A Ramp to College: Intensive Cognitive-Communication Rehabilitation (ICCR) for Young Adults with Acquired Brain Injury

Presented at the 36th Annual New Hampshire Brain Injury and Stroke Conference
May 15th, 2018
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Disclosures

• Swathi Kiran has a financial relationship with The Learning Corporation/Constant Therapy (consulting fee).

• Natalie Gilmore and Lindsey Foo have no relationships to disclose.
After this Session You will be Able to:

1. List four principles of experience-dependent neuroplasticity

2. Identify an evidence-based approach for treating 1) attention; 2) language; 3) memory; and 4) executive function

3. State four key components of the intensive cognitive-communication rehabilitation (ICCR) program

4. Describe three outcomes of the intensive cognitive-communication rehabilitation (ICCR) program
Agenda

Foundations of ABI and ICCR Program

1. Review acquired brain injury (ABI)
2. Discuss recovery and neuroplasticity in this population
3. State of cognitive rehabilitation and transition to college services for young adults with ABI
4. Intensive Cognitive-Communication Rehabilitation (ICCR) program
Background: ABI - Etiology

• Acquired brain injury (ABI)
  A brain injury that occurs after birth that is not hereditary, congenital, degenerative, or related to birth trauma

Traumatic brain injury (TBI)
• Motor vehicle accidents
• Falls
• Assault
• Recreational injuries

Non-traumatic injury
• Stroke
• Brain tumor
• Infection
• Hypoxia/anoxia

1 https://www.biausa.org/
Background: ABI - Pathophysiology

TBI

Stroke
## Background: ABI - Long-term effects

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Domain</th>
<th>TBI</th>
<th>Stroke (aphasia)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognition</strong></td>
<td>Attention</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Executive Function</td>
<td>2</td>
<td>4</td>
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<td></td>
<td>Memory</td>
<td>2</td>
<td>5, 6</td>
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<tr>
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<td>Language</td>
<td>2</td>
<td>7</td>
</tr>
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<td></td>
<td>Visuospatial Skills</td>
<td>2</td>
<td>8</td>
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<tr>
<td></td>
<td>Processing Speed</td>
<td>9</td>
<td>10</td>
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<tr>
<td><strong>Psychosocial</strong></td>
<td>Anxiety</td>
<td>11</td>
<td>12</td>
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<tr>
<td></td>
<td>Depression</td>
<td>11</td>
<td>13</td>
</tr>
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<td></td>
<td>Anger/Irritability</td>
<td>11</td>
<td>14</td>
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<tr>
<td><strong>Physical</strong></td>
<td>Sleep/energy level</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Vision</td>
<td>19</td>
<td>20</td>
</tr>
</tbody>
</table>

Background: ABI - Prevalence

- 1-2 million individuals with TBI in the US annually\(^{21}\)
  - Young adults frequently-affected\(^{21}\)
    - Rise in recreation-related injuries
- 800,000 individuals with stroke yearly nationwide\(^{21}\)
  - 10-15% in working-age individuals\(^{22}\)
    - Increase in vascular risk factors
- Deficits are often chronic (i.e., >6 months post onset)\(^{2,7}\)
- Participation in school and work is often limited due to injury severity\(^{23-28}\)
- Reduced quality of life and increased societal burden\(^{29-32}\)

\(^{2}\)Rabinowitz et al. 2014; \(^{7}\)Sinanović et al. 2012; \(^{21}\)CDC; \(^{22}\)Smajlovic et al. 2015; \(^{23}\)Matuzzi & Pfenninger, 2018; \(^{24}\)Graham et al. 2011; \(^{25}\)Todis & Glang, 2008; \(^{26}\)Lawrence, 2010; \(^{27}\)Cahill et al. 2014; \(^{28}\)Kennedy et al. 2008; \(^{29}\)Ellis et al., 2012; \(^{30}\)Coronado et al. 2012; \(^{31}\)Hilari et al. 2016; \(^{32}\)Stochetti & Zanier 2016
Background: Young adults with ABI and college

• College is a rite of passage for many young adults.

• Unfortunately, skills important for success in college are often impaired after ABI, making participation challenging\(^{33-36}\)
  • Requires high motivation and support\(^{25}\)
  • 80% of young adults with TBI report struggling with academic material\(^{28}\)

• Provides an opportunity to improve cognition and build social skills, confidence and independence

How can we reconcile this mismatch?

