Treatment Sequences to Maximize Recovery from Aphasia

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Overarching research question:
How do we maximize recovery from aphasia?

- Primary goal of the Aphasia Research Project is to develop and test treatments intended to maximize recovery from spoken and written language impairment
  - We aim to
    - understand the nature of the impairment (behavioral and neural underpinnings)
    - develop treatment sequences that build upon one another
    - examine behavioral and neural changes in response to treatment
Left middle cerebral artery stroke

- Most common cause of aphasia
- Disrupts vascular support for left perisylvian brain regions
- Damage results in classic “perisylvian” aphasia types

Broca’s  Wernicke’s  Conduction  Global
Left perisylvian region

Sylvian Fissure

Damage to left perisylvian region due to strokes.

B = Broca’s area
M = Primary Motor
S = Somatosensory
SMG = Supramarginal gyrus
W = Wernicke’s area
Aphasia profiles vary with regard to comprehension and production of language.
Perisylvian aphasias share a common impairment of phonology.
Phonological impairment is common following left perisylvian damage

Also in individuals with perisylvian damage who evolve to Anomic Aphasia
What does phonological impairment look like?

“No, there’s too many things... too many things different... There’s too many things”

“pa...puh... puh...puh... piles”

“kofale....We have thousands of those in our .... all around it... where we live. They’re all over the place... And they’re good to eat.”

phonemic paraphasias
What does phonological impairment look like?

Impaired phonological awareness and phonological manipulation skills

/d/-/l/-/g/  [dig]
/p/-/A/-/t/  [pat]
/b/-/oI/-/l/  [boil]
Impaired sound-letter correspondences

“Write the letter that goes with the sound.”

[s]  [g]
[t]  [l]
[n]  [z]
[k]  [th]
[r]  [w]
[b]  [ch]
[d]
Phonological Alexia

Reading Words

Reading Nonwords

Arizona Battery for Reading and Spelling (http://www.aphasia.arizona.edu/)

machine +
head +
laugh +
kept +
storm +
count +
glacier +
bribe +
dringe "princh"
mofer "morph"
andon "annock"
barcle "bercel"
Phonological Agraphia

Spelling Words
- vague +
- field +
- bump +
- debt +
- pint +
- trade +
- gross -

Spelling Nonwords
- flig -
- hoach -
- snite -
- glope -
- boak +
- cheed -
Consider the cognitive processes
Phonological Impairment

“apple”

Acoustic Analysis —> Semantics —> Orthographic Lexicon —> Graphic Motor Programs

Phonologic Lexicon —> Phonemes —> Speech Motor Programs

whole words —> sound-letter —> letter-sound

Phonemes —> Graphemes —> Visual Analysis

Lexical Sub-lexical

Lexical Sub-lexical

“apple”

apple
Testing phonological skills with nonword reading

Can’t use sublexical route to assist with reading

Can’t sound out words or nonwords

Phonological Alexia

Lexical
Sub-lexical

Speech Motor Programs

“dust?”

reg irreg nonwords
Testing phonological skills with nonword spelling

```
<table>
<thead>
<tr>
<th>Lexical</th>
<th>Sub-lexical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonologic Lexicon</td>
<td>Orthographic Lexicon</td>
</tr>
<tr>
<td>Phonemes</td>
<td>Graphemes</td>
</tr>
</tbody>
</table>
```

- Can’t use sublexical route to assist with spelling
- Can’t sound out spellings for unfamiliar words or nonwords

Phonological Agraphia

```
<table>
<thead>
<tr>
<th>reg</th>
<th>irreg</th>
<th>nonwords</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>
```

Graphemes

Phonemes

Acoustic Analysis

Semantics

“dusp”
Anomic Aphasia with Phonological Alexia/Agraphia

- 4 months post LMCA stroke
  - Anomic aphasia
    - WAB: 82.2
    - BNT: 50/60

“This guy flying a kite. Um, he’s walking a dog, or his dog’s walking him, I dunno. Um, this man is fishing..... This man or, man, or m-, is um sailing...This couple is reading a book and pouring a wine. Or listening to the radio. Um... there car in the garage... The frag up the pole... Uh... um it’s a scenery behind ‘em... I don’t know.”
Phonological impairment has striking effect on sentence-level writing!

- 4 months post LMCA stroke
  - Anomic aphasia
    - WAB: 82.2
    - BNT: 50/60

“This guy flying a kite. Um, he’s walking a dog, or his dog’s walking him, I dunno. Um, this man is fishing..... This man or, man, or m-, is um sailing...This couple is reading a book and pouring a wine. Or listening to the radio. Um...there car in the garage... The frag up the pole... Uh... um it’s a scenery behind ‘em... I don’t know.”

