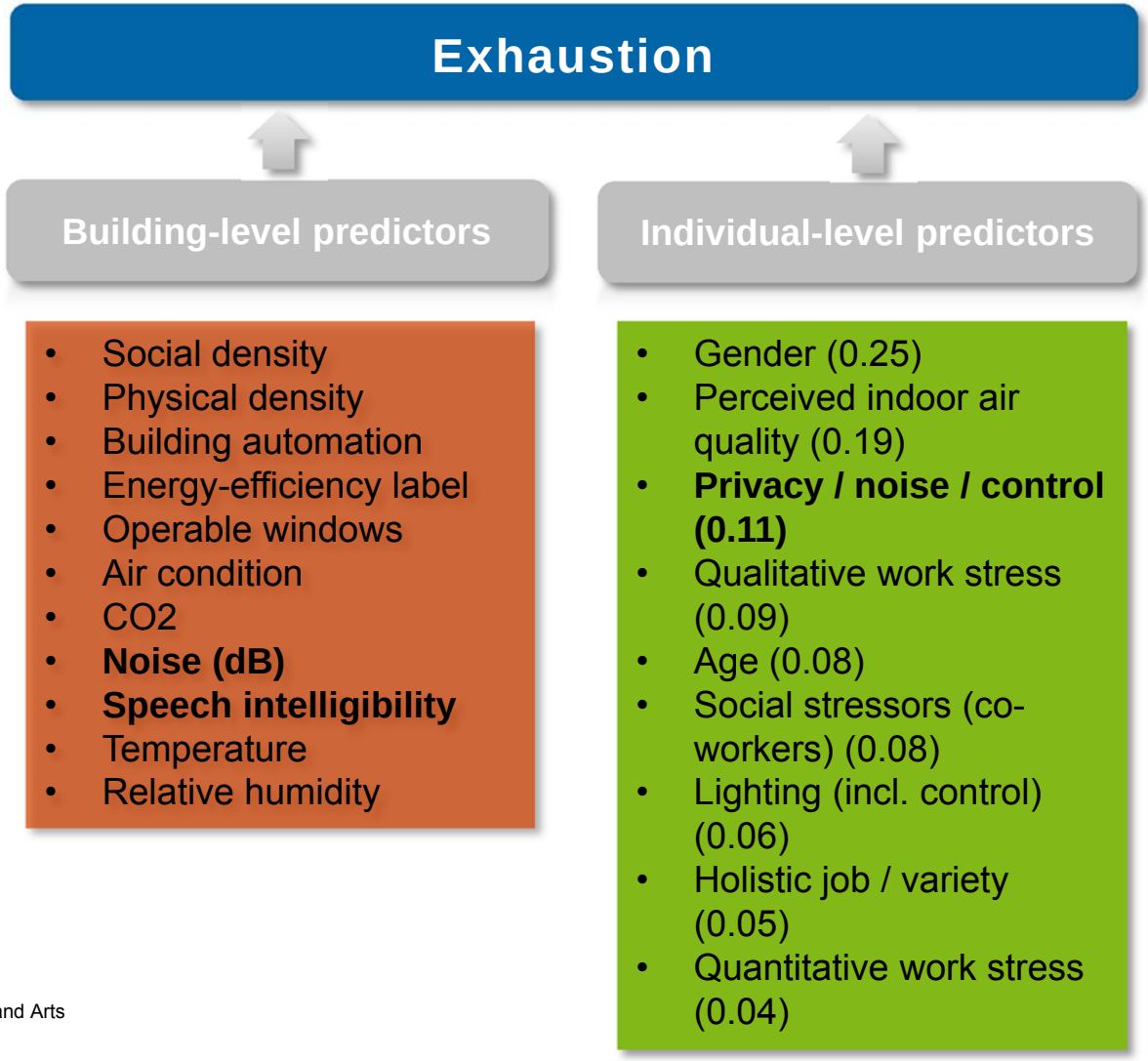
Multi-level Analysis for Satisfaction with Work Environment



