FICAN Symposium
February 16, 2000
San Diego, California

Effects of Aircraft Noise on Children's Cognition and Long Term Memory

Staffan Hygge

Kungl Tekniska Högskolan - Royal Institute of Technology Centre for Built Environment

Laboratory of Applied Psychology

Gävle, Sweden

Three set of studies:

1. Classroom noise experiments on long term memory
2. The Munich airport noise study on children
3. Laboratory studies on noise and memory

General conclusions

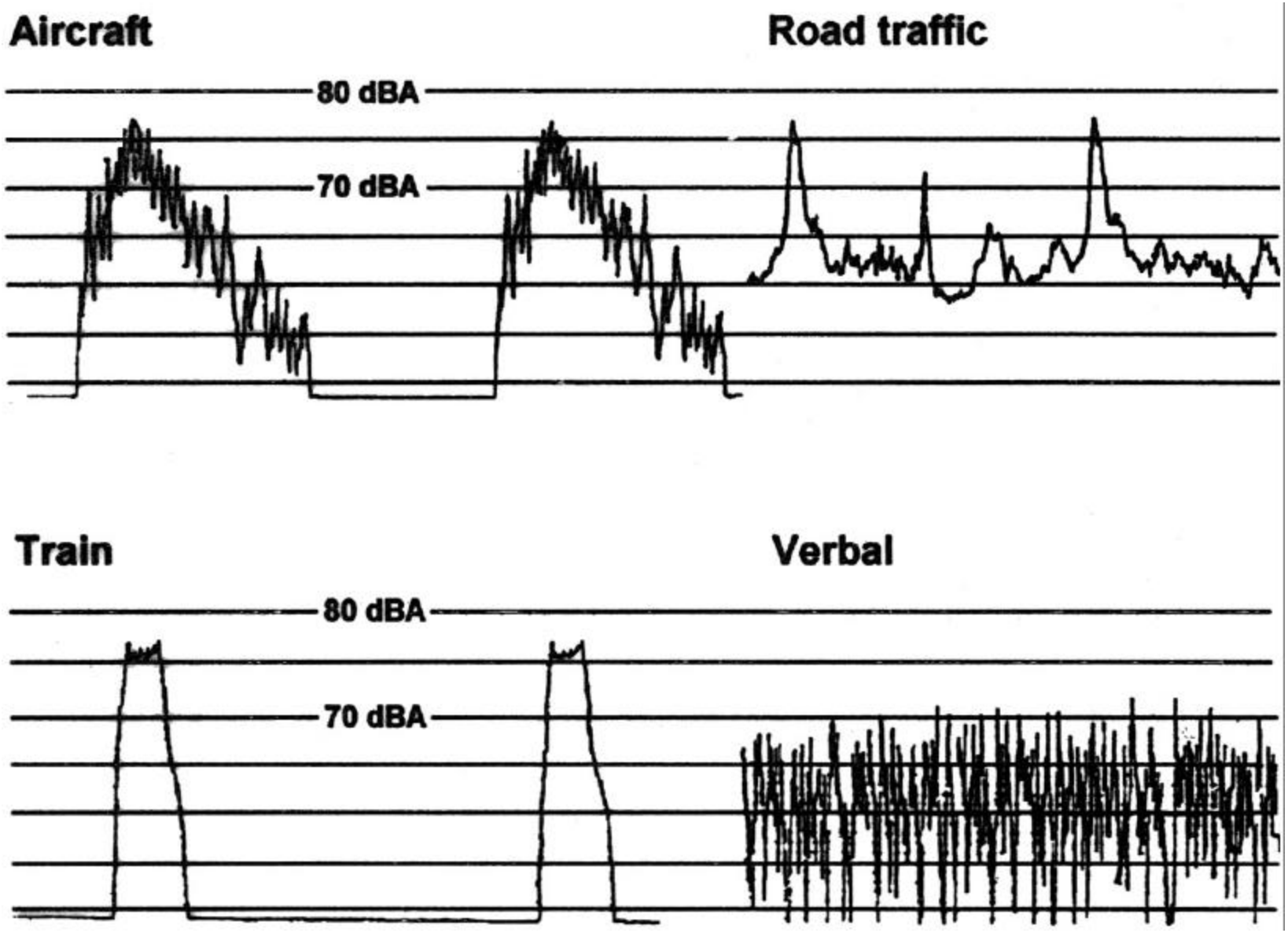
- There are impairing noise effects on long-term recall, both from acute and chronic noise exposure
- The noise effect on recall is sometimes reversible
- The noise effects on long-term recognition is smaller than for recall
- The noise effects are not mediated by attention
- Aircraft noise is more impairing than road traffic noise and irrelevant speech