**Written picture description**

- Dog is cuming
- Man is fly kite
- sailboat
- lady & guy the picnic and book and with wine

Phonological Text Agraphia
Beeson, Rising, et al. (2016)
Neuropsychological Rehabilitation
Broca’s Aphasia with Alexia/Agraphia

- 2 years post left MCA stroke
- Broca’s Aphasia with severe apraxia of speech
- AQ = 40

“Bobo … one … Bobo one … bye… bye”

Written picture description

CAR TRUCK HOUSE KITE BOAT RAP "BOBO"
Phonological + Lexical Impairment

Global Alexia

Global Agraphia

Reading

Spelling

Percent Correct

Percent Correct

- Regular
- Irregular
- Nonwords

Regular Words
stop
pillow

Irregular Words
castle
type

Nonwords
flig
hoach

Regular
Irregular
Nonwords
Phonological Impairment plus lexical-semantic and orthographic impairment

Lexical
Sub-lexical

Phonologic Lexicon
Phonemes
Speech Motor Programs
“pill?”

Orthographic Lexicon
Graphemes
Graphic Motor Programs
pow

Acoustic Analysis

Semantics

Visual Analysis

“pill”

whole words

sound-letter

letter-sound

Global Alexia/Agraphia

(< 30% correct)

Phonological Impairment

Phonologic Lexicon

Orthographic Lexicon

Phonological Impairment
Two Profiles with Perisylvian Damage showing Phonological Impairment

**Global Agraphia**

- Lexical-Semantic & Phonological Impairment
- ABRS* (< 30%)

**Phonological Agraphia**

- Predominantly Phonological Impairment
- (lexicality effect)

Both have impaired phonological skills.

Both warrant phonological treatment.

* Arizona Battery for Reading and Spelling ([http://www.aphasia.arizona.edu/](http://www.aphasia.arizona.edu/))
How common is phonological impairment after left perisylvian damage?
Chronic aphasia due to left perisylvian damage

Aphasia Types
- 19 Anomic (many evolved)
- 13 Broca’s
- 1 Global
- 9 Conduction
- 5 Wernicke’s

Mean Age: 59.1 yrs.
Time Post Onset: 2.5 yrs.
Aphasia Quotient: 63.4
Performance on Test Battery (N = 47)

- Phonological impairment easily detected on nonword reading and spelling tasks.
  - Reading and spelling of real words also impaired.
  - Written spelling more impaired than oral reading.

Visual-Orthographic Processing
Allographic/Graphomotor Skills
Semantic Processing
Phonology-Orthography Transcoding
Phonological Manipulation
All participants had phonological impairment, but single word reading and writing was more impaired in some.

- Global Agraphia (n = 27) (<30% correct spelling of real words)
- Phonological Agraphia (n = 20)
Treatment Sequence for Individuals with Phonological Impairment

- **Perisylvian Aphasia with Global Agraphia**
  - Lexical-Semantic Tx
  - retrain spelling for specific words

- **Perisylvian Aphasia with Phonological Agraphia**
  - Phonological Tx
  - retrain sound-letter correspondences and phonological manipulation skills
  - train problem-solving strategies to self-correct spelling errors

- **Interactive Tx**
  - Sentence Writing Tx
  - Improve speed and accuracy of sentence writing with copy and recall at the sentence level

- **Lexical Retrieval Tx**
  - train lexical retrieval strategies including semantic and phonological self-cuing
Treatment for Global Agraphia

Lexical spelling treatment paired with repeated spoken production of target words and links to meaning

Retrain spellings for specific words

Follow with phonological treatment directed toward sublexical skills
Lexical–Semantic Treatment

- **Purpose**
  - Strengthen written spelling for specific words
    - and the links to meaning

- **Goal**
  - To retrain single-word written vocabulary for use in communication (and to stimulate spoken production)
  - To establish written “key words” for use in phonological treatment

- **Approach**
  - Copy and Recall Treatment (CART)
    - Train 24 words (4 groups consonants/2 groups vowels)

leaf  net  chin  cake
Lexical Spelling Treatment

Copy and Recall Treatment

Model
“hammer”

Repeat
“hammer”

hammer

Beeson, 1999, *Aphasiology*
Beeson, Rising, & Volk, 2003, *JSLHR*
Lexical spelling treatment (also includes repetition of spoken words)

Homework for Copy and Recall Treatment

Listen, repeat word, copy word.

