

Functional Communication in Chronic Aphasia and Executive Function: The Effect of Treating Cognitive Flexibility

Therapeutic intervention for chronic aphasia is typically directed toward two goals, the retraining of deficits in specific linguistic structures and/or compensatory skills training to enhance communication (Lyon, 1992; Park & Ingles, 2001). Efforts directed toward both types of trained behaviors are seen commonly during therapy sessions; however, often use of these skills is not observed outside of the therapy context, especially in less structured, more natural communication situations (Coelho & Duffy, 1987; Kiran, 2007; Kraat, 1990; Purdy, Duffy, & Coelho, 1994; Purdy & Koch, 2006; Thompson & Byrne, 1984; Van Mourik, Verschaeve, Boon, Paquier, & Van Harskamp, 1992). Intact executive function ability, specifically cognitive flexibility, has been implicated as necessary for independent use of compensatory strategies and self-cuing techniques which are often central goals of aphasia intervention (Fridriksson, Nettles, Davis, Morrow, & Montgomery, 2006; Helm-Estabrooks, 2002; Keil, 2003; Keil & Kaszniak, 2002; Purdy & Koch, 2006). Deficits in executive function, specifically cognitive flexibility, have been identified in individuals with aphasia (Chapey, 2001; Chiou & Kennedy, 2009; Hula & McNeil, 2008; Keil, 2003; Purdy, 1992, 2002; Smith, 1980) and the severity of executive function deficits have been found to inversely correlate with communication success regardless of severity of the language impairment (Hinckley, 2002; Keil, 2003; Purdy, 1992, 2002). Because communication is, in large part, a problem-solving task (Chapey, 1977, 2001) which requires the ongoing monitoring of progress towards a goal and modification of strategy when necessary, cognitive flexibility is arguably an essential skill for functional communication (Miyake, Emerson, & Friedman, 2000). If, indeed, stronger cognitive flexibility leads to the restoration of more functional communication in persons with aphasia, then perhaps intervention enhancing this skill would also result in enhanced functional communication (Fridriksson et al., 2006; Helm-Estabrooks, 2002; Keil, 2003; Keil & Kaszniak, 2002; Purdy & Koch, 2006). To examine the effect of flexibility skills training on outcomes in aphasia therapy, a single-subjects design with repeated measures across four subjects with pre and posttest measures was implemented in the current study.

Method

Four adult volunteers with chronic aphasia participated in the study (see Table 1 for demographic information). Pretesting consisted of verification of intact color recognition (the Color Recognition subtest of the *Burns Brief Inventory of Communication and Cognition* (BBICC)); measures of aphasia severity and functional communication (the *Boston Naming Test* (BNT), *Aphasia Diagnostic Profiles* (ADP), *Communication Activities of Daily Living* (CADL-2); and assessment of cognitive flexibility (the *Wisconsin Card Sorting Test* (WCST)). Two sets of non-standardized dependent variables were used during the experiment, a transactional success in conversation measure (Ramsberger & Rende, 2002) and an assessment of the frequency of communication breakdowns. Additionally, instances of communication breakdown were further analyzed to determine the how often independently initiated repairs occurred and whether these attempts were successful.

Data was collected throughout the experimental period which was comprised of 24, 45-minute, 1:1 therapy sessions scheduled twice per week for 12 consecutive weeks. All 24 sessions were audio recorded for assessing the frequency of communication breakdowns and attempted

repairs as well as inter and intracoder reliability. Sixteen of the sessions consisted of typical activities associated with aphasia therapy addressing language and communication deficits with individualized goals and procedures determined by the participant's master's-level graduate student clinician addressing their individual language and communication deficits. These 16 sessions comprised the initial and final segments of the study, or the pre and posttest baseline conditions (A). The experimental treatment condition, (B), was carried out over the other 8 of the sessions (see Figure 1). The sessions targeting cognitive flexibility were comprised of paper and pencil tasks taken directly from the Cognitive Shift Module of the *Frontal Executive Program* (Delahunty & Morice, 1993), a neurocognitive rehabilitation program for chronic schizophrenia designed to address cognitive inflexibility (Delahunty & Morice, 1996; Delahunty, Morice, & Frost, 1993) including maintaining, switching or shifting sets and engaging, disengaging and re-engaging behaviors (Delahunty & Morice, 1993). Examples are depicted here in Figure 2.