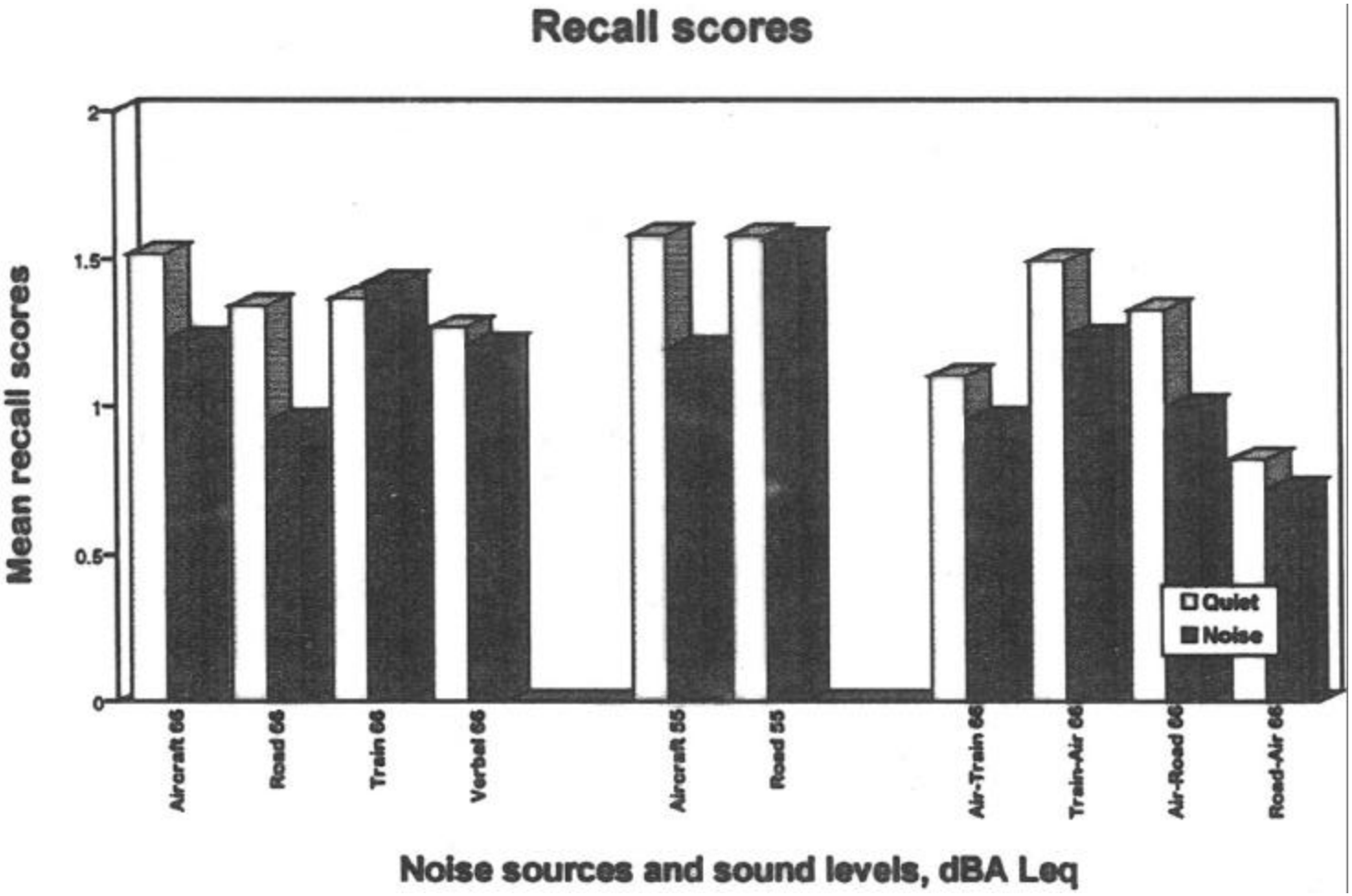
1. Classroom noise experiments on long term memory

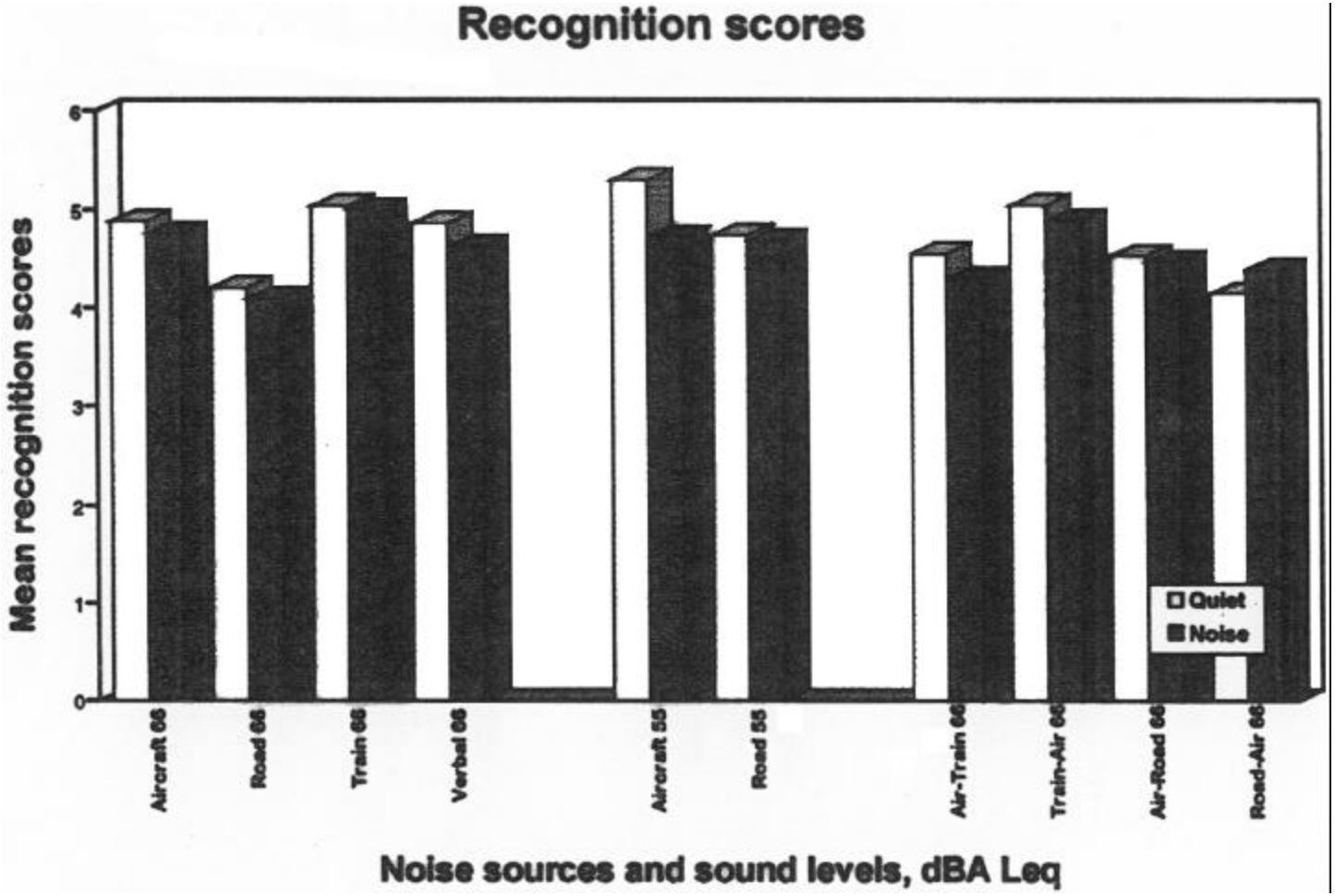
Research design for the classroom experiments