“talking” photo album
Words Trained in Lexical Treatment

Key words-Consonants

Set 1  rug, top, leaf, safe, net
Set 2  cake, fire, moon, pie, dog
Set 3  book, goat, zoo, ship, van
Set 4  hat, web, chin, judge, three

Key words-Vowels

Set 1  hat/van, cake/safe, ship/chin
      fire/pie, net/web, leaf/three
Set 2  top/dog, bone/goat, rug/judge
      moon/zoo, cow/mouth, foot/book

pictures available at
http://www.aphasia.arizona.edu/
Copy and Recall Homework

- Daily homework pages for repeated copy practice
- Review each session for accountability

Homework is fun!
Example Response to Lexical Treatment (spelling)

Treatment 2 x per week with homework

Treatment duration ~ 4-8 weeks

4 sets/6 words trained to >80% accuracy.
Response to Copy and Recall Treatment

Pre-treatment (1st probe)

dog bo Top F He Fly Moon Flo 3 The Tec's Foot Book Wo co pie Top Bo Cok C Zoo Shop Rope

After 4 weeks of treatment

Foot LEAF Book THREE Cow MOUTH CAKE HAT
Top SAFE GOAT FIRE Dog WET BONE PIE
Van CHIN Moon ZOO WEB Rug Judge SHIP

Graph showing improvement in Naming and Spelling post-treatment.
Improved written and spoken production of targeted words

% Correct

Written Naming  Spoken Naming

Pre-Tx  Post-CART

Global Agraphia

n = 27
Lexical Spelling Treatment (Texting modality)

Texting Copy and Recall Treatment (T-CART)

Model
“hammer”

Repeat
“hammer”

Retrain spelling and left-handed text messaging

Beeson, Higginson, Rising (2013) JSLHR
Lexical Semantic → Phonological Treatment

retrain specific words

retrain sound-letter correspondences
Treatment Sequence for Individuals with Phonological Impairment

Phonological Treatment:
To strengthen sound-letter correspondences and phonological manipulation skills

\[
/f/ = f \quad m = /m/ \quad b - a - t = bat
\]

Use “key words” as needed to retrieve phonology/orthography

- fire --- /f/ --- f
Phonological Treatment

- Prerequisite skills
  - Able to read, write, and name key words for consonants and vowels (we typically use the 24 items from CART)
    - high frequency, concrete, regularly spelled nouns
    - used to retrain sound-letter (and letter-sound) correspondences
  - Train with lexical approach if necessary (CART)
Example Key Words (trained with CART as needed)

Key words-Consonants
Set 1  rug, top, leaf, safe, net
Set 2  cake, fire, moon, pie, dog
Set 3  book, goat, zoo, ship, van
Set 4  hat, web, chin, judge, three

Key words-Vowels
Set 1  hat/van, cake/safe, ship/chin
       fire/pie, net/web, leaf/three
Set 2  top/dog, bone/goat, rug/judge
       moon/zoo, cow/mouth, foot/book

available at http://web.me.com/pelagie1/Aphasia_Research_Project/CART.html
Clinician

Say /p/

What is your key word for /p/? (Show picture if necessary).

Write your key word for /p/ pie

Underline /p/ in your word pie

Now say the sound /p/

Patient

/p/

“pie”

pie

pie

/p/

DVD or YouTube homework

Phonological Treatment

Sound → Letter

/f/ - f [fire]
/d/ - d [dog]

Sound-to-letter correspondences: Using key word
Phonological Treatment: Letter-to-Sound Training

Clinician
• Show the letter “s”  
  • What is your key word for this?
• Show the picture if necessary
  • Your key word is “safe”, write “safe”
• What’s the 1st sound?
• Show the letter “s”  
  • What is this sound?

Patient
“safe”

“safe”

“ssss”

“ssss”
Phonological Treatment (Letter → Sound)

s - /s/

n - /n/

What sound goes with this letter?
Advanced Phonological Treatment: Phoneme Manipulation Tasks

- **Blending**
  - What word (or nonword) do these sounds make?
    - e.g., m–ea–n  p–o–t  n–a–p

- **Segmenting**
  - What is the last sound of “hood”?
  - What is the vowel sound in “zone”?
  - What’s the last sound of “maze”?
Treatment Sequence for Individuals with Phonological Impairment