Measures of transactional success were taken four times during the experiment replicating the procedure described by Ramsberger and Rende (2002). In this "Lucy task", aphasic participants who had just seen an episode of the television series *I Love Lucy* were individually assigned to one of sixteen typical-speaking volunteers. The teams were instructed to work together to discuss the *I Love Lucy* episode in sufficient detail so the non-aphasic partner would be able to re-tell the story. The number of main ideas and the percent of possible main ideas for each story in the non-aphasic partner's retelling were used as the measure of the transactional success for the aphasic participant. *Lucy* task one was completed one week prior to the experimental period. Task 2 was completed on the same day as experimental session 8, task 3 on the same day as session 16, and the final conversation was scheduled on the same day as the last session. Also at the end of the experimental period, re-administration of the BNT, CADL-2, ADP, and the WCST were completed as posttest measures.

Results

Pretest and posttest results are presented in Tables 2, 3, 4, and 5. While analyses are still underway, visual inspection of the data suggests that there is little difference across measures based on the type of aphasia or its severity. Changes in performances on the WCST suggest improvement for all four participants, possibly reflective of improvement in cognitive flexibility. Tables 6 through 13 show data collected during therapy sessions from all four participants with aphasia and Tables 14 and 15 are data from the *Lucy* task; Figures 3 through 18 display these data graphically. Inter-rater and intra-rater reliability calculations for these measures are pending. Visual examination of the data in Figure 19 indicates that no change was evident across measures of transactional success, which is consistent with the lack of change noted across the standardized tests, consistent with the findings of Ramsberger and Rende (2002). The most marked change, however, was the percent of attempted communication repairs following breakdowns for both the *Lucy* task and therapy sessions by the three subjects demonstrating greater deficits in cognitive flexibility in pretesting (see Figure 20). Specifically, following intervention for cognitive flexibility, spontaneous attempts to repair communication breakdowns increased by 50 to 100% for 75% of participants. These participants attempted many more repairs after flexibility training although the overall relative percentage of successful versus unsuccessful repairs remained unchanged. It appears, therefore, that the linguistic or compensatory skills needed to affect repairs did not improve.

Discussion

The findings of the current study provide preliminary support to the predictions that for individuals with chronic aphasia (1) the use of exercises to enhance cognitive flexibility may improve problem solving skills and (2) the use of exercises to enhance cognitive flexibility may increase attempts to repair communication breakdowns. The results also suggest that use of the *Frontal/Executive Program* can lead to improvements in cognitive flexibility in individuals with aphasia. The current findings may also indicate that to achieve superior functional communication outcomes that intervention for cognitive flexibility may need to be addressed concurrent with, or perhaps prior to implementation of linguistic or compensatory intervention for individuals with chronic aphasia identified with both disabilities. From a broader perspective, the current study also adds support to the claim that the use speech-language intervention for aphasia in its chronic phase and for therapeutic intervention for cognitive disorders is efficacious.

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Table 1

Characteristics of Four Participants with Aphasia

Participant	1	2	3	4
Age in Years	65.0	64.0	65.5	61.75
Gender	Female	Male	Female	Female
Years of Education	14	14	9	16
Lesion Site	Brainstem	Fronto-temporal	Fronto-temporal	Fronto-temporal
Months Post Onset	127	24	38	33
Premorbid Handedness	Right	Right	Right	Right
Premorbid Profession	Nurse	Radiology Technician	Factory Worker	Legal Secretary