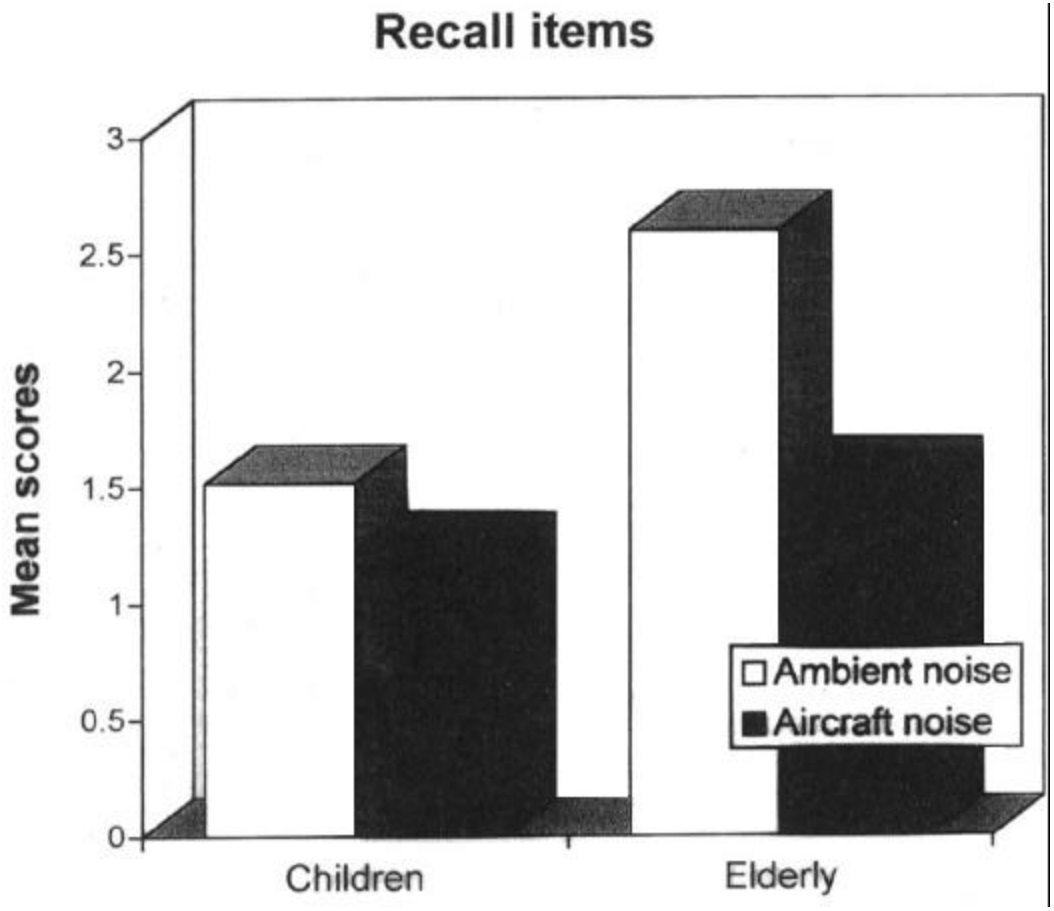
Session #			
1	2	3	4
Reading text 1	Test text s1 Reading new text in **noise**	Test text s2 Reading new text in silence	Test text s3
Reading text 1	Test text s1 Reading new text in silence	Test text s2 Reading new text in **noise**	Test text s3

Note: *Silence* is actually the ambient noise level is achieved by instructing the children to be as silent as possible, and they do that.


