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Clinical Application of the Research Methodology for Phoneme-Based Rehabilitation for Anomia

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Words have a magical power. They can bring either the greatest happiness or deepest despair; they can transfer knowledge from teacher to student; words enable the orator to sway his audience and dictate its decisions. Words are capable of arousing the strongest emotions and prompting all men's actions.

- SIGMUND FREUD, *The Educator's Book of Quotes*

Learning Objectives

- Review information processing models of aphasia (traditional vs. parallel distributed processing)
- Identify principles of PDP models and neuroplasticity that can be applied clinically to aphasia treatment and recovery of skills
- Review study by Dr. Diane Kendall and colleagues in area of phoneme based naming treatment
- How to potentially implement phonomotor (phoneme based) therapy in clinical setting (case study)

A little Aphasia History Review…

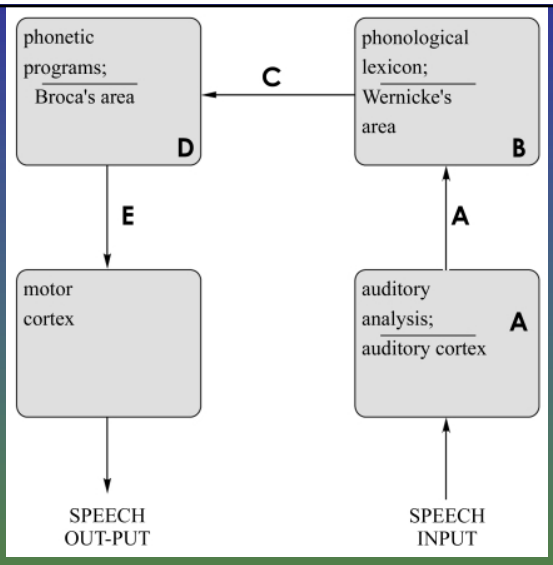
- Since the work of Paul Broca in the 1800's, the "modular" classification of brain function has been recognized and accepted
- Wernicke's research further demonstrated that disconnections between "modules" resulted in specific aphasic symptoms
  - Was the 1st to diagram an information processing network/model (has been modified over the years)

Aphasia Classification Revisited

- Wernicke, Lichtheim and other neurologists continued to report new aphasic syndromes and attempted to explain these symptom complexes by developing information processing models.
- These models attempted to provide a topographic map of the brain modules that mediate speech and language as well as relate this topographic map to anatomic regions of the brain

Wernicke and Lichtheim

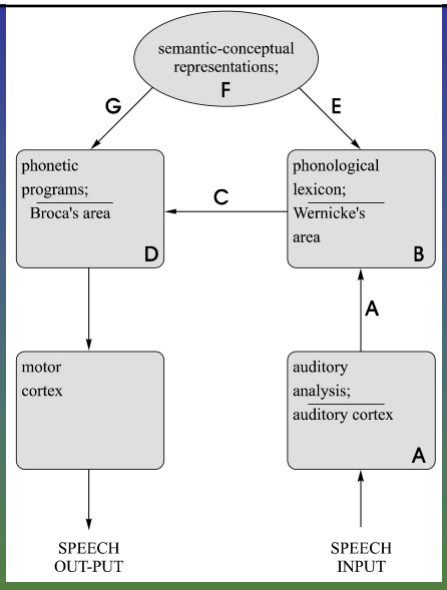
- "Diagram Makers" – aimed to aid teachers and researchers to classify aphasic disorders via **localization**
- **Modularity** = "Different parts of the brain store different forms of information and mediate different cognitive activities" (Heilmann)



Wernicke's schema. In this model disruption of Wernicke's area (B) induces Wernicke's aphasia (fluent jargon, impaired comprehension, repetition and naming), C; conduction aphasia (fluent with phonemic paraphasic errors, impaired repetition, naming, intact comprehension of major lexical items), D; Broca's aphasia (non-fluent, impaired naming and repetition, intact comprehension of major lexical items).

