Good working memory capacity facilitates long-term memory encoding of speech in stationary noise

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INTRODUCTION

Background noise makes listening more cognitively demanding, especially for persons with hearing impairment, and this seems to affect memory encoding (Rönnberg et al., 2010). In the present study, we investigated whether long term memory encoding of speech, in quiet and in background noise adjusted to retain intelligibility, improves when the talker's face is visible, and whether such an enhancement is associated with working memory capacity (WMC).

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METHOD

Experiment 1

Participants (Mishra et al., 2013)
20 Swedish speakers (11 f); age 19-35 (M = 25.9, SD = 4.4);
normal hearing (> 25 dB HL, 125 Hz-8 kHz)

Material (Mishra et al., 2013)
13 item lists of audiovisual (AV) and auditory (A-only) 2-digit numbers presented at 65 dB SPL in:
- Quiet
- International Speech Testing Signal (ISTS, (Holube et al., 2010)
- Steady-state speech-weighted (SSSW) noise

Intelligibility in noise ~90%
SNR M = -2.17 dB (SD=0.85)
Intelligibility level SSSW M = 93.8% (SD=3.0); ISTS M = 92.3% (SD=2.9)

Tasks
As experiment 2

Experiment 2

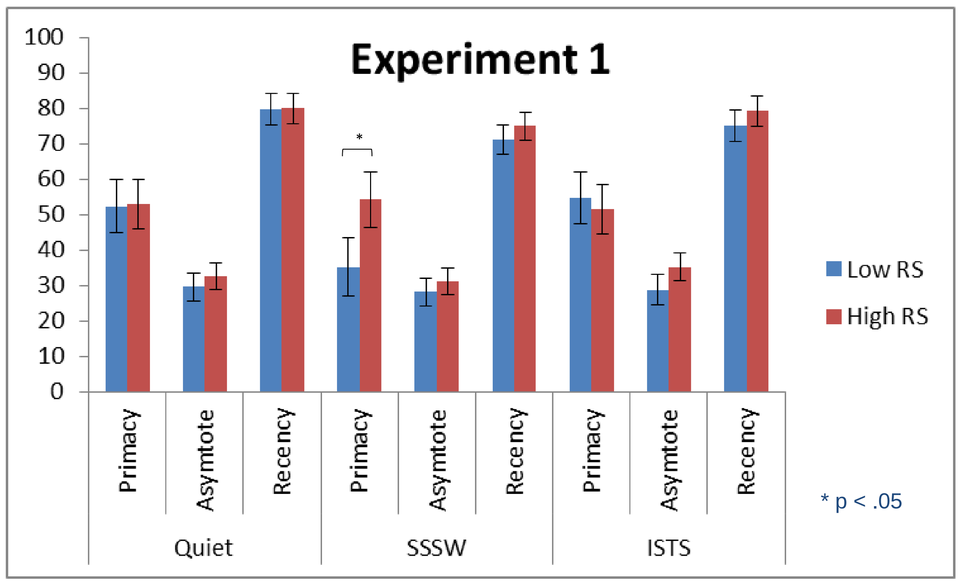
Participants (Mishra et al., 2014)
24 Swedish speakers (10 f); age 61-75, M=69, SD=4.7); sensorineural hearing loss (Air-Bone gap <10 dB HL); average pure-tone threshold (PTA4; 0.5, 1, 2, 4 kHz) 34.5 dB HL (SD=3.6).

