Bilingualism

- Clinical feasibility of AI Doctors: Evaluating the replacement potential of large language models in outpatient settings for central nervous system tumors
- Transient selective aphasia in highly proficient bilinguals triggered by electrical stimulation of the left superior temporal gyrus
- Functional MRI for bilingual epilepsy surgery patients: serving a diverse pediatric cohort
- Bilingual awake craniotomy with English and Polish language mapping in a 15-year-old patient provides evidence for the role of the left superior temporal gyrus in language switching
- Enhanced efficiency in the bilingual brain through the inter-hemispheric cortico-cerebellar pathway in early second language acquisition
- Unveiling the neuroplastic capacity of the bilingual brain: insights from healthy and pathological individuals
- Polish cross-cultural adaptation of a disease-specific quality-of-life instrument: The Penn Acoustic Neuroma Quality-of-Life Scale
- Polish cross-cultural adaptation of the Glasgow Benefit Inventory as an instrument for the post-intervention measurement of change after Gamma Knife treatment

---

Bilingualism refers to the ability to use two languages proficiently. A bilingual person can speak, understand, read, and write in two languages with varying degrees of fluency. Bilingualism is not a uniform concept; it can manifest in different ways depending on factors such as language proficiency, context, and the timing of learning.

Here are key points about bilingualism:

Types of Bilingualism: 1. **Simultaneous Bilingualism**: This occurs when a person learns two languages from birth or early childhood, typically in a bilingual environment. This is common in families where parents speak different languages.

2. **Sequential (or Successive) Bilingualism**: This happens when a person learns a second language after already being proficient in a first language, often in childhood or adulthood. For example, a child might learn their native language at home and then acquire a second language at school.

3. **Balanced Bilingualism**: This refers to a situation where a person has nearly equal proficiency in both languages. While rare, this is the ideal for some bilinguals.

4. **Dominant Bilingualism**: In this case, one language is stronger or more frequently used than the other. For instance, someone who speaks both Spanish and English but uses English more often may be considered dominant in English.

5. **Passive Bilingualism**: A person understands a second language but is not able to speak or use it actively.

Cognitive and Neurological Aspects: - **Cognitive Benefits**: Bilingualism has been linked to cognitive advantages, such as better executive function (e.g., problem-solving, multitasking, and memory) and delayed onset of age-related cognitive decline, including Alzheimer's disease.

- **Language Switching**: Bilinguals can switch between languages depending on the context, a

process known as **code-switching**. This flexibility relies on the brain's ability to manage and control both languages.

- **Brain Activation**: Studies have shown that bilinguals often have denser gray matter in areas of the brain related to language processing. The brain of a bilingual person is particularly adept at managing the interference from competing languages, which enhances cognitive flexibility.

Social and Cultural Aspects: - **Cultural Identity**: Bilingualism can be tied to cultural identity. For many bilinguals, each language may represent a different cultural aspect of their life, and they may switch languages depending on the social or cultural context.

- **Communication**: Bilinguals have the advantage of communicating with a wider range of people across different linguistic communities, which can be particularly useful in multilingual regions or professional settings.

Challenges of Bilingualism: - **Language Interference**: Sometimes, one language can interfere with the other, causing errors such as mixing vocabulary, grammar, or pronunciation (e.g., "Spanglish" or "Franglais"). This is especially common in simultaneous bilinguals.

- **Language Maintenance**: Bilinguals may struggle to maintain proficiency in both languages, especially if one language is used more frequently than the other. This can lead to **language attrition**, where one language becomes weaker over time.

- **Social Perceptions**: In some regions, bilingual individuals may face social stigma or discrimination, especially if one of their languages is viewed as less prestigious or less widely spoken.

Conclusion: Bilingualism is a dynamic and complex phenomenon that involves not just language proficiency but also cognitive, social, and cultural factors. It provides numerous benefits, both personally and professionally, but can also come with challenges, particularly in balancing both languages and navigating social perceptions.

The utility of intraoperative mapping in multilingual patients with brain tumors in speech-eloquent locations is evidenced by reports of heterogeneity of the location and number of language areas. Furthermore, preserving the ability to switch between languages is crucial for multilingual patients' communication and quality of life. Barua et al. report the first case of intraoperative bilingual and language-switching testing in a child undergoing awake craniotomy for a tumor within the left superior temporal gyrus using a novel test paradigm. Stimulation of the posterior superior temporal gyrus resulted in anomia when switching from Polish to English, in the absence of any stimulation effect on switching from English to Polish or object naming in each language [1)]

The article *"Bilingual awake craniotomy with English and Polish language mapping in a 15-year-old patient provides evidence for the role of the left superior temporal gyrus in language switching"* (Acta Neurochir, 2024 Nov 13;166(1):452) presents an intriguing study on the role of the left superior temporal gyrus (STG) in bilingual language switching. The authors—Neil U Barua, Hajira Mumtaz, Sonia Mariotti, Molly Cree, Agdaliya Mikhalkova, Greg A Fellows, and Anna E Piasecki—explore a novel approach to intraoperative language mapping in a young multilingual patient undergoing awake craniotomy for a tumor in the left superior temporal gyrus. This report highlights the utility of mapping bilingual language areas and provides significant insights into the complex brain regions

involved in switching between languages.

Strengths:

1. **Novel Methodology**: The use of a bilingual awake craniotomy in a 15-year-old patient is groundbreaking, as it is the first report of such an approach for mapping language switching between English and Polish. This methodology can offer a deeper understanding of the neural mechanisms underlying multilingual language processing, especially in children, who may exhibit unique brain adaptations.

