

WHEN DOES FORGETTING BECOME ACCELERATED? OPERATIONAL NORMATIVE BENCHMARK FOR THE REY AUDITORY VERBAL LEARNING TEST



SAPIENZA
UNIVERSITÀ DI ROMA



UNIVERSITÀ
DEGLI STUDI
DEL MOLISE



Luca Pizzoni^{1*}, Alessandro Von Gal¹, Andrea Di Piero¹, Cecilia Guariglia^{1,2,3} and Laura Piccardi^{1,4}

¹Department of Psychology, “Sapienza” University of Rome, Rome, Italy.

²Department of Medicine and Health Sciences, University of Molise, Campobasso, Italy.

³Cognitive and Motor Rehabilitation and Neuroimaging Unit, IRCCS Fondazione Santa Lucia, Rome, Italy.

⁴IRCCS San Raffaele Cassino, Cassino (FR), Italy.

RAVLT recall normally declines after one week in healthy adults, providing a benchmark for identifying abnormal long-term forgetting in clinical populations.

INTRODUCTION	METHODS	RESULTS	CONCLUSIONS	REFERENCES																																				
- Accelerated Long-Term Forgetting (ALF) involves disproportionate forgetting over extended delays (hours, days, weeks) despite normal learning and early retention. - ALF is increasingly recognized as a potential marker of preclinical Alzheimer’s disease (AD).^{1,2} - ALF’s assessment in clinical settings remains limited by the lack of standardized tools and normative benchmarks. - This study aimed to provide a normative benchmark for one-week forgetting on the Rey Auditory Verbal Learning Test (RAVLT) in cognitively healthy adults.	- Pre-registered systematic review and meta-analysis (OSF: 10.17605/OSF.IO/W89QZ). Inclusion criteria: studies assessing RAVLT delayed recall after 15–30 min and one week in cognitively healthy adults. - Standardized mean changes were calculated using SMCR. - Random-effects meta-analysis was performed using restricted maximum likelihood. - Sensitivity analyses tested different pre–post correlations: $r = .3, .5$, and $.7$.	16 included studies; 1,565 cognitively healthy adults. Significant decline in RAVLT recall over one week: SMCR = -1.27, 95% CI $[-1.45, -1.09]$, $p < .001$. <table><thead><tr><th>Study</th><th>SMC [95% CI]</th></tr></thead><tbody><tr><td>Helmstaedter et al 2019</td><td>-1.23 [-1.44, -1.02]</td></tr><tr><td>Pugh et al 2024</td><td>-1.01 [-1.42, -0.60]</td></tr><tr><td>Hanojulu et al 2019</td><td>-1.66 [-2.19, -1.14]</td></tr><tr><td>Studer et al 2024a</td><td>-1.11 [-1.45, -0.77]</td></tr><tr><td>Visser et al 2019</td><td>-1.06 [-1.64, -0.48]</td></tr><tr><td>Polat et al 2020</td><td>-1.62 [-2.22, -1.01]</td></tr><tr><td>Studer et al 2024b (1)</td><td>-1.22 [-1.49, -0.94]</td></tr><tr><td>Studer et al 2024b (2)</td><td>-1.06 [-1.30, -0.82]</td></tr><tr><td>Studer et al 2024b (3)</td><td>-0.93 [-1.28, -0.58]</td></tr><tr><td>Ricci et al 2022</td><td>-0.87 [-0.98, -0.76]</td></tr><tr><td>Alvarez-Schulze et al 2022</td><td>-1.86 [-2.06, -1.67]</td></tr><tr><td>C. Helmstaedter et al 1998</td><td>-0.78 [-1.27, -0.29]</td></tr><tr><td>van der Werf et al 2016</td><td>-1.92 [-2.44, -1.40]</td></tr><tr><td>Baker et al., 2021</td><td>-2.15 [-2.91, -1.39]</td></tr><tr><td>Lugheimer et al., 2026</td><td>-1.09 [-1.29, -0.90]</td></tr><tr><td>Miller et al. 2015</td><td>-1.42 [-1.78, -1.06]</td></tr><tr><td>Random-Effects Model</td><td>-1.27 [-1.45, -1.09]</td></tr></tbody></table> Standardized Mean Change Fig. 1. Forest plot of one-week RAVLT forgetting in cognitively healthy adults.	