Perisylvian Aphasia with Phonological Agraphia

Phonological Tx

Interactive Tx

retrain sound-letter correspondences and phonological manipulation skills

train problem-solving strategies to self-correct spelling errors

Direct Treatment Gains

- L-S Consonants
- S-L Consonants
- L-S Vowels
- S-L Vowels
- Nonword Blending

Post
Pre

5 weeks consonants
6 weeks vowels
5 weeks blending

- 5 weeks consonants
- 6 weeks vowels
- 5 weeks blending
Interactive Spelling Treatment

- **Purpose**
  - Strengthen the interactive use of orthography and phonology

- **Goal**
  - To improve spelling accuracy by increasing self-detection and correction of errors

- **Approach**
  - Use residual or re-trained phonology to sound-out plausible spellings
  - Identify and correct errors
  - Use of electronic spell-checker to aid in error correction
Interactive Spelling Treatment: *Problem-solving approach*

1. Listen to the word.
2. Repeat it.
3. Sound out the word and try to write it.
4. Look at it. Is it correct?
5. Correct it. Try to get as close as you can.
6. Type in spell checker.
7. Is it correct?
8. If not, do you see the correct word?
9. Copy the correct spelling.
10. Circle the correct spelling.
“Write ‘magic’”

He wrote: \textit{m a j c}

[typed into spellchecker]

→ magic

Interactive treatment promotes a problem-solving approach to spelling.
Problem Solving at Sentence Level

1. Generate sentence using target spelling word.
2. Read sentence aloud.
3. Identify spelling errors and missing words.
4. Correct spelling errors using problem solving (sound out, examine for errors, use spell checker).
5. Note: grammatical/morphemic errors may also be detected/corrected.
   - Wrote: *My surgean approve me for surgery.*
   - Read as, “My surgeon approved me for surgery.”
   - Participant corrected *surgeon* using the spell checker, and sounded out and identified the missing /d/ in *approved.*
Interactive Treatment Homework

Franklin Spell Checker

Phone
Example response to phonological and interactive treatment

Total treatment time:
- 16 weeks phonological
- 6 weeks interactive

- 16 weeks phonological
- 6 weeks interactive
Before Tx

Dog is cuming
Man is fly kite
sailboat
lady & guy the picnic and book
with wine

After Tx

The man a reading a book. The lady is pouring
wine or soda. A differt man the flyer a
kite, the dog help him. A man is fishing of
a pier. A couple is sailing a boat.
Positive self-ratings after treatment

- Overall spelling ability:
  - “somewhat better”
- Ability to use strategies (e.g., detect and correct spelling errors):
  - “better”
- Overall confidence regarding written and spoken communication:
  - “better”

Reported increased confidence writing e-mails to friends and family

Was able to return to role as teaching assistant for Sunday school class
“Bobo … one … Bobo one … bye… bye”

“House…trees….
car…cars…boy…girls…wine”
Using orthography to cue phonology
Lexical → Phonological → Interactive → Lexical Retrieval

Orthography → Semantic self cue.
Orthography → Phonology: Phonemic self cue.
Wife’s Thoughts on Treatment

“The writing has really helped because he has started like writing down a few letters and then the word will come right out. And while I’m at work, he’ll call me. And then he starts talking, and I’m like, ‘I don’t know what you’re saying.’ And I’ll say, ‘Start to write it and put it in the spell checker and call me back with it.’ That has amazingly helped….”

“It really made a world of difference.”
Conduction aphasia: WAB AQ 49.5 at 1.3 years post stroke

Used written word to stabilize phonology for spoken production (decrease paraphasias)

Greater improvement in written than spoken language

WAB AQ 49.5 → 53.3
Regained phonological awareness skills.

- Anomic aphasia
  - 1.9 years post onset when tx began
  - WAB Aphasia Quotient 92.4 → 95.3
  - Boston Naming Test 48 → 52
  - Significant improvement phonological skills and spelling
How do we maximize recovery from aphasia?

- Remediate the core phonological deficit
- Implement treatment sequences that strengthen underlying skills and provide support to advance to next level

4-6 weeks
- Lexical-Semantic Tx

6-16 weeks
- Phonological Tx

6 weeks
- Interactive Tx

Lexical Retrieval Tx
Aphasia Research Project

Current:
Pelagie Beeson
Kindle Rising
Chelsea Bayley
Alyssa Sachs
Steven Rapcsak
Dianne Patterson
Mira Fein

Alumni:
Mira Fein
Christie Shultz
Andrew DeMarco
Christine Shipman
Esther Kim
Maya Henry
Erin O’Bryan
Mara Goodman
Sharon Antonucci

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