Aircraft
Road traffic
80 dBA
70 dBA
Train
Verbal
80 dBA
70 dBA


Recall scores
Mean recall scores
2
1.5
1
0.5
0
Aircraft 65
Road 65
Train 65
Verbal 65
Aircraft 55
Road 55
Air-Train 65
Train-Air 65
Air-Road 65
Road-Air 65
Quiet
Noise
Noise sources and sound levels, dBA Leq


Recognition scores
Mean recognition scores
0
1
2
3
4
5
6
Aircraft 65
Road 65
Train 65
Verbal 65
Aircraft 55
Road 55
Air-Train 60
Train-Air 60
Air-Road 60
Road-Air 60
Quiet
Noise
Noise sources and sound levels, dBA Leq

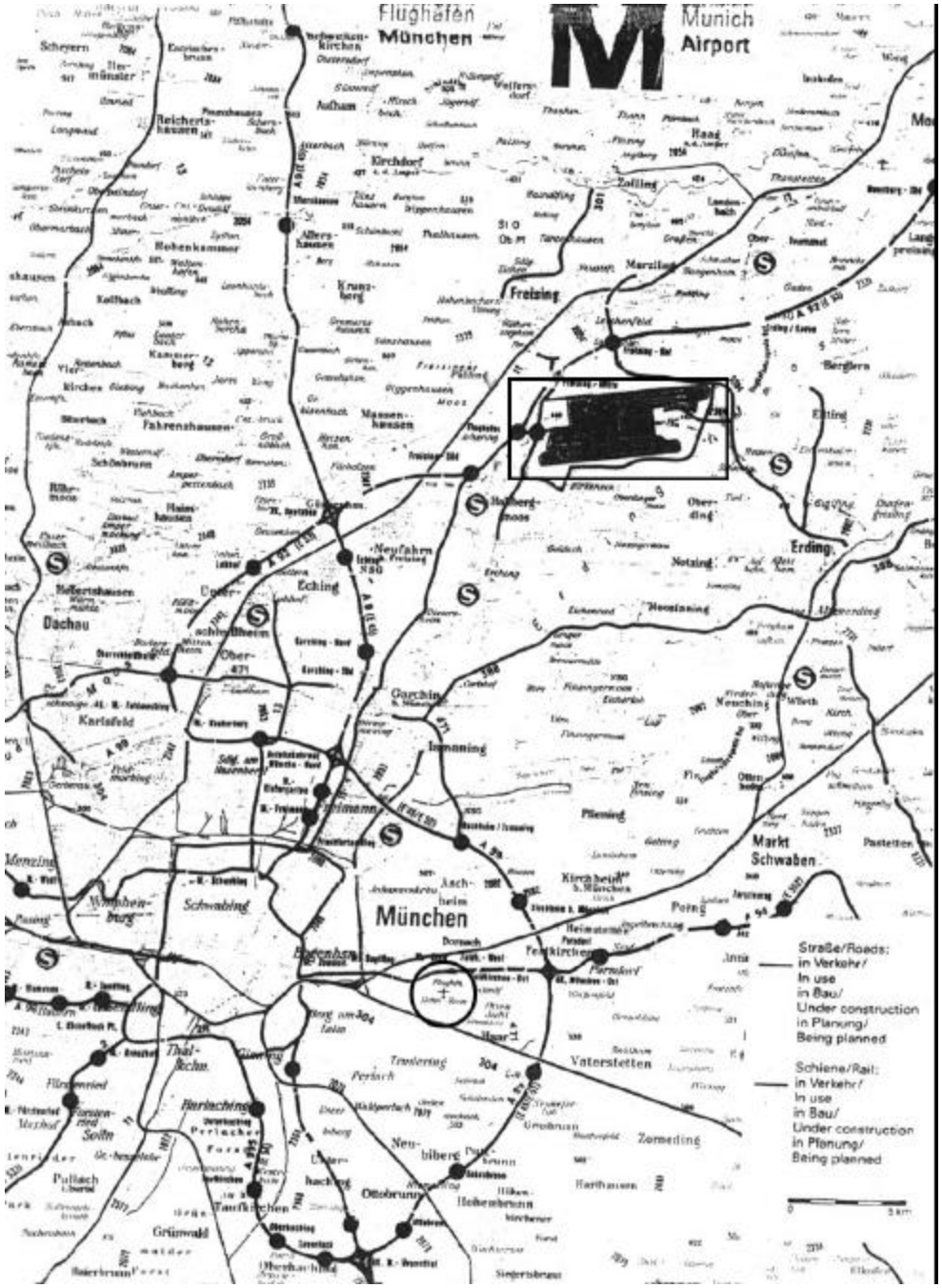


Mean scores on the recall items after learning in aircraft noise at 66 dBA L_{eq} and ambient noise for children aged 12-14 years and elderly aged 65-74 years.

