ACOUSTICS
PERFORMANCE
Talking Points

PARTNERSHIP INITIATIVE
INTEGRATED DESIGN LAB
at the Center for Integrated Design

Figure 1:
Open-Plan offices are advantageous for communication and are popular in sustainable design for being materially streamlined, but they may negatively impact employees' performance, satisfaction, and privacy.

Source: https://www.theatlantic.com/magazine/archive/2014/04/the-optimal-office/358640/

Keywords:
Auditory distraction, performance, cognition, noise, open-plan office

CONTENT OVERVIEW

ACOUSTICS + PERFORMANCE

Acoustics have a dramatic impact on productivity of workers, students, and instructors through distraction, poor concentration, and speech inaudibility. Satisfaction is diminished since these issues can compound and lead to employee loss. Regarding open-office plans, productivity and satisfaction can be diminished, but research shows that employees prone to these characteristics will exhibit them regardless of the environment.

I. Reduced Noise Levels

i. Benefits to hospital staff
   a. Improved acoustics contribute to decreased strain on staff, facilitating an increased capacity to care for patients
   b. Improved acoustic conditions in the healthcare environment also reduce risks of conflicts and errors
   c. Reduced noise and distractions contribute to reducing errors in medication preparation
   d. In a classroom setting, "Very good" acoustic treatments give high absorption of noise with high "speech intelligibility", so neither students nor instructors have to speak louder or repeatedly to their audience over short distances.

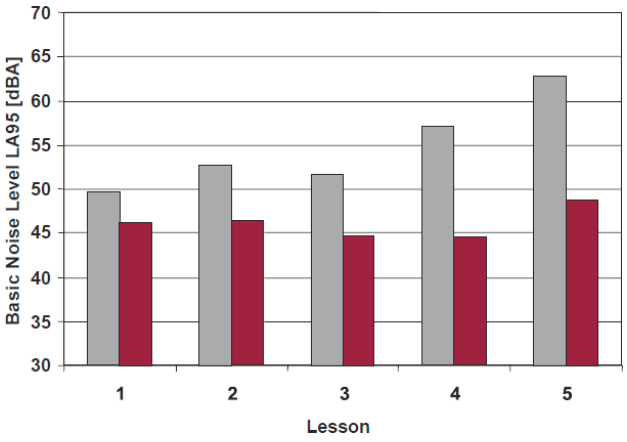

Figure 2: Base Noise Level observed in classrooms over all lessons conducted in the morning. Data reflects instructors reported Bad ( ) and Very good ( ) room acoustics.

Source: Tiesler 2015

II. Increased Noise Levels

i. Noise has been shown to decrease performance of tasks involving writing and math, particularly from speech noise.
ii. Complex tasks that demand intensive concentration and cognitive capacity suffer more than simple, well- rehearsed motoristic tasks
iii. Problems with concentration seem to arise with greater noise because "irrelevant sounds impair cognitive performance by breaking through selective attention"
iv. Poor acoustics can also "lead to dissatisfaction with the office environment and can affect workers' performance"
   a. Coping strategies for dealing with increased noise in office environments, such as leaving one's desk, switching workstations or working more slowly also contributed to a "direct loss of work performance"
   b. Most office workers survey have found " their concentration being impaired by offices sounds such as unanswered phones and background speech".

v. Speech Intelligibility is a common complaint arising from the combination of poor acoustics and noise
    a. Both the intelligibility of nearby speech and volume influence the level of distraction, annoyance and productivity

III. Classroom Performance

i. Reverberation time affects both students and teachers
    a. Children whose classrooms had long reverberation performed worse than children from classrooms with short reverberation
    b. Children whose classrooms had long reverberation reported a higher burden of noise in the classroom and judged the relations to their peers and teachers less positively
    c. Reverberation time as well as noise exposure had an effect on job satisfaction, lack of energy, and interest in leaving the job for school teachers

ii. Chronic Noise Exposure
    a. External noise it appears to be the noise levels of individual events that have the most impact while background noise in the classroom also has a significant negative effect
    b. The siting and the internal layout of a school should be such that classrooms are not exposed to high levels of noise from external sources such as road traffic, railways, or aircrafts
    c. It is essential to minimize background noise levels in the classroom to ensure that optimum conditions for teaching and learning are achieved
    d. It has previously been found that the negative effects of environmental noise are long term

		Independent variable used in the statistical model			
		Acoustical classification (reference: Low RT)		Self-rated noise exposure (reference: Never/rare)	
Well-being measure	Estimate	Medium RT	High RT	¼-½ of the time	≥½ of the time
Job satisfaction	Difference	−0.16 (−0.53-0.21)	−0.37 (−0.72-−0.01)	−0.32 (−0.53-−0.11)	−0.42 (−0.68-−0.17)
	p	.553	.044	.001	<.001
Physical discomfort and exertion	Difference	0.05 (−0.31-0.41)	0.25 (−0.10-0.59)	0.17 (−0.13-0.46)	0.25 (−0.11-0.60)
	p	1.000	.184	.397	.237
Lack of energy	Difference	0.18 (−0.41-0.77)	0.60 (0.04-1.16)	0.96 (0.42-1.51)	1.51 (0.85-2.16)
	p	.981	.035	<.001	<.001
Lack of motivation	Difference	0.04 (−0.71-0.80)	0.28 (−0.45-1.00)	0.64 (0.19-1.10)	0.88 (0.33-1.43)
	p	1.000	.636	.003	.001
Sleepiness	Difference	−0.11 (−1.00-0.79)	0.33 (−0.53-1.19)	0.60 (0.09-1.10)	0.68 (0.07-1.29)
	p	1.000	.633	.016	.025
Interest in leaving the job	Difference	2.09 (0.79-5.53)	5.88 (2.39-14.46)	1.98 (0.70-5.64)	3.71 (1.19-11.58)
	p	.139	<.001	.200	.024

Note: RT = reverberation time. The associations are reported as mean difference and 95% confidence intervals from the reference level for job satisfaction and fatigue dimensions and as odds ratios for expressing interest in leaving the job. All estimates are adjusted for the effects of health factors and socioeconomic characteristics of the school. *p* values are Bonferroni corrected for multiple comparisons.