2. **Clinical Relevance**: The study is highly relevant for clinical neuropsychology, particularly for multilingual patients with brain tumors in speech-eloquent regions. By demonstrating the distinct brain activity involved in language switching, the findings may guide surgeons in preserving both language abilities during resection of tumors in these areas, ultimately improving postoperative quality of life for patients.

3. **Specific Findings**: The case highlights the critical role of the posterior superior temporal gyrus (STG) in switching between languages. The stimulation-induced anomia specifically when switching from Polish to English—without affecting the ability to name objects in each language individually—emphasizes the specialized role of the STG in language switching rather than simple language production. This nuanced finding adds to the existing body of literature and suggests the need for further studies to map out language-specific regions more thoroughly.

Weaknesses:

1. **Generalizability**: As a single case report, the findings should be viewed with caution. It is difficult to generalize the results to other bilingual individuals, particularly in different age groups, with different language pairs, or those with other neurological conditions. The authors themselves acknowledge that further studies with larger sample sizes are needed to confirm the results and expand the findings to a wider population.

2. **Language Pair Considerations**: The study examines only two languages—English and Polish. While this is an important step, the findings are limited to this particular language pair. Different language pairs may activate different regions of the brain due to variations in phonology, syntax, and other language-specific features. It would be interesting to see if similar results are observed in individuals who speak languages that are typologically distant, such as English and Mandarin, or among individuals with more complex multilingual profiles.

3. **Neuroplasticity**: The study does not address the potential influence of neuroplasticity on language functions in multilingual individuals. Children, in particular, may demonstrate different neural organization compared to adults, and the influence of age, experience, and neural reorganization in response to the tumor could affect the outcome. This aspect would benefit from further exploration.

Suggestions for Future Research:

- **Larger Cohort Studies**: It would be valuable to conduct similar research on a larger cohort of multilingual patients to identify whether the observed effects are consistent across different language pairs and in different populations (e.g., adults vs. children).

- **Long-Term Follow-Up**: A longitudinal follow-up of postoperative language outcomes would offer insight into the long-term impact of preserving specific areas of the STG and other brain regions involved in language switching.

- **Comparative Language Pairs**: Future studies could explore different language pairs or more complex multilingual cases, which might reveal additional findings or patterns in language representation and switching.

Conclusion:

This report provides compelling evidence for the involvement of the left superior temporal gyrus in language switching, contributing valuable knowledge to the field of multilingual neuropsychology. Although the findings are based on a single case, the study demonstrates the importance of intraoperative language mapping in bilingual patients undergoing neurosurgery. The findings hold promise for improving surgical outcomes for multilingual individuals, offering a more nuanced understanding of how the brain manages multiple languages. Nonetheless, further research is needed to validate these results and extend the implications to broader clinical practice.

Neural basis of language switching and the cognitive models of bilingualism remain controversial.

Sierpowska et al. explored the functional neuroanatomy of language switching implementing a new multimodal protocol assessing neuropsychological, functional magnetic resonance, and intraoperative Electrostimulation mapping results. A prospective series of 9 Spanish-Catalan bilingual candidates for awake brain surgery underwent a specific language-switching paradigm implemented both before and after surgery, throughout the Electrostimulation procedure, and during functional magnetic resonance both pre-and postoperatively. All patients were harboring left-hemispheric intrinsic brain lesions and were presenting functional language-related activations within the affected hemisphere. Language functional maps were reconstructed based on the intraoperative Electrostimulation results and compared to the functional magnetic resonance findings. Single language-naming sites (Spanish and Catalan), as well as language-switching naming sites were detected by Electrostimulation mapping in 8 patients (in one patient only Spanish-related sites were detected). Single naming points outnumbered the switching points and did not overlap with each other. Within the frontal lobe, the single language naming sites were found significantly more frequently within the inferior frontal gyrus as compared to the middle frontal gyrus [X2 (1) = 20.3, p < .001]. Contrarily, switching naming sites were distributed across the middle frontal gyrus significantly more often than within the inferior frontal gyrus [X2 (1) = 4.1, p = .043]. Notably, there was not always an overlap between functional magnetic resonance and Electrostimulation mapping findings. After surgery, patients did not report involuntary language switching and their neuropsychological scores did not differ significantly from the pre-surgical examinations. Our results suggest a functional division of the frontal cortex between naming and language switching functions, supporting that non-language specific cognitive control prefrontal regions (middle frontal gyrus) are essential to maintain effective communication together with the classical language-related sites (inferior frontal gyrus) [2)].

1)
Barua NU, Mumtaz H, Mariotti S, Cree M, Mikhalkova A, Fellows GA, Piasecki AE. Bilingual awake craniotomy with English and Polish language mapping in a 15-year-old patient provides evidence for the role of the left superior temporal gyrus in language switching. Acta Neurochir (Wien). 2024 Nov 13;166(1):452. doi: 10.1007/s00701-024-06358-7. PMID: 39535621.
2)
Sierpowska J, Fernandez-Coello A, Gomez-Andres A, Camins À, Castañer S, Juncadella M, Gabarrós A, Rodríguez-Fornells A. Involvement of the middle frontal gyrus in language switching as revealed by Electrostimulation mapping and functional magnetic resonance imaging in bilingual brain tumor patients. Cortex. 2017 Nov 14;99:78-92. doi: 10.1016/j.cortex.2017.10.017. [Epub ahead of print]

PubMed PMID: 29197227.