Lichtheim

- Expanded Wernicke's model to include localization of **semantics** and to account for fluent aphasic syndromes where repetition remained intact
- Patient "activates" semantic representations and these concepts directly activate Broca's area, then motor cortex.
- Repetition occurs when patient performs auditory analysis, activates phonological word representations, and transmits phonological information via the arcuate fasciculus to Broca's area then to motor cortex – Can happen in absence of activating semantic representations (or if these representation were degraded)
- Example: Can "hear" phonemes and activate phonological representations (repeat) but not necessarily attribute meaning
  - -Transcortical Sensory Aphasia



Wernicke-Lichtheim's schema. In this model interruption of pathway E or degradation of F (the semantic-conceptual field) would produce transcortical sensory aphasia with fluent speech, impaired comprehension, but normal repetition. Interruption of pathway G would induce transcortical motor aphasia with a loss of spontaneous speech, but with intact repetition and comprehension.

Limitations of Modular Processing Models

- Do not specify characteristics of articulatory motor, acoustic and concept domains and how they are stored in brain (Kendall, et al)
- Does not account for how the domains interact with one another
- "Linear" and sequential in fashion – One step at a time?

Present Day MRI Imaging:

- Language processing is not confined to Broca's and Wernicke's areas
- **Systems composed of many neural sites working in close cooperation**
- Language processing engages several regions of the left hemisphere which lie outside the traditional classical language areas

Parallel Distributed Processing (PDP)

– Stephen Nadeau

- Brain is a "neural network machine."
- Information is "distributed" throughout the neural network, versus being "localized" in predictable modules
- **Knowledge** = strength of neural synapses; learning occurs as result of changing the strengths of these synapses.
- Even in presence of brain damage to one network, all learning/knowledge is not lost as another network can be activated. Damaged network (unless completely destroyed) experiences "***graceful degradation***."

- **Phonological knowledge is distributed across semantic, acoustic, orthographic and articulatory motor representations**
- **Semantics/concepts are widely distributed in areas throughout the temporal, parietal, and frontal lobes of BOTH hemispheres**

PDP…

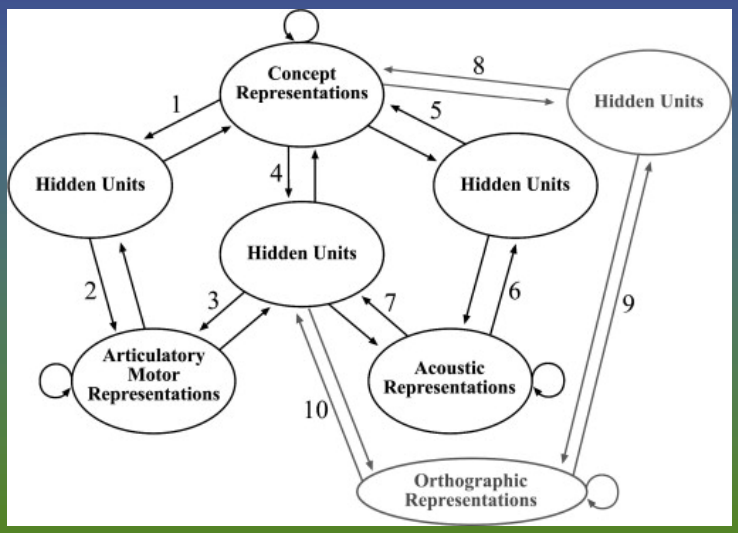
- Knowledge is stored as patterns of connectivity within and between domains (not just in one "module").
- Understanding the meaning of a word that is heard is achieved through the connections between the domain that contains sound features and the domain that contains concept features.
- Translating heard sound sequences into articulatory sequences (repeating), is contained in a network that contains acoustic representations to the articulatory motor representations