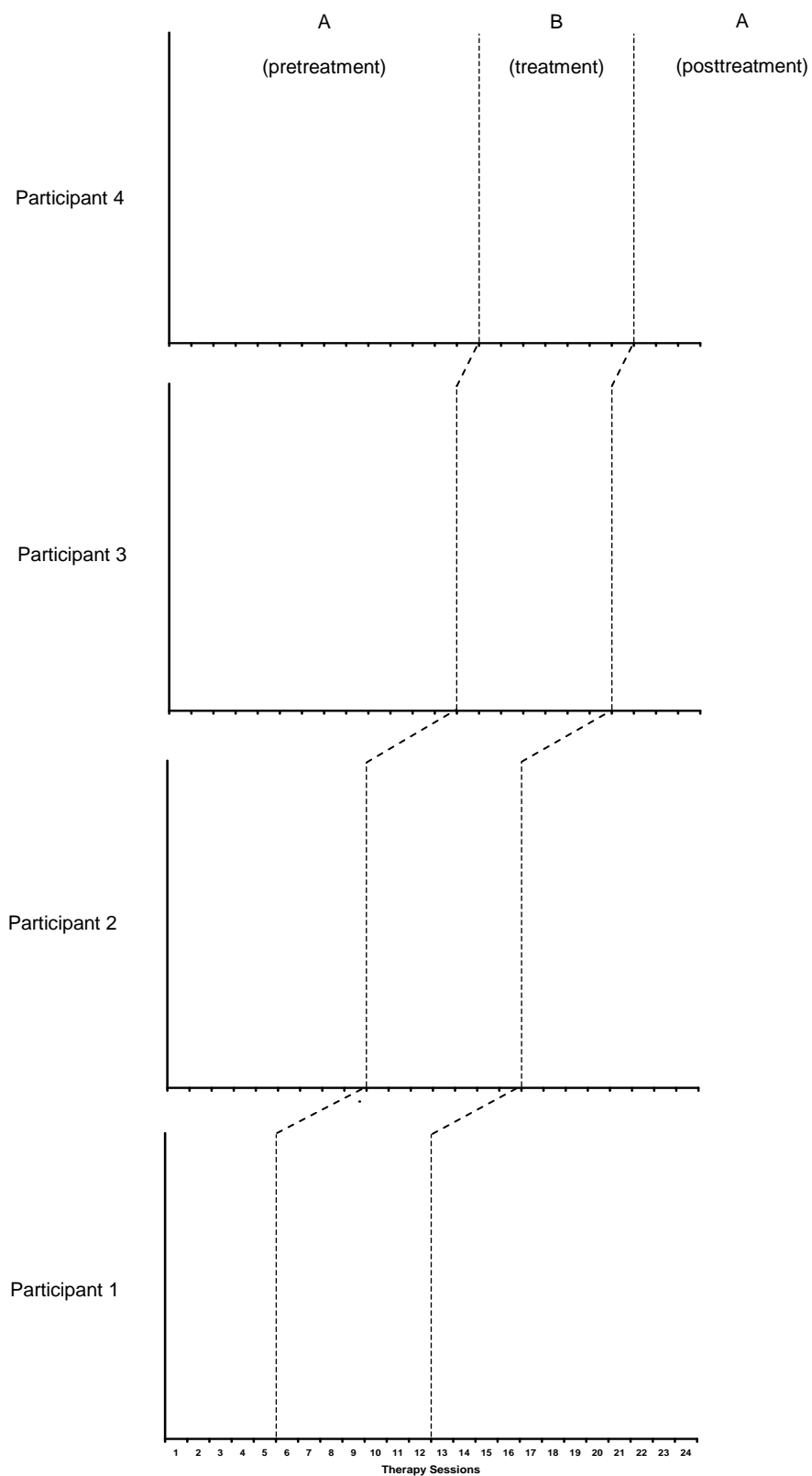
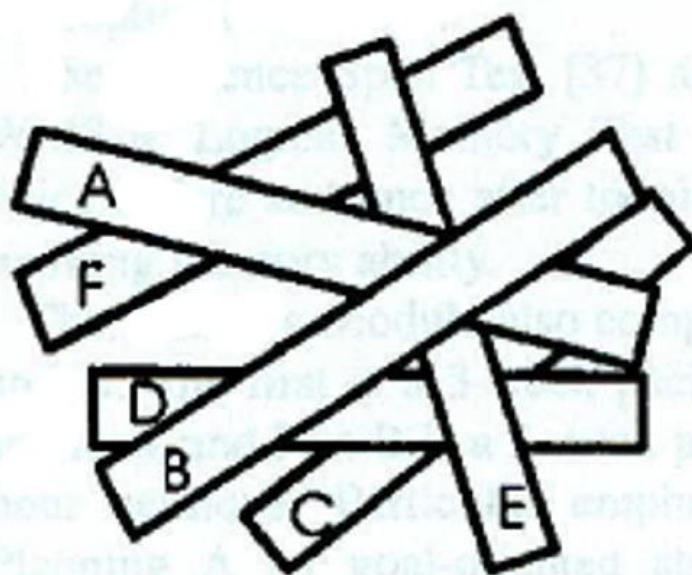