Multi-level Analysis for Work Engagement



Multi-level Analysis for Exhaustion



Activity-based office concepts

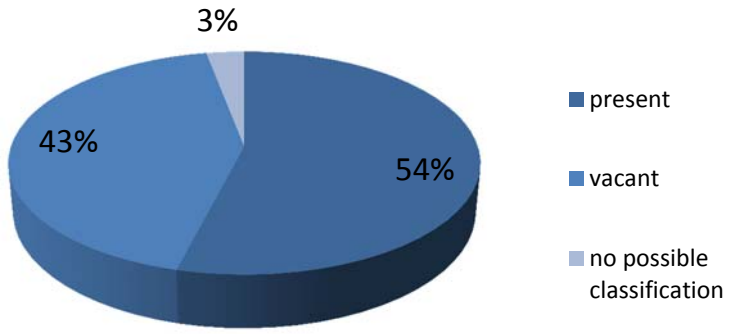
Office Utilization Rate – All Office Areas

Study (Office)	Office type	Number of observed points	% Present	% Absent	% Vacant	% No possible classification
1	Activity based office	217	37%	21%	42%	0%
2	Multi-space	114	42%	21%	37%	0%
3	Multi-space	170	39%	26%	35%	0%
4	Open-plan	226	38%	22%	40%	0%
5	Open-plan	118	41%	27%	32%	0%
6	Open-plan	163	36%	20%	44%	0%
7	Open-plan	262	35%	18%	42%	5%
8	Cellular office	266	40%	20%	40%	0%
9	Open-plan	285	25%	15%	58%	2%
10	Multi-space	196	37%	31%	29%	3%
11	Open-plan	607	36%	21%	37%	6%
12	Aktivity based office	319	31%	22%	47%	0%
13	Cellular office	122	54%		43%	3%
	Average		**38%**	**22%**	**40%**	**1%**

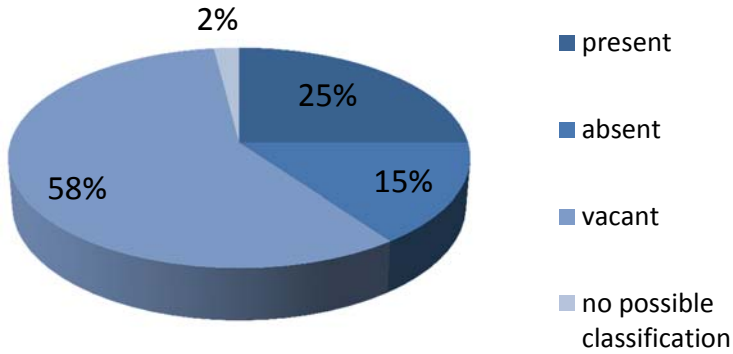
the highest

the lowest

The study with the highest present rate



The study with the lowest present rate



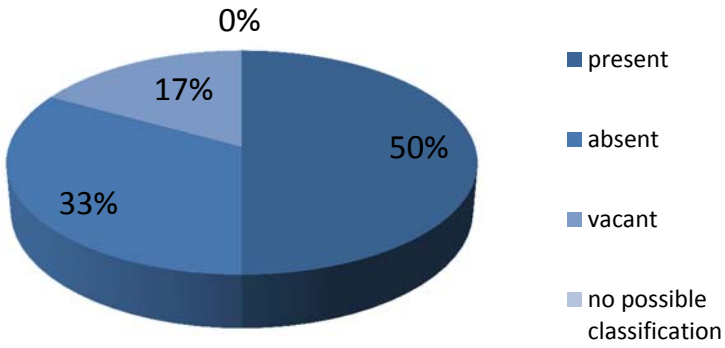
Office Utilization Rate – Standard Workstation

Study (Office)	Office type	Number of workstations	% Present	% Absent	% Vacant	% No possible classification
1	Activity based office	162	50%	33%	17%	0%
2	Multi-Space	90	40%	23%	36%	1%
3	Multi-Space	154	41%	28%	31%	0%
4	Open-plan	202	39%	23%	38%	0%
5	Open-plan	113	43%	26%	31%	0%
6	Open-plan	146	42%	28%	25%	5%
7	Open-plan	203	44%	22%	30%	4%
8	Cellular office	245	42%	22%	36%	0%
9	Open-plan	272	26%	16%	58%	0%
10	Multi-Space	183	40%	33%	27%	0%
11	Open-plan	560	37%	23%	36%	4%
12	Activity based office	280	30%	25%	45%	0%
13	Cellular office	112	40%		58%	2%
	Average		**40%**	**25%**	**36%**	**1%**

