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Constraint Induced Language Therapy for Aphasia

Presented By:
Anastasia Raymer, Ph.D.

Moderated By:
Amy Hansen, M.A., CCC-SLP, Managing Editor, SpeechPathology.com

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Constraint Induced Language Therapy for Aphasia

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Acknowledgments:

Leora Cherney, Rehabilitation Institute of Chicago

Janet Patterson, Cal State University Hayward

Tobi Frymark, Tracy Schooling, & Rob Mullen, American Speech-Language-Hearing Association

Principles of Evidence Based Practice (Sackett et al., 2000)

clinical expertise

clinical decision-making

scientific evidence

patient values
Experience-dependent Neuroplasticity

An enriched experience changes the brain
(Rosenzweig & Bennett 1996; Petrosini et al., 2009)

We must understand ways to amplify the experiences in therapy to maximize benefits and minimize counterproductive effects

Principles of Neuroplasticity:
Animal Models
Kleim & Jones, JSLHR 2008

• Use it or Lose it: degradation of function (and neural representation) may occur with disuse
• Use it and Improve it: training can lead to enhancement of a function (and neural correlates)
• Specificity: the nature of the training experience influences the functional changes
• Repetition Matters: much repetition necessary
• Intensity Matters: intensive training necessary
Principles of Neuroplasticity:
Animal Models
Kleim & Jones, JSLHR 2008

• Time Matters: differential effects over recovery
• Salience Matters: experience must be meaningful
• Age Matters: younger is better
• Transference: training of one behavior can generalize to other behaviors
• Interference: training on one behavior can impede improvement of another

<table>
<thead>
<tr>
<th>Dependent Variables: Outcome Measures</th>
<th>Acquisition</th>
<th>Generalization/Transference</th>
<th>Interference</th>
<th>Maintenance</th>
<th>Neural Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing</td>
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<tr>
<td>Intensity</td>
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<tr>
<td>Quantity</td>
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<tr>
<td>Salience</td>
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<tr>
<td>Treatment Variables</td>
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<tr>
<td>Neural Conditions</td>
<td></td>
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</tbody>
</table>

Raymer et al., 2008

Principles of experience-dependent plasticity in aphasia rehabilitation

• Use it to improve it
• Intensity matters
  Kleim & Jones, 2008

The case of Constraint Induced Aphasia Therapy (CILT)
  Pulvermuller et al 2001
Learned non-use hypothesis
Taub, Uswatte & Elbert (2002)
Monkeys with de-afferented limbs

Overcoming Learned Nonuse
Taub, Uswatte & Elbert (2002): restrained monkey’s good limb and forced use of impaired limb

Constraint Induced Movement Therapy
Taub et al 1994
Hakkennes & Keating 2005

(Mark & Taub, 2004)
Constraint Induced Language Therapy—CILT
Pulvermuller et al. 2001

- Forced verbal language use
  - Verbalization required; Compensatory strategies prohibited

- Intensive treatment schedule
  - 3 hrs/day 5 days/week 2 weeks
  - Massed practice

- Shaping verbal responses
  - Begin with words or short phrases
  - Move to longer and more complex utterances
  - Barrier games
  - Go Fish-like activity: pictures selected for individual participants; response components predetermined


Constraint Induced Language Therapy (CILT)
(Pulvermuller et al., Stroke, 2001)

Barrier activity with dyad of patients
Verbal games

Compared intensive CILT and traditional nonintensive therapy

Results: Forced language group > traditional tx group in overall language battery, auditory comp and naming

Are the results due to forced language use or intensive treatment schedule?

