HOW CAN TECHNOLOGY ENABLE REHABILITATION IN CHRONIC APHASIA? A REVIEW OF THE LITERATURE

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DISCLOSURES

- Swathi Kiran
  - Co-founder of Constant Therapy (now- The Learning Corporation),
  - Consultant for The Learning Corporation

NEUROPLASTICITY

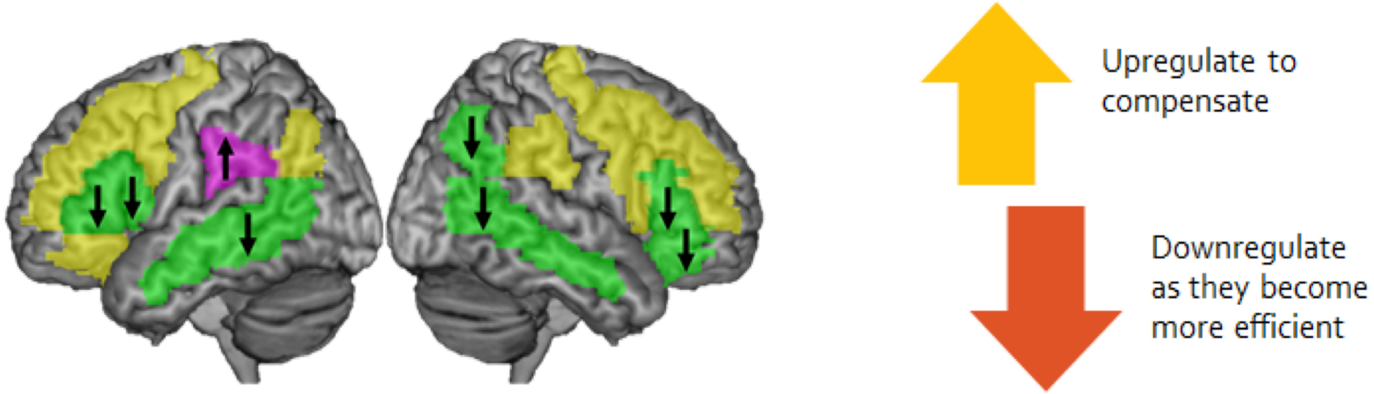
- The **adaptive capacity** of the Central Nervous System
- The mechanism by which the brain encodes experiences and **learns new behaviors**
- The mechanism by which the damaged brain **"relearns" lost behavior** in response to rehabilitation

(Kleim & Jones, 2008)

Understanding language recovery and neuroplasticity

A network of regions in LH and RH

- Traditional Language Regions
- Homologous Right Hemisphere Regions
- Domain general regions



MAXIMIZING NEUROPLASTICITY

"Neuroplasticity is often experience dependent, time-sensitive and strongly influenced by features of environment. Motivation and attention can be critical modulators of plasticity. Skills training can improve behavioural outcomes on the backbone of neuroplasticity; **in many cases, maintenance of behavioural gains depends on continued therapeutic exposure. ê**

(Cramer, et. al., 2011, pp1063, Brain)

PRINCIPLES OF NEUROPLASTICITY

1. Use it or lose it
2. Use it and improve it
3. Specificity
4. Repetition
5. Intensity

(Kleim & Jones, 2008)

PRINCIPLES OF NEUROPLASTICITY

6. Time
7. Salience
8. Age
9. Transference
10. Interference

(Kleim & Jones, 2008)

- Review studies of rehabilitation outcomes in individuals with chronic aphasia report that therapy is indeed effective for these individuals

Allen L, Mehta S, McClure JA, Teasell R. Therapeutic interventions for aphasia initiated more than six months post stroke: a review of the evidence. Top Stroke Rehabil 2012;19(6): 523–535; Teasell R, Mehta S, Pereira S, et al. Time to rethink long-term rehabilitation management of stroke patients. Top Stroke Rehabil 2012;19(6): 457–462

- More intense therapy for patients results in greater outcomes in acute and chronic aphasic patients
  - ICAP aphasia

    Persad, C., Wozniak, L., & Kostopoulos, E. (2013). Retrospective analysis of outcomes from two intensive comprehensive aphasia programs. Topics in Stroke Rehabilitation, 20(5), 388-397. doi:10.1310/tsr2005-388
  - Very early aphasia therapy in acute aphasia

    Godecke, E., Rai, T., Ciccone, N., Armstrong, E., Granger, A., & Hankey, G. J. (2013). Amount of therapy matters in very early aphasia rehabilitation after stroke: a clinical prognostic model. Semin Speech Lang, 34(3), 129-141. doi:10.1055/s-0033-1358369
  - Systematic review of constrained induced aphasia therapy

    Cherney LR, Patterson JP, Raymer A, Frymark T, Schooling T. Evidence-based systematic review effects of intensity of treatment and constraint nduce language therapy for individuals with stroke-induced aphasia. J Speech Lang Hear Res 2008;51(5):1282–1299
  - Systematic review of aphasia therapy studies

    Bhogal SK, Teasell R, Speechley M. Intensity of aphasia therapy, impact on recovery. Stroke 2003; 34(4):987–993;

- A recent influential study (ACTNOW) suggested that rehabilitation was no more effective in promoting change on the measured outcomes than everyday communication with hospital volunteers in acute stroke survivors

  - A best-practice, flexible intervention by NHS SL therapists, up to three contacts per week for up to 16 weeks compared with a similar number of AC contacts by employed visitors
  - There was no evidence, on any measure, of added benefit of early communication therapy beyond that from AC.
  - Functional communication improved for both groups

  Bowen, A., Hesketh, A., Patchick, E., Young, A., Davies, L., Vail, A., . . . Tyrrell, P. (2012). Clinical effectiveness, cost-effectiveness and service users' perceptions of early, well-resourced communication therapy following a stroke: a randomised controlled trial (the ACT NoW Study). Health technology assessment, 16(26), 1-160. doi:10.3310/hta16260