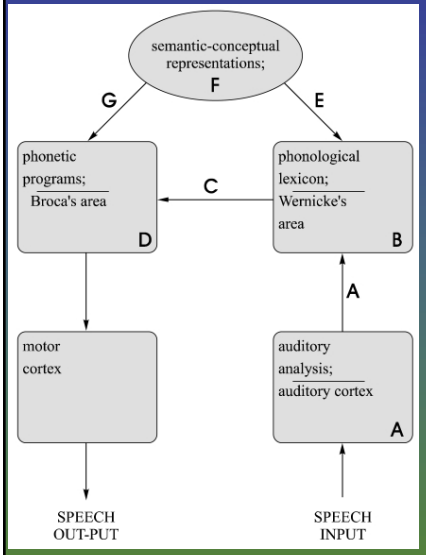
PDP…

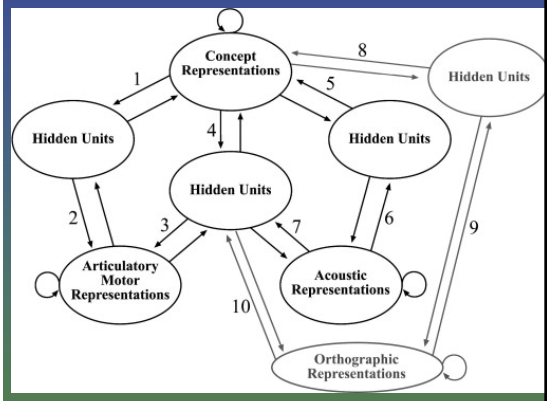
- **Acoustic Representations** (Wernicke's Area) = large number of units that represent acoustic features of phonemes
- **Articulatory Motor Representations** (Broca's Area) = units that represent discreet articulatory features of speech

- Each "unit" is connected to most other units within the specified domain ("hidden units" that connect to form pattern association network – these perform computations of encoding phonology, semantics, and orthography and allow predictions re: rules and patterns to take place, leading to generalization)
- Knowledge within each domain = **"connection strengths"** between units (analogous to knowledge being represented as strength of synaptic connections between neurons).
- When learning language, connection strength between the units are gradually adjusted so that pattern of activity in one domain elicits correct pattern of activity in units in another domain **"Parallel Processing"** (Kendall, et al)

Embrace the "Chaos…" PDP models reflect "chaotic order." Multiple processes happening simultaneously.







PDP Example with Whole Word Meaning

"HOUSE"

- Arbitrary relation (initially) between how word is heard, spoken or written and its meaning
- Activation of units representing features of "house" such as visual attributes, construction materials, contents, etc.
- These units connect via hidden units to other domains (how "house" sounds; how "house" is written; how "house" is said).
- As concepts/features are strengthened, so is the concept of "house" (vocabulary); thus, so strengthened are the association networks. Will be activated each time "house" is accessed.
- Networks have unique characteristics based upon individual's learning, life experience, culture, etc. (why not all patients respond to SFA similarly)….

How PDP theory can aid Anomia

- Relationship between word forms and meaning is largely arbitrary *(exception: onomatopoeic words "oink" "meow")*
- Little generalization when treating via "whole word" naming therapy to non trained stimuli
- Kendall, et al hypothesized that it is possible to improve word retrieval by enhancing **phonological sequence knowledge** across domains
- **Premise:** How children acquire language rules – learn phonology, regularities of phonological sequences, associate combinations with meaning for both production and comprehension = "Bottom Up Processing"

- Apply same principle of language learning to "relearning"
- Broader training of phonological knowledge can lead to generalization of word finding/naming
- **Strengthen connections between linguistic domains, activate parallel processes, and increase access to vocabulary (multi-modal approach)**
- Base therapy on PDP model and principles of neuroplasticity related to aphasia recovery

PDP with Phonology

/b/

- Activate acoustic representation – how does it sound? What makes it different from a /p/ or a /d/?
- Activate orthography (how "b" looks)
- Activate articulatory motor (lips together, blow apart, voiced)
- Activate concept representations (semantics) = words that may start with /b/ -- ball, bed

Phoneme based therapy brings these parallel distributed processes to high levels of consciousness

Decrease "arbitrary" aspects

Will this work with an adult brain that has been injured??

- Consider NEUROPLASTICITY Principles
- Applying these principles to what we hypothesize about PDP provides the "evidence" for designing the specific phonomotor approach

Principles of Neuroplasticity

(Raymer, et al Translations Research in Aphasia – review of animal and human studies)

- Brain, regardless of age, is flexible and capable of change
- Neuroimaging studies have found evidence for reorganization of language in aphasia
  - Recruitment of residual left hemisphere structures premorbidly involved in language function
  - Recruitment of right hemisphere regions homologous to left hemisphere language areas (Raymer, et al)

- Intensive treatment in chronic stages of recovery can be effective in improving function and preventing loss of function (animal and human studies)
- Arguments/evidence for less intense treatment in acute phase and increasing "aggressive" treatment over time
  - *Tx that is too early/too intense after stroke may be counter-indicated: Excito-toxic Effects. "Reorganization of neural connectivity after stroke is a complex multiphasic process."* (Allred et all, 2014).
- Failure to participate in rehab has adverse impact on recovery = "learned non-use"

- Greater treatment effects seen for "trained" language behaviors
  - "Use it and Improve it" via skill training.
  - "Therapeutic Speaking" – learning the "skill" of talking (Rosenbek, ASHA Conference 2014)
- Complex and rich treatment environments more likely to produce significant behavior gains
- Salience is important. Treatment must "matter" to the patient.