Study	SMC [95% CI]	Helmstaedter et al 2019	-1.23 [-1.44, -1.02]	Pugh et al 2024	-1.01 [-1.42, -0.60]	Hanojulu et al 2019	-1.66 [-2.19, -1.14]	Studer et al 2024a	-1.11 [-1.45, -0.77]	Visser et al 2019	-1.06 [-1.64, -0.48]	Polat et al 2020	-1.62 [-2.22, -1.01]	Studer et al 2024b (1)	-1.22 [-1.49, -0.94]	Studer et al 2024b (2)	-1.06 [-1.30, -0.82]	Studer et al 2024b (3)	-0.93 [-1.28, -0.58]	Ricci et al 2022	-0.87 [-0.98, -0.76]	Alvarez-Schulze et al 2022	-1.86 [-2.06, -1.67]	C. Helmstaedter et al 1998	-0.78 [-1.27, -0.29]	van der Werf et al 2016	-1.92 [-2.44, -1.40]	Baker et al., 2021	-2.15 [-2.91, -1.39]	Lugheimer et al., 2026	-1.09 [-1.29, -0.90]	Miller et al. 2015	-1.42 [-1.78, -1.06]	Random-Effects Model	-1.27 [-1.45, -1.09]	- Healthy adults show a quantifiable decline in RAVLT recall over one week. - One-week forgetting is therefore not necessarily pathological. - Prediction intervals provide a useful normative range for expected long-term memory decline. - These benchmarks may help distinguish normal forgetting from ALF in clinical populations.	¹: Pizzoni L, Piero AD, Blasutto B, Casagrande M, Piccardi L, Guariglia C. Accelerated long-term forgetting in Alzheimer's disease continuum: A systematic review and meta-analysis. <i>J Alzheimers Dis.</i> 2026;111(4):1459-1482. ²: Rodini M, De Simone MS, Caltagirone C, Carlesimo GA. Accelerated long-term forgetting in neurodegenerative disorders: A systematic review of the literature. <i>Neurosci Biobehav Rev.</i> 2022; 141:104815. doi: 10.1016/j.neubiorev.2022. CONTACT *luca.pizzoni@uniroma1.it  ALZHEIMER'S ASSOCIATION AAIC 26
Study	SMC [95% CI]																																							
Helmstaedter et al 2019	-1.23 [-1.44, -1.02]																																							
Pugh et al 2024	-1.01 [-1.42, -0.60]																																							
Hanojulu et al 2019	-1.66 [-2.19, -1.14]																																							
Studer et al 2024a	-1.11 [-1.45, -0.77]																																							
Visser et al 2019	-1.06 [-1.64, -0.48]																																							
Polat et al 2020	-1.62 [-2.22, -1.01]																																							
Studer et al 2024b (1)	-1.22 [-1.49, -0.94]																																							
Studer et al 2024b (2)	-1.06 [-1.30, -0.82]																																							
Studer et al 2024b (3)	-0.93 [-1.28, -0.58]																																							
Ricci et al 2022	-0.87 [-0.98, -0.76]																																							
Alvarez-Schulze et al 2022	-1.86 [-2.06, -1.67]																																							
C. Helmstaedter et al 1998	-0.78 [-1.27, -0.29]																																							
van der Werf et al 2016	-1.92 [-2.44, -1.40]																																							
Baker et al., 2021	-2.15 [-2.91, -1.39]																																							
Lugheimer et al., 2026	-1.09 [-1.29, -0.90]																																							
Miller et al. 2015	-1.42 [-1.78, -1.06]																																							
Random-Effects Model	-1.27 [-1.45, -1.09]																																							