Analysis of variance

Age:	$F(1,244) = 11.48$, $p = .001$
Noise:	$F(1,244) = 32.67$, $p = .000$
Age x Noise:	$F(1,244) = 10.56$, $p = .001$

2. The Munich airport noise study on children


Flughafen
München
Munich
Airport
Freising
Erding
Dachau
Garching
Ismaning
Markt
Schwaben
Aschheim
München
Vaterstetten
Straße/Roads:
in Verkehr/
In use
in Bau/
Under construction
in Planung/
Being planned
Schiene/Rail:
in Verkehr/
In use
in Bau/
Under construction
in Planung/
Being planned

Initial (and final) sample sizes

	Airport	
Group	Old	New
Experimental	78 (65)	116 (111)
Control	56 (43)	124 (108)
Sum	**134 (108)**	**240 (219)**

Total sums

Initial sample = 374 Final sample = 327

Measurement waves

1. Oct 91 - Feb 92

   May 17th, 1992 - change-over of airports

2. Oct 92 - Feb 93

3. Oct 93 - Feb 94

Dependent measures

Psychophysiology

- Overnight cortisol, adrenaline, nor-adrenaline
- Blood-pressure, resting and reactivity

Cognition

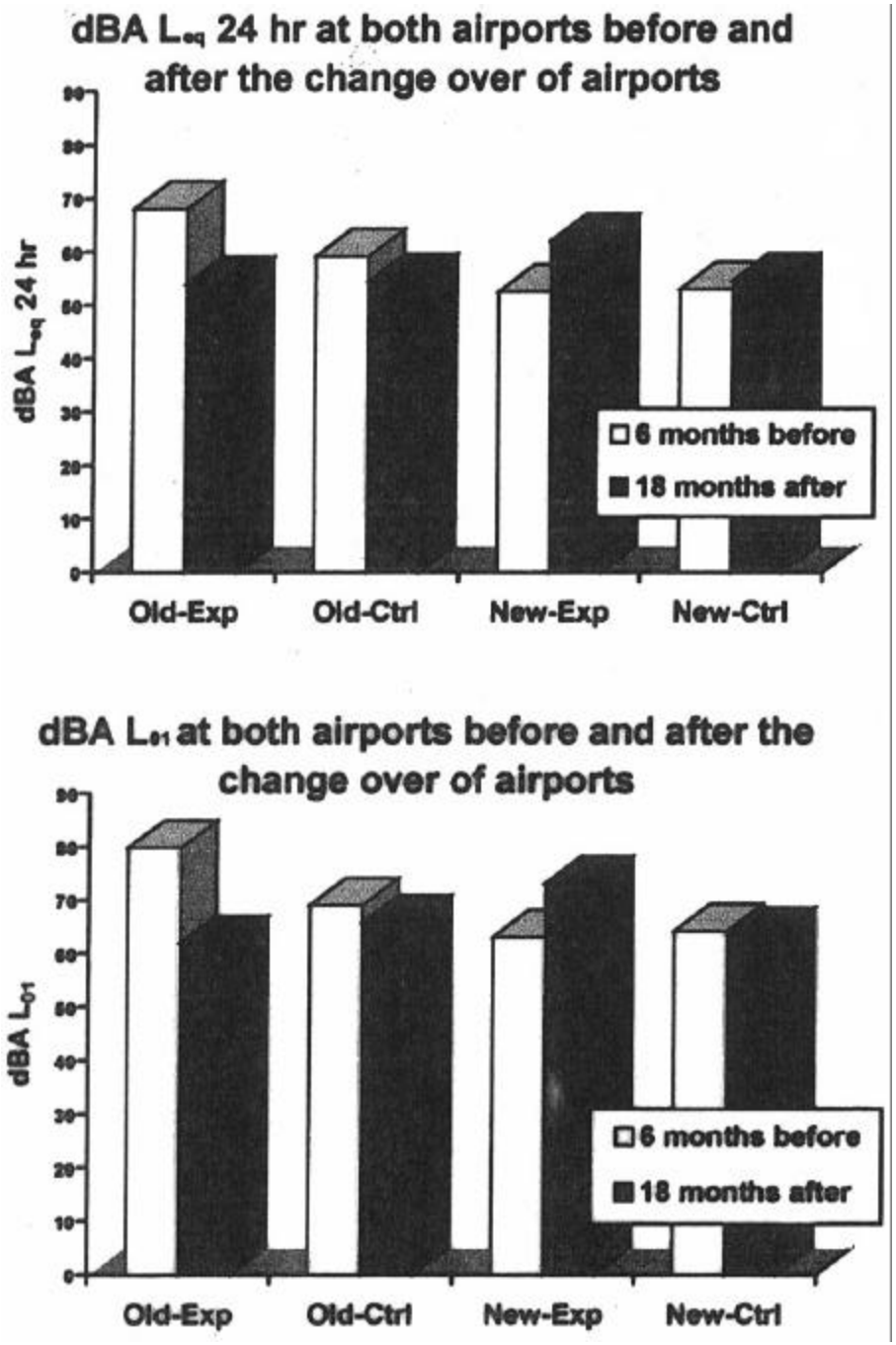
- Audiometric screening
- Annoyance to different noise sources
- Annoyance to community noise, master-scaled
- Auditory discrimination against different noise backgrounds (Signal-to-noise-task)
- Choice reaction time (in noise and quiet)
- Running memory
- Embedded figures
- Long-term recall
- Standardized German reading test and word test

