**Minding the bilingual gap: A systematic review and perspective on EEG-based diagnoses of dementia**

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*Dementia* is an indisputably prevalent neurodegenerative disease, affecting over 55 million people worldwide – a number projected to double in the coming decades [1, 2]. Characterized by progressive decline in memory, language, attention, planning, and reasoning, dementia substantially increases social and physical dependency in older adults and places mounting pressure on healthcare systems across the globe [e.g., 1, 2]. Against this backdrop, early dementia diagnosis is not merely desirable but a central clinical priority.

*Electroencephalography* (EEG) is a promising, non-invasive and cost-efficient tool for early detection: dementia is reliably associated with slower EEG activity (increased delta/theta power), reduced connectivity, and decreased signal complexity relative to healthy peers [e.g., 2]. Yet, a crucial dimension of individual variability is absent from current EEG-based diagnostic protocols – language background, despite robust evidence that lifelong bilingualism reshapes brain structure and function [e.g., 3, 4, 5]. Adult bilinguals, for instance, often show faster neural dynamics (increased alpha/beta/gamma power), greater functional connectivity, and higher signal complexity [4, 5], and behaviorally, bilingualism is associated with a 4-5-year delay in dementia symptom onset [e.g., 6].

This systematic literature review (SLR) examines how bilingual EEG adaptations intersect with dementia EEG-biomarkers, in a context where no studies to date have directly compared monolingual and bilingual patients with dementia using EEG. It synthesizes 30 EEG studies on neural correlates of adult bilingualism and 73 studies on EEG-based biomarkers in Alzheimer's disease and related dementias (see Table 1). Using qualitative thematic analysis and quantitative topic modelling, we map bilingual EEG adaptations onto dementia markers to identify key similarities and differences. Across the studies, bilinguals frequently show patterns *opposite* to those seen in dementia on key resting-state EEG measures (i.e., spectral, connectivity, and complexity measures). In Alzheimer's disease, brain activity typically shows increased slow-wave (delta/theta) and decreased fast-wave activity, whereas adult bilinguals show increased fast-wave (alpha/beta/gamma) activity with baseline slow-wave levels. This contrast is consistent with a protective effect of lifelong bilingual experience but raises a clinical concern: standard resting-state EEG biomarkers may be less sensitive for bilinguals, risking systemic underdiagnosis. This review therefore advocates for bilingual-norm referenced EEG protocols and systematic reporting of language background in next-generation dementia screening tools.

## References


**[1]** WHO [World Health Organization]. *Dementia*. 2025.

**[2]** Yue Yuan & Yang Zhao. The role of quantitative EEG biomarkers in Alzheimer's disease and mild cognitive impairment: Applications and insights. *Frontiers in Aging Neuroscience*, 17, 1522552.https://doi.org/10.3389/fnagi.2025.1522552. 2025.

**[3]** Michal Korenar, Jeanine Treffers-Daller & Christos Pliatsikas. Dynamic effects of bilingualism on brain structure map onto general principles of experience-based neuroplasticity. *Scientific reports, 13*(1), 3428. https://doi.org/10.1038/s41598-023-30326-3. 2023a.

**[4]** Sergio M. Pereira Soares, Maki Kubota, Eleonora Rossi & Jason Rothman. Determinants of bilingualism predict dynamic changes in resting state EEG oscillations. *Brain and language, 223*, 105030. https://doi.org/10.1016/j.bandl.2021.105030. 2021.

**[5]** John G. Grundy, John A.E. Anderson & Ellen Bialystok. Bilinguals Have More Complex EEG Brain Signals in Occipital Regions than Monolinguals. *NeuroImage, 159*, 280–288. https://doi.org/10.1016/j.neuroimage.2017.07.063. 2017.

**[6]** John A.E. Anderson, Kornelia Hawrylewicz & John G. Grundy. Does bilingualism protect against dementia? A meta-analysis. *Psychonomic bulletin & review, 27*(5), 952–965. https://doi.org/10.3758/s13423-020-01736-5. 2020.


## Figures and Tables

Table 1: Raw frequency distribution of EEG signal types across included dementia and bilingual research papers

| Dementia (n = 73) | | Bilinguals (n = 30) | |
|---|---|---|---|
| **Signal type** | **n** | **Signal type** | **n** |
| rsEEG (EC) | 45 | rsEEG (EC) | 2 |
| rsEEG (EO) | 4 | - | - |
| ERP | 2 | ERP | 22 |
| tsEEG | 2 | - | - |
| REM-EEG | 1 | - | - |
| rsEEG unspecified | 1 | - | - |
| rsEEG (EO & EC) | 6 | rsEEG (EO & EC) | 1 |
| rsEEG (EC) & ERP | 1 | - | - |
| rsEEG (EO) & REM-EEG | 1 | - | - |
| rsEEG (EC) & tsEEG | 1 | - | - |
| rsEEG (EO) & tsEEG | 1 | - | - |
| tsEEG & behavioral | 2 | tsEEG & behavioral | 2 |
| ERP & behavioral | 2 | ERP & behavioral | 3 |
| rsEEG (EC) & FDG-PET | 1 | - | - |
| rsEEG (EO & EC) & flash-visual evoked potential | 1 | - | - |
| rsEEG (EO + EC) & MRI | 1 | - | - |
| rsEEG (EO) & fMRI | 1 | - | - |

*Note: rsEEG (EC) = resting-state EEG, eyes closed; rsEEG (EO) = resting-state EEG, eyes open; ERP = event-related potential; tsEEG = task-state EEG; REM-EEG = EEG during REM sleep; FDG-PET = Fluorodeoxyglucose Positron Emission Tomography. "&" indicates that multiple signals contributed to the findings. "Behavioral" refers to task-based measures (e.g., reaction time, accuracy).*