Online Appendix

Case Histories

The following case histories document the course of recovery from time of onset of the cerebrovascular accident (stroke) until 6 months after CIAT II.

Case 1

Participant 1 is a 60-year-old man who is 9 years poststroke. At the time of CIAT II treatment, his MRI showed a middle cerebral artery infarction with extensive frontoparietal and superior temporal damage. The total lesion volume was 201.7 cm³. Prior to the stroke the participant was a dentist. Initial assessment of speech and language skills revealed a global aphasia with severe verbal and oral apraxia. Immediately poststroke the participant spoke very little and perseveratively responded “yes, yes, yes” to most questions. His receptive language ability was also impaired. In his acute inpatient speech rehabilitation, his expressive language skills improved to where he could use one word in repetition. At discharge, his initial diagnosis of global aphasia was changed to a severe Broca’s aphasia with moderate to severe verbal apraxia.

At the time of CIAT II treatment, Participant 1 was able to ambulate without assistance and had a minimally functional right upper extremity. He attempted to use 2–3 words to communicate, but syntactic ability was impaired and fluency was reduced by hesitations and interruptions. The family described his speech as telegraphic but capable of communicating an idea. In pretreatment diagnostic testing using the Western Aphasia Battery-R (WAB–R), Participant 1’s Picture Description task response was as follows:

“He flying a kite, uh, uh, girl is build the sand, uh, uh, castle. Dog is run around, and, uh, uh, and, no, we, no . . . dang; picnic at yard. Fixin’, the, uh, uh, man catch the fish. Uh, uh, the house is, wave flag. Uh, sailboat, and, uh wind.”

During treatment Participant 1 was extremely compliant with all therapeutic tasks and with the homework assigned. His wife, the primary caregiver, was with him throughout the 3 weeks of therapy and reported that he completed all work assigned to be accomplished outside the therapy environment. By Treatment Day 3, his score on the “How Well” scale of the Verbal Activity Log (VAL) had improved rapidly from 1.3 to 2.6. When Participant 1 and his caregiver were asked about this improvement on Treatment Day 4, the caregiver stated that her husband had decided to do more homework than was assigned and that they were “talking” about everything, which they had not been doing prior to treatment. Both the participant and caregiver thought that this increase in talking was helping to improve word finding and syntactic ability. The caregiver also documented on Treatment Day 4 that her husband was self-correcting some errors that had been common in his verbal output. The VAL score plateaued from Treatment Days 2–9, and then rose slowly to 2.9 on Treatment Day 15. On Treatment Day 15, the WAB–R was re-administered. The following is Participant 1’s posttherapy Picture Description:

“The kite is flying. The boy is holding the kite. The dog was running. The girl, was, uh. The wine is flowing. The boy is reading the book. The boy is get the sandals off. We were getting the picnic. The green grass trees are shading the house. The car is parked. The man is fishing. The man is catching the fish. The sailboat is moving. The flag was waving. The little girl was building the castle.
The man and the girl was playing the radio.”

At the Month 2 follow-up, when asked about use of the phone, Participant 1 reported that he had begun to call the pharmacy independently to re-order his monthly medications. His wife verified this, and both participant and caregiver stated that the pharmacist had no difficulty understanding the telephoned request.

Case 2

Participant 2 is a 72-year-old man who was 22 months poststroke at the time of CIAT II. His MRI revealed an anterior cerebral artery infarction with posterior frontal and parietal damage. The total lesion volume was 155.0 cm$^3$. Prior to his stroke the participant had been a life insurance salesman and then an executive for approximately 50 years. He has a bachelor’s degree in business with four additional degrees granted to him postgraduation in the area of insurance. He is a member of the “Million Dollar Club,” which indicates his success at providing insurance sales.

Immediately poststroke the participant was unable to speak at all. He could gesture for emergency communication and attempted to use a few verbalizations. For example, when the participant needed someone’s attention, he would say, “Dit, dit, dit” and increase his volume if there were no immediate response. He was initially diagnosed with global aphasia and severe verbal apraxia with a minimal degree of spastic dysarthria. He participated in inpatient rehabilitation for approximately 3 months and was then seen in outpatient speech therapy for an additional 6 months. His receptive language improved to the point where he could follow two- to three-step commands and could follow a conversation. His expressive ability at this time was marked by one-word utterances.

At the time of CIAT II initiation, Participant 2 had regained functional motor control of the more-affected lower extremity, and he was able to ambulate independently. He had limited function with his more-affected upper extremity and did not attempt to use it for activities of daily living. The participant was able to communicate minimally by answering yes and no questions. He often reversed his yes/no responses secondarily but could self-correct. Participant 2’s family described his verbal behavior as minimal with no desire to communicate verbally. The speech-language pathologist working with him in outpatient therapy agreed. She stated that he was compliant with work during therapy sessions, but no generalization was noted on any language and/or speech tasks in the therapy environment. In pretreatment testing with the WAB–R, Picture Description task performance was as follows:

“Lady read; [ţaɾ]; dog, lake, dog, [sʊl]; car; [cæf]; [həs]; boat.”

During treatment, Participant 2 had two caregivers who worked with him daily. Both caregivers were familiar with the goals of CIAT II and carried out homework assignments with him. By the second day of treatment, his VAL score had approximately doubled from 0.7 to 1.5. However, although Participant 2 was compliant with all work assigned, his motivation for improvement was minimal at the beginning of therapy. His caregivers reported that he did not use the language ability he developed in the laboratory for communication purposes. However, on Treatment Day 6 his attitude began to change. At one point during the treatment exercises, he became annoyed at the clinician because he felt that she was not requiring him to achieve the best performance of which he was capable on a particular task. He also demonstrated annoyance with his primary caregiver because his cell phone, lying on a table beyond his reach, kept vibrating during one of the exercises, and she did not turn it off. Participant 2 looked at his
caregiver and explicitly stated quite loudly and unexpectedly, “Turn it off.” These examples of mild annoyance seemed promising to the therapists because they seemed to indicate that the participant was beginning to be motivated to improve. After Treatment Day 6, the VAL scores remained at a plateau of 1.5 but then suddenly came close to doubling to 2.9 on Treatment Day 14.

On Treatment Day 15, the WAB–R was re-administered. The following is the Picture Description posttherapy:

“Reading a book, and, uh, a male. She is moving a bottle of wine. A kite, and uh, moving a line. He is flying a kite. A dog, and a, uh, is fun. A castle and uh, the, uh; the woman and a castle. A blue boat and a number 4-7-0. A man is fishing and caught a fish. Flag, and, uh, is flying. A tree and a shade. Shade is for the house”.

Follow-up data indicated that improvement continued to occur posttherapy. At the Week 2 follow-up, the participant’s wife reported that he had initiated calling one of his former clients to wish her a “happy birthday.” Prior to the stroke, this had been a long-standing custom of his with clients. At the Month 2 follow-up, the participant’s wife had him retell a story about a business trip that they had just taken to an insurance sales conference. He described where they had gone and mentioned that he had left his wife in the hotel room while she was napping to participate in a meeting session without notifying her of his intention. When his wife went to look for him, one of his colleagues reported that he was sitting on a panel talking about the best options for life insurance customers, which the people in charge of that session had asked him to participate in.

Case 3

Participant 3 was an 83-year-old woman who was 18 months poststroke when she underwent CIAT II. Her lesion damaged the inferior parietal and posterior frontal lobes. The total lesion volume was 38.7 cm³. Participant 3 had 2 years of college, and her primary occupation had been housewife/homemaker. Her family described their mother prestroke as a gregarious individual who loved to laugh. She participated in many social activities, such as card games, outings, shopping, and talking with friends on the phone. Immediately poststroke the participant was unable to speak but attempted to communicate with gestures and by pointing. She was initially diagnosed with severe Broca’s aphasia and verbal apraxia. In acute inpatient rehabilitation she received physical, occupational, and speech therapy. Upon her discharge from acute rehabilitation, she could use single words to communicate and could follow simple commands.

At the time of CIAT II treatment, the participant was able to ambulate short distances and preferred to use a wheelchair for longer distances. She could use her right upper extremity for many functional purposes, but there was a substantial motor deficit. The participant could communicate at that time with yes/no responses and could repeat words and phrases if requested. She used a pointing response to communicate needs to her family and did not leave her house for any reason other than doctor visits.

Participant 3 had four children; three of them took responsibility for her primary care. She lived with one of her sons and daughter-in-law, and on different days her two daughters attended CIAT II with her and helped with home practice and follow-through activities. The caregivers were of the opinion that their mother’s limited ability to communicate was a natural outcome of her stroke. There had been little success in acute rehabilitation, and they had then just
assumed that her recovery was complete and did not pursue other options for therapy. Her score on the VAL How Well scale before treatment was just 0.6 units.

Participant 3 demonstrated good motivation to improve her verbal skills once enrolled in therapy. By Treatment Day 2, her VAL score more than tripled, going from 0.6 to 2.0, suggesting that there had been substantial latent verbal ability that had been held in inhibition, characterized here as learned nonuse, perhaps aided by her family’s opinion of her limited potential for improvement and consequent lack of encouragement to attempt verbal communication. On Treatment Day 6, it was reported during the administration of the VAL that the participant attended church for the first time since her stroke. She stated that she had fun, and could talk “a little bit” to some of her friends. Subsequently, she began to ask to be taken out to eat and to undertake attempts at conversation with persons who were assisting her in stores. Both of her daughters reported that if their mother felt any pressure in the communicative situation, she tended to “shut down” and point to them to take care of any verbal communication required. This behavior was addressed during treatment and she was helped in a problem-solving discussion to deal with the feelings of inadequacy she was experiencing. She was asked to role-play situations that were making her feel uncomfortable, and both daughters reported an improvement in her cooperation while out of the home. The participant’s immediate and extended family began to talk with her more on the phone. She became independent with dialing the number of the person with whom she wanted to speak and has continued talking frequently on the phone. By Treatment Day 13, her VAL How Well score nearly doubled again, from 2.0 on Day 2 to 3.9, before regressing slightly to 3.6 on Treatment Day 15, the latter being a fairly large but not atypical day-to-day variation in score.

Compliance posttherapy has been moderate to minimal. During the first 3–4 weeks after treatment, the participant’s VAL score improved slightly; subsequently, there was no further change. However, during the Month 6 follow-up phone call the participant reported that she was continuing to use speech and language for everyday needs and requests and that she was continuing to make phone calls to her family and close friends.

Case 4

Participant 4, a 68-year-old woman, had experienced a stroke 5 years before enrollment. She had spent 4 months in acute inpatient physical, occupational, and speech therapies. Her MRI showed extensive lateral frontotemporal damage with a separate medial parietal infarct. The total lesion volume was 130.2cm³. Participant 4 had been diagnosed with mild global aphasia in the acute/early subacute period. Subsequently, her speech comprehension improved, and her diagnosis was revised to severe Broca’s aphasia. No verbal apraxia was indicated in her medical records at any time. She had a master’s degree in education and had been an educator in a public school system who had been promoted to an administrative position. She was retired from the school system when the stroke occurred.

Approximately 3 months before CIAT II was initiated, Participant 4 underwent CIMT for her right lower extremity, with good results. She appeared motivated to improve her overall condition; however, once CIAT II was begun, her motivation diminished. She was noncompliant for the first 9 days, carrying out her homework assignments minimally and frequently refusing to continue therapeutic exercises in the laboratory after a few attempts. However, from Treatment Day 2 to 9, she did improve 0.6 units on the VAL How Well scale. In her last 6 days, she became more compliant and during that period improved in her ability to communicate verbally by an
additional 0.6 units.

All participants enrolled in CIAT II were required to have a caregiver present with them 100% of the time. Participant 4’s husband was still working and could not attend therapy with his wife for the first 2.5 weeks of the 3-week therapy period. Instead, a paid assistant attended therapy with her. This caregiver worked for the family as a housekeeper during the day and performed night shift duties only with the participant. Therefore, she was unfamiliar with the participant’s routine during the day and was unfamiliar with her communication style. She felt awkward asking the participant to complete somewhat difficult homework activities. With that as a contributing factor, compliance on the assigned homework activities was, as noted, poor at best.

Compliance posttherapy has been a challenge. Although the participant has the same two primary caregivers during the day and night as she had before CIAT II, these persons have very different expectations for language output from her, with the night shift caregiver having lower expectations. This discrepancy is very confusing to the participant. She stated during a follow-up phone call that she was not engaging in the homework package activities and had returned to her routine of watching movies and riding her bicycle in her neighborhood. This lack of compliance is reflected in both her relatively small treatment effect and her little further improvement after the end of treatment.

Case History Summary

Because of poor compliance, the record of Participant 4 should probably not be considered characteristic. In each of the other three cases the training records indicated a rapid initial improvement over the first one to three treatment days, followed by a slower, more incremental improvement. The sudden initial increase in real-world function may represent the period during which learned nonuse is rapidly overcome or counterconditioned. A similar pattern of day-to-day performance change tends to occur with respect to the rate at which spontaneous real-world upper extremity movement occurs with CI Movement therapy.