\(^{25}\)Todis & Glang, 2008; \(^{28}\)Kennedy et al. 2008; \(^{33}\)Hassanbeigi et al. 2011; \(^{34}\)Krumrei-Mancuso et al. 2013; \(^{35}\)Stadler et al. 2016; \(^{36}\)Taraban et al. 2000;
Background: Impairment- & Functionally-based Cognitive Rehabilitation

1. Impairment-based approaches seek to strengthen cognitive-linguistic skills at the precise level of breakdown to maximize neurological gains\(^{37,38,39}\)

2. Functional approaches support cognitive-linguistic improvements in everyday, personally meaningful contexts\(^{40,41,42}\) and compensatory approaches help individuals adapt to their ABI

- Gold-standard cognitive rehabilitation (CR) = combination of these two approaches for comprehensive treatment\(^{43}\)

\(^{37}\)Kleim & Jones, 2008; \(^{38}\)Boyle, 2010; \(^{39}\)Sohlberg & Mateer, 1987;
\(^{40}\)Elman & Bernstein-Ellis, 1999; \(^{41}\)Jung Kim et al. 2000; \(^{42}\)Kagan, 2011;
\(^{43}\)Cicerone et al. 2019
Background: Cognitive Rehabilitation Recommendations

Evidence-Based Cognitive Rehabilitation: Systematic Review of the Literature From 2009 Through 2014

Keith D. Cicerone PhD a, b, Yelena Goldin PhD a, b, c, Keith Ganci PhD c, Amy Rosenbaum PhD d, Jennifer V. Wethe PhD e, Donna M. Langenbahn PhD f, g, James F. Malec PhD e, h, Thomas F. Bergquist PhD e, Kristine Kingsley PsyD f, g, Drew Nagele PsyD i, j, Lance Trexler PhD h, k, Michael Fraas PhD l, Yelena Bogdanova PhD m, n, J. Preston Harley PhD o

Cicerone et al. 2019
Background: Cognitive Rehabilitation (CR) Practice Standards

• **Attention:**
  - Direct attention training & metacognitive training after TBI and stroke (i.e., “thinking about thinking”)

• **Language & Communication:**
  - Cognitive-linguistic therapy for language deficits post left hemisphere (LH) stroke (e.g., semantic treatment)
  - Interventions for functional communication impairment post-TBI (e.g., pragmatics)

• **Memory:**
  - Strategy training for mild impairments (i.e., internal or external) to improve prospective memory and performance in everyday tasks

• **Executive Function:**
  - Metacognitive strategy training for self-monitoring and regulation following TBI
  - Problem-solving and goal management strategy training with application to everyday, functional contexts post-TBI

• **Comprehensive-holistic neuropsychological rehabilitation:**
  - Programs targeting cognitive impairments in individual and group contexts while also addressing psychosocial aspects of the injury for individuals with TBI or stroke of all severities and at all stages of recovery

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Cicerone et al. 2019
Background: Comprehensive, contextualized CR

• With the ultimate goal of meeting “real-world” goals, comprehensive, contextualized CR\(^{44}\) ...
  1) implements restorative and compensatory approaches in individual and group contexts
  2) targets multiple cognitive-linguistic domains within everyday activities
  3) supports management of emotional and interpersonal challenges

• Significant gains in functional outcomes like community integration and productivity\(^{43,45-47}\)
  • Cognition has improved, yet measured less consistently and/or thoroughly

\(^{43}\)Cicerone et al. 2019; \(^{44}\)Ylvisaker et al. 2002; \(^{45}\)Cicerone et al. 2000; \(^{46}\)Cicerone et al. 2005; \(^{47}\)Cicerone et al. 2011
Background: Experience-dependent neural plasticity

- Brain reorganization happens as a result of behavioral, sensory, and cognitive experiences (e.g., rehabilitation)

- Important principles of neuroplasticity
  - Use it or lose it
  - Use it and improve it
  - Repetition
  - Intensity
  - Specificity
  - Salience
  - Age

Photo courtesy of cognifit.com

## Background: ABI - Recovery

<table>
<thead>
<tr>
<th>Factor</th>
<th>TBI</th>
<th>Stroke (aphasia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>X 58</td>
<td>X 59</td>
</tr>
<tr>
<td>Initial severity</td>
<td>✔ 58,60</td>
<td>✔ 59,61,62,63,64</td>
</tr>
<tr>
<td>Age</td>
<td>✔ 58,60</td>
<td>X 59 ✔ 63,64</td>
</tr>
<tr>
<td>Injury site/extent</td>
<td>✔ 58,65</td>
<td>✔ 61</td>
</tr>
<tr>
<td>Education</td>
<td>✔ 60,65</td>
<td>✔ 63</td>
</tr>
<tr>
<td>Cognitive Status</td>
<td>✔ 58,60,65,66</td>
<td>✔ 67,68</td>
</tr>
</tbody>
</table>