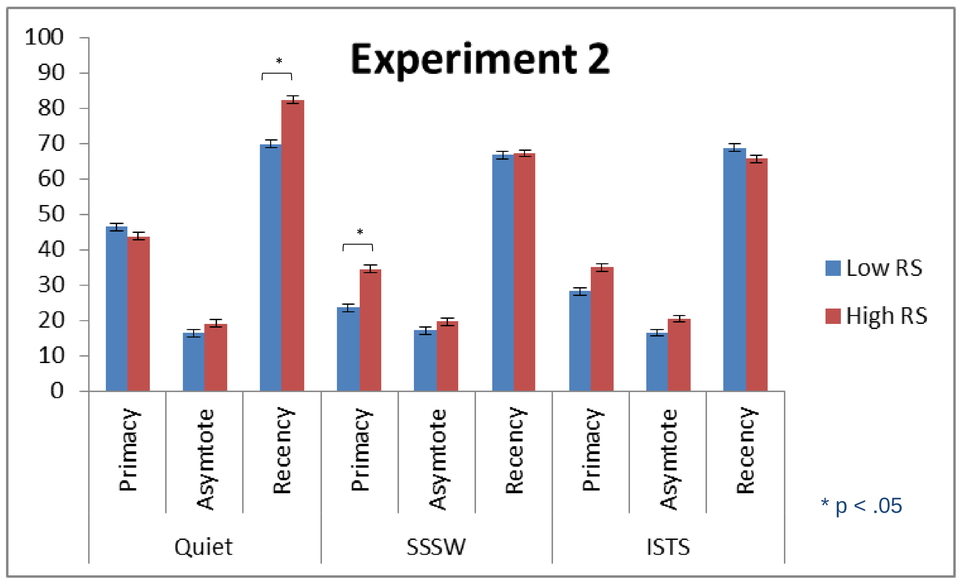
Material (Mishra et al., 2014)
As experiment 1

Intelligibility in noise ~90%
SNR M = -0.17 dB (SD=1.39)
Intelligibility: SSSW M = 94.5% (S.D=3.0); ISTS M = 88.3% (S.D=3.0)

Tasks
- Free recall of 13 item lists
- Reading span (WMC, Daneman & Carpenter, 1980, Rönnberg et al., 1989)

RESULTS





Free recall

		Experiment 1 Normal hearing, n=20				Experiment 2 Hearing impaired, n=24			
		AV		A-only		AV		A-only	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Quiet	Primacy	59.38	20.63	46.25	24.37	47.92	20.41	42.19	24.40
	Asymptote	35.00	14.20	26.67	8.94	17.13	6.93	18.29	6.80
	Recency	84.38	15.64	72.50	16.02	77.08	16.35	75.00	19.50
SSSW	Primacy	51.25	28.93	35.63	22.68	31.77	19.15	26.04	20.50
	Asymptote	33.89	15.15	25.56	7.73	18.06	6.29	18.52	5.29
	Recency	79.38	15.85	65.00	16.52	67.71	15.16	66.15	14.50
ISTS	Primacy	51.88	20.79	47.50	27.39	34.90	17.67	28.13	16.99
	Asymptote	34.03	15.74	29.03	11.63	17.71	6.01	19.10	6.26
	Recency	80.63	21.64	66.25	14.68	66.15	22.87	68.23	18.79

Reading span
Experiment 1: M = 29.70 (SD = 6.76)
Experiment 2: M = 21.38 (SD = 4.71)

Free recall ANOVA

Experiment 1
Modality, F (1, 19) = 90.82, MSE = 111.39, p = .000, η2 = .83
Background, F (2, 38) = 5.92, MSE = 158.41, p = .006, η2 = .24
Serial pos, F (2, 38) = 89.90, MSE = 653.13, p = .000, η2 = .83
Backg x Serial pos x RS, F (4, 60) = 2.87, MSE = 153.92, p = .03, η2 = .16.

Experiment 2
Modality, F (1, 23) = 4.52, MSE = 83.15, p = .04, η2 = .16
Background, F (2, 46) = 14.70, MSE = 197.59, p < .001, η2 = .39
Serial pos, F (2, 46) = 185.00, MSE = 545.28, p < .001, η2 = .89
Background x Serial pos, F (4, 92) = 3.43, MSE = 291.91, p = .01
Backg x Serial pos x RS, F (4, 88) = 2.44, MSE = 274.73, p = .05, η2 = .10

CONCLUSIONS

- Free recall improved when the talker's face was visible but enhancement was not associated with WMC
- Good WMC improved free recall of early list items in SSSW noise, reflecting facilitation of long-term memory encoding. This suggests that SSSW noise reduces cognitive capacity available for the long-term memory encoding of speech that is necessary for enduring retention of spoken information, irrespective of hearing status
- For participants with hearing impairment, good WMC improved free recall of late list items in quiet, reflecting facilitation of working memory encoding. This suggests that for individuals with hearing impairment, short term retention of speech heard even under the most favourable conditions is a function of individual WMC. These findings support and extend the ELU model (Rönnberg et al., 2013).

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