- Intensive, frequent treatment enhances recovery. "You get better at doing what you practice." (Rosenbek).
  - -aging brains will require increased repetitions, but will retain some degree of plasticity.
- Bhogal, Teasell and Speechley (2003) reviewed 10 studies of aphasia tx – greatest treatment effects seen with average of 8.8 hours/week for 11.2 weeks. **Those with least effects received average of 2 hours/week for 22.9 weeks**

Lingering Clinical Question:

How do we systematically determine the amount of repetition required for acquisition, maintenance, and generalization of language skills and demonstrate neuroplastic changes have occurred?

Kendall, et al Research Study Synopsis

- **Premise:** Direct therapy at the level of the phonologic processor instead of whole word route to improve naming (impairment based approach)
- 10 people with anomia and aphasia due to left hemisphere stroke; 6 months or more post stroke; right handed; mono-English speaking; no significant AOS, degenerative disease or chronic medical illness
- 96 hours of phoneme based. 2 hours/day; 4 days/week for 12 weeks. Session length = 1 hour

- Primary Outcome measure = Confrontation Naming (alternate administration of Lists A and B of the Object Action Naming Test)
- Secondary Outcome measure = Phonological Production (consonants trained in therapy), nonword repetition (nonstandardized 10 item repetition test with 2 syllable nonwords with trained phonemes and phoneme sequences), discourse production (Brookshire Discourse Production Test)
- Treatment Structure = Modified Lindamood Sequencing Program (LiPS) – see handout
- All consonants and vowels were trained; once single phonemes were mastered, they were combined into CV and VC, then CVC, VCC, CCV combinations followed by 2-3 syllable combinations

Phoneme Based Treatment in Summary…

- Train patient to form concepts of individual phonemes via pairing visual depictions (drawing of the mouth); proprioceptive feedback, and visual feedback; verbal descriptions of oral-motor features. (rich, complex therapy)
- Then, train phonologic and orthographic sequence knowledge: Patient recognize, distinguish, and manipulate one, two, and three syllable non-words and words composed of phonemes (hear it, read it, see it, say it)…
- All in context of intense, drill based treatment with high frequency of therapy hours across shorter time span

- Results = As predicted, improvements seen in primary and secondary outcome measures with evidence of generalization for 8/10 individuals for Primary Outcome Measure; Nonword Rep = 6/7 individuals; Discourse 4/6 (word count) and 4/6 for content units; phonologic production 10/10
- Positive treatment effect maintained when 8 of the 10 subjects available were tested 3 months after completion of treatment (mean gain of 9.5 on BNT).
- Most gains achieved AFTER therapy, suggesting that once phonological repertoire and phoneme sequence knowledge is learned, those with anomia may be able to continue to strengthen neural networks and connections between concept representations and phonological sequence knowledge on their own (e.g., "building" vocabulary = increased generalization).

- How can we apply this theory and research clinically?

Clinical Considerations

Barriers or "Opportunities for Modifications:"

- Time
- Aphasia Classification
- Auditory Comprehension
- "Clean Aphasia"
- Exclusive treatment? Compensatory treatment?
- Stimuli Selection / Materials
- Patient "buy in" – Task may be perceived as abstract or too simplistic

Case Study – MSU Clinic

- "Sue"
- 75 year old right-handed female
- Status post Left posterior temporal-parietal CVA January 6, 2012
- Primary Complaint (she and caregivers) **"I know what I want to say and just can't say it."**
- June 6, 2012: Diagnostic Assessment via BDAE = Profile aligning with fluent aphasia syndrome, Anomic.
- Relatively grammatically correct and fluent speech disrupted by word finding difficulties, intact repetition ability, mild auditory comp difficulties.

Case Study…

- Word finding difficulties throughout conversation, Cookie Theft Picture – ineffective and effective circumlocution; able to talk around words to some degree and use gestures to describe functions, attributes
- BNT – only able to complete items 1-20 due to fatigue and significant frustration/struggle. Named 7/20 correctly and w/o latency. Phonemic paraphasias and circumlocution on incorrect items; abandonment of attempts.
- Phonemic Awareness: non-standardized assessment through auditory discrimination (words same/different, rhyming) 50% on both tasks; Able to identify real vs. nonsense words to 100%
- Written Expression: Mechanics and letter forms in tact; spelling errors, written paraphasias (e.g., car for cat) and significant frustration)
- No identifiable motor speech deficit.

