Neural Correlates of Specific Language Impairment

Alyson D. Abel, Julia Newton, Tracy Love
School of Speech, Language & Hearing Sciences
San Diego State University

SDSU Center for **Clinical** and **Cognitive Neuroscience**

LANGUAGE LEARNING LAB

SAN DIEGO STATE UNIVERSITY — School of Speech, Language, & Hearing Sciences

Language and Neuroscience Group

INTRODUCTION

Specific Language Impairment (SLI)
- Affects 7% of children[1]
- Heterogeneous language disorder in the absence of known casual factors that persists into adulthood
- Deficits can include understanding and/or use of vocabulary, syntax, etc.

Brain correlates of SLI
- Little research examining neural underpinnings of the disorder [2-5]
- Most have focused on structural brain differences in SLI
- Newer methods have expanded our understanding of underlying behavioral characteristics of SLI by examining functional differences.

Research Aim
To investigate cerebral blood volume in regions of interest associated with language processing in children with SLI

METHODS

Perfusion
Cerebral Blood Flow (CBF) = the amount of arterial blood in a given time (*mL blood/100 g tissue/minute*)
- Magnetic pulse tags arterial blood as it flows into cerebral tissue.
- Acquire images of tagged blood throughout the brain.

Allows:
1. The examination of potential differences in brain structure between SLI and typically developing (TD) children
2. To determine if functionally compromised areas are better predictors of performance on standardized language assessments

MRI Data Acquisition
- Scans performed on GE Discovery MR750 3.0T using a 32-channel head coil
- **Structural**: whole brain; MPRAGE T1; 0.8mm isotropic, 172 slices
- **CBF**: whole brain; pseudo-continuous arterial spin labeling sequence; 20 slices (6mm) [6]
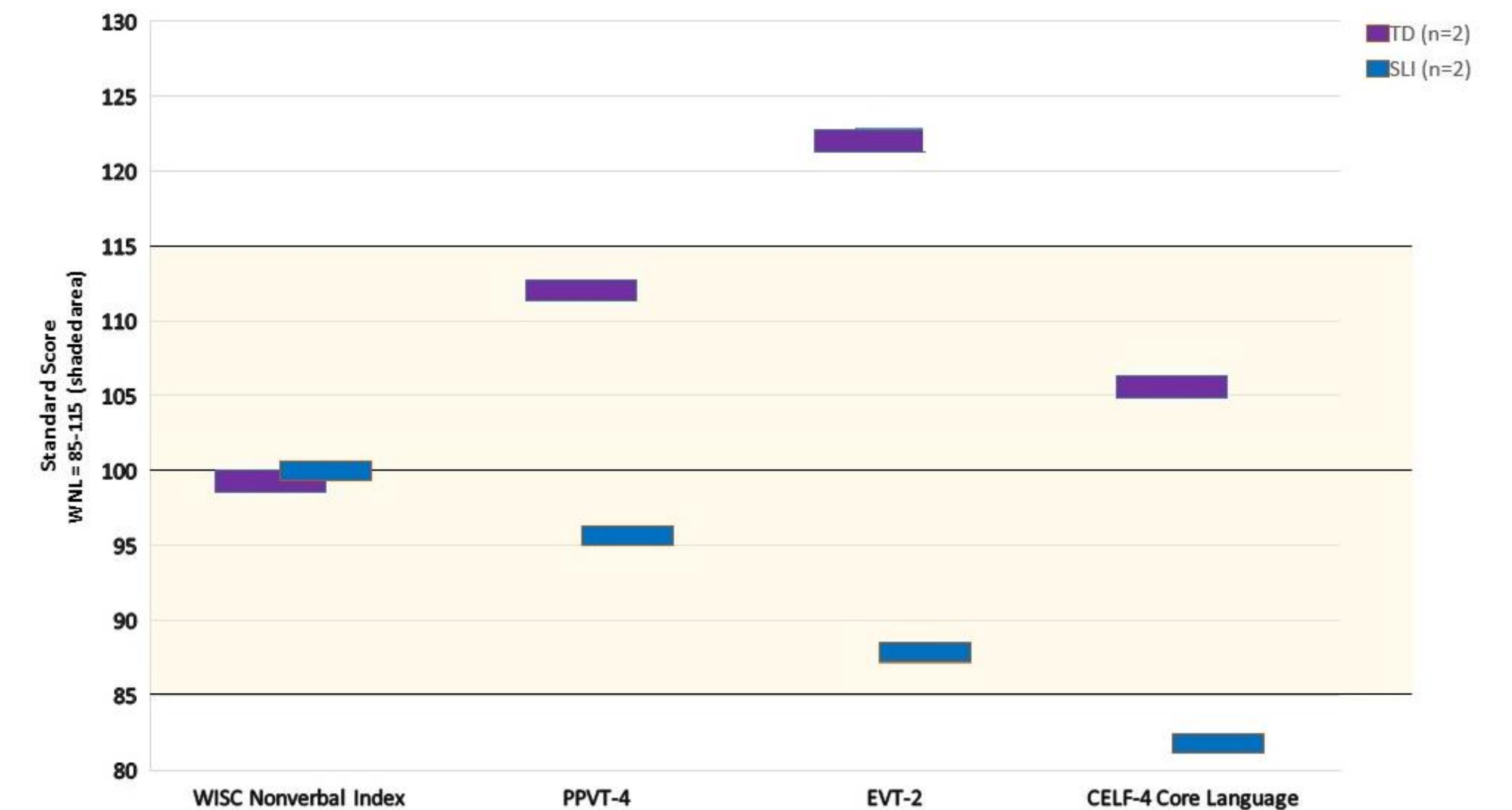- Total duration: 60 minutes

Data Analysis
- Derived measures of cerebral gray and white matter using the Freesurfer image analysis suite.
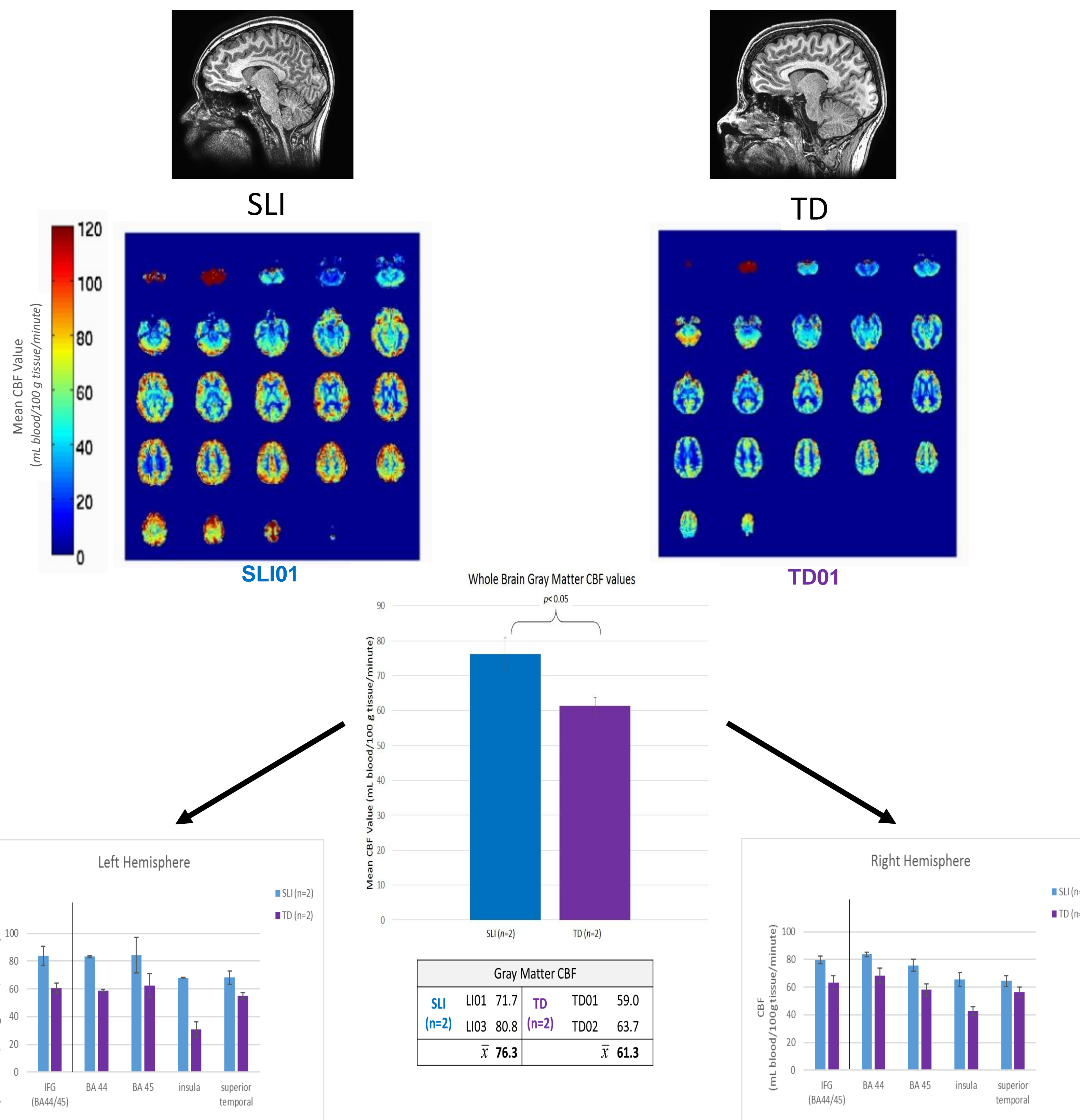- CBF maps are generated to examine CBF to the whole brain and specific regions of interest

PARTICIPANTS

Participant	Age	Sex
SLI01	11;10	Female
SLI02	9;5	Male
TD01	15;0	Male
TD02	14;6	Female

- Two groups of children, 9-16 years old
- SLI and TD controls
- **Inclusion criteria**: average or above average performance on nonverbal cognitive assessment (WISC-5 [7]), normal hearing, and an absence of concomitant diagnosis
- **Group Classification:** performance on CELF-4 [8] language assessment (standard score ≥1 SD below the mean classified as SLI)

PRELIMINARY RESULTS

SLI — SLI01

TD — TD01

Whole Brain Gray Matter CBF values — $p < 0.05$

Left Hemisphere

Right Hemisphere

Gray Matter CBF			
SLI (n=2)	LI01 71.7	TD (n=2)	TD01 59.0
	LI03 80.8		TD02 63.7
	$\bar{x}$ 76.3		$\bar{x}$ 61.3

SUMMARY

- Preliminary data (SLI, *n*=2; TD, *n*=2) suggest that, overall, the SLI group has a higher volume of blood flow than the TD group
- This difference can also be seen in specific areas that are integral to language (e.g., BA 45) and have been implicated in the behavioral language impairments that the SLI group displays.
    - This *could* represent a system that is working harder albeit less efficiently.

Findings from this research may prove critical to our efforts to lessen the impact of academic and social disability associated with SLI.

ACKNOWLEDGMENTS

REFERENCES

1. Tomblin, J.B., Records, N.L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). The prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research, 40*, 1245-1260.
2. Badcock, N.A., Bishop, D.V., Hardiman, M.J., Barry, J.G., & Watkins, K.E. (2012). Co-localization of abnormal brain structure and function in specific language impairment. *Brain and Language, 120*, 310-320.
3. Gauger, L.M., Lombardino, L.J., & Leonard, C.M. (1997). Brain morphology in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 40*(1272-1284.
4. Herbert, M.R., Ziegler, D.A., Makris, N., Bakardjiev, A., Hodgson, J., Adrien, K.T., . . . Caviness, V.S. (2003). Larger brain and white matter volumes in children with developmental language disorder. *Developmental Science, 6*, F11-F22.
5. Girbau-Massana, D., Garcia-Marti, G., Marti-Bonmati, L., & Schwartz, R.G. (2014). Gray–white matter and cerebrospinal fluid volume differences in children with specific language impairment and/or reading disability. *Neuropsychologia, 56*, 90-100.
6. Shin, D., Liu, T., Wong, E., Jung, Y. 2012. Pseudocontinous arterial spin labeling with optimized tagging efficiency. *Magnetic Resonance in Medicine, 68*, 1135-1144.
7. Wechsler, D. (2014). *Wechsler Intelligence Scale for Children - Fifth Edition.* Bloomington, MN: PsychCorp.
8. Semel, E., Wiig, E.H., & Secord, W.A. (2003). *Clinical Evaluation of Language Fundamentals – Fourth Edition.* Toronto, Canada: The Psychological Corporation/A Harcourt Assessment Company.

Neural Correlates of Specific Language Impairment

Alyson D. Abel, Julia Newton, Tracy Love
School of Speech, Language & Hearing Sciences
San Diego State University

INTRODUCTION

Specific Language Impairment (SLI)
- Affects 7% of children[1]
- Heterogeneous language disorder in the absence of known casual factors that persists into adulthood
- Deficits can include understanding and/or use of vocabulary, syntax, etc.

Brain correlates of SLI
- Little research examining neural underpinnings of the disorder [2-5]
- Most have focused on structural brain differences in SLI
- Newer methods have expanded our understanding of underlying behavioral characteristics of SLI by examining functional differences.

Research Aim
To investigate cerebral blood volume in regions of interest associated with language processing in children with SLI

METHODS

Perfusion
Cerebral Blood Flow (CBF) = the amount of arterial blood in a given time (*mL blood/100 g tissue/minute*)
- Magnetic pulse tags arterial blood as it flows into cerebral tissue.
- Acquire images of tagged blood throughout the brain.

Allows:
1. The examination of potential differences in brain structure between SLI and typically developing (TD) children
2. To determine if functionally compromised areas are better predictors of performance on standardized language assessments

MRI Data Acquisition
- Scans performed on GE Discovery MR750 3.0T using a 32-channel head coil
- **Structural**: whole brain; MPRAGE T1; 0.8mm isotropic, 172 slices
- **CBF**: whole brain; pseudo-continuous arterial spin labeling sequence; 20 slices (6mm) [6]
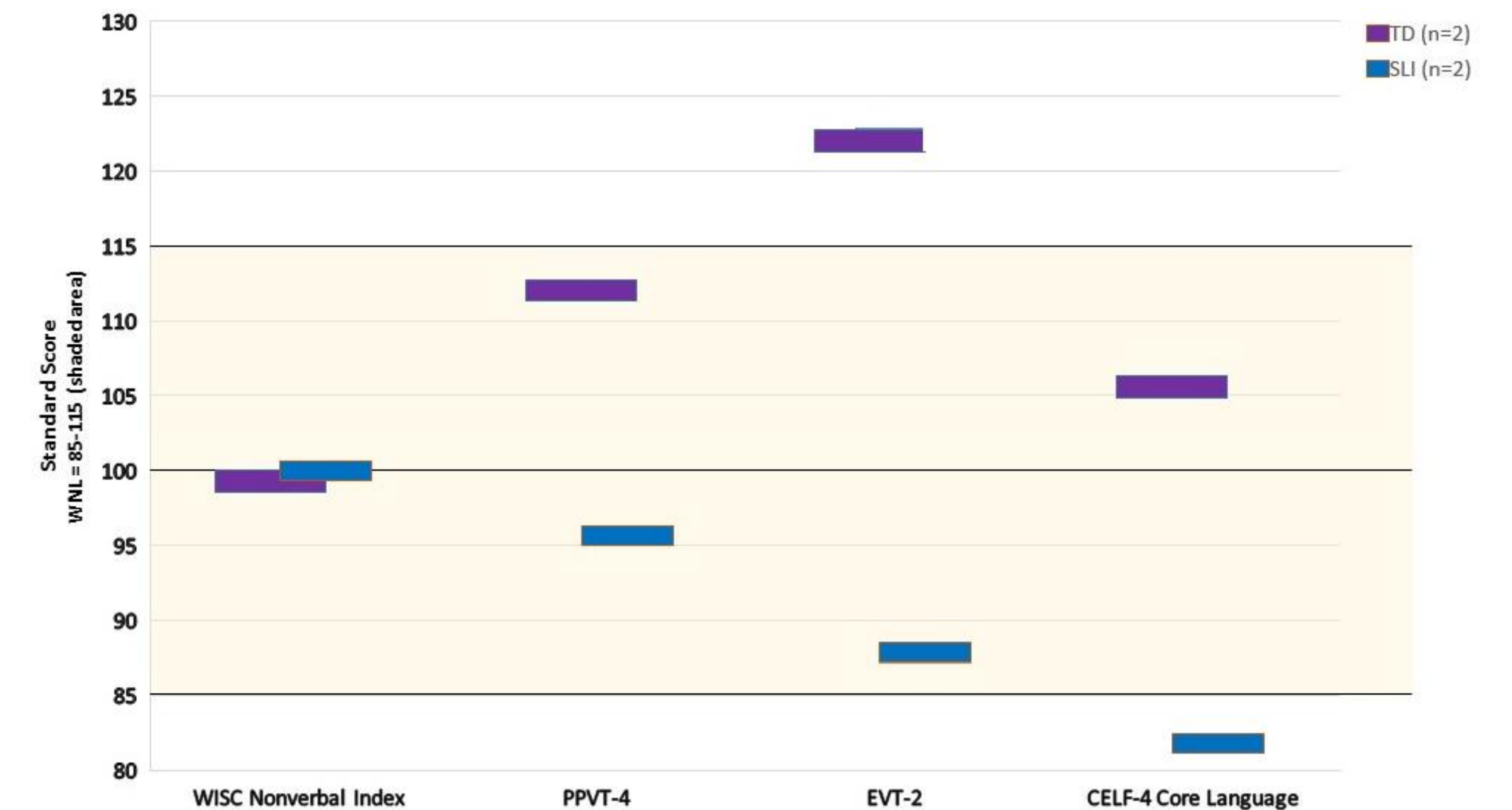- Total duration: 60 minutes

Data Analysis
- Derived measures of cerebral gray and white matter using the Freesurfer image analysis suite.
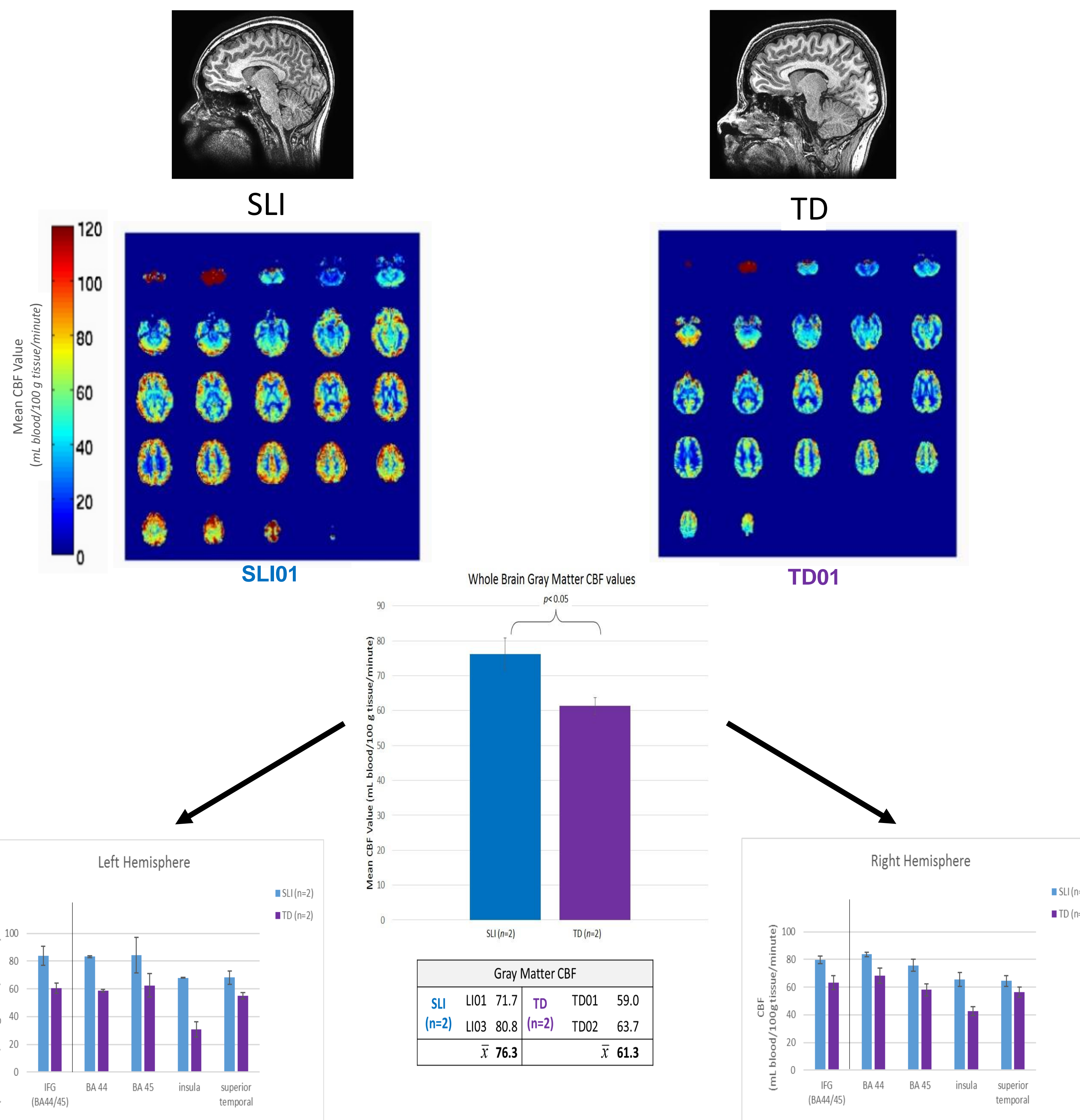- CBF maps are generated to examine CBF to the whole brain and specific regions of interest

PARTICIPANTS

Participant	Age	Sex
SLI01	11;10	Female
SLI02	9;5	Male
TD01	15;0	Male
TD02	14;6	Female

- Two groups of children, 9-16 years old
- SLI and TD controls
- **Inclusion criteria**: average or above average performance on nonverbal cognitive assessment (WISC-5 [7]), normal hearing, and an absence of concomitant diagnosis
- **Group Classification:** performance on CELF-4 [8] language assessment (standard score ≥1 SD below the mean classified as SLI)

PRELIMINARY RESULTS

SLI — SLI01

TD — TD01

Whole Brain Gray Matter CBF values

$p < 0.05$

Gray Matter CBF			
SLI (n=2)	LI01 71.7	TD (n=2)	TD01 59.0
	LI03 80.8		TD02 63.7
	$\bar{x}$ 76.3		$\bar{x}$ 61.3

Left Hemisphere

Right Hemisphere

SUMMARY

- Preliminary data (SLI, *n*=2; TD, *n*=2) suggest that, overall, the SLI group has a higher volume of blood flow than the TD group
- This difference can also be seen in specific areas that are integral to language (e.g., BA 45) and have been implicated in the behavioral language impairments that the SLI group displays.
  - This *could* represent a system that is working harder albeit less efficiently.

Findings from this research may prove critical to our efforts to lessen the impact of academic and social disability associated with SLI.

ACKNOWLEDGMENTS

REFERENCES

1. Tomblin, J.B., Records, N.L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). The prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research, 40*, 1245-1260.
2. Badcock, N.A., Bishop, D.V., Hardiman, M.J., Barry, J.G., & Watkins, K.E. (2012). Co-localization of abnormal brain structure and function in specific language impairment. *Brain and Language, 120*, 310-320.
3. Gauger, L.M., Lombardino, L.J., & Leonard, C.M. (1997). Brain morphology in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 40*(1272-1284.
4. Herbert, M.R., Ziegler, D.A., Makris, N., Bakardjiev, A., Hodgson, J., Adrien, K.T., . . . Caviness, V.S. (2003). Larger brain and white matter volumes in children with developmental language disorder. *Developmental Science, 6*, F11-F22.
5. Girbau-Massana, D., Garcia-Marti, G., Marti-Bonmati, L., & Schwartz, R.G. (2014). Gray–white matter and cerebrospinal fluid volume differences in children with specific language impairment and/or reading disability. *Neuropsychologia, 56*, 90-100.
6. Shin, D., Liu, T., Wong, E., Jung, Y. 2012. Pseudocontinous arterial spin labeling with optimized tagging efficiency. *Magnetic Resonance in Medicine, 68*, 1135-1144.
7. Wechsler, D. (2014). *Wechsler Intelligence Scale for Children - Fifth Edition*. Bloomington, MN: PsychCorp.
8. Semel, E., Wiig, E.H., & Secord, W.A. (2003). *Clinical Evaluation of Language Fundamentals – Fourth Edition*. Toronto, Canada: The Psychological Corporation/A Harcourt Assessment Company.