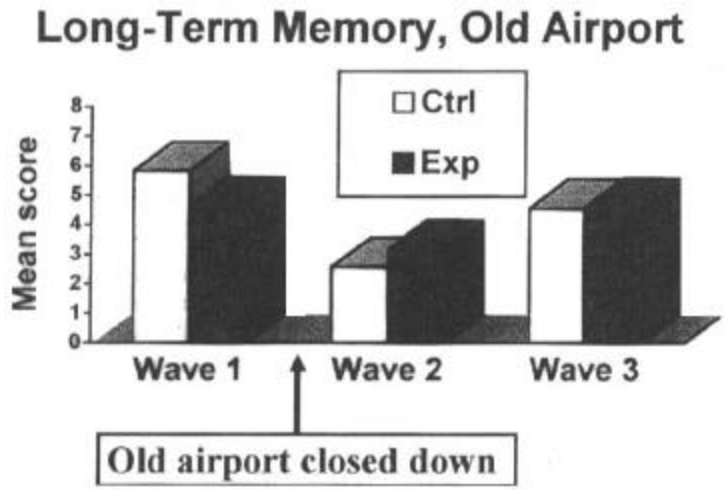
Motivation

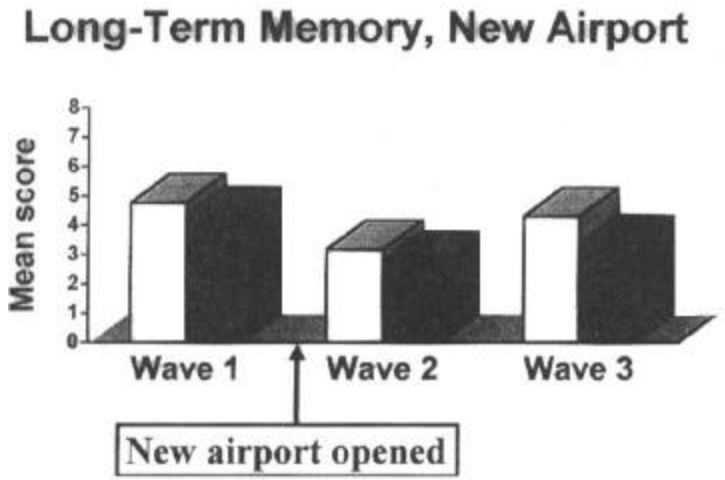
- Glass & Singer aftereffect
- Persistence on challenging task

Quality if life

- Lewis scale
- Mood scales, resting and reactive
- Environmental perception questionnaire


dBA Leq 24 hr at both airports before and after the change over of airports
dBA Leq 24 hr
0
10
20
30
40
50
60
70
80
90
6 months before
18 months after
Old-Exp
Old-Ctrl
New-Exp
New-Ctrl
dBA L01 at both airports before and after the change over of airports
dBA L01
0
10
20
30
40
50
60
70
80
90
6 months before
18 months after
Old-Exp
Old-Ctrl
New-Exp
New-Ctrl