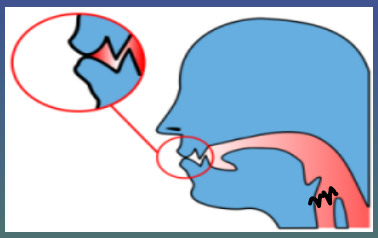
Treatment Plan

- Implement Phoneme based therapy for naming
- Traditional approach ("barrier") – 2x/week for 50 minutes each session
- Long Term Goal (within 2 semesters; approx. 52 hours of individual therapy): Improve score on BNT by 10 points (17/20 items)

Treatment Materials

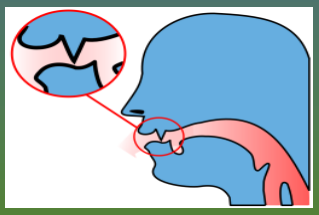
- Modified LiPS protocol
  - Modify based on client need related to communication capabilities
  - Reduced set of phonemes to start with given time constraints
- Visuals (mouth pictures, quiet/noisy)
  - Important for direct instruction as well as vehicle for patient to respond and "talk" about features
- Graphics, "animated" phoneme production (quite/noisy, visuals, Iowa site (http://www.uiowa.edu/~acadtech/phonetics/)

Sample "Mouth Pictures"



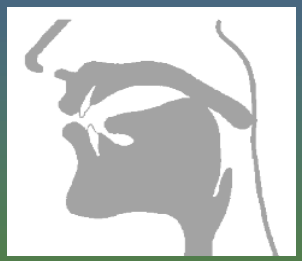
This visual was used to describe the /p/ and /b/ phonemes. A jagged line was drawn for the /b/ to indicate voicing.

This visual was used to describe the /f/ and /v/ phonemes. A jagged line was drawn for the /v/ to indicate voicing.



This visual was used to describe the /t/ and /d/ phonemes. A jagged line was drawn for the /d/ to indicate voicing.

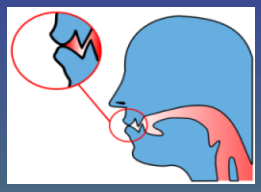
This visual was used to describe the /k/ and /g/ phonemes. A jagged line was drawn for the /g/ to indicate voicing.



Noisy

Quiet

Let's take a Treatment Example



Stage 1:

Exploration of Sounds:

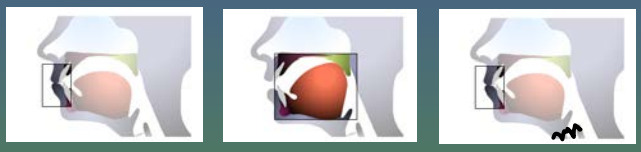
- Targets /p/ and /b/ paired with vowels
- Clinician: Shows Sue mouth picture for /p/, directs Sue to look in mirror and repeat the sound after the clinician.
- Clinician provides knowledge of results
- Clinician asks Sue to describe what she saw, heard and felt when producing the sound ("what did you feel?" "what parts of your mouth were moving?" "Was is a noisy or quiet sound?")
- This process is repeated with /b/

Stage 1: Motor Description

- Clinician provides a description of each sound.
- **Clinician tells Sue which articulators are moving and how they move**. *"For /p/, our lips come together then blow apart. Our voice is off and our tongue is not moving."*
- Sue repeats sound and is asked "how was that sound made?"
- Clinician provides knowledge of results
- When needed, clinician prompts with questions regarding motor description ("Did your lips blow apart or stay together?" "Are your lips in smiling position or rounded (for vowels)?")

Stage 1: Perception Task

- Clinician produces a sound (/p/) and asks Sue to choose that sound from array of pictures (in Sue's case, field of 3 was too difficult and frustrating, so we reduced to 2, then worked back up to 3).