Forced Language Use?
CILT versus PACE: Intensive
Maher et al. JINS 2006

CILT: N = 4  PACE: N = 5

TX: 4 days/week, 3 hours/day, 2 weeks = 24 total TX hours

WAB improved: 3/4 CILT, 1/5 PACE
BNT improved: 3/4 CILT, 0/5 PACE
ANT improved: 2/4 CILT, 1/5 PACE

*Intensity also plays a role
ASHA N-CEP (National Center for Evidence Based Practice): Facilitating Series of Evidence Based Systematic Reviews

• criteria for prioritizing topics
  – Incidence/prevalence
  – Risk/potential harm
  – Public policy or reimbursement issues
  – Importance to clients consumers
  – Answerable question
  – Representation of diverse areas of practice
  – Existence of other systematic reviews/guidelines
  – Level of interest among ASHA membership
  – Existence of studies currently underway

First Systematic Review:
Constraint Induced Language Therapy (CILT) for Aphasia (Cherney et al., 2008) (updated 2010)

• Public policy or reimbursement issues
  – Of considerable importance to funding agencies, third party payors
  – Several CILT clinics have been established across the country
  – Private clinics charging out-of-pocket

• Importance to clients/consumers
  – CILT has been (incorrectly) described as the only aphasia treatment with evidence
  – It has an internet presence

EBSR Committee
Volunteer Evidence Panel
Leora Cherney, Ph.D., CCC-SLP, BCNCD-A
Rehabilitation Institute of Chicago
Chicago IL
Janet Patterson, Ph.D., CCC-SLP
VA Medical Center,
Hayward CA
Anastasia Raymer, Ph.D., CCC-SLP
Old Dominion University
Norfolk VA

Staff: ASHA’s National Center for Evidence-Based Practice in Communication Disorders
Tobi Frymark, M.A., CCC-SLP
Tracy Schooling, M.A., CCC-SLP
Beverly Wang, B.S.
Cherney et al 2008: ASHA EBSR Process

• Identify evidence panel
  – selected by N-CEP based on
    • input from ASHA Special Interest Divisions
    • input from ASHA National Office staff
    • review of who has published on this topic
• Define clinical questions & search parameters
• Conduct literature search
  – NCEP Information manager
• Critically appraise the evidence
• Evaluate & synthesize evidence
• Write EBSR summary

Framing the clinical question

 рол Two principles of CILT are intertwined
  • Constraint
  • Intensive/Massed practice

rol PICO (Population-Intervention-Comparison-Outcome)
  • P = stroke-induced chronic aphasia, stroke-induced acute aphasia
  • I = CILT and intensive aphasia treatment
  • C = contrasting treatment or no treatment
  • O = measures of language impairment, communication activity/participation (WHO ICF)

CILT Questions

• For stroke-induced chronic aphasia, what is the influence of constraint-induced language therapy on measures of language impairment? measures of communication activity/participation?
• For stroke-induced acute aphasia, what is the influence of constraint-induced language therapy on measures of language impairment? measures of communication activity/participation?
• For stroke-induced chronic aphasia, what treatment outcomes are maintained following constraint-induced language therapy?
Intensity Questions

• For stroke-induced chronic aphasia, what is the influence of treatment intensity on measures of language impairment? measures of communication activity/participation?

• For stroke-induced acute aphasia, what is the influence of treatment intensity on measures of language impairment? measures of communication activity/participation?

• For stroke-induced chronic aphasia, what treatment outcomes are maintained following intensive language treatment?

Search Parameters: Original Review

• Inclusion:
  – Peer-reviewed literature from 1990 to 2006
  – Written in English
  – Adults ages 18 years or older
  – Stroke-induced aphasia
  – Direct comparison of CILT with other treatment approach or no treatment; or direct comparison of two treatment intensities

• Exclusion:
  – Studies including individuals with underlying cognitive deficits
  – Other primary medical diagnoses
  – Pharmacological intervention as comparison treatment
  – Mixed treatments

Search Parameters: Updated 2010 Review

• Same as earlier review

• Peer-reviewed literature from
  January 2006 – August 2010
Of 26 studies rated, 18 examined CILT

2008 Review:
Pulvermuller et al., 2001
Meinzer et al., 2004
Meinzer et al., 2005
Pulvermuller et al., 2005
Maher et al., 2006

2010 Update:
Breier et al., 2006
Meinzer et al., 2006
Breier et al., 2007
Meinzer et al., 2007
Meinzer, Streiftau, & Rockstroh, 2007
Meinzer et al., 2008
Richter et al., 2008
Szaflarski et al., 2008
Breier et al., 2009
Farooqi-Shah & Virion, 2009
Goral & Kempler, 2009
Meinzer et al., 2009
Kirmess & Maher, 2010