Figure 1. Illustration of the repeated measures across subjects design for the four participants showing timing of baselines (A) and flexibility training (B) phases.



6	54	62	7	40	98	53	16	49	47	88	92	23	89
11	27	1	21	7	76	40	22	12	35	98	99	96	17
83	18	29	65	37	68	83	37	67	31	24	42	26	23
47	73	9	38	69	41	96	97	4	25	43	38	98	96

Figure 2. Two examples of activities used in cognitive flexibility training, the top requiring identification of sequence of how items would be removed from the top down and the bottom requiring the crossing out of odd or even numbers (Delahunty & Morice, 1996).

Table 2

Pretest and Posttest Standard Scores of the Aphasia Diagnostic Profiles

Classification Profile	Participant							
	1		2		3		4	
	Fluent		Fluent		Nonfluent		Fluent Anomic	
	Borderline		Conduction		Mixed			
	pre	post	pre	post	pre	post	pre	post
Aphasia Severity	105	112	110	116	90	86	113	123
Lexical Retrieval	10	11	13	12	7	7	12	16
Auditory Comprehension	13	15	12	15	8	7	14	14
Repetition	8	9	9	10	7	7	10	9
Alternative Communication	116	116	126	126	88	90	118	126

Table 3

Pretest and Posttest Raw Scores of the Boston Naming Test for Each of the Four Participants

	Participant							
	1		2		3		4	
	pre	post	pre	post	pre	post	pre	post
Spontaneous Correct	26	38	47	52	5	3	49	54
Cued Correct	5	1	2	1	2	1	2	0
Total Correct	31	39	49	53	7	4	51	54
Errors by Type								
Phonological Paraphasias	0	0	5	4	14	10	5	3
Verbal Paraphasias	9	6	5	2	6	4	3	3
Neologisms	0	0	0	0	8	9	0	0
Multi-word responses	17	10	1	1	5	18	1	2
Perseverations	3	3	0	0	20	15	0	0

Table 4

Number of Main Ideas and Percent of Potential Main Ideas Expressed by Non-Aphasic Conversation Partners During the Four Lucy Tasks

	Participant							
	1		2		3		4	
	pre	post	pre	post	pre	post	pre	post
Raw Score	84	85	85	87	37	35	97	98
Percentile	72	77	77	81	7	6	98	99
Stanine	6	6	6	7	2	2	9	9

Table 5

Pretest and Posttest Results of the Wisconsin Card Sorting Test for Each of the Four Participants

	Participant							
	1		2		3		4	
	pre	post	pre	post	pre	post	pre	post
Completed Trials	128	128	128	128	128	128	84	74
Total Correct	85	76	65	79	42	71	67	63
Percent Errors	34	41	49	38	67	45	20	15
Perseverative Responses	33	50	58	55	97	50	11	11
% Perseverative Responses	26	39	45	43	76	39	13	15
Perseverative Errors	24	37	45	39	77	40	9	8
% Perceverative Errors	19	29	35	30	60	31	11	11
Conceptual Responses	57	56	46	57	16	46	66	60
% Conceptual Responses	45	44	36	45	13	36	79	81
Categories Completed	2	4	4	3	1	0	6	6
Trials to 1st Category	11	11	11	51	14	-	11	10
Failure to Maintain Set	5	1	0	2	0	5	1	0
Learning to Learn	-15.7	-12.4	-15.3	+7.0	-	-	-1.5	-1.8

