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Bilingualism enhances preterm-born children’s executive function: An fNIRS study

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Introduction

Executive function is critical for goal-directed problem solving and attention, and is a foundational tenet for learning throughout the lifespan (Zelazo, 2015).

Research Questions:
1. Are there differences in EF in monolingual versus bilingual preterm-born children, as measured by the DCCS task and the GNG task?
2. Are there differences in the neural recruitment of EF in monolingual versus bilingual preterm-born children during the DCCS and GNG task, as measured by functional Near-Infrared Spectroscopy (fNIRS)?

Methods

Participants: 16 preterm born children. 9 bilingual, 7 monolingual. Match on birth characteristics (Gestational age, acuity, birth weight, LOS)

Language category:
- Monolingual: English
- Heritage Speaker: English and receptive Spanish
- Bilingual: English and Spanish, daily production in both

Triangulated measures of bilingualism:
- Peabody Picture Vocabulary Test 4th Ed. (PPVT)
- Test de Vocabulario de Imágenes Peabody (TVIP)
- Parent Report

Behavioral Measurements of EF:
- Go/No-Go Task
  - Inhibitory control and response
  - Accuracy and average reaction time/stimulus
- Dimensional Card Change Sort (DCCS) Task
  - Cognitive flexibility
  - Accuracy, number of cards sorted/block and average reaction time/card

Neural EF data:
- Neural activation patterns
- Prefrontal cortex
- OxyHb, DeoxyHb, Hbtotal concentration levels
- NIRs: NIRStim, NIRStar

Results

DCCS Task: fNIRS results
- Oxyhemoglobin:
  - in both the border and color dimensions, the bilingual preterm-born children showed significantly lower changes in hbo when compared to the monolingual preterm-born children
  - No significant changes in hbo observed in the shape dimension.
- Deoxy-hemoglobin:
  - The monolingual children showed significant increases in hbr levels while the bilingual group showed significant decreases in hbr levels – for all dimensions

Go/No-Go Task
- Both groups performed similarly in terms of accuracy
- Bilingual preterm-born children were significantly faster – on both tests of EF

These data indicate:
- The neural correlates of executive functioning are different depending on one’s language profile
- Bilinguals recruit less OxyHb when having to engage in inhibition (they were also the fastest)
- Monolinguals generally needed more hbo for both tasks

Conclusions

Behaviorally, the bilingual preterm-born children were significantly faster than the monolingual preterm-born children at tasks of EF

Neurally, these results imply that monolingual preterm-born children need to recruit significantly more hbo to be able to perform tasks of EF.

What’s more, bilinguals recruited neural tissue differently from monolinguals. Possibly, less effort required necessitates less oxygenated hemoglobin levels.

Given that bilingualism confers significant health benefits, it is worth exploring how we can change the national discourse around bilingual curricula in public education given our results:
1. In accordance with past literature, there does seem to be a bilingual ‘edge’ in E.F. especially in speed of task performance for preterm children
2. This study also contributes to psycholinguistic theory: productive, creative capacity in the L2 may be a required threshold to reap the benefits of bilingualism

Acknowledgements and References

- Special thanks to all our research participants and their families
- Thanks to the Adaptive Neural System Laboratory staff and graduate students
- Supported by, Robert Wood Johnson Foundation, Kranys Innovation Fund, Language Learning Grant