Rating the Evidence

• ASHA's Levels of Evidence Scheme
  – Developed by ACEBP & N-CEP
  – Evaluates state of the evidence by methodological quality & stage of research
• 2 reviewers clinically sifted studies for inclusion
  – Blind reviewers
  – 91% agreement
• 2 reviewers appraised studies for quality
  – Blind reviewers
  – One article authored by committee member (AMR) was reviewed by two other reviewers (JP, LC)
  – All disagreements resolved by consensus
• 3 reviewers determined stage of research

Evaluating the Evidence - Methodological Quality

ASHA Levels of Evidence Scheme (Mullen, 2007)
Similar to PEDRO scale (Maher et al., 2003)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Highest Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Design</td>
<td>Controlled trial</td>
</tr>
<tr>
<td>Blinding</td>
<td>Assessors blinded</td>
</tr>
<tr>
<td>Sampling</td>
<td>Random sample adequately described</td>
</tr>
<tr>
<td>Group Comparability/</td>
<td>Groups comparable at baseline or</td>
</tr>
<tr>
<td>Participants described</td>
<td>Participants well described</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Valid &amp; reliable outcome measure*</td>
</tr>
<tr>
<td>Protocol Description</td>
<td>Treatment protocol described**</td>
</tr>
<tr>
<td>Treatment Fidelity</td>
<td>Evidence provided</td>
</tr>
<tr>
<td>Significance</td>
<td>p value reported/calculable</td>
</tr>
<tr>
<td>Precision</td>
<td>Effect size &amp; confidence interval</td>
</tr>
<tr>
<td>Intention to Treat</td>
<td>Analyzed by intention to treat</td>
</tr>
<tr>
<td>(controlled trials only)</td>
<td></td>
</tr>
</tbody>
</table>
# highest quality indicators across 26 studies (CILT + Intensity) of the EBSR

- Comparable groups/ Participants well-described: 25
- Valid outcomes/Protocol described: 24
- Significance calculable: 24
- Precision calculable: 19
- Design: Controlled trial: 7
  - Intention to treat: 5/7
- Assessor blinded: 6
- Treatment fidelity: 5
- Random sample well-described: 2

### Quality Scores & Effect Sizes (d) CILT Studies

#### Impairment Outcomes: Aphasia Batteries

<table>
<thead>
<tr>
<th>Score</th>
<th>Outcome measure</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meinzer et al., 2007b</td>
<td>7/10 AAT Profile</td>
<td>&lt;.0001</td>
<td>.45</td>
</tr>
<tr>
<td>Maher et al., 2006</td>
<td>6/9 WAB AQ</td>
<td>.004</td>
<td>1.01</td>
</tr>
<tr>
<td>Pulvermuller et al., 2001/6/9</td>
<td>AAT Profile</td>
<td>.04</td>
<td>2.18</td>
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<tr>
<td>Meinzer et al., 2005</td>
<td>5/9 AAT Profile</td>
<td>&lt;.0001</td>
<td>1.63</td>
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<tr>
<td>Breier et al., 2006</td>
<td>5/9 WAB AQ</td>
<td>n.s.</td>
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</tr>
<tr>
<td>Kirmess &amp; Maher, 2010</td>
<td>5/9 NGA</td>
<td>.34</td>
<td></td>
</tr>
<tr>
<td>Meinzer et al., 2004</td>
<td>4/8 AAT Profile</td>
<td>&lt;.0001</td>
<td>.34</td>
</tr>
<tr>
<td>Faroqi-Shah et al., 2009</td>
<td>4/9 WAB AQ</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Meinzer et al., 2008</td>
<td>4/9 AAT Profile</td>
<td>&lt;.0001</td>
<td>.45</td>
</tr>
<tr>
<td>Meinzer et al., 2009</td>
<td>4/9 AAT Profile</td>
<td>&lt;.001</td>
<td>.34</td>
</tr>
</tbody>
</table>