Table 6

Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 1 Talled During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	CB	TAR	UAR	SAR
1	-	-	-	-
2	125	82	45	37
3	133	69	33	36
4	126	53	26	27
5*	90	44	25	19
6*	22	15	8	7
7*	90	44	30	14
8*	100	59	40	19
9*	83	52	35	17
10*	52	36	22	14
11*	30	20	11	9
12*	49	37	28	9
13	-	-	-	-
14	172	111	73	38
15	200	148	95	53
16	168	61	42	19
17	162	120	65	56
18	123	80	50	30
19	152	113	78	35
20	127	82	54	28
21	138	104	55	49
22	-	-	-	-
23	-	-	-	-
24	-	-	-	-

Table 7

Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 1 during Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	PAR	PUAR	PSAR
1	-	-	-
2	65	55	45
3	52	48	52
4	42	49	51
5*	49	57	43
6*	68	53	47
7*	49	68	32
8*	59	68	32
9*	63	67	33
10*	69	61	39
11*	67	55	45
12*	76	76	24
13	-	-	-
14	65	66	34
15	74	64	36
16	36	69	31
17	74	54	47
18	65	63	38
19	74	69	31
20	65	66	34
21	75	53	47
22	-	-	-
23	-	-	-
24	-	-	-

Table 8

Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 2 Talled During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	CB	TAR	UAR	SAR
1	80	52	24	28
2	94	57	29	28
3	86	44	22	22
4	-	-	-	-
5	69	33	17	16
6	125	74	48	26
7	-	-	-	-
8	-	-	-	-
9*	-	-	-	-
10*	50	31	18	13
11*	42	25	13	12
12*	-	-	-	-
13*	34	21	13	8
14*	89	46	23	23
15*	55	38	17	21
16*	35	28	17	11
17	-	-	-	-
18	-	-	-	-
19	25	17	11	6
20	29	28	17	11
21	37	27	17	10
22	97	72	49	23
23	115	80	45	35
24	-	-	-	-

Table. 9

Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 2 During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	PAR	PUAR	PSAR
1	65	46	54
2	61	51	49
3	51	50	50
4	-	-	-
5	48	52	48
6	59	65	35
7	-	-	-
8	-	-	-
9*	-	-	-
10*	62	58	42
11*	60	52	48
12*	-	-	-
13*	62	62	38
14*	52	50	50
15*	69	45	55
16*	80	61	39
17	-	-	-
18	-	-	-
19	68	65	35
20	96	61	39
21	73	63	37
22	74	68	31
23	70	56	44
24	-	-	-

Table 10

Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 3 Talled During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	CB	TAR	UAR	SAR
1	255	100	74	26
2	-	-	-	-
3	207	44	29	15
4	196	34	28	6
5	254	55	45	10
6	203	70	50	20
7	234	62	49	13
8	205	58	45	13
9	213	55	37	18
10	145	50	33	17
11	197	56	44	12
12	181	48	39	9
13*	74	25	19	6
14*	48	18	15	3
15*	27	12	7	5
16*	46	23	17	6
17*	69	33	23	10
18*	132	73	55	18
19*	51	21	14	7
20*	91	47	39	8
21	54	28	20	8
22	186	89	71	18
23	129	59	47	12
24	119	119	54	19

Table 11

Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 3 During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	PAR	PUAR	PSAR
1	39	74	26
2	-	-	-
3	21	66	34
4	17	82	14
5	22	82	18
6	34	71	29
7	26	79	21
8	28	76	24
9	26	67	33
10	34	66	34
11	28	79	21
12	27	81	18
13*	34	76	24
14*	38	83	17
15*	44	58	42
16*	50	74	26
17*	48	70	30
18*	55	75	25
19*	41	67	33
20*	52	83	17
21	52	71	29
22	48	80	21
23	46	80	20
24	61	74	26