Background: Current Continuum of Care

Emergency Department → Inpatient Rehab → Acute Care → Outpatient Care → Long term Community-based Care

Lorenz, L. & Katz, G., 2015
Background: Rehabilitation in the Chronic Phase

Gap in services

Outpatient Care; ICAPS; TBIMS
Residential Programs; Home Health
Statewide Head Injury Program (SHIP)

Support Groups
- Community college
- Disability services
Background: Intensive Cognitive-Communication Rehabilitation

• The ICCR program provides comprehensive, contextualized CR via a simulated college milieu

<table>
<thead>
<tr>
<th>EBP Cog Rehab</th>
<th>Principles of Neuroplasticity</th>
<th>Profiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual &amp; group therapy</td>
<td>Contextualized learning</td>
<td>Intensity</td>
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<tr>
<td>ICCR</td>
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</table>
• Significant gains on 2/4 standardized assessments of cognitive-linguistic function as the number of ICCR semesters increased

• Significant improvements in classroom participation, individual therapy and at least one aspect of life participation and quality of life for individuals who participated in multiple semesters of the program (n=3)

70Gilmore et al. 2018, AJSLP
Methods: Our program

Intensive Cognitive-Communication Rehabilitation (ICCR)

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
<tr>
<td>9:30 - 10:00</td>
<td>Quiz</td>
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<tr>
<td>10:00 - 11:00</td>
<td>Political Science Lecture</td>
<td>Physics Lecture</td>
<td>Political Science Lecture</td>
<td>Physics Lecture</td>
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<tr>
<td>11:00 - 12:00</td>
<td>Lecture Review</td>
<td>Lecture Review</td>
<td>Lecture Review</td>
<td>Lecture Review</td>
</tr>
<tr>
<td>12:00 - 1:00</td>
<td>Practice Quiz</td>
<td>Practice Quiz</td>
<td>Practice Quiz</td>
<td>Practice Quiz</td>
</tr>
<tr>
<td>1:00 - 2:00</td>
<td>Lunch</td>
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</tr>
<tr>
<td>2:00 - 3:00</td>
<td>Marketing/Finance</td>
<td>English</td>
<td>Marketing/Finance (Quiz)</td>
<td>English (Quiz)</td>
</tr>
<tr>
<td>3:00 - 4:00</td>
<td>Tech</td>
<td>Tech</td>
<td>Tech</td>
<td>Tech</td>
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</table>

- ~6 young adults with ABI in each class
- College-level courses
- Functionally-based application of skills and strategy training in classroom setting & 1:1
- Impairment-based 1:1 intervention of discrete cognitive-linguistic skill areas
Methods: Treatment - Core Courses

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<tr>
<td>12:00 - 1:00</td>
<td>Practice Quiz</td>
</tr>
</tbody>
</table>

- **Lecture (10-11am)**
  - Watch lecture with minimal clinician interference
  - Quizzed 2x/week on content

- **Lecture Review (11-12:30pm)**
  - Clinician-guided review of lecture information
  - Allows for metacognitive strategy instruction/modeling/application

- **Practice Quiz Questions (12:30-1:00pm)**
  - Answer practice potential quiz questions re: lecture content as a group
  - Application of test-taking strategies (e.g., process of elimination)

Course Content:
https://oyc.yale.edu/; https://www.khanacademy.org/
Methods: Treatment - Metacognitive strategy instruction

Metacognition = “thinking about thinking”

Four primary strategies:

- **RITA**
  - Rehearse, Imagine, Take Time, Activate
- **LEAP**
  - Listen Actively, Eliminate Distractions, Ask Questions, Paraphrase
- **TPDR**
  - Think, Plan, Do, Review
- **STEP BACK**