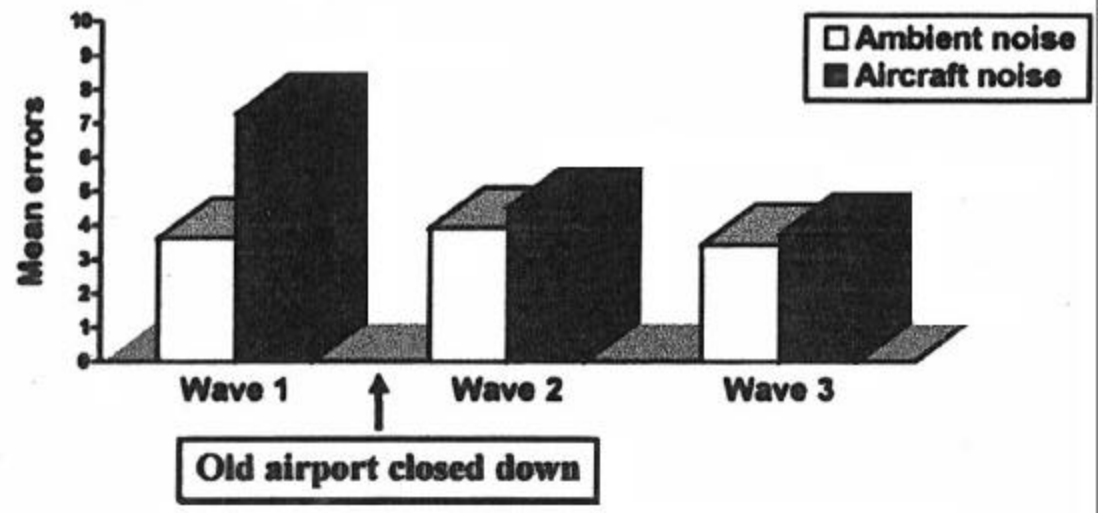


Long-term memory

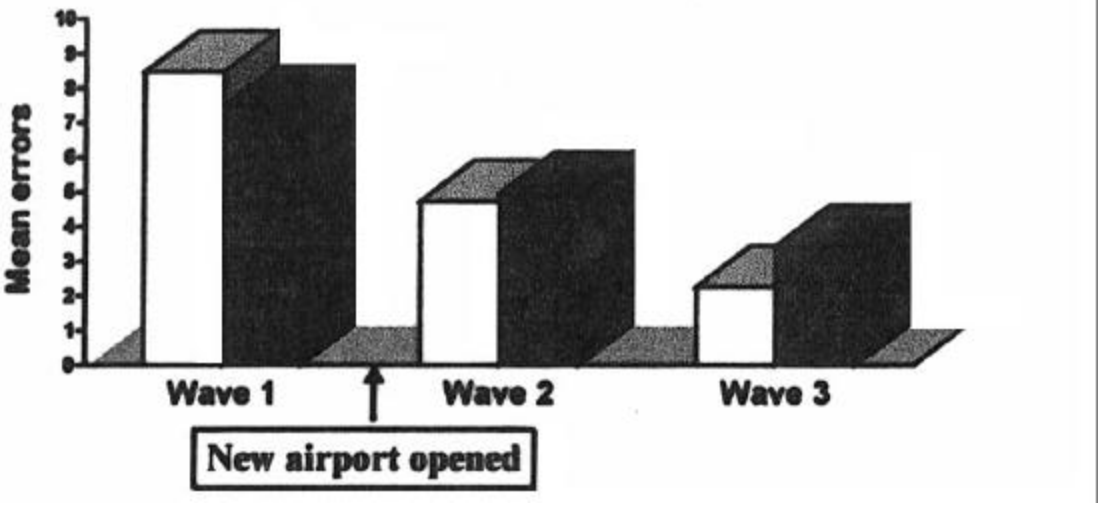
Statistical analyses

Airport x Groups x Wave	$F(1.9, 595) = 5.03$, $p < .01$, Greenhouse-Geisser
Old airport at wave 1	$t(104) = 1.88$, $p < .05$ one tailed
New airport at wave 3	$t(208) = 2.72$, $p < .01$

Difficult Word List, Old Airport



Difficult Word List, New Airport



3. Laboratory studies on noise and memory

Three independent groups

1. Silence ~38 dBA L_{eq}
2. Fluctuating road traffic noise 66 dBA L_{eq}
3. Fluctuating meaningful irrelevant speech, 66 dBA L_{eq}, same time pattern as the road traffic noise

Sixteen boys and 16 girls from high school in each group (N = 96)

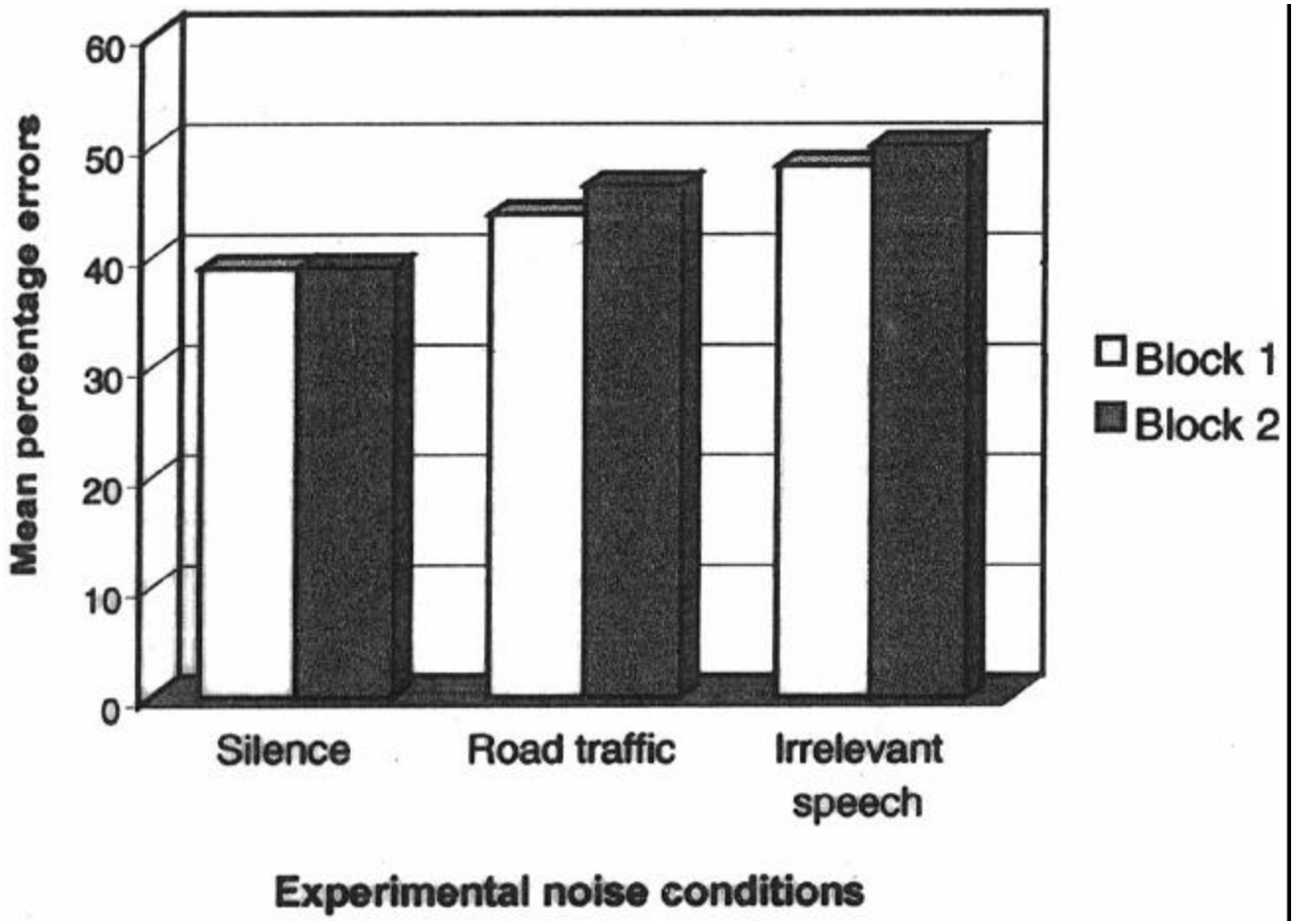
Dependent Measures	Memory System	Processes
2, 9) Search and memory task (SMT)	Primary memory	Immediate memory processing
16) Free recall and recognition of text reading	Episodic memory	Context dependent memory
15) Free recall and recognition of text reading	-”-	Deep vs. shallow encoding
11-12, 14) Free and cued recall of sentences encoded with and without enactment	-”-	-”-
13) Recognition of faces and family names	-”-	Conscious vs. non-conscious processes Incidental learning
13) Recognition of first names	-”-	Incidental learning
8) Word-stem completion	Perceptual Representation System (PRS)	Conscious vs. non-conscious processes Incidental learning
5) Word fluency 6)Word comprehension	Semantic memory	Conscious vs. non-conscious processes General knowledge
1, 10) Self-reported affect circumplex measure		State-dependent memory