#### Impairment Outcomes: Naming Tests

<table>
<thead>
<tr>
<th>Score</th>
<th>Outcome measure</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meinzer et al., 2007b</td>
<td>7/10 AAT Naming</td>
<td>&lt;.01</td>
<td>.31</td>
</tr>
<tr>
<td>Maher et al., 2006</td>
<td>6/9 BNT</td>
<td>.006</td>
<td>.16</td>
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<tr>
<td>Pulvermuller et al., 2001/6/9</td>
<td>AAT Naming</td>
<td>&lt;.02</td>
<td>1.12</td>
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<tr>
<td>Breier et al., 2006</td>
<td>5/9 BNT</td>
<td>n.s.</td>
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<tr>
<td>Faroqi-Shah et al., 2009</td>
<td>4/9 BNT</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Kirmess &amp; Maher, 2010</td>
<td>5/9 NGA Naming</td>
<td>.03</td>
<td>.85</td>
</tr>
<tr>
<td>Meinzer et al., 2008</td>
<td>4/9 AAT Naming</td>
<td>&lt;.004</td>
<td>.34</td>
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<tr>
<td>Pulvermuller et al., 2005/3/8</td>
<td>AAT Naming</td>
<td>.05</td>
<td>.25</td>
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<tr>
<td>Meinzer et al., 2007</td>
<td>3/9 AAT Naming</td>
<td>n.s.</td>
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</table>
### Quality Scores & Effect Sizes (d) CILT Studies

**Impairment Outcomes: Auditory Comprehension**

<table>
<thead>
<tr>
<th>Score</th>
<th>Outcome measure</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meinzer et al., 2007b</td>
<td>7/10 Token Test AAT Comprehension</td>
<td>&lt;.008</td>
<td>.31</td>
</tr>
<tr>
<td>Pulvermuller et al., 2006/9</td>
<td>TT AAT Comprehension</td>
<td>&lt;.04</td>
<td>.92</td>
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<tr>
<td>Breier et al., 2006</td>
<td>5/9 WAB Aud Comp</td>
<td>n.s.</td>
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<tr>
<td>Kimmess &amp; Maher, 2010</td>
<td>5/9 NGA Aud Comp</td>
<td>n.s.</td>
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<tr>
<td>Meinzer et al., 2008</td>
<td>4/9 AAT Comprehension</td>
<td>&lt;.008</td>
<td>.22</td>
</tr>
<tr>
<td>Richter et al., 2008</td>
<td>4/9 Token Test</td>
<td>n.s.</td>
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<tr>
<td>Szafiarski et al., 2008</td>
<td>4/9 BDAE Aud Comp</td>
<td>n.s.</td>
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<tr>
<td>Pulvermuller et al., 2005/8</td>
<td>AAT Token Test</td>
<td>.03</td>
<td>.25</td>
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<tr>
<td>Meinzer et al., 2006</td>
<td>3/9 Token Test errors</td>
<td>n.s.</td>
<td>AAT Comprehension</td>
</tr>
</tbody>
</table>

**Activity/Participation Outcomes: Communication Log/Rating Scales**

<table>
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<tr>
<th>Score</th>
<th>Outcome measure</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulvermuller et al., 2001</td>
<td>6/9 Comm Activity Log Patient.</td>
<td>&lt;.001</td>
<td>3.77</td>
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<tr>
<td>Meinzer et al., 2005</td>
<td>5/9 Comm. Effect. Index</td>
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<tr>
<td>Quantity Pt.</td>
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<td>Quantity Fam.</td>
<td>&lt;.0001</td>
<td>2.35</td>
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<tr>
<td>Comp. Pt.</td>
<td>&lt;.01</td>
<td>1.07</td>
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<tr>
<td>Comp. Fam.</td>
<td>&lt;.02</td>
<td>1.1</td>
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<tr>
<td>Goral &amp; Kempler, 2009</td>
<td>5/9 Social communication</td>
<td>.001</td>
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**Activity/Participation Outcomes: Connected Speech Measures**

