Fatiguing effect of in-cabin aircraft noise on cognition

UNSW AUSTRALIA

Never Stand Still | Science | School of Aviation

Noise research

- Aircraft flyover noise - plethora of research
  - Long-term memory,
  - Reading ability,
  - Comprehension, and
  - Episodic memory.

(Clark et al., 2005; Haines et al., 2001)

- Little is known about in-cabin noise; even less relating to noise and fatigue

Accident report - 1997

Korean Air Flight 801

- CVR evidence indicated that the captain was tired. At the beginning of the approach, the captain made unsolicited comments related to **fatigue** (p. 149).

- According to his family, the captain slept his **normal sleep routine** in the days before the accident and had an opportunity to receive adequate rest (p. 149).

Accident report - 1997

Korean Air Flight 801

- The accident occurred after midnight (about 0042) in the flight crew's home time zone (which is 1 hour behind Guam local time) (p.148).

- On the basis of the time of day, statements recorded on the CVR, and sleep and fatigue research, the Safety Board concludes that the captain was **fatigued**, which degraded his performance and contributed to his failure to properly execute the approach (p. 150).

Accident report - 2013

Asiana Airlines Flight 214

- Therefore, the NTSB concludes that the flight crew was experiencing **fatigue**, which likely degraded their performance during the approach (p. 86).

- There is no evidence that any of the pilots began their duty period with a preexisting sleep debt or fatigue (p. 85).

- The human body cannot adapt to transiting 8 time zones in the span of 10 hours; therefore, all three pilots were likely fatigued as a result of circadian disruption (p. 86).

Fatigue defined

Biological drive for recuperative rest

(Williamson et al., 2011. p. 499)

Major causes of fatigue

1. Time of day of operation
2. Long duration of wakefulness
3. Inadequate sleep
4. Pathological sleepiness (sleep apnea)
5. Prolonged work hours

(Åkerstedt, 2000. p. 395)

Not as clear as 1st thought

Combination of:

1. Time of day (circadian rhythm), and
2. Sleep deprivation (time since last slept)

(Williamson & Friswell, 2011)

Prevention

Individuals

- Modifying personal lifestyle to allow for adequate sleep.