COCHRANE REVIEWS: BRADY ET AL., 2012, 2016

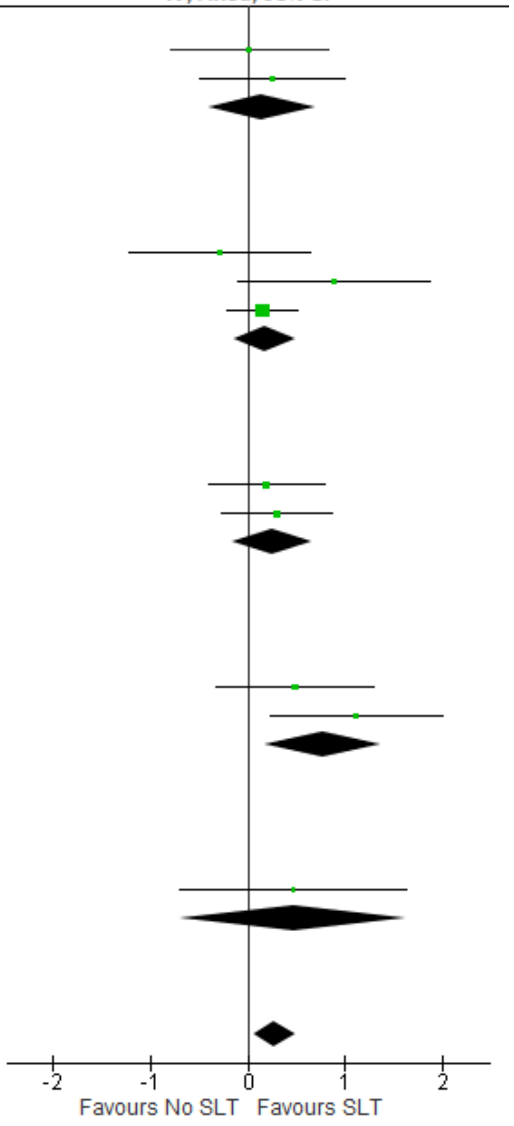
	2012	2016
RCTs	39	57
Randomised comparisons	51	74
n	2518	3002
SLT v No SLT	19 comparisons n=1414	27 comparisons n=1620
SLT v Social Support	7 comparisons n=432	9 comparisons n=447
SLT v SLT	25 comparisons n=910	38 comparisons n=1242

SLT v No SLT (10 RCTs)

Primary Outcome: Functional Communication

Study or Subgroup	SLT Mean	SLT SD	SLT Total	No SLT Mean	No SLT SD	No SLT Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
1.1.1 WAB (Spontaneous Speech)								
Katz 1997i	13.8	5.3	10	13.7	5	15	6.9%	0.02 [-0.78, 0.82]
Katz 1997ii	13.8	5.3	11	12.2	6.7	19	8.0%	0.25 [-0.50, 1.00]
Subtotal (95% CI)			**21**			**34**	**14.9%**	**0.14 [-0.40, 0.69]**
Heterogeneity: Chi² = 0.17, df = 1 (P = 0.68); I² = 0%								
Test for overall effect: Z = 0.51 (P = 0.61)								
1.1.2 ANELT								
★ B.A.Bar 2011 i	43.7	4.7	9	45.4	6.4	9	5.1%	-0.29 [-1.22, 0.64]
Doesborgh 2004	34.3	8.4	8	25.5	10.3	10	4.6%	0.88 [-0.10, 1.87]
Laska 2011	2.15	1.766664	59	1.88	1.77988764	55	32.9%	0.15 [-0.22, 0.52]
Subtotal (95% CI)			**76**			**74**	**42.6%**	**0.18 [-0.15, 0.50]**
Heterogeneity: Chi² = 2.94, df = 2 (P = 0.23); I² = 32%								
Test for overall effect: Z = 1.07 (P = 0.28)								
1.1.3 Functional Communication Profile								
Wertz 1986i	59.35	19.62	31	55.6	19.56	17	12.7%	0.19 [-0.40, 0.78]
Wertz 1986ii	62.05	21.83	37	55.6	19.56	18	13.9%	0.30 [-0.27, 0.87]
Subtotal (95% CI)			**68**			**35**	**26.5%**	**0.25 [-0.16, 0.66]**
Heterogeneity: Chi² = 0.07, df = 1 (P = 0.79); I² = 0%								
Test for overall effect: Z = 1.18 (P = 0.24)								
1.1.4 Chinese Functional Communication Examination								
Zhang 2007i	184.25	52.11	19	155.67	66.83	9	6.9%	0.49 [-0.32, 1.29]
Zhang 2007ii	202	24.24	20	155.67	66.83	8	5.8%	1.11 [0.24, 1.99]
Subtotal (95% CI)			**39**			**17**	**12.6%**	**0.77 [0.18, 1.37]**
Heterogeneity: Chi² = 1.06, df = 1 (P = 0.30); I² = 6%								
Test for overall effect: Z = 2.55 (P = 0.01)								
1.1.5 AAT (Spontaneous Speech)								
★ Mattioli 2014	4.2	1.20166551	6	3.75	0.39370039	6	3.3%	0.46 [-0.69, 1.62]
Subtotal (95% CI)			**6**			**6**	**3.3%**	**0.46 [-0.69, 1.62]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.79 (P = 0.43)								
Total (95% CI)			**210**			**166**	**100.0%**	**0.28 [0.06, 0.49]**
Heterogeneity: Chi² = 7.66, df = 9 (P = 0.57); I² = 0%								
Test for overall effect: Z = 2.56 (P = 0.01)								
Test for subgroup differences: Chi² = 3.41, df = 4 (P = 0.49), I² = 0%								