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<th>Outcome measure</th>
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<th>d</th>
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<tbody>
<tr>
<td>Maher et al., 2006</td>
<td>6/9 story retelling # wds</td>
<td>.72</td>
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<tr>
<td># utterances</td>
<td>.82</td>
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<td></td>
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<tr>
<td>mean length utt.</td>
<td>.99</td>
<td></td>
<td></td>
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<tr>
<td>Breier et al., 2006</td>
<td>5/9 % CIUs Dual card task</td>
<td>&lt;.02</td>
<td>.57</td>
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<tr>
<td>Accuracy task</td>
<td>n.s.</td>
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<tr>
<td>Goral &amp; Kempler, 2009</td>
<td>5/9 Narrative – words</td>
<td>n.s.</td>
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</tr>
<tr>
<td>Kirmess &amp; Maher, 2010</td>
<td>5/9 Dual card task requests</td>
<td>.93</td>
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</tr>
<tr>
<td>Breier et al., 2009</td>
<td>4/9 % CIUs Dual card task</td>
<td>&lt;.051</td>
<td>.06</td>
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<tr>
<td>Faraji-Shah et al., 2009</td>
<td>4/9 Cinderella Sentences tense</td>
<td>.059</td>
<td>.61</td>
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<td>Szafiarski et al., 2008</td>
<td>4/9 Fable Retell – words</td>
<td>.051</td>
<td>.31</td>
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<tr>
<td>utterances</td>
<td>n.s.</td>
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Overall Findings - CILT

- 18 studies with 202 participants
- Language impairment measures: CILT resulted in some positive changes – overall aphasia quotients and naming scores; somewhat less for auditory comprehension
- Communication activity/participation measures: mixed results; some large positive favoring CILT; some large positive favoring comparison treatment
- Data available primarily for chronic aphasia. No data speak to the effects of CILT in acute aphasia; some data for subacute aphasia (Kirmess & Maher).
- Maintenance of CILT effects: reported to lead to positive changes; no effect sizes calculable.

CILT and Treatment Intensity

- Observations suggest that there can be complex interactions among intensity of treatment schedule, type of treatment, and type of outcome measure.

Future Research

- Across studies, majority of participants were nonfluent and moderately impaired; therefore generalizability of results is limited for individuals with fluent aphasia and individuals with mild and severe aphasia.
- Future studies need to tease out more carefully the impact of constraint and intensity on outcome.
- Future research must be designed to ensure that they are of highest quality.
- Future studies should address issues of effectiveness and cost effectiveness.
Future Research

- Lillie & Mateer 2006 expressed interest in applying principles of CI in other cognitive domains such as attention and memory
- Overcome ‘cognitive nonuse’ by restraining strategies and forcing cognitive mechanism to function
- Yet to be investigated

Neuroplastic Changes: Post Intensive CILT

Left Perilesional Changes – improved patterns of activation
- Meinzer et al 2004 MEG Reduced left perilesional slow wave activity
- Meinzer et al. 2008 fMRI + MEG – Increased activity in regions of pre-tx slow wave activity
- Menke et al. 2009 fMRI – some increases in perilesional temporal regions
- Left Posterior changes
  - Pulvermuller et al 2005 EEG

Neuroplastic Changes: Post Intensive CILT

Right Frontal changes
- Pulvermuller et al 2005 EEG – increased activity
- Richter et al 2008 fMRI – reduced activity correlated with tx success
- Meinzer et al. 2009 MEG – reduced activity

Right Temporal changes – some increases, some decreases
- Menke et al. 2009 fMRI

No changes
- Breier et al 2006 MEG – No signif associations post tx
What determines neural reorganization in left perilesional vs right hemisphere?

- Smaller left hemisphere lesions allow for perilesional mediation
- Larger left hemisphere lesions require more right hemisphere mediation  
  \[\text{Crosson et al 2007}\]

- Neural mediation may change over time
  - Acute – little activation of perilesional or right
  - Subacute – more right hemisphere mediation
  - Chronic – more left perilesional mediation  
  \[\text{Saur et al 2006}\]

Translational Neuroscience in Aphasia

We have applied many principles of neuroplasticity to enrich our therapeutic repertoire and evidence base for patients with aphasia

Most research mainly in proof-of-principle stage, with fewer RCTs (7% of studies - Togher et al. 2009)

We need to continue forward to optimize our treatments, lead to the best randomized clinical trials, and best language rehabilitation services possible for our patients