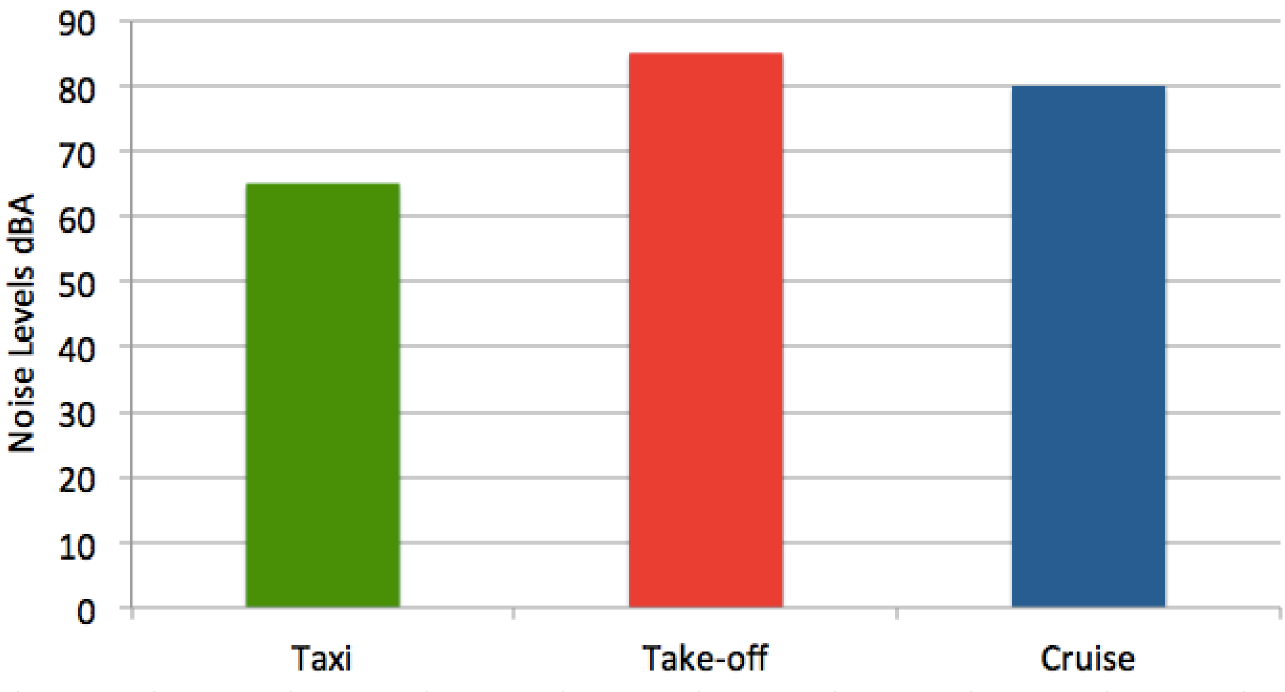
Organisations

- Modifying rosters or providing opportunity for sleep (or rest).

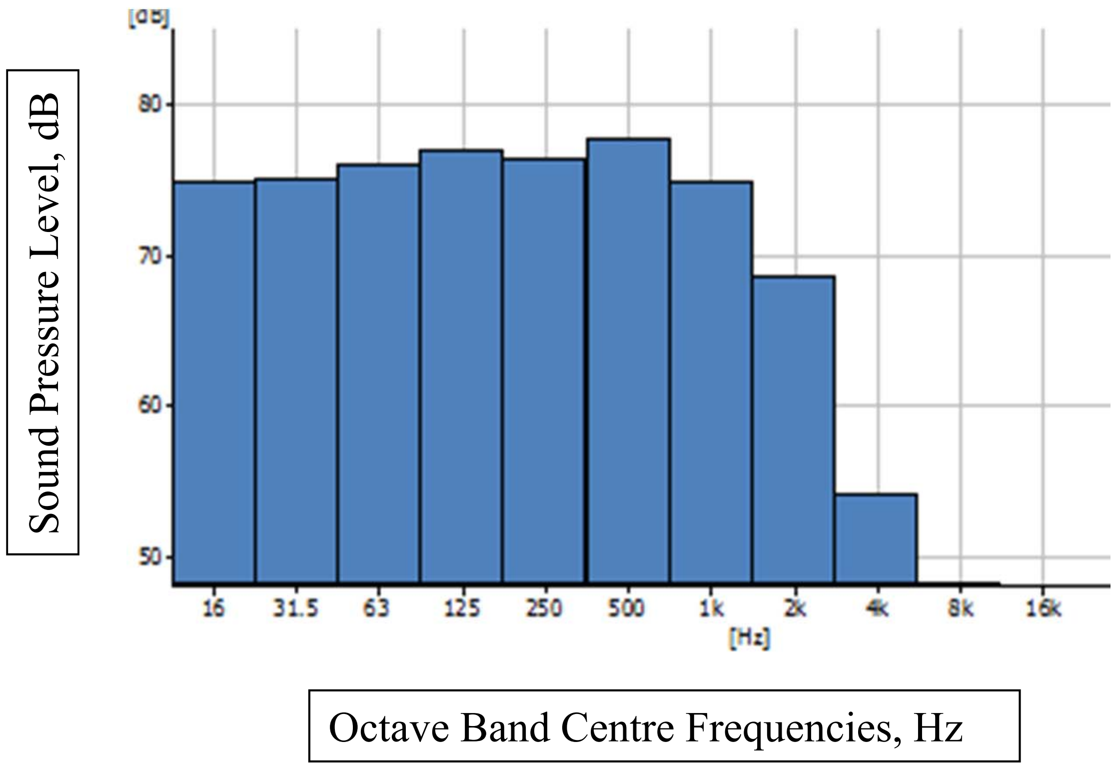
In-cabin noise levels

Range of aircraft

- B747
- B737
- A321
- MD80
- ATR



In-cabin noise levels



Noise research – continuous noise

- 2hrs of 51 dBA of open-plan office noise

↓ Degrades memory for words,

↑ Increase self-reported levels of tiredness, and

↓ Reduced motivation.

