Investigating changes in connected speech in nonfluent/aagrammatic primary progressive aphasia following script training

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Introduction

• Nonfluent/agrammatic PPA (nfvPPA) is characterized by
  • agrammatism in language production 
  and/or
  • effortful, halting speech (apraxia of speech) 
    (Gorno-Tempini, et al. 2011)

• Positive treatment effects have been reported following intervention targeting the core clinical features of nfvPPA  
  (Schneider et al., 1996; Machado et al., 2014; Hameister et al., 2017; Henry et al., 2013; Henry et al., 2018)

• Video-Implemented Script Training for Aphasia (VISTA) has been shown to be effective for individuals with nfvPPA  
  (Henry et al., 2018)
  • participants practiced individualized scripted material in sessions with the clinician
    • video-based home practice
  • results indicated significant improvement in accurate script production at post-treatment
    • gains maintained up to one year post-treatment

Aims & Hypotheses

• We aimed to
  • extend findings of Henry et al., 2018 by analyzing connected speech samples of a larger sample of individuals with nfvPPA treated with VISTA
  • investigate the utility of largely automated discourse measures related to
    • speech fluency
    • grammar
    • Informativeness

• We predicted
  • trained scripts would show significant improvement from pre- to post-treatment
    • potential for generalization to untrained scripts at the individual level
  • improvements would differ significantly between trained and untrained topics from pre- to post-treatment with trained topics demonstrating greater improvement
Methods

- 20 individuals (10 from Henry et al., 2018) meeting current consensus criteria for nfvPPA

Demographics and Speech, Language and Cognition Scores at Pre-Treatment

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>68.45 (5.8)</td>
</tr>
<tr>
<td>Sex</td>
<td>12 female, 8 male</td>
</tr>
<tr>
<td>Years of Education</td>
<td>16.65 (2.6)</td>
</tr>
<tr>
<td>Handedness</td>
<td>19 right, 1 left</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Speech, Language and Cognition</th>
<th>Score (SD)</th>
</tr>
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<tbody>
<tr>
<td>Mini-Mental State Examination (30)</td>
<td>27.3 (2.4)</td>
</tr>
<tr>
<td>Western Aphasia Battery AQ (100)</td>
<td>86.42 (9.0)</td>
</tr>
<tr>
<td>PPVT-short (16)</td>
<td>14.78 (2.0)</td>
</tr>
<tr>
<td>AOS rating^1 (0=none - 7=profound)</td>
<td>3.2 (1.2)</td>
</tr>
<tr>
<td>Dysarthria rating^2 (0=none - 7=profound)</td>
<td>1.85 (1.7)</td>
</tr>
<tr>
<td>Northwestern Anagram Test (%)</td>
<td>64.39 (21.8)</td>
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</tbody>
</table>

^1 from Wertz et al. (1984); AQ = Aphasia Quotient, PPVT = Peabody Picture Vocabulary Test, AOS = Apraxia of Speech

- Participants were treated using VISTA
  - four scripts entered treatment following a single-subject multiple baseline design; two remained untrained
  - scripts were treated in twice weekly sessions with a clinician
  - homework consisted of unison speech production, or “speech entrainment” (Fridriksson et al., 2012) practice for 30 minutes/day
    - audiovisual model was a healthy speaker slowly producing script with exaggerated articulatory gestures
    - probes eliciting responses to script topics conducted twice pre-treatment and post-treatment

- Responses were transcribed and coded using Computerized Language ANalysis (CLAN) (MacWhinney, 2000)

- Transcriptions were analyzed using CLAN for
  - words per minute (WPM)
  - fluency disruptions per hundred words (i.e., number of fillers, phonological fragments, partial words, retracings, and repetitions)
  - mean length of utterance in morphemes (MLU\textsubscript{m})
  - grammatical complexity index
  - proportion of open to closed class words
  - propositional idea density

In-Session Treatment Hierarchy

<table>
<thead>
<tr>
<th>Clinician-Guided VISTA Treatment Hierarchy (Henry et al., 2018)</th>
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<tbody>
<tr>
<td>Participant is asked to:</td>
</tr>
<tr>
<td>1. Choose each correct script sentence from four foil sentences.</td>
</tr>
<tr>
<td>2. Put the script sentences in the correct order.</td>
</tr>
<tr>
<td>3. Read the entire script aloud.</td>
</tr>
<tr>
<td>4. Produce individual scripted sentences in response to questions.</td>
</tr>
<tr>
<td>5. Produce the entire script from memory.</td>
</tr>
<tr>
<td>6. Respond to questions with scripted sentences out of the correct order of the script</td>
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</table>

During the second treatment session for a given script, a novel communication partner has an unscripted conversation with the participant to promote conversational usage of scripted material.

*Note: Feedback regarding articulation and grammar occurred during steps 3-6, with targeted practice, as needed.*
Results

• Trained script topics showed significant improvement from pre- to post-TX in
  • WPM*
  • Fluency disruptions per 100 words*
  • MLUm*
  • Grammatical complexity*
  • Proportion of open to closed class words*

• Untrained script topics showed significant improvement from pre- to post-TX in
  • Fluency disruptions per 100 words*

Fixed Effect of Time on Discourse Measures for Trained Topics

Note: Each model includes a random intercept for participant. The y axis presents fitted values from the linear mixed effects model. The fitted regression line and standard error are shown in color. Each participant’s average performance across scripts at pre- and post-treatment are shown in black.
Results

Significant Interactions of Time and Training Condition

- Significant interaction of time and script type (trained vs. untrained) for
  - Script accuracy (percent intelligible scripted words)
  - WPM
  - Fluency disruptions per 100 words
  - MLUm
  - Proportion of open to closed class words

Note. Each model includes a random intercept for participant. The y axis presents fitted values from the linear mixed effects model. Standard error is shown in shaded color along the fitted regression line.
Discussion

- Script training has the potential to yield improvements for individuals who present with deficits in grammar and/or motor speech (i.e., apraxia).

- Largely automated discourse measures hold promise as a means of reducing time demands associated with discourse analysis, promoting real-world clinical utility.

- Complementing previous findings (Henry et al., 2018), we found improvements for trained topics on additional measures examining:
  - grammar (grammatical complexity, MLUm, proportion of open to closed class words)
  - speech fluency (fluency disruptions)
  - speech rate (WPM)

- Greatest benefit of script training is observed for practiced material:
  - untrained topics showed a significant reduction for fluency disruptions per 100 words:
    - small, numerical improvements on other variables
  - heterogeneity in generalization effects observed at individual level

- Future Directions
  - examine potential differential effects for individuals with relatively isolated deficits (motor speech vs. agrammatism)
  - examine whether treatment-induced improvements on relevant outcome measures generalize to other connected speech tasks
  - explore additional outcome measures (e.g., acoustic measures) that may aid in characterizing motor speech ability as a complement to linguistically-based discourse measures

Acknowledgements
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