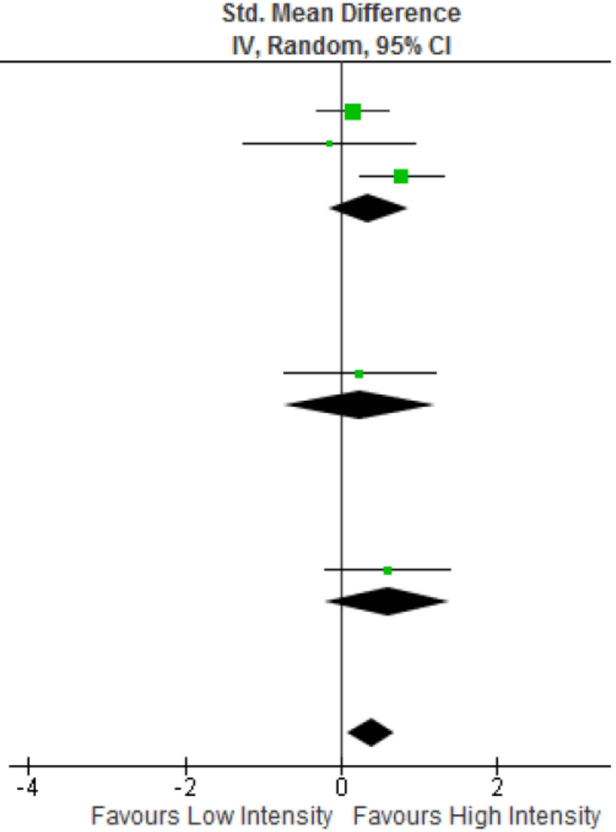
Std. Mean Difference IV, Fixed, 95% CI



HIGHER V LOWER INTENSITY: APHASIA SEVERITY

5.8 Severity of impairment: Aphasia Battery Score

	High Intensity SLT			Low Intensity SLT				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
5.8.1 Aphasia Quotient (WAB)								
Bakheit 2007	70.3	26.9	35	66.2	26.2	38	38.7%	0.15 [-0.31, 0.61]
ORLA 2006	57.58	14.82	6	60.48	19.35	7	7.7%	-0.15 [-1.25, 0.94]
VERSE I	55.386	31.112	32	30.835	31.8343	27	29.9%	0.77 [0.24, 1.30]
Subtotal (95% CI)			**73**			**72**	**76.3%**	**0.35 [-0.16, 0.85]**
Heterogeneity: Tau² = 0.10; Chi² = 3.92, df = 2 (P = 0.14); I² = 49%								
Test for overall effect: Z = 1.34 (P = 0.18)								
5.8.2 AAT overall								
Pulvermuller 2001	55.58	5.88	10	54.14	6.3	7	9.7%	0.23 [-0.74, 1.20]
Subtotal (95% CI)			**10**			**7**	**9.7%**	**0.23 [-0.74, 1.20]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.46 (P = 0.65)								
5.8.3 Boston Diagnostic Aphasia Examination (10 weeks)								
SP-I-RiT	2.67	0.49	13	2.38	0.46	12	13.9%	0.59 [-0.22, 1.39]
Subtotal (95% CI)			**13**			**12**	**13.9%**	**0.59 [-0.22, 1.39]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.44 (P = 0.15)								
Total (95% CI)			**96**			**91**	**100.0%**	**0.38 [0.07, 0.69]**
Heterogeneity: Tau² = 0.01; Chi² = 4.28, df = 4 (P = 0.37); I² = 7%								
Test for overall effect: Z = 2.43 (P = 0.02)								
Test for subgroup differences: Chi² = 0.37, df = 2 (P = 0.83), I² = 0%								



(Brady et al 2016)

Intervention approaches for aphasia

Which treatments work for which patients??

Standardize & personalize intervention

Age

Lesion location

Lesion size/volume

Months post stroke

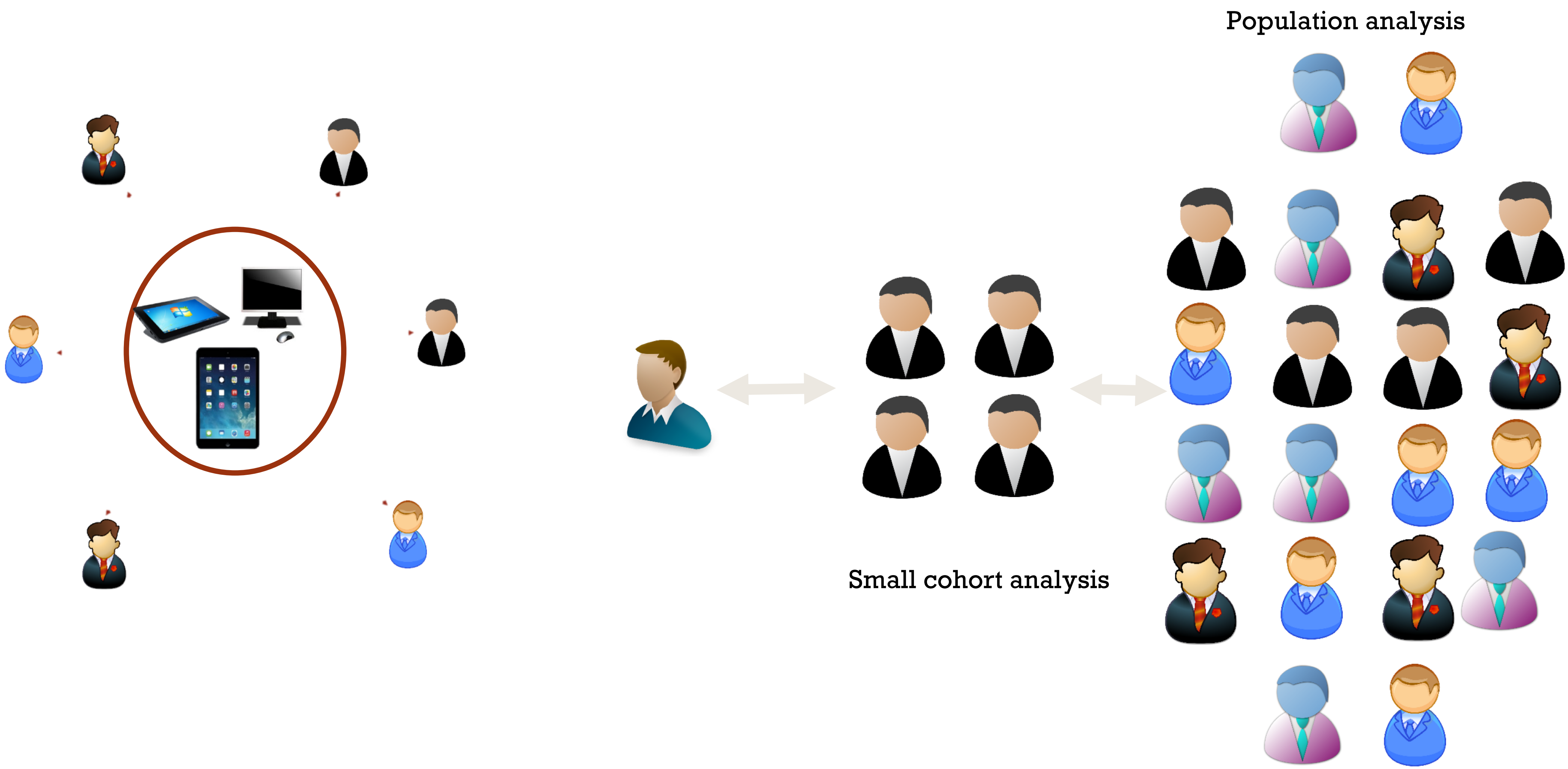
Education

Severity of impairment

Amount of therapy

Type of treatment

→ Therapy Outcomes


Population analysis
Small cohort analysis

USING TECHNOLOGY TO IMPROVE TREATMENT DELIVERY

- Main advantage is to provide therapy to people who cannot travel to obtain rehabilitation services.
- Speech language pathology services are particularly suited to telerehabilitation due to the emphasis on auditory/visual interaction
- Thus far, videoconferencing services between client and clinician for audiology, stuttering, and motor speech have been reported (Georgeadis et al., 2004; Hill et al., 2006)
- Several centers set up for providing aphasia therapy over the internet

- Computer programs also provide an opportunity for patients to practice more intensely and consistently than what is typical in weekly/biweekly visits to a clinical location.

- Swales Q14 MA, Hill AJ, Finch E. Feature rich, but user-friendly: speech pathologists' preferences for computer-based aphasia therapy. Int J Speech Lang Pathol 2015:1–14

- "As more and better software programs for the delivery of therapy are developed, there is the possibility to achieve the intensive levels of stimulation and practice necessary to trigger reorganization of neuronal assemblies."

- "In particular, if programs can be devised that allow users under the guidance of clinicians to self-administer the therapy, then limitations of therapists and therapy time can be circumvented."