### Memory Strategies

**RITA – Rehearse, Imagine, Take time, Activate**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Stands for</th>
<th>How to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Rehearse</td>
<td>- Rehearse, repeat, and review to remember information</td>
</tr>
</tbody>
</table>
| I      | Imagine    | - Take a mental picture  
|        |            | - Try to learn as many visual details as possible |
| T      | Take time  | - Take time to consciously rehearse and study the information |
| A      | Activate   | - Work in different modalities (read, write, listen, do) and levels of processing (re-organize, outline, create, discuss, teach)  
|        |            | - Link new information with old; make associations  
|        |            | - This works especially well with new people |
Methods: Treatment – Elective

- Discussion and project-based learning opportunities
- Target reading, writing, and problem-solving skills
- Provide metacognitive strategy instruction/application
- Quizzed 2x/week on content

Summary: Chapter 2

Kathy continues to recall her childhood at Halisham. A few days after his tantrum, Tommy stops her on the stairs to apologize for his behavior. Kathy feels embarrassed to be addressed in such a public place, as the stairs are crowded...
Methods: Treatment – Technology skills session

- Constant Therapy
- ICCR course website
- Text-to-speech (e.g., VoiceDream)
Methods: Treatment - Individual

- Clinician-directed intervention
- Target cognitive-linguistic goals for academic success
- Address GAS goals for increased independence
### Methods: Treatment – Facilitating the Transition

<table>
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<td>Practice Quiz</td>
</tr>
<tr>
<td>1:00 - 2:00</td>
<td>Lunch &amp; Learn</td>
</tr>
<tr>
<td>2:00 - 3:00</td>
<td>Marketing/Finance</td>
</tr>
<tr>
<td>3:00 - 4:00</td>
<td>Tech</td>
</tr>
</tbody>
</table>

- **Resource packet**
- **Student Rights**
- **Disability Services**
- **Post-Secondary Education Options**
- **Technology**
- **Neuropsych testing**

Connect with other individuals with ABI who have returned to school or work.
Do participants...

... demonstrate improvements in cognitive-linguistic skills?

... demonstrate improvements in participation/quality of life?

... improve in their academic performance?

... improve on individual speech-language therapy goals?
Methods: Standardized Assessments – Impairment-based measures

**Language**
- Verbal Expression
- Written Expression
- Auditory Comprehension
- Reading Comprehension

**Non-Linguistic Cognition**
- Attention
- Memory
- Visuospatial Skills
- Executive Functions

- Western Aphasia Battery – Revised (WAB-R)\(^{71}\)
- Discourse Comprehension Test (DCT)\(^{72}\)
- Test of Everyday Attention (TEA)\(^{73}\)
- Repeatable Battery for the Assessment of Neuropsychological Status - Update (RBANS)\(^{74}\)
- Scales of Cognitive and Communicative Ability for Neurorehabilitation (SCCAN)\(^{75}\)

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\(^{71}\)Kertesz, 2007;\(^{72}\)Brookshire & Nicholas, 1997;\(^{73}\)Robertson, Ward, Ridgeway, & Nimmon-Smith, 1994;
\(^{74}\)Randolph, 2012;\(^{75}\)Milman et al. 2008
Methods: Standardized Assessments – Participation/QOL

• Child and Adolescent Scale of Participation (CASP)\textsuperscript{76}
  • Captures students’ and caregivers’ current perception of ability
    • Involves home, school, and community participation

• TBI-QOL\textsuperscript{77} and Neuro-QOL\textsuperscript{78}
  • Self-reported measures of health-related QOL
    • Anxiety, Depression, Communication, Cognitive Function, Positive Affect

• Goal Attainment Scaling (GAS)\textsuperscript{79}
  • Client sets 1-2 personal goals for the semester outside of cognitive-linguistic therapy goals
Methods: Informal Measures – Therapy and Academic Performance

• Weekly quizzes
• Performance in individual speech therapy
• Post-program enrollment in school
Results Fall 2016 – Spring 2019
Participants

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etiology</td>
<td>TBI</td>
<td>CVA</td>
<td>TBI</td>
<td>TBI</td>
<td>TBI</td>
<td>Tumor</td>
<td>CVA</td>
<td>TBI</td>
</tr>
<tr>
<td>Age</td>
<td>21</td>
<td>29</td>
<td>25</td>
<td>22</td>
<td>25</td>
<td>24</td>
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<td>26</td>
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<td>14</td>
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<td>15</td>
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<td>36</td>
</tr>
<tr>
<td>Language severity (WAB-AQ)</td>
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<td>79</td>
<td>63</td>
<td>94</td>
<td>68</td>
<td>82</td>
<td>88</td>
<td>91</td>
</tr>
<tr>
<td>Cognitive severity (RBANS Total)</td>
<td>45</td>
<td>64</td>
<td>46</td>
<td>78</td>
<td>49</td>
<td>44</td>
<td>52</td>
<td>53</td>
</tr>
</tbody>
</table>

Note: 4 /12 originally enrolled participants withdrew from the program after the first semester and thus, are not represented in this table or included in the analysis.
RQ 1: Demonstrate significant gains in cognitive-linguistic skills?

**Summary:** Yes, Young adults with chronic ABI show significant gains in language and cognitive function over time!
RQ 1: What LANGUAGE skills are improving?

**Summary:** Young adults with chronic ABI are significantly improving in speech production, word retrieval and writing.

*Significance key: * = p < .05, ** = p < .01, *** = p < .001*
RQ 1: What COGNITIVE skills are improving?

Summary: Young adults with chronic ABI are significantly improving in attention, memory and visuospatial/constructional skills.
RQ 2: Demonstrate improvements in participation?

**Summary:** Yes, Young adults with chronic ABI significantly improve in their participation, specifically in the community and school contexts.
RQ 2: Demonstrate improvements in quality of life?

Summary: ICCR students with TBI demonstrated significantly decreased depression over the course of multiple semesters of ICCR.
RQ 2: Demonstrate improvements in participation/quality of life?

## Status after ICCR

<table>
<thead>
<tr>
<th>Exp.</th>
<th>P1</th>
<th>P2</th>
<th>P4</th>
<th>P8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etiology</td>
<td>TBI</td>
<td>CVA</td>
<td>TBI</td>
<td>TBI</td>
</tr>
<tr>
<td># of semesters</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Current Setting</td>
<td>School</td>
<td>School</td>
<td>School</td>
<td>School</td>
</tr>
</tbody>
</table>

**Summary:** All four students who graduated from ICCR have moved on to post-secondary education.
RQ 3: Improve in their academic performance?

Summary: Participants accuracy on quizzes significantly improved across the semester.

Week: $\beta = .02$, $SE = .01$, $t(df=223) = 2.07$, $p < .05$

Semester*Week: $\beta = -.01$, $SE = .004$, $t(df=223) = -1.37$, N.S.
RQ 4: Improve in their individual speech therapy?

<table>
<thead>
<tr>
<th></th>
<th>Goal</th>
<th>Pre-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Edit writing samples and identify 80% of errors given &lt;5 cues to detect/correct errors</td>
<td>Identified 50% of errors</td>
</tr>
<tr>
<td>2</td>
<td>Create a plan and timeline to apply to college</td>
<td>No plan in place</td>
</tr>
</tbody>
</table>

**Summary:** Students were working on more complex goals and/or with less clinician support by the end of the ICCR semester. They also progressed on personal goals (e.g., navigating campus), showing increased independence.
Discussion

• Cumulative benefit of academically-focused intensive rehabilitation program
  • Significant improvements in language (e.g., word retrieval) and cognitive function (e.g., attention)
  • Significant gains in neighborhood, community and school participation
  • Significantly less depression reported by students with TBI

• Gains in academic performance
  • Quiz scores significantly increased over the course of the semester

• Ramp to college success
  • All ICCR students that have graduated the program have successfully enrolled in post-secondary education (e.g., community college, 4-year university)
Discussion

Why these results?

ICCR provided...

- Intensive
- Repetitive
- Specific
- Salient

training on multiple cognitive-linguistic domains in a contextualized environment
Conclusion

• Future work will
  • Involve larger, more diverse participant sample
  • Investigate predictors of treatment response/candidacy
  • Examine effects of ICCR on specific cognitive-linguistic domains and the neuroplasticity supporting those gains
Thank you!

- Dean’s Funding from Sargent College of Health and Rehabilitation Sciences

- Current ICCR Team at BU Aphasia Research Laboratory
  - Natalie Gilmore, Lindsey Foo, Maria Dekhtyar & Swathi Kiran

- MS students: Mallory Wallace, Megan Byrne, Kristin Kwan, Victoria Francesca, Kara Sheftic
- Undergrad students: Cat Perreira, Mallory Haratz, Nika Egringos

- ICCR students, families, and caregivers
- Past lab members and MS students
Questions ???

ACTIVELY recruiting participants!
aphasiaresearchlaboratory@gmail.com
617-353-2706
Supplemental slides
References
1. Brain Injury Association of America https://www.biausa.org/