Table 12

Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 4 Tallied During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	CB	TAR	UAR	SAR
1	204	125	67	58
2	23	11	7	4
3	132	69	36	33
4	143	53	29	24
5	103	43	20	23
6	-	-	-	-
7	74	24	9	15
8	45	31	17	14
9	47	23	12	11
10	-	-	-	-
11	56	33	18	15
12	-	-	-	-
13	90	42	19	23
14*	34	14	8	6
15*	20	11	7	4
16*	22	11	6	5
17*	12	8	4	4
18*	30	22	13	9
19*	33	26	13	13
20*	30	21	14	7
21*	24	20	8	12
22	108	56	36	20
23	113	61	41	20
24	66	32	15	17

Table 13

Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 4 During Each Therapy Session with Flexibility Training Sessions Marked with an Asterisk ()*

Session	PAR	PUAR	PSAR
1	61	53	46
2	47	64	36
3	50	52	48
4	37	55	45
5*	42	47	53
6*	-	-	-
7*	32	37	63
8*	67	55	45
9*	49	52	48
10*	-	-	-
11*	59	45	45
12*	-	-	-
13	47	45	55
14	41	57	43
15	55	64	36
16	50	55	45
17	67	50	50
18	73	59	41
19	79	50	50
20	70	67	33
21	83	40	60
22	52	64	36
23	54	67	33
24	48	47	53

Table 14

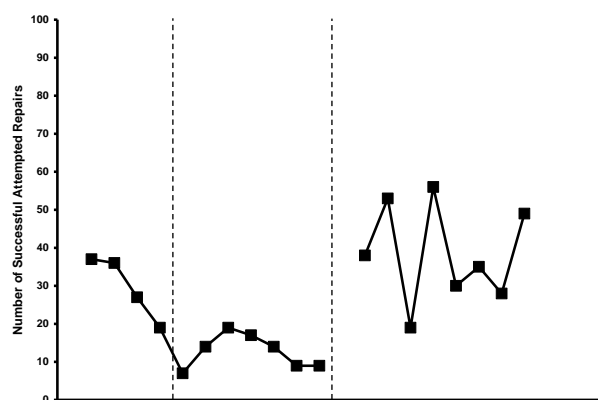
Tally of the Number of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempts (UAR), and Successful Attempted Repairs (SAR) for Aphasic Participants During Lucy Tasks 1 and 2

Lucy Task	Participant			
	1	2	3	4
1				
CB	33	65	143	57
TAR	16	32	40	53
UAR	11	20	34	31
SAR	5	12	6	22
2				
CB	220	138	229	141
TAR	168	75	93	100
UAR	119	43	81	45
SAR	49	32	12	55

Table 15

Tally of the Number of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempts (UAR), and Successful Attempted Repairs (SAR) for Aphasic Participants During Lucy Tasks 3 and 4

Lucy Task	Participant			
	1	2	3	4
3				
CB	264	97	265	114
TAR	196	64	119	95
UAR	129	35	103	46
SAR	67	29	16	49
4				
CB	285	115	195	128
TAR	274	80	109	89
UAR	198	50	100	48
SAR	76	30	9	41



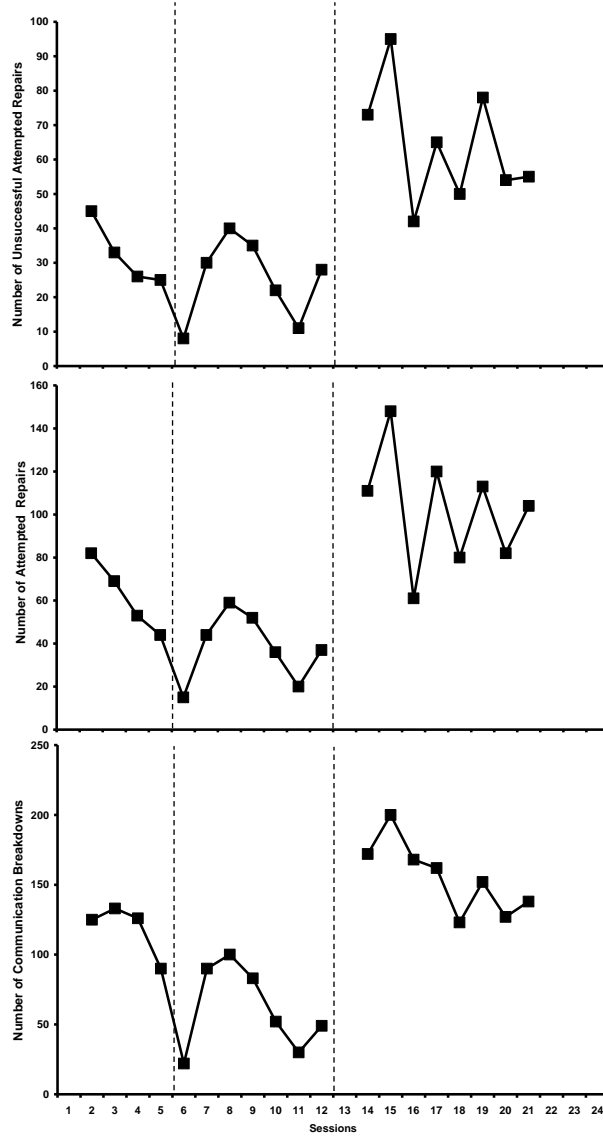


Figure 3. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 1 Talled During Each Therapy Session.

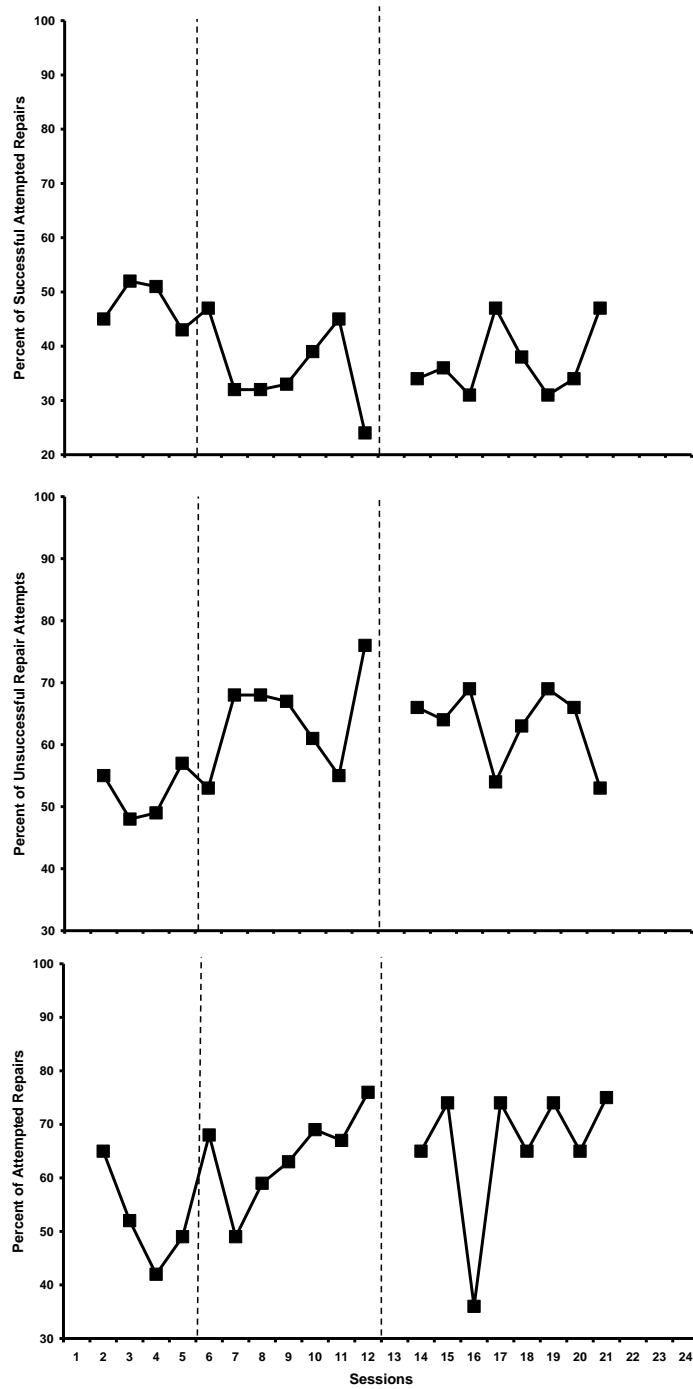
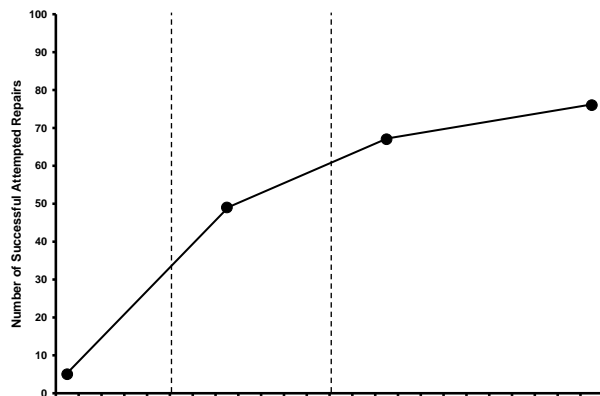


Figure 4. Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 1 During Each Therapy Session.



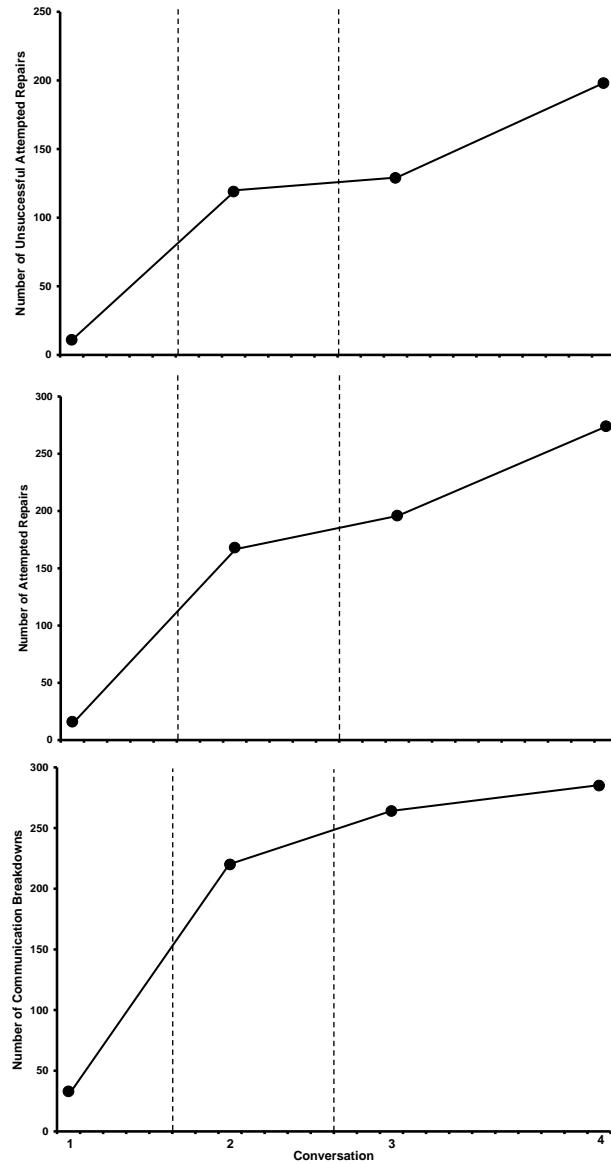


Figure 5. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 1 Talled During the Four *Lucy* Tasks.