(Jahncke et al., 2011)

Noise research – continuous noise

- 3hrs of 55 dBA of open-plan office noise

↓ Reduced work rate by 3%, and

↑ Increased self-reported fatigue levels.

(Witterseh et al., 2004)

Australian Standards – recommended noise levels

	Recommended	Maximum	
5 OFFICE BUILDINGS			
Board and conference rooms	30	40	0.6 to 0.8
Cafeterias	45	50	See Note 3
Call centres	40	45	0.1 to 0.4
Computer rooms	45	50	See Note 3
Corridors and lobbies	45	50	0.4 to 0.6
Design offices	40	45	0.4 to 0.6
Draughting offices	40	50	0.4 to 0.6
General office areas	40	45	0.4 to 0.6
Private offices	35	40	0.6 to 0.8
Public spaces	40	50	0.5 to 1.0
Reception areas	40	45	See Note 3
Rest rooms and tea rooms	40	45	0.4 to 0.6
Toilets	50	55	—
Undercover carparks	55	65	—

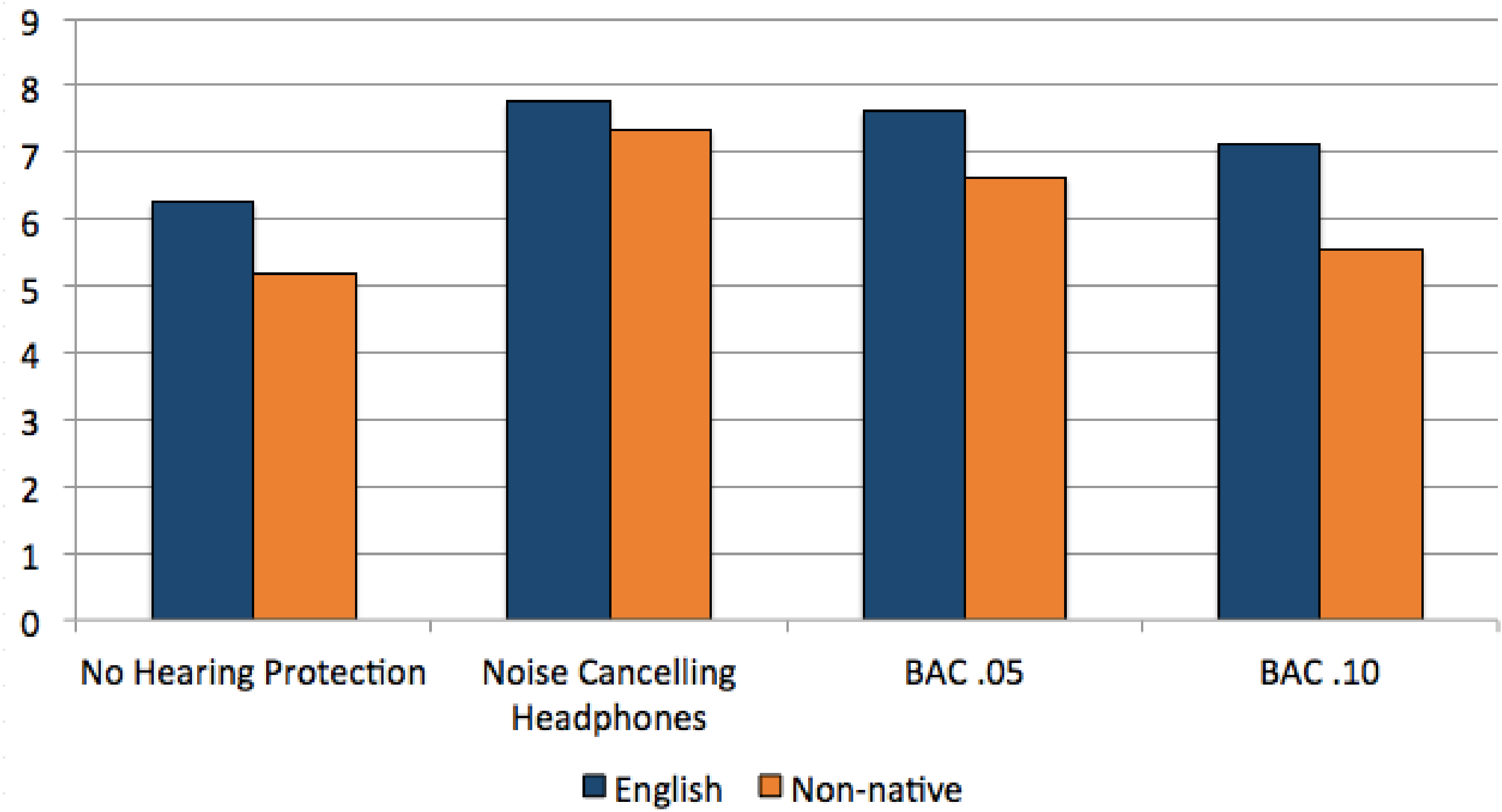
(AS/NZS 2107, 2000)

