

## 1 Summary

Psychophysics laboratory is used to test the effects of indoor environment on human perception, performance, and bodily responses. The laboratory is used both for public-funded scientific research and for industrially funded research and development. The laboratory contains two experimental rooms a control room (Fig. 1). It is located at Joukahaisenkatu 7, FI-20520 Turku, Finland.

## 2 Facts about the laboratory

### Space

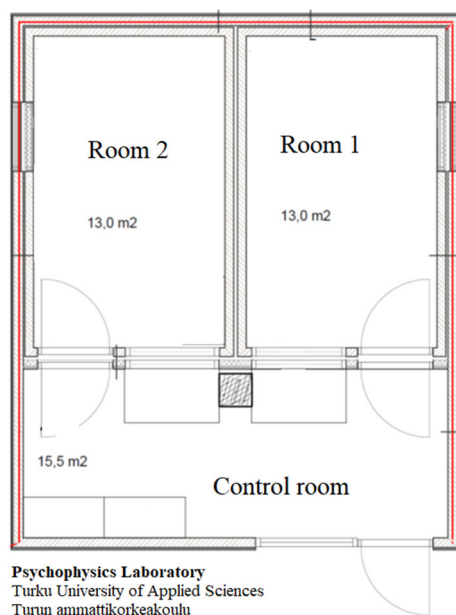
- Length 4.6 m, width 2.8 m
- Suspended ceiling at 2.6 m height is 40 mm mineral wool on 600x600 grid
- The space above suspended ceiling (520 mm) allows most HVAC installations to be tested
- Background noise level is under hearing threshold, under 17 dB  $L_{Aeq}$
- Exceptionally high sound isolation between rooms 1 and 2 and external space
  - Airborne sound insulation  $D_{nTw} > 75$  dB
  - Impact sound insulation  $L'_{nTw} < 30$  dB
- Reverberation time under 0.3 seconds

### Acoustic stimuli

- Experimental sounds can be played using loudspeakers or headphones
- Built-in sound masking system with 4 loudspeakers provides a desired background noise

### Ventilation

- Room temperature can be controlled between 18 and 35 °C
- Ventilation rate can be controlled between 0 and 120 l/s per room



**Fig. 1.** The laboratory compartment consists of control room and two identical experimental rooms 1 and 2 where the studied indoor environment is created. It is possible to run two separate experiments in parallel or one experiment in two rooms.



## 3 What is measured in Psychophysics Laboratory?

Psychophysics quantitatively examines the relationship between environmental stimuli and human experience, in other words, sensations and perceptions. Psychophysical experiments quantify both the stimuli and human experience. Therefore, a perfectly controlled indoor environment is crucial.

Cognitive psychology examines persons' mental processes, for example, attention, memory, creative thinking, problem solving, and language use. Cognitive psychology experiments examine how different stimuli or conditions influence cognitive processes. While psychophysics examines the relation between stimuli and sensation or perception, cognitive psychology examines the relation between stimuli or condition and performance.

Physiological stress response takes place in the body during a stressful situation. Stress reaction can be detected in many different bodily responses, for example, in heart rate, blood pressure, and hormones. Measuring these reactions is an objective way of defining the stress level of a person during different environmental stimuli.

**Independent variables**, i.e., physical conditions, that are controlled in the room are

- Acoustic environment
- Sound quality
- Thermal environment
- Air quality
- Lighting

One of these physical conditions is the stimulus that is investigated.

**Dependent variables**, i.e., variables which responses are measured are:

*Subjective responses towards the indoor environment, e.g.*

- Annoyance, satisfaction, disturbance, comfort
- Other experiences

*Cognitive performance, e.g.,*

- Short-term memory
- Working memory
- Reading comprehension
- Attention

*Physiological stress responses, e.g.,*

- Heart rate variability
- Blood pressure
- Stress hormone concentration (plasma/saliva)
- Eye movements



## 4 Examples of experimental studies conducted by our research group

- More than 25 experiments have been conducted since 2004, increasingly after 2016
- More than 20 experiments have been published

We have conducted experiments under the following themes. The number of experiments under the theme are given in brackets.

Physiological stress caused by different noise qualities:

- Office noise (1)
- Tonal noise (1)
- Impulsive noise (1)

Work performance loss caused by speech:

- Speech with different speech intelligibility levels (7)
- Speech versus silence (1)

Annoyance and /or loudness of specific sounds qualities:

- Spectrum of broadband noise (3)
- Tonality (1)
- Impulsiveness (1)
- Infrasound (1)

Comparison between several sound qualities (3)

Annoyance caused by sound transmitted to resident

- Annoyance caused by impact sounds through the floor (2)
- Annoyance caused by living sounds transmitted through wall (1)
- Annoyance caused by living sounds transmitted through facade (1)

Work performance loss caused by elevated room temperature (5)

Work performance loss caused by reduced air quality (1)

Work performance loss caused by three simultaneous factors: elevated room temperature, reduced air quality, and reduced room acoustic quality in an open-plan office (1)

Work performance change caused by different interior designs (1)

Many of the experiments were conducted during the time, when the Psychophysics research team was located at Finnish Institute of Occupational Health.

## 5 Contact persons

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## 6 Photographs

**Figs. 2–5** illustrate the laboratory spaces.



**Fig 2.** The compartment seen from the outside.



**Fig 3.** Control room where the experiments and indoor environment conditions are controlled. View to the rooms can be blocked by window shades. Entrance to experimental rooms 1 and 2 are seen on the right and left.



**Fig. 4.** View to the experimental room 2. Rooms 1 and 2 are identical.



**Fig. 5.** The thermal conditions and air quality is controlled by two independent ventilation systems for rooms 1 and 2. They are located in the ceiling of the control room.