Neural Correlates of Syntactic Processing in Monolingual and Bilingual Children using Functional Near Infrared Spectroscopy (fNIRS) Imaging

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QUESTION
Do differences in early life language experience (bilingual vs. monolingual) change patterns of neural activity in classic language and cognitive tissue?

HYPOTHESES
Bilingualism reflects more robust language specific activity (Broca’s Area, BA; Superior Temporal Gyrus, STG)¹-³ or, reflects a cognitive general ‘dual task’ activity (Dorsolateral Prefrontal Cortex, DLPFC), or, reflects increased cognitive and language specific resources relative to monolingualism

METHOD
Participants

- **Monolingual**
  - Children 6-10 years
  - n=20

- **Bilingual**
  - Children 6-10 years
  - n=20

Early Exposed (Simultaneous)
- L1 & L2 = birth
- n=10

Later Exposed (Sequential)
- L1, birth; L2 = 5 years
- n=10

Task
Plausibility judgment of relative clause sentences⁴

- **Sentences**
  - Object Subject (OS): The child spilled the juice that stained the rug
  - Subject Object (SO): The juice that the child spilled stained the rug

RESULTS NEUROIMAGING

**Bilingual Age Of First Exposure To New Language Impacts Brain Organization**

- **Early Exposed**
  - Same pattern of brain activity as monolinguals

- **Later Exposed**
  - Different pattern of brain activity as monolinguals

**RESULTS BEHAVIOURAL**

Sentence Differences

- All participants showed increased reaction times (red) and greater errors (blue) for the complex SO sentences

**CONCLUSION**

In this first-time study of the brains of bilingual children reading, we found that early exposure to two languages yields comparable use of the classic language brain structures as seen in monolingual children

Supports the Hypothesis that bilingualism is predominantly a language specific activity, with greater neural activity (more extensive ‘extent and variability’) in classic language brain structures, which may lead to enhanced linguistic processing¹

Later exposed bilinguals show different patterns of neural activity in脑 tissue commensurate with increased demands on executive functions and language processing

No evidence for neural trauma due to early bilingual language exposure

New evidence that Bilingual language learning abides by principles of maturation and sensitive period hypothesis

REFERENCES

5. Ye, Tak, Jang, & Jiang (2009). Neuroimage, 44, 428-447

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What is fNIRS?

- Measures oxygenated, deoxygenated blood, and BOLD
- Advance - Statistical Parametric Mapping for NIRS (NIRS-SPM⁵)
- Good spatial (~4 cm) & temporal (10 Hz) resolution
- Advance - Tolerates movement

New Data Analysis

- Advance - Multilevel Modeling
- Hitachi ETG 4000
- 48 Channel

Neuroimaging Functional Near Infrared Spectroscopy (NIRS)

**Neuroimage, 44**

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