Figure 3: Effects of acoustic classification and noise exposure on Well-Being Indicators.

Source: Kristiansen 2013

IV. Open-Plan Offices

i. Drawbacks

a. Open-plan offices have higher rates of noise disturbance than private offices

b. Exposure to office noise negatively impacted ratings of adverse perceptions, selected symptoms, and self-assessed performance, but not necessarily the performance of office tasks

c. Occupants who in their daily work were disturbed by open-plan office noise responded differently to noise than those who were not

d. Noisiness of open-plan offices is not an intrinsic quality, time-averaged SPLs over the working day were practically the same in both office types

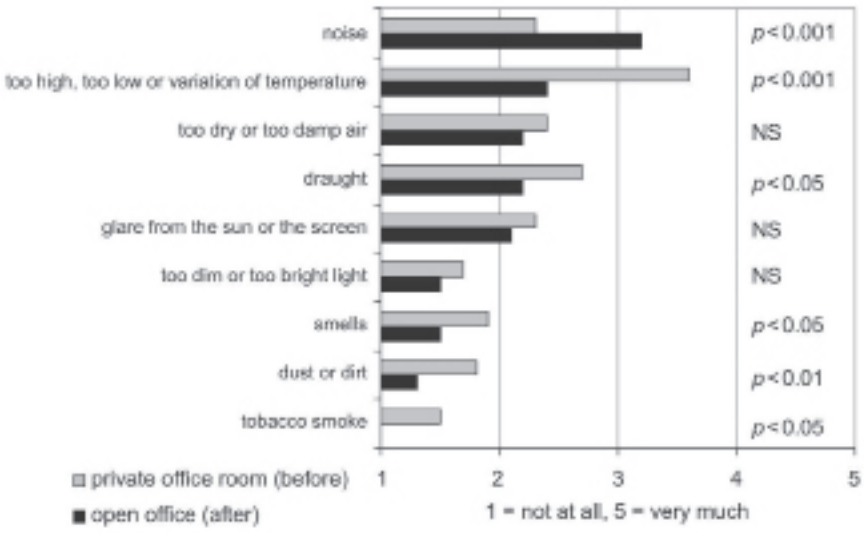

Figure 4:
How much have the following indoor environmental factors disturbed you at your workstation during the last 3 months? Mean values and the significance of change (p-value)

Source: Kaarela 2009

Figure 5:
How much do the following sounds disturb your concentration on your work at your workstation? Mean values and the significance of change (p-values).

Source: Kaarela 2009

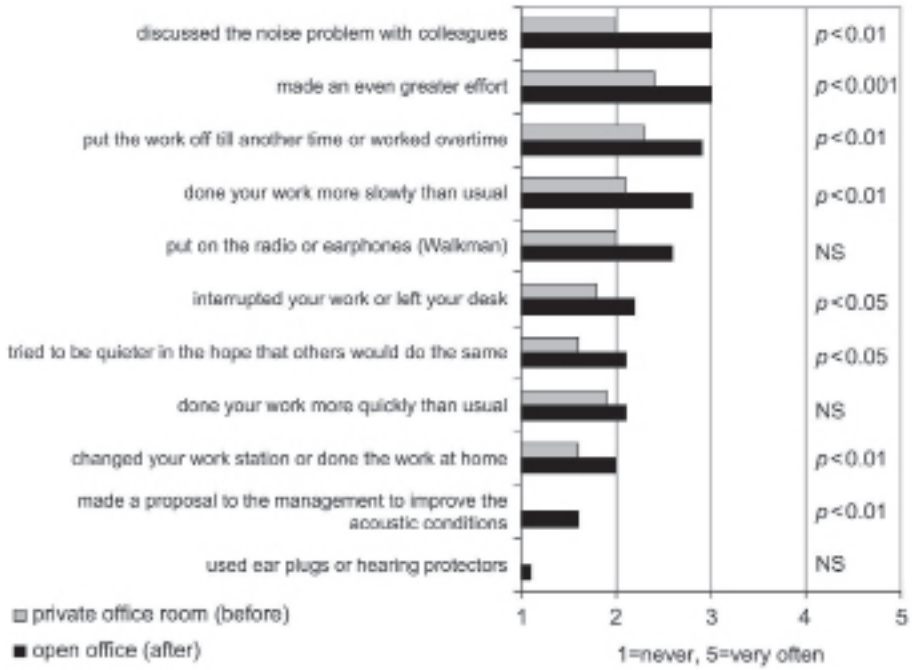

Figure 6:
How often do you act in the following way to cope with your work because of the sounds in your work environment? Mean values and the significance of change (p-value)

Source: Kaarela 2009

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