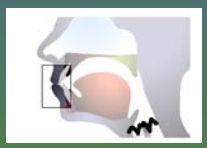
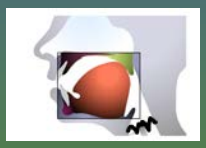
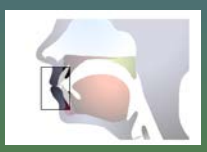
- Clinician provides KR for each attempt
- Clinician asks questions for both correct and incorrect responses (similar questions from exploration and motor description)

Stage 1: Production Task

- Clinician elicits sounds auditorily (repetition), visually (mouth pictures), and by providing motor description to client ("make the sounds where your lips….")
- KR provided for each attempt
- Clinician asks questions for both correct and incorrect responses (e.g., "You said /b/. Is that sound made when your lips comes together and blow apart with your voice turned on?)

Stage 1: Graphemes

- Tiles are placed on the table with mouth pictures.
- Clinician allows Sue to review the tiles and pictures
- Clinician asks Sue to select a single grapheme and place it on the picture that represents that sound
- Clinician asks questions after tile is placed.

g p b

- If correct, next tile is placed. If incorrect, set aside and move to next tile.
- After all sounds are reviewed, only correct ones should remain on pictures.
- Incorrect tiles are placed one by one on correct picture after SLP asks questions to prompt Sue. For example, "This tile says /p/, how is that sound made?" Sue may say, "with lips together, then blow apart, and quiet." SLP says, "correct," "what picture shows you that?"
- After graphemes are successfully matched to mouth pictures, graphemes are used in production and perception tasks with KR provided for each attempt

Stage II: Syllables

- Next phase of treatment once mastery of stage one is achieved.
- Training progresses hierarchically (VC, CV, CVC, CCV, etc. = refer to handout).
- Performance-based and client progresses through 1, 2, and 3 sound single syllable words to 2-syllable combinations based on 80% accuracy over 3 sessions*.
- Perception and Production tasks involve similar cues and coaching found in Stage 1 (refer to handout); production involves saying each sound individually elicited by tiles or mouth pictures, then blended together, then changing one phoneme to elicit new combinations.
- **Due to time restrictions, we marked accuracy across 2 sessions.*

Sample Therapy Goals

- Sue will answer questions about the features of the phonemes p, b, f, v, t, d, k, g, θ (think), ð (this), s, and z using the phonomotor treatment strategy with 90% accuracy* within 45 seconds of presentation of corresponding grapheme across 2 consecutive sessions.

- **Baseline:** Sue answered questions about voicing and articulation features with the p, b, f, v, t, and d with 81% accuracy within 1 minute of presentation of grapheme and their correct "mouth" picture.

- **End of Semester Status:** Sue achieved this goal with p, b, f, v, t, d, k, and g. Continuing direct assessment of the knowledge of voicing and articulation features should not be continued with those phonemes. Introduction of the θ (think), ð (this), s, and z was recommended.

**Higher accuracy was deemed necessary given alterations to time spent on therapy*

- Sue will correctly produce the p, b, f, v, t, d, k, g, θ (think), ð (this), s, and z phonemes with 80% accuracy when presented with only the orthographic image and without cueing for articulation.

- **Baseline:** Sue produced the p, b, f, v, t, and d with 100% accuracy when cues for articulation were provided coupled with the visual stimulus.

- **End of Semester Status:** Sue demonstrated 80% accuracy without cueing for production of p, b, f, v, t, d, k, and g during several therapy sessions when presented only with grapheme. However, accuracy was not consistent across multiple sessions. Targeting productions should be continued. Additional phonemes should be added with success.

Additional Modifications

- Client "buy in" was facilitated via direction instruction and education regarding semantic versus phonologic knowledge.
- Due to "abstract" nature of task, simple key word pictures were added to graphemes to add saliency in initial stages
  - Picture of Dog for "d" Pig for "p"
  - Increase client motivation and "understanding" of rationale for describing sound features as well as aiding activation of concept representations (**Working at impairment level needs to be meaningful to client)
- Given word finding issues, client encouraged to use gesture to "describe" features of sounds (e.g, tongue bunched up in back of mouth, touching throat for "noisy.")

End of Fall Semester Results

- Sue improved score on **BNT items from 7/20 to 14/20** with improvement seen on words primarily containing the phonemes practiced in treatment
  - BNT items also completed in faster time and with less subjectively reported frustration than initial eval
- Caregiver and Client Report: Improved conversational skills; reduced frustration.
- A "Believer" in the therapy approach
- **Achieved efficacious and effective results** thus far
- Therapy to continue

Side notes…

- Caregivers were trained for homework assignments involving identifying graphemes/phonemes (need extra practice for "therapeutic speaking").
- Treatment did not exclusively focus on phonomotor therapy (further reducing intensity)
  - Also worked on complex auditory comprehension
  - General conversational exchanges with external "stop" strategies and topic maintenance

Additional Clinical Options Moving Forward

- Target phonemes most representative of patient's needs/vocabulary (greetings, family names)
- Train family member or friend and "prescribe" specific homework to reach additional therapy hours
- Flexibility with % accuracy before moving through stages of treatment hierarchy?
- Provide knowledge of results (% success; was objective met?) in addition to knowledge of performance (general quality performance/ information about the correct production)?