Varley R. Rethinking aphasia therapy: a neuroscience perspective. Int J Speech-Language Pathol 2011;13(1):11–20

Recent reviews of technological applications

Computer based- Single program applications

Lingraphica
- Aftonomos et al., 1997

MossTalk
- Fink et al., 2002; Raymer et al., 2006; Ramsberger & Marie, 2007

Multicue
- Doesborgh et al., 2004

AphasiaScripts
- Cherney & Halper, 2008; Manheim et al., 2009; Cherney et al., 2014

Sentactics
- Thompson et al., 2010

SentenceShaper
- Linebarger et al., (2007)

Computer based- Multiprogram applications

Constant Therapy
- Des Roches, et al., 2015

Tactus Therapy
- Stark & Warburton, 2016

Lingraphica TalkPath
- Steele et al., 2014

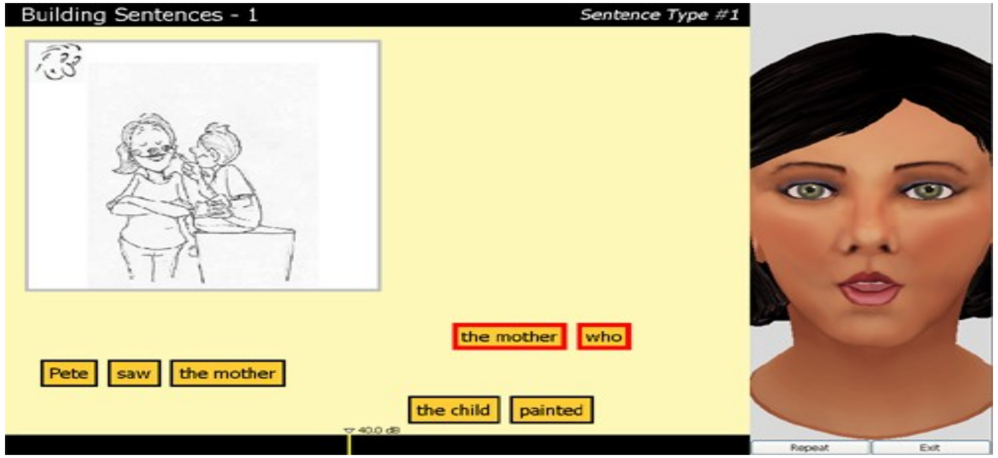
StepByStep
- Mortley et al., 200; Palmer et al., 2012

Computer based cognitive rehabilitation

Cogmed
- Akerlund et al., 2013; Bjorkldahl, 2013; De Luca 2014; Lundqvist et al., 2010; Westerberg et al., 2007

Posit Science
- Lebowitz et al., 2012

Lumosity
- Zickefoose et al., 2013

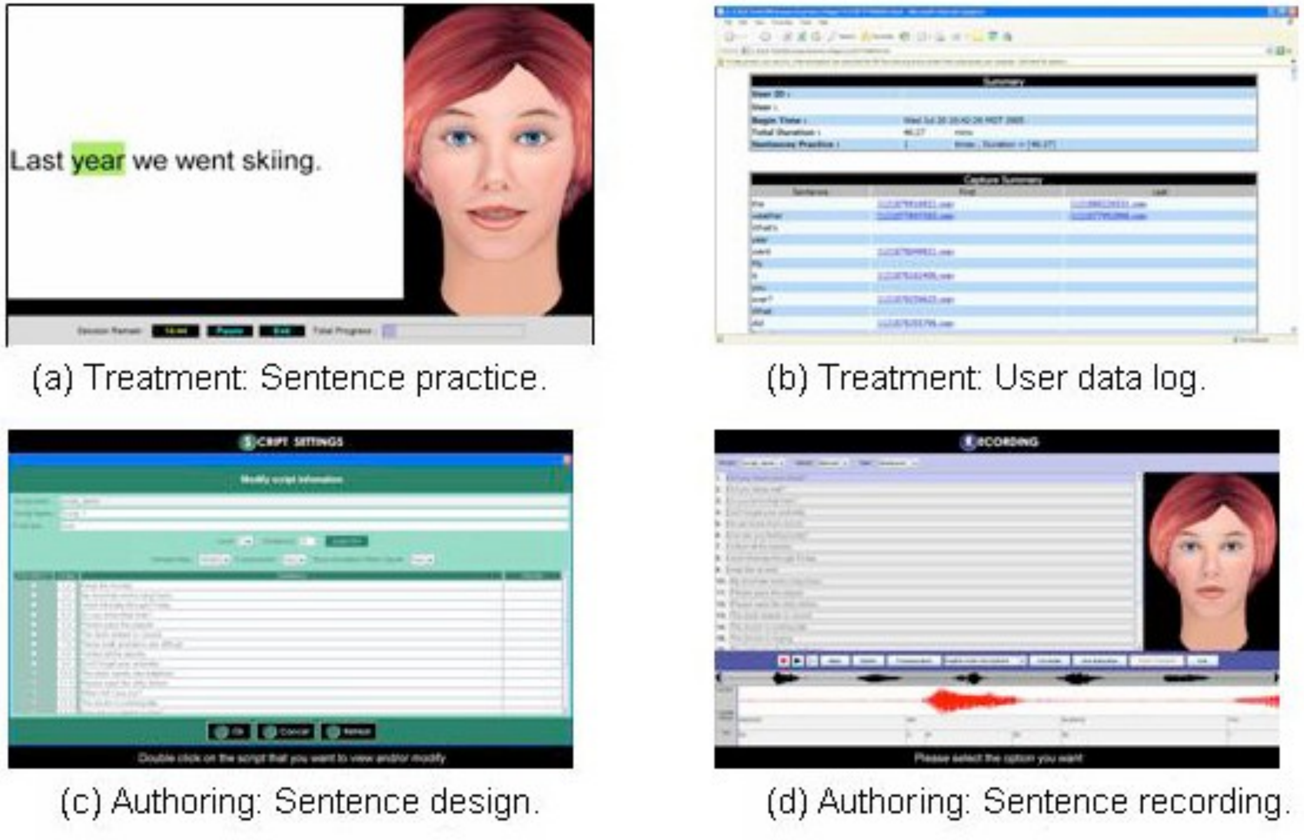


Sentactics is a computer-automated program that trains patients in comprehension and production of complex sentences based on TUF

"Sabrina," an automated clinician, presents the patient with stimuli and gives feedback about the patient's performance

Thompson CK, Choy JJ, Holland A, Cole R. Sentactics(R): Computer-Automated Treatment of Underlying Forms. *Aphasiology.* 2010;24(10):1242-1266.

ORLA WITH VIRTUAL THERAPIST (ORLA-VT)



(a) Treatment: Sentence practice.
(b) Treatment: User data log.
(c) Authoring: Sentence design.
(d) Authoring: Sentence recording.

Cherney LR. Oral reading for language in aphasia (ORLA): evaluating the efficacy of computer-delivered therapy in chronic nonfluent aphasia. *Top Stroke Rehabil.* 2010;17(6):423-431.

COMPUTERIZED BRAIN REHABILITATION SOFTWARE

- **Multicue software**
- Makes different types of cues (semantic, phonemic, general information) available to patients as they practice word retrieval. Results from18 patients with aphasia who received Multicue therapist improved on the Boston Naming Test (BNT), but the changes were not significant when compared with the control group.

Doesborgh S, van de Sandt-Koenderman M, Dippel D, van Harskamp F, Koudstaal P, Visch-Brink E. Cues on request: The efficacy of Multicue, a computer program for wordfinding therapy. *Aphasiology.* 2004;18(3):213-222.; Vanmourik M, Vandesandtkoenderman WME. Multicue. *Aphasiology.* 1992;6(2):179-183.

- **MossTalk**
- Also provides patient initiated cues during word retrieval. This program was shown to be effective in increasing patients' comprehension and lessening word retrieval deficits in aphasic individuals and those who had semantic dementia.

Fink RB, Brecher A, Schwartz MF, Robey RR. A computer-implemented protocol for treatment of naming disorders: Evaluation of clinician-guided and partially self-guided instruction. *Aphasiology.* 2002;16(10-11):1061-1086; Fink R, Brecher A, Sobel P, Schwartz M. Computer-assisted treatment of word retrieval deficits in aphasia. *Aphasiology.* 2005;19(10):943 - 954.; Raymer AM, Kohen FP, Saffell D. Computerised training for impairments of word comprehension and retrieval in aphasia. *Aphasiology.* 2006;20(2-4):257-268.;Jokel R, Rochon E, Anderson ND. Errorless learning of computer-generated words in a patient with semantic dementia. *Neuropsychological Rehabilitation.* 2010;20(1):16-41.

COMPUTERIZED BRAIN REHABILITATION SOFTWARE

- **StepByStep**
- Palmer et al found the 15 patients assigned to a computer treatment group showed more improvement on their naming ability than did 13 patients who practiced everyday language activities, including conversation and support groups and reading and writing activities.

Palmer R, Enderby P, Cooper C, et al. Computer therapy compared with usual care for people with long-standing aphasia poststroke: a pilot randomized controlled trial. *Stroke.* 2012;43(7):1904-1911.

- **Lingraphica**
- Structured language therapy to 50 patients in community settings showed improvements on standardized tests such as the WAB and CETI.

Aftonomos, L. B., Appelbaum, J. S., & Steele, R. D. (1999). Improving outcomes for persons with aphasia in advanced community-based treatment programs. Stroke, 30(7), 1370-1379.

- **Constant Therapy**
- Standardized and individualized treatment for 51 patients using the software showed significant changes on WAB, CLQT, BNT etc

Des Roches CA, Balachandran I, Ascenso EM, Tripodis Y, Kiran S. Effectiveness of an impairment-based individualized rehabilitation program using an iPad-based software platform. *Frontiers in Human Neuroscience.* 2015;8.

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FOCUSED REVIEW ARTICLE

Front. Neurosci., 28 July 2017 | https://doi.org/10.3389/fnins.2017.00382

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Technology-Based Rehabilitation to Improve Communication after Acquired Brain Injury

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The utilization of technology has allowed for several advances in aphasia rehabilitation for individuals with acquired brain injury. Thirty-one previous studies that provide technology-based language or language and cognitive rehabilitation are examined in terms of the domains addressed, the types of treatments that were provided, details about the methods and the results, including which types of outcomes are reported. From this, we address questions about how different aspects of the delivery of treatment can influence rehabilitation outcomes, such as whether the treatment was standardized or tailored, whether the participants were prescribed homework or not, and whether intensity was varied.

	Study	Participants			Treatment		Main results
		N, age, MPO*	Etiology and severity	Control group	Type	Duration and intensity	
Language, single domain, naming	Aftonomos et al., 1997	N:23, age:64.3, MPO:46.3 (all chronic)	**Stroke* (mostly)** Mixed levels of severity and aphasia type	**No**	**Lingraphica** Interactive lexical items in the major linguistic categories that appear in a field of semantically related items; works on word retrieval on multiple levels	Mean duration:16.8 weeks (varied), intensity mean:1.99 sessions per week in clinic, variable intensity decided by patient for homework	All standardized tests (WAB*, BNT*, BDAE*) showed gains for most patients
	Fink et al., 2002	N:6, age:60.5, MPO:49.2 (all chronic)	**Stroke** Mixed levels of severity and aphasia type	**No**, two equal groups (full clinician guidance vs. partial guidance)	**MossTalk Words** Cued naming	4 weeks or until criterion, 3 times per week; variable intensity decided by patient for independent practice in partial guidance group	Both groups showed gains on trained words (as measured by PNT*), gains on PRT* for one clinician-guided and on PORT* for two partial-guided patients
	Raymer et al., 2006	N:5, age:70.8, MPO:92 (2 were subacute, 3 were chronic)	**Stroke** Mixed levels of severity and aphasia type	**No**, two levels of intensity (crossed design)	**MossTalk** Multimode matching exercises	Each training phase: 12 sessions, lower intensity: 1–2 times per week, higher intensity: 3–4 times per week	All patients improved in trained items, more in higher intensity phase, one patient showed gains on WAB AQ* and BNT
	Ramsberger and Marie, 2007	N:4, age:67.5, MPO:31.5 (all chronic)	**Stroke** Mixed levels of severity and aphasia type,	**No**, two levels of intensity (crossed design)	**MossTalk Words** Self-cued naming with partial clinician guidance	15–20 sessions per word list Lower intensity: 2 times per week Higher intensity: 5 times per week	Three patients showed gains in naming, regardless of intensity
	Doesborgh et al., 2004	N:18, age:62 (EG*), 65 (CG*), MPO:13 (EG), 13 (CG) (all chronic)	**Stroke** Moderate to severe, global aphasia excluded	**Yes** No treatment (N:10)	**Multicue** Self-cued naming	2 months, 2-3 times per week	EG showed gains on BNT, but no between group differences

Domain(s) treated	Study	Was the treatment tailored?	Home practice	Varied intensity	Within task improvement	Within task generalization	Maintenance	Impairment-based improvement	Functional/quality of life improvement
Language, single domain, naming	Aftonomos et al., 1997	X	X	X				X	
	Fink et al., 2002	X	X (partial guidance group)		X	X	X	X	
	Raymer et al., 2006	X		X - compared two levels	X	X		X	
	Ramsberger and Marie, 2007	X	X	X - compared two levels	X	X	X		
	Doesborgh et al., 2004							X	
	Loverso et al., 1992				X			X	
	Bruce and Howard, 1987				X	X			
	Fridriksson et al., 2009		X		X			X	
	Harnish et al., 2014	X			X	X	X		
	Kurland et al., 2014	X	X	X	X			X	
	Woolf et al., 2016	X	X	X	X		X		
Language, single domain, reading	Katz and Wertz, 1992	X				X		X	
	Katz and Wertz, 1997	X						X	
	Cherney, 2010							X	
Language, single domain, sentence processing and production	Cherney and Halper, 2008	X	X	X	X		X	X	X
	Manheim et al., 2009	X	X	X			X		X
	Cherney et al., 2014	X	X		X	X	X		
	Kalinyak-Fliszar et al., 2015				X	X		X	
	Thompson et al., 2010				X			X	
	Linebarger et al., 2007	X	X	X				X	
	Crerar et al., 1996				X	X			
Language, single domain, writing	Seron et al., 1980	X		X		X	X		
	Laganaro et al., 2006			X - compared two levels of item numbers	X		X		

Domain(s) treated	Study	Was the treatment tailored?	Home practice	Varied intensity	Within task improvement	Within task generalization	Maintenance	Impairment-based improvement	Functional/quality of life improvement
Language, multiple domains	Choi et al., 2016	X	X	X			X	X	
	Stark and Warburton, 2016	X	X	X			X	X	
	Steele et al., 2014	X	X	X					X
	Corwin et al., 2014							X	
	Mortley et al., 2004	X	X	X	X	X			
	Palmer et al., 2012	X	X	X	X		X		
Language and cognitive	Des Roches et al., 2015	X	X	X - compared EGs who receive more intensive than CG	X			X	
	Hoover and Carney, 2014	X	X					X	X
	Wcislo et al., 2010	X						X	
	Wenke et al., 2014	X		X - compared EGs who also receive more intensive than CG				X	X

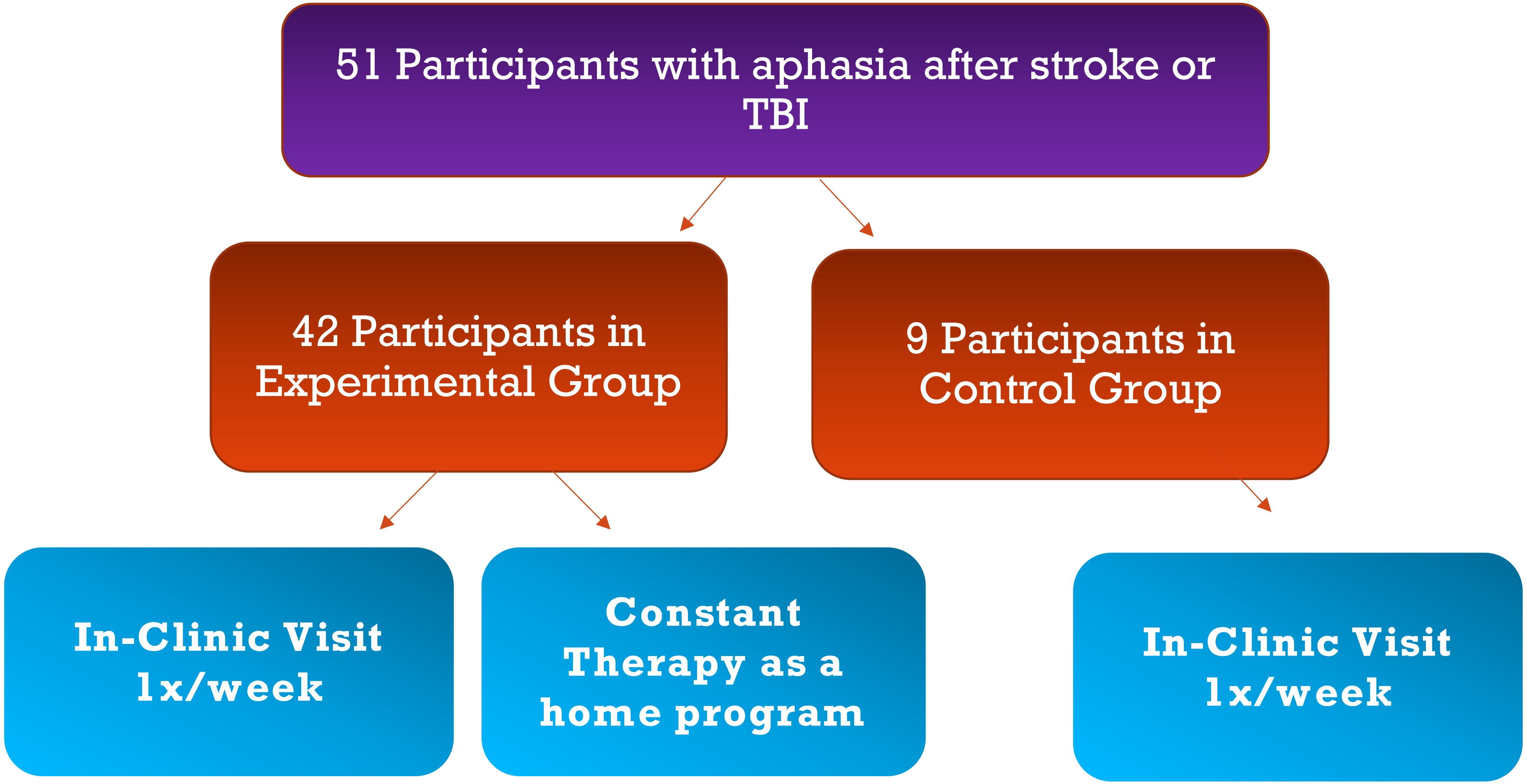
These studies highlight-

- Remotely delivered therapy is effective
- Improvements in impairment based measures
- Treatment is typically tailored for the patient
- Homework is typically practiced
- Intensity of treatment is varied across studies

These studies do not answer

- Is therapy at home as good as therapy in the clinic
- Does therapy result in improvements beyond targeted behavior?
- Who does the therapy benefit?
- What is the optimal intensity/frequency of therapy?

Effectiveness of an impairment-based individualized rehabilitation program using an iPad-based software platform



Des Roches et al., 2015, FIHN

COGNITIVE TASKS

ATTENTION	VISUO-SPATIAL PROCESSING	ANALYTICAL REASONING	MEMORY	QUANTITATIVE REASONING	ARITHMETIC
Symbol Matching	Clock Math	Word Ordering	VISUAL	Word Problem	Addition
Slapjack	Clock Reading	Picture Ordering	Face Matching	Currency Math	Subtraction
Flanker	Symbol Matching	Instruction Sequencing	Word Matching	Clock Math	Multiplication
Picture N-Back Memory	Map Reading	Map Reading	Picture Matching	Number Pattern	Division
	Calendar		Picture N-Back Memory	Functional Math	
	Mental Rotation		Pattern Recreation		
	Pattern Recreation		Slapjack		
			AUDITORY		
			Environmental Sound Match		
			Sound Matching		
			Auditory Command		

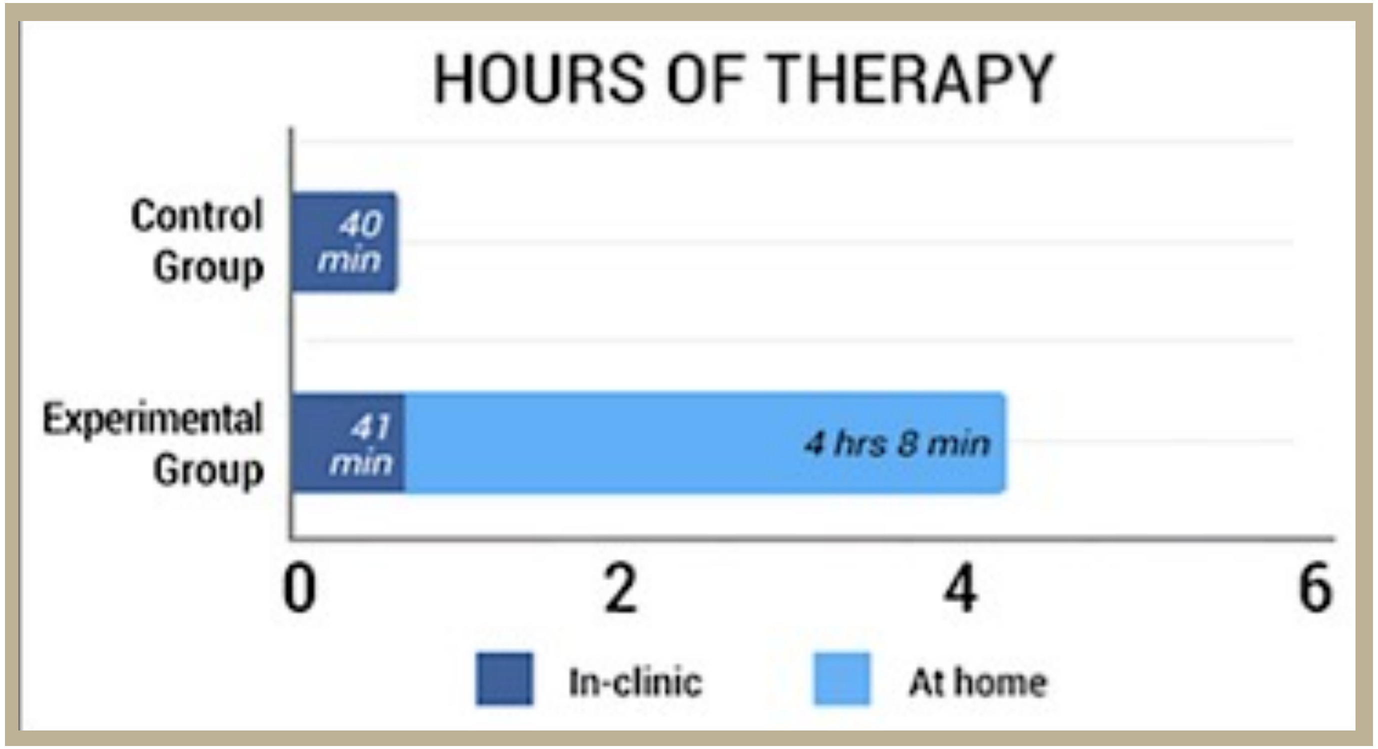
LANGUAGE TASKS

AUDITORY COMP	WORD RETRIEVAL	WRITING	READING	SPEAKING
Auditory Command	Syllable ID	Picture Spelling Completion	Odd One Out Semantic	Word Repetition
Voicemail	Sound ID	Word Spelling Completion	Category Matching	Word Imitation
Spoken Word Comprehension	Rhyming	Word Copy Completion	Feature Matching	Read Word Aloud
Word ID	Category Matching	Picture Spelling	Written Word Comp	Picture Naming
PHONOLOGICAL PROCESSING	Feature Matching	Word Spelling	Word ID	SENTENCE PLANNING
Minimal Pairs Same/Diff	Picture Naming	Word Copy	Category ID	Instruction Sequencing
Letter to Sound Matching	Spoken Word Comp		Short Reading	Active Sentence Completion
Sound to Letter Matching	Letter to Sound Matching		Long Reading Comp	Passive Sentence Completion
Spoken Sound	Sound to Letter Matching		Written Lexical Decision	
Spoken Rhyming			Active Sentence Completion	
Spoken Syllable			Passive Sentence Completion	
Minimal Pairs Written Cue			Functional Reading	
Minimal Pairs Spoken Cue			Inference Reading	
			Instruction Sequencing	

Subtest	Experimental Group (N= 41)	Control Group (N = 9)
WAB-LQ	2.13 (t = -2.05, p <.05)	1.42 (ns)
WAB-CQ	2.15 (t = -2.16, p <.05)	1.32 (ns)
WAB-AQ	3.18 (t = -2.89, p <.01)	0.65 (ns)
CLQT-composite severity	5.26 (t = -3.10, p < .01)	4.44 % (ns)
CLQT-Attention	10.9 % (t = -1.93, p <.05)	7.6% (ns)
CLQT-Memory	1.55% (ns)	1.14% (ns)
CLQT-Executive Function	5.06% (t = -2.74, p < .01)	1.66% (ns)
CLQT- Language	1.42% (ns)	1.65% (ns)
CLQT- Visuospatial skills	6.89 (t = -3.45, p < .001)	2.96% (ns)

- Experimental patients show more significant changes on standardized tests than control patients.
- Patients with lower initial scores showed more improvements than patients with higher initial scores.

Des Roches et al., 2015



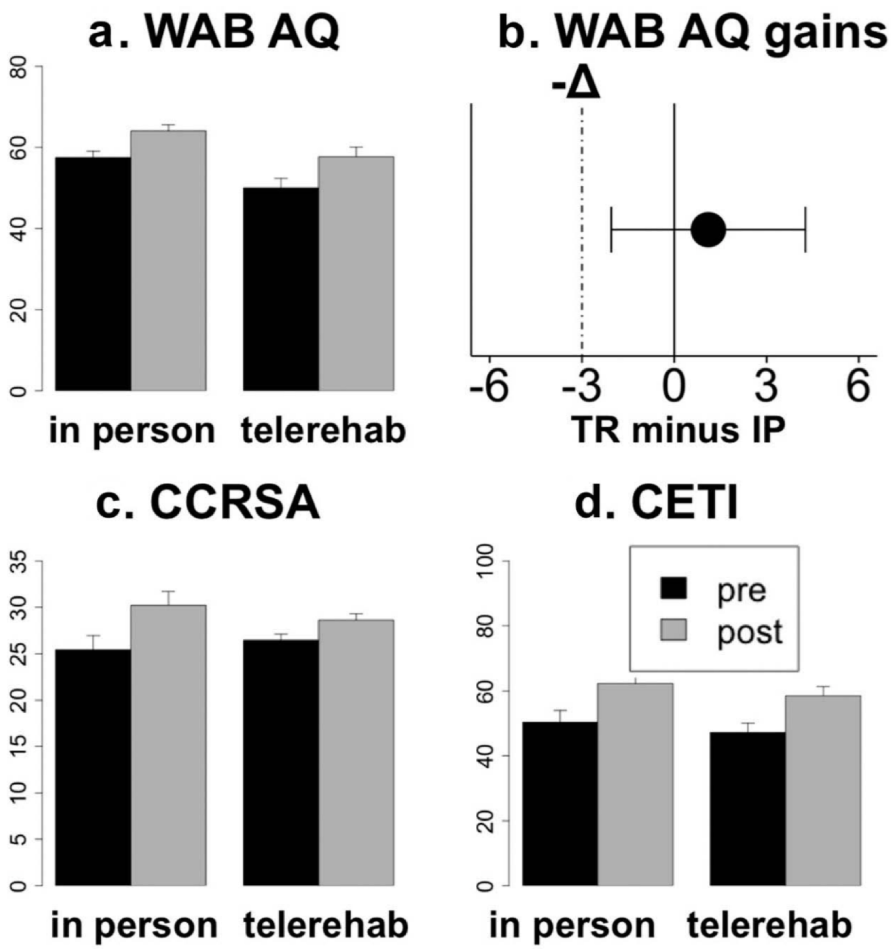
Des Roches, et. al. (2015).

Computer-based treatment of poststroke language disorders: a non-inferiority study of telerehabilitation compared to in-person service delivery

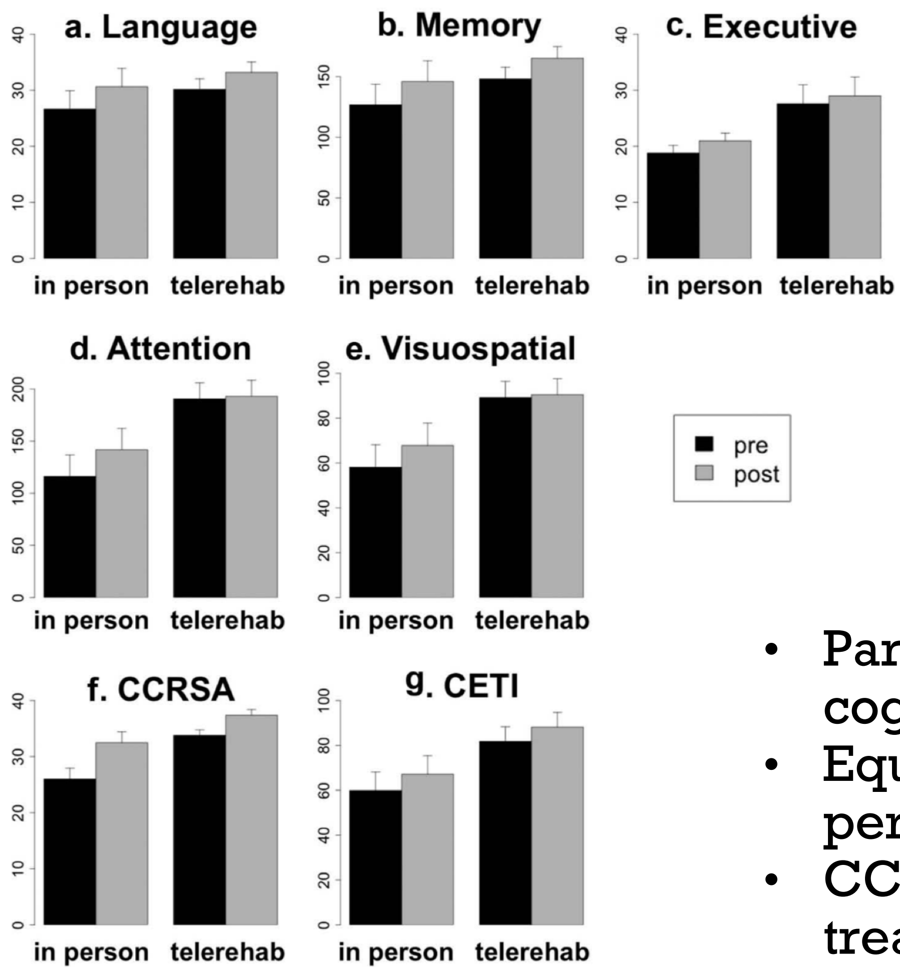
Table 1. Demographic characteristics of participants, with mean ± standard deviation for quantitative measures.

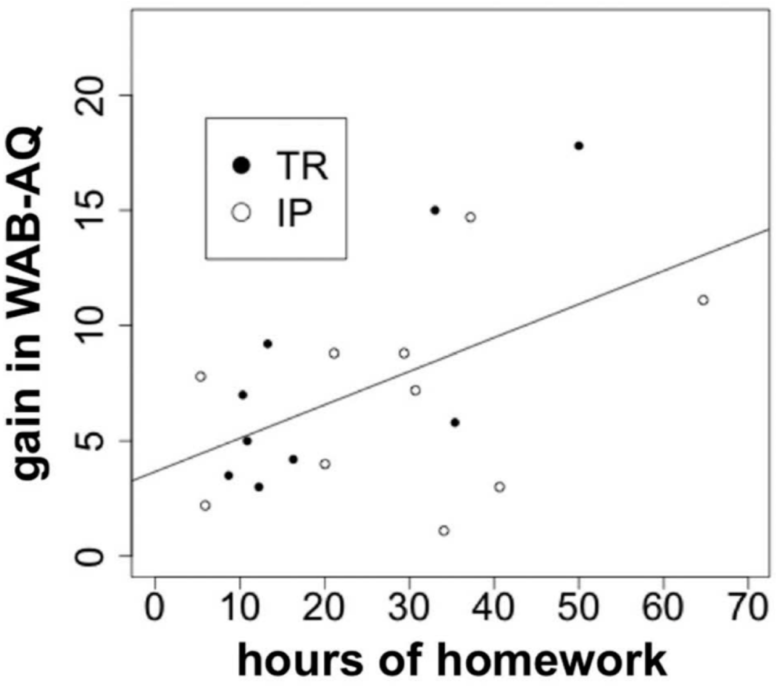
Group	*N*	Age	Sex	Etiology	WAB Pre	WAB Post
Aphasia in person	16	62.9 ± 11.6	5 F, 11 M	15 LH stroke, 1 other[a]	(*n* = 15) 57.5 ± 23.6	64.1 ± 23.5
Aphasia telerehab	17	66.8 ± 11.2	7 F, 10 M	17 LH stroke	(*n* = 15) 50.0 ± 24.4	57.7 ± 24.9
Cog-Ling in person	6	63.2 ± 8.4	3 F, 3 M	3 LH stroke, 2 RH stroke, 1 other[b]	-	-
Cog-Ling telerehab	5	60.8 ± 10.4	2 F, 3 M	3 RH stroke, 2 other[c]	-	-

- 12 weeks of treatment, either through telerehabilitation or through in person treatment.
- Worked on various exercises from Lingraphica (Talkpath software), training with communication partner and other traditional language therapy tasks



Meltzer et al,. 2017, Aphasiology





- Participants improved on all measures (language and cognitive linguistic deficits)
- Equivalent gains between telerehabilitation and in-person treatment
- CCRSA questionnaire showed an advantage for in person treatment
- Improvements on WAB correlate with amount of homework practice

Meltzer et al,. 2017

FACTORS THAT ARE RELEVANT TO TECHNOLOGICAL APPLICATIONS -

- Treatment Intensity
- Personalizing Treatment
- Taking ownership of one's care

THANK YOU, QUESTIONS?