Australian Standards – recommended noise levels

	Recommended	Maximum	
6 PUBLIC BUILDINGS			
Airport terminals—			
Departure lounges	45	55	See Note 3
Luggage despatch and collection areas	45	55	See Note 3
Passenger check-in areas	45	50	See Note 3
Art galleries	40	45	See Note 3
Auditoriums—			
Cabarets and theatre restaurants	35	40	Curve 3*
Concert and recital halls	See Note 5	See Note 5	See Note 5
Conference and convention centres—			
Without sound reinforcement—			
Up to 50 persons	35	40	Curve 1*
From 50 to 250 persons	30	35	Curve 1*
With sound reinforcement	35	45	Curve 1*
Drama theatres (see Notes 5 and 8)	25	30	Curve 1*
Exhibition areas	40	50	See Note 3
Cinemas (see Notes 5 and 8)	30	35	Curve 1*
Opera halls	See Note 5	See Note 5	See Note 5
Theatres for operetta and musical plays	See Note 5	See Note 5	See Note 5

(AS/NZS 2107, 2000)

Noise research – continuous noise



(Molesworth et al., 2014)

Current study – Aim

1. Does in-cabin aircraft noise at 80 dBA for 83 min degrade recognition memory?

2. Do active noise attenuation headphones (attenuate noise by 20 dBA) mitigate these effects?

3. Is there a relationship between language background and the effects of in-cabin aircraft noise on recognition memory?

Current study – Participants

- 84 university students (48 female)
- 42 non-native English speaker
- Average age = 22 years
- All with normal hearing

Current study – Procedure

3 groups

1. No noise (quiet)

2. No hearing protection + 80dBA noise

3. Noise cancelling headphones + 80dBA noise

Current study – Procedure

- Watch animated video – subtitles
- 80dBA of reproduced aircraft noise for 83 minutes
- Complete recognition memory test:

1. Prior, and
2. After noise

Recognition Memory Test

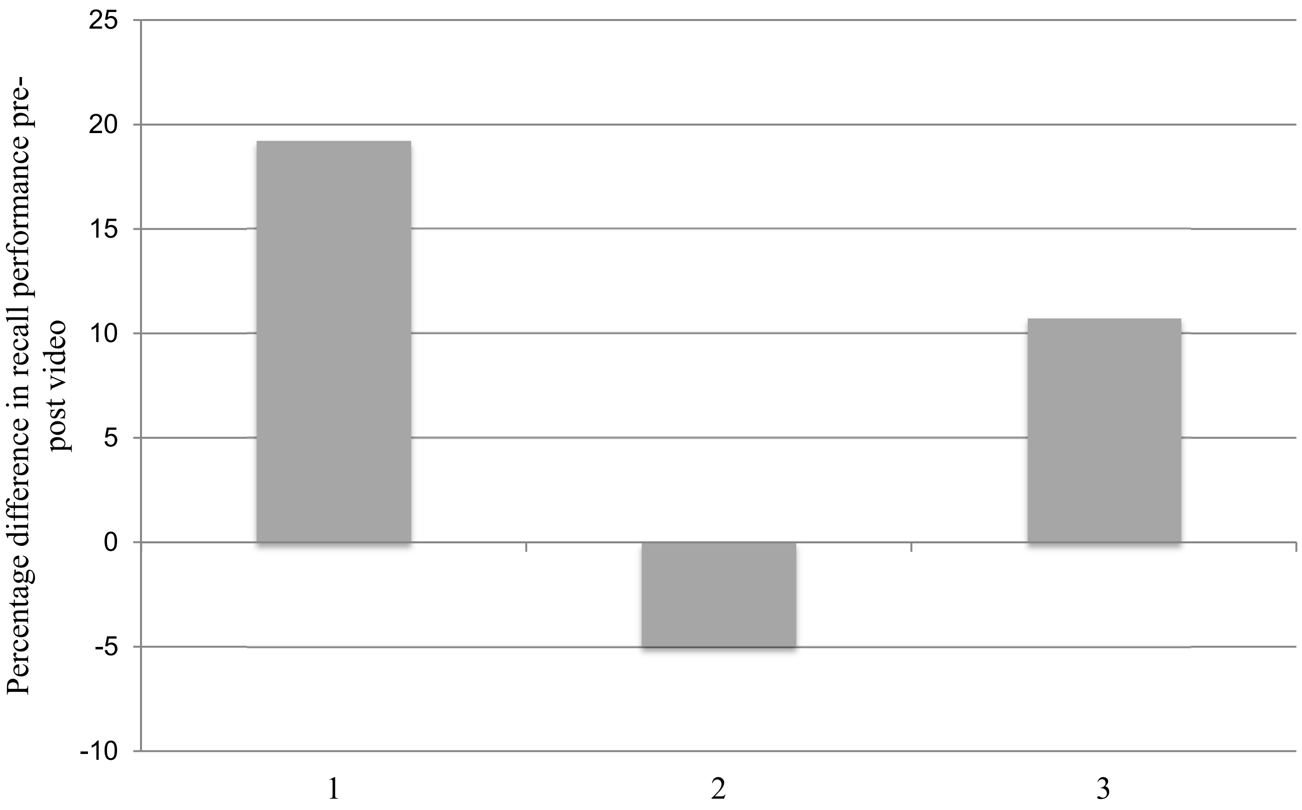
- 90 seconds of information about aircraft
- Example:

"it has a double-bubble fuselage design and according to the manufacturer this provides passengers with an extraordinary amount of personal space".