Summary

- Promising research by Kendall and colleagues shows solid initial evidence for treatment effects (generalization) with phoneme based therapy for naming in patients with aphasia
- Therapy is rooted in evidence based principles including the premises of PDP models of communication and neuroplasticity principles related to aphasia recovery
- Therapy can be applied in clinical setting with modifications imposed by time restrictions, patient variables and accommodations needed to address other deficit areas, though progress will be slower
- Future directions for therapy may involve advocating for clients to participate in more intense therapy over shorter time periods versus traditional outpatient model.

Further studies and research….

- University of Washington Aphasia Lab: http://depts.washington.edu/sphsc/labsites/kendall/about.htm

Comparing Phonomotor Tx to SFA

- Kendall and colleagues are in the process of a new VA RR&D grant (2014-2017) where n=80 individuals will be randomized to receive either Phonomotor or SFA. Both groups will receive 60 hours therapy (2 hours/day, 5 days/week for 6 weeks). We will compare their naming performance immediately after treatment, at 3 months and at 1 year. We are interested in generalization to untrained measures.

Dosage:

- Kendall is writing a grant to answer that essential question. She will take the SFA treatment participants from the existing trial and put them into either massed or distributed treatment doses of phono motor. Mass is the current dose at 2 hours day - while distributed will be 3 hours/week for a total of 60 hours over 20 weeks.

Further studies and research….

Additional Treatment Effects:

- From UW Aphasia Lab, Liz Brookshire published reading data from the old phonomotor trial where she found positive effects in reading performance following treatment.

Newly Published Research:

The influence of phonomotor treatment on word retrieval abilities in 26 individuals with chronic aphasia: An open trial Diane L. Kendall, Megan Oelke, Carmel Elizabeth Brookshire, and Stephen E. Nadeau ***Journal of Speech, Language, and Hearing Research***, Just Accepted, released March 11, 2015. doi:10.1044/2015_JSLHR-L-14-0131

References

- Allred, R.P., Kim S.Y., Jones, T.A. (2014). Use it and/or lose it – experience effects on brain remodeling across time after stroke. Frontiers in Human Neuroscience, June 27;8:379.
- Chapey, R. (2009). Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders. Chapter 26, "*Language Rehabilitation from a Neural Perspective*; Nadeau, S., Rothi, LI, and Rosenbeck, J. Baltimore, Maryland: Lipincott Williams and Wilkins.
- Heilman, K. (2006). Aphasia and the diagram makers revisited: an update of information processing models. Journal of Clinical Neurology, Vol 2, 149-162.
- Kendall, D., Rosenbek, J.C., Heilman, K.M., Conway, T., Kenberg, K., Gonzalez-Rothi, L.J., Nadeau, S.E. (2008). Phoneme-based rehabilitation of anomia in aphasia. Brain and Language, 105, 1-17.
- Ludlow, C.L., Hoit, J., Kent, R., Ramig, L.O., Shrivastav, R., Strand, E., Yorkston, K., Sapienza, C.M. (2008). Translating principles of neuroplasticity into research on speech motor control recovery and rehabilitation. Journal of Speech, Language, and Hearing Research, Vol. 51, s240-s258.
- Raymer, A.M., Beeson, P., Holland, A., Kendall, D., Maher, L.M., Martin, N., Murray, L., Rose, M., Thompson, C.K., Turkstra, L., Altman, L., Boyle, M., Conway, T., Hula, W., Kearns, K., Rapp, B., Simmons-Mackie, N., Gonzalez-Rothi, L.J. (2008). Translational research in aphasia: from neuroscience to neurorehabilitation. Journal of Speech, Language and Hearing Research, Vol. 51, s259-s275.
- Rosenbek, John (2014). Seminar: *Neuroplasticity: Even Big Ideas Are Not Enough*. ASHA Convention, Orange County Convention Center, Orlando, Florida, Saturday, November 22, 2014.