Chronological Order of Dependent Measures and Time Limits for Each Task

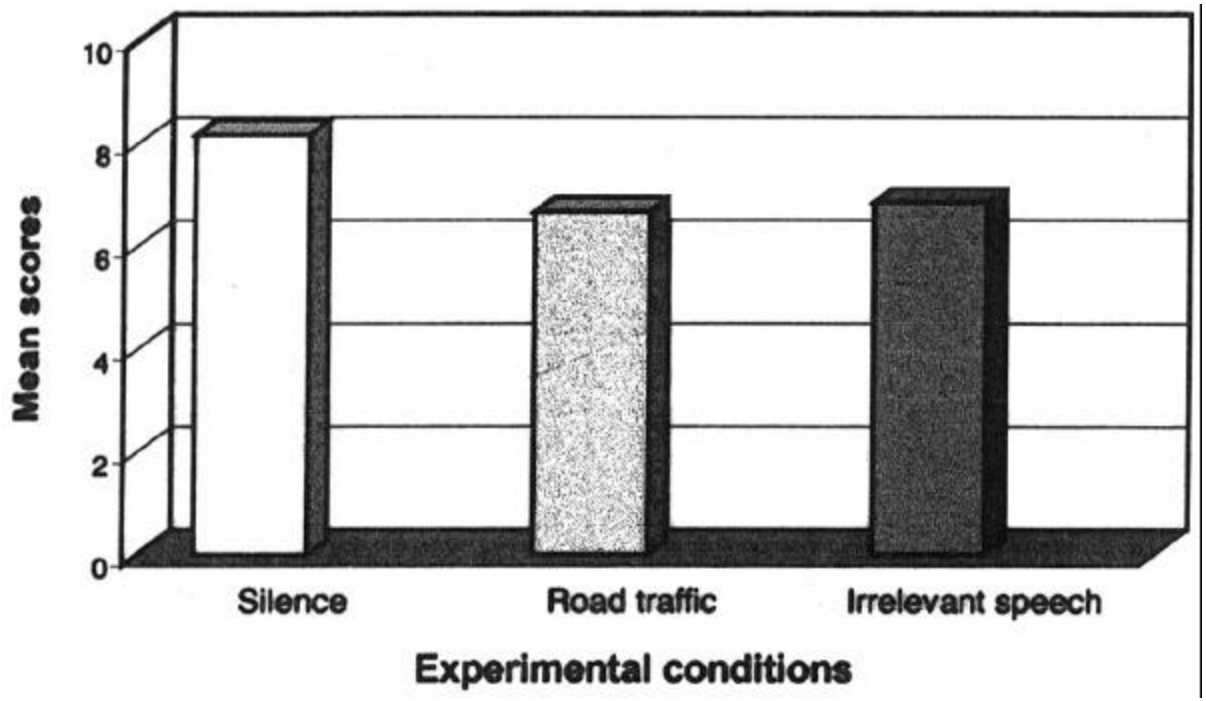
No.	Dependent measure	Block	Time Limit min.
1)	Self-reported affect	Block 1	5
Part 1	**Encoding and retrieval in verbal-road traffic noise or silence**		
2)	Search and memory task (SMT)	Block 1	6
3)	Reading a text		15
4)	Face and name encoding*		2.5
5)	Word fluency*		3
6)	Word comprehension*		7
7)	Sentences with and without enactment*		4.5
8)	Word-stem completion*		6
9)	Search and memory task(SMT)	Block 2	6
Part 2	**Retrieval in silence**		
10)	Self-reported affect	Block 2	5
11-12)	Free and cued recall of sentences encoded with and without enactment*		10
13)	Recognition test of faces and first and family names*		12
14)	Cued recall of sentences*		4.5
15)	Test of recall and recognition of text in task 3		5
Part 3	**Retrieval in road traffic noise**		
16)	Test of recall and recognition of text in task 3		5

Note. The * means that the test and the time limits were adapted from the Betula project (Nilsson et al., 1997)

Mean percentage errors on the search and memory task (SMT) in primary memory as a function of experimental conditions and blocks



Mean scores on the recall items in episodic memory as a function of experimental noise conditions



Two examples of alternative causal patterns