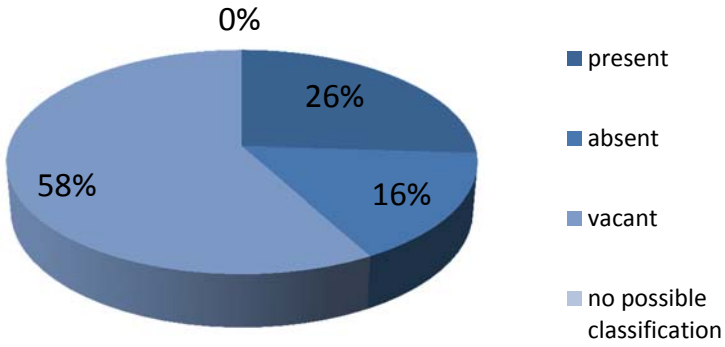
the highest

the lowest

The study with the highest present rate



The study with the lowest present rate



Peak of Present and Absent

Study (Office)	Office Type	Number of observed points	Peak % Present	Peak % Present and Absent (=in use)
1	Activity based office	217	70%	84%
2	Multi-space	114	50%	70%
3	Multi-space	170	52%	81%
4	Open-plan	226	53%	74%
5	Open-plan	118	52%	78%
6	Open-plan	163	43%	65%
7	Open-plan	262	57%	76%
8	Cellular office	266	58%	85%
9	Open-plan	285	36%	50%
10	Multi-space	196	48%	80%
11	Open-plan	607	52%	80%
12	Activity based office	319	42%	67%
13	Cellular office	122	68%	72%
	Average		**52%**	**74%**

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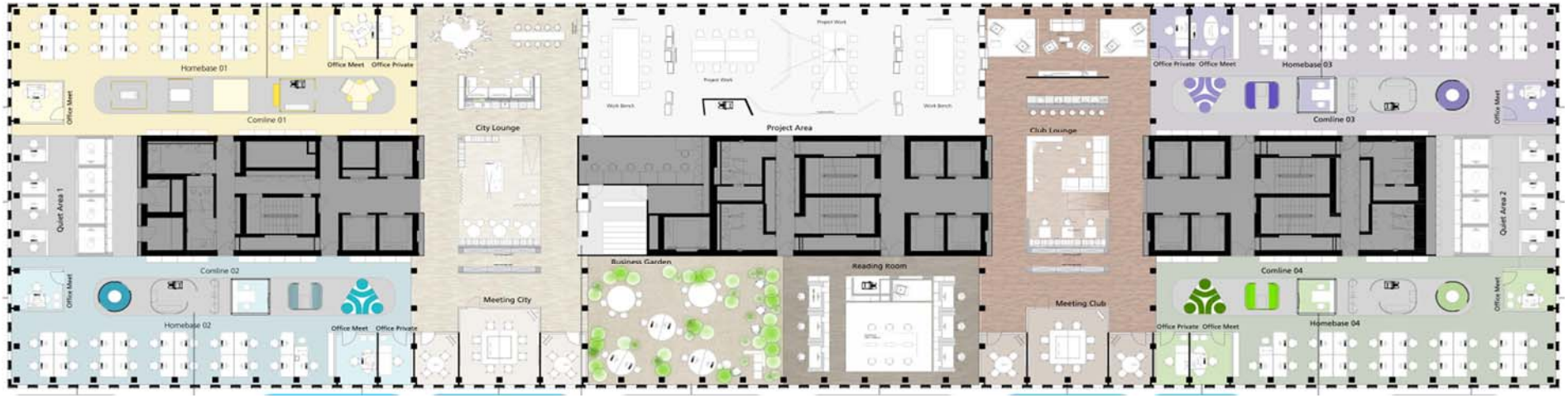
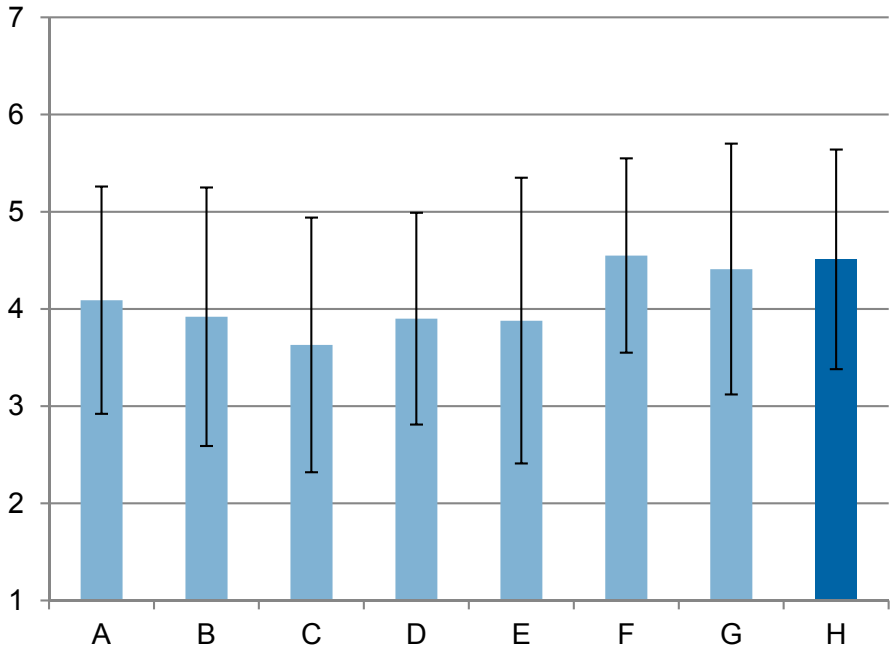
Pilot project Smart Working CS-Tower Zurich



- 158 workspaces for 215 employees (sharing ratio 75 %)
- 10.5 m^2 per employee
- 22 Standard workspaces in 4 „Homebases“ (each for 50 employees)
- 70 additional workspaces in special areas such as Projekt Area, Business Garden, Reading Room and Quiet Areas
- 36 alternative (not fully equipped / substandard) workspaces
- No solo offices for managers

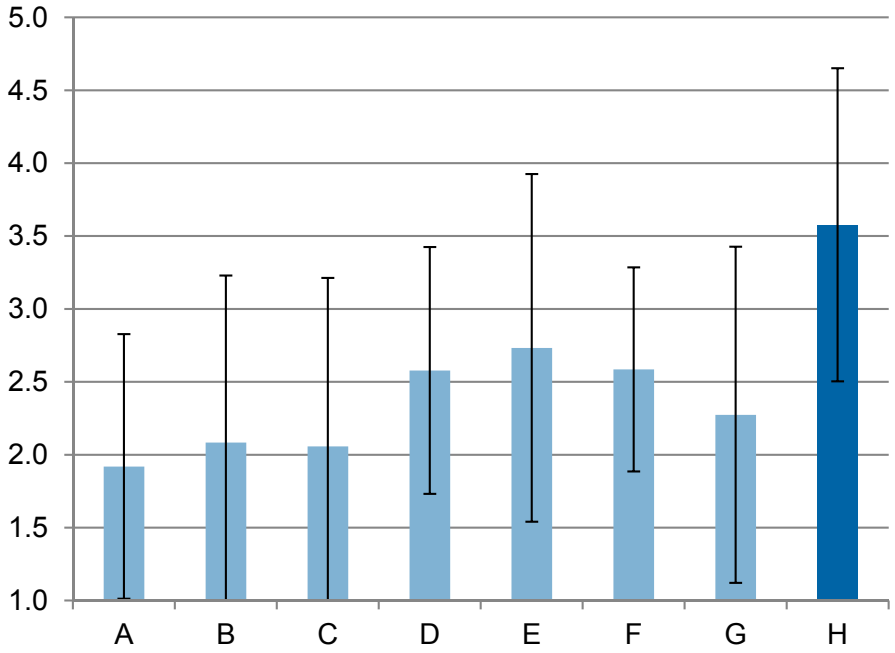
Comparison of SmartWorking with 7 other offices of the same organisation

Privacy



Differences H-A, H-C, and H-D statistically significant (p<.05)

Retreat areas for undisturbed work



Differences between H and all other offices statistically significant (p<.05)

A-C: open plan offices (n=132, 33, 46)
G: team offices (n=98)

D-F: multi-space offices (n=49, 45, 29)
H: SmartWorking (n=145)

Windlinger, Gersberg & Konkol, 2015

Conclusions

Concluding Statements

- Perception-based data explain variance in (perception-based) outcomes, building-related data do not.
- In offices, office noise, speech privacy, distractions, and control are inseparable. In this cluster, the perceived amount of distractions is the best predictor for health, job satisfaction and self-assessed work performance. (For some knowledge/information workers, interruptions/distractions are a crucial part of their job).
- In offices, satisfaction with acoustics and the role of acoustics for health and work engagement should not be confused.
- Sound masking and/or activity-based office concepts may be better solutions than traditional absorption oriented approaches
- Acoustical zoning in activity-based office concepts may be more important than traditional planning for office acoustic → acoustic quality of offices will depend on occupants' behaviour
- What do office occupants do if they are dissatisfied with their acoustic environment?

Thank you.

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