Dual-Language Exposure Following Preterm Birth: Language, Executive Function, and Frontal Lobe Development

Kelly A. Vaughn[1], Anny Castilla-Earls[2], Johanna Bick[2], Susan H. Landry[1], & Dana DeMaster[1]
[1]University of Texas Health Sciences Center at Houston; [2]University of Houston

Introduction

- **Bilingual Development**
  - In large U.S. cities like Houston, Texas, >50% of infants born today are Hispanic/Latino[1].
  - These children are most often raised in Spanish/English bilingual environments[2].
  - Research suggests bilingual exposure does not negatively impact language development for:
    - typically-developing children[3]
    - children with autism[4,5]
    - children with Down syndrome[6]
    - children with cochlear implants[7,8]
  - For decades, researchers have agreed that early exposure has significant benefits for acquiring two languages[9,10]
    - This can be explained by neuroplasticity, which is greatest early in life[11]
    - Executive function (EF) abilities may also support early bilingual development
- **Language Development Following Preterm Birth**
  - Preterm birth affects approximately 10% of infants born in the U.S. and has long-term consequences for health and neuropsychological problems, including language and EF impairments[14,15]
  - Researchers who study infants born very or extremely preterm. (i.e., before 32 weeks gestation) have proposed that bilingual exposure may "overwhelm" these children[12,13]
  - For very preterm infants, prenatal brain development is incomplete at birth, which may lead to even more neuroplasticity[16]
- **Central Hypotheses**
  - If neuroplasticity supports bilingual language development and very preterm infants may have increased neuroplasticity, then neuroplasticity should support bilingual language development for very preterm infants.
  - If EF supports bilingual language development and very preterm infants have EF difficulties, then very preterm children may have more difficulties acquiring two languages

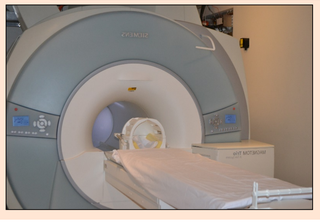
Method & Results

- **Study Overview**
  - Data comes from a pilot study of toddler development following preterm birth
  - Participants were 12 toddlers born very preterm & their mothers
  - Behavioral measures were conducted in the toddlers' homes and included: mother-child toy play and 3-6-9 box
  - Toddlers and mothers were grouped into "single-language" (n = 5, English-only) and "dual-language" (n = 7, English & Spanish) based on mother's language use during mother-child toy play
  - MRI data was collected at Baylor College of Medicine's Core for Advanced MR Imaging (CAMRI) in a 3T Siemen's Magentom Trio scanner during natural sleep
  - T1-weighted anatomical scan

TA	TR	TE	# Slices	Voxel Size
3:50	2170 ms	3.6 ms	192	1.0 x 1.0 x 1.0 mm^3

  - T2-weighted anatomical scan

TA	TR	TE	# Slices	Voxel Size
3:10	3200 ms	410 ms	176	1.0 x 1.0 x 1.0 mm^3

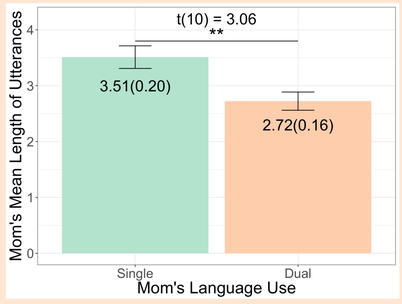


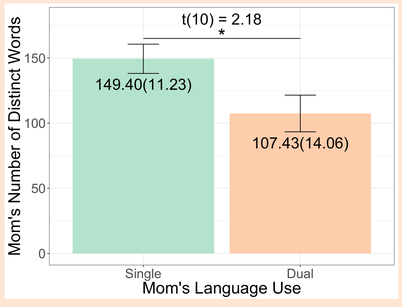
Method & Results

- **Mother-Child Toy Play[17]**
  - Parents and toddlers provided with age-appropriate toys for a 10-minute video-recorded interaction
  - Parents were asked to play with their toddlers in "typical ways"

  - Videos were coded by a bilingual research assistant to assess mother and child language production

Mother Language Outcomes	Language Group	Mean	SE	t	p
% Codeswitching	Single	0.00	0.00	NA	
	Dual	0.09	0.03		
Number of Utterances	Single	161.20	24.38	0.56	0.59
	Dual	142.29	22.56		
Syntactic Complexity	Single	0.86	0.02	0.88	0.40
	Dual	0.81	0.04		



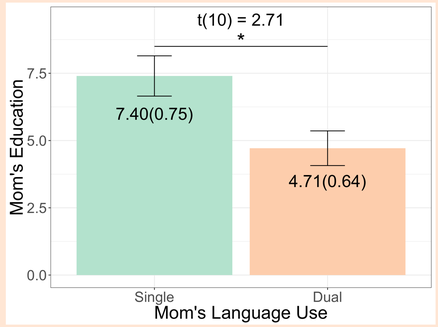


Child Language Outcomes	Language Group	Mean	SE	t	p
Number of Utterances	Single	19.80	10.70	1.76	0.11
	Dual	3.71	1.80		
Mean Length of Utterances	Single	1.43	0.17	1.06	0.32
	Dual	0.93	0.37		
Number of Distinct Words	Single	15.00	8.43	1.70	0.12
	Dual	2.86	1.18		

Method & Results

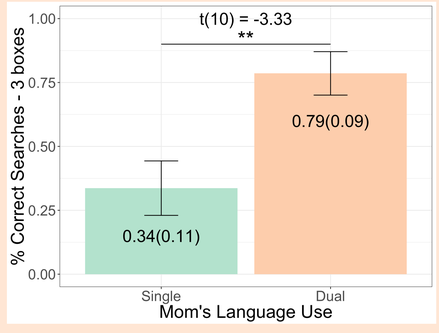
- **Mother's Language Use and Other Background Variables**

	Language Group	Mean	SE	t	p
Age Corrected for Prematurity (months)	Single	16.20	0.74	1.36	0.21
	Dual	15.00	0.54		
Gestation at birth (weeks)	Single	26.20	0.74	0.61	0.55
	Dual	25.71	0.42		
Bayley III Cognitive (raw)	Single	16.20	2.76	0.02	0.98
	Dual	16.14	0.71		



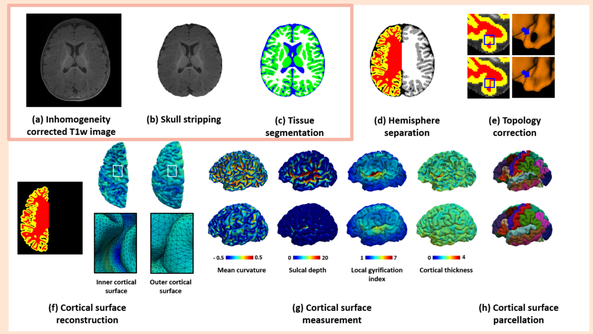
- **3-6-9 Box Task[18]**
  - Toddler-friendly task that taps into working memory and inhibition
  - Rewards are placed in each box
  - Child opens boxes one by one to find rewards
  - Researcher distracts the child for five seconds between searches

  - The number of boxes increases from 3 to 6 to 9 when children are successful
  - Most children in this study were unsuccessful with 6 boxes, so only 3 box results are presented (#correct/total # searches)



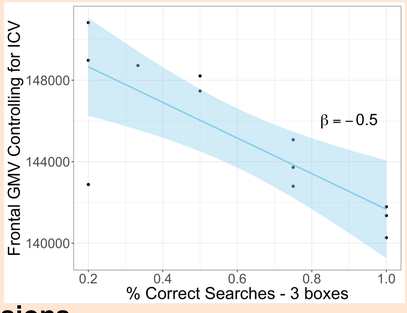
Method & Results

- **MRI Analyses**
  - Infant Brain Extraction Analysis Toolbox (iBEAT) v 2.0 Cloud (www.ibeat.cloud)[19,20]



  - FSL used to calculate gray matter volume (GMV) and intracranial volume from iBEAT tissue segmentation output[21]

	Language Group	Mean (Controlling for ICV)	SE	F	p
Frontal GMV	Single	149272	2361	4.93	0.05
	Dual	142247	1976		
Temporal GMV	Single	105532	3295	0.15	0.71
	Dual	103838	2758		
Parietal GMV	Single	100818	1463	0.21	0.66
	Dual	99919	1225		
Occipital GMV	Single	65883	1774	3.24	0.11
	Dual	70165	1485		
Subcortical GMV	Single	33513	890	0.25	0.63
	Dual	32920	745		
Intracranial Volume (ICV)	Single	1691509	50497	-1.11	0.29
	Dual	1741985	14865		



Conclusions

- Single-language moms had higher levels of education and produced longer utterances with more varied vocabulary than dual-language moms
- Differences between single-language moms and dual-language moms were unrelated to toddler language production
- Toddlers with dual-language moms performed better on an EF task than toddlers with single-language moms, which corresponded to decreased frontal lobe gray matter volume
- These findings suggest that dual language exposure does not "overwhelm" children born very preterm
  - Frontal lobe neuroplasticity may support bilingual development
  - EF also seems to be related to bilingual development

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