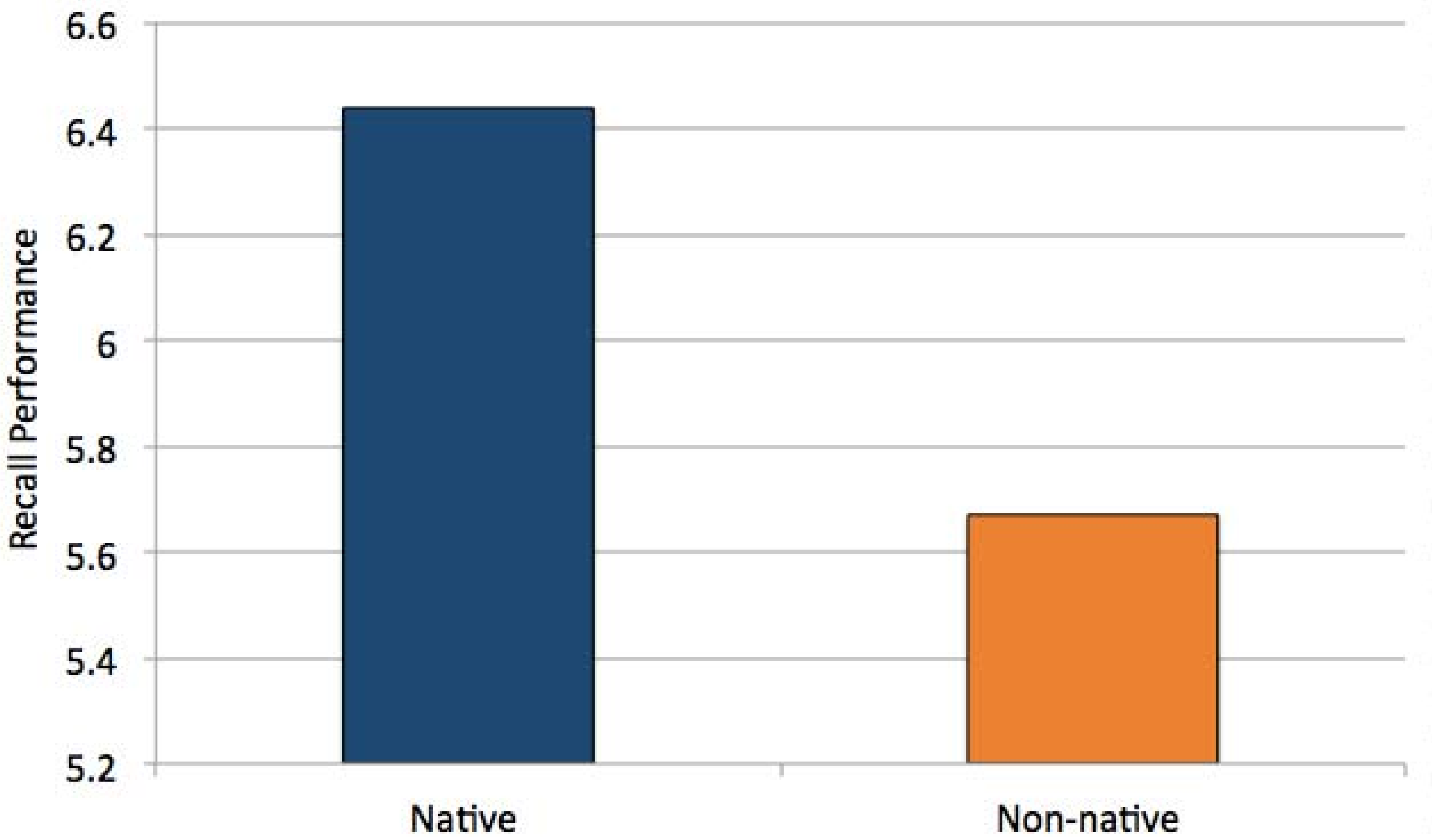
The same sentence appeared in the written scrip, except with three options for one word.

"it has a double-bubble fuselage **configuration/ design/ uncertain** and according to the manufacturer this provides passengers with an extraordinary amount of personal space".

Current study – Results



Current study – NS vs. ESL



Main effect for language background ($F(2, 78) = .567$, $p = .570$, $\eta_p^2 = .014$.)

Summary

- 80dBA of reproduced aircraft noise for 83min degraded recall performance
- Noise cancelling headphones alleviated some of the effects*

*Noise cancelling headphones reduce noise by ~ 20bBA

Summary

- Prolonged exposure to noise can be fatiguing
- Noise adversely affect recognition memory
- Recognition memory is used extensively in pilot operations
  - ATC instructions
  - Checklists
  - Decision-making

Noise and Fatigue - why

2 theories (similar effects)

1. All sounds are processed
2. Stimulates arousal

= Cognitively taxing

Noise and Fatigue – cognition

- All sounds are processed cognitively, including, noise and the target sounds
- The processing of noise consumes limited capacity of working memory
- Consumes energy resulting in depletion of resources.
- Results – reduction in performance

Noise and Fatigue – increase arousal

- Noise stimulates arousal
- Increased arousal is cognitively taxing
- Consumes energy resulting in depletion of resources.
- Results – reduction in performance

Noise and fatigue - summary

- Precise reason – unknown
- Noise is fatiguing
- Adversely affects performance
- Working memory vulnerable to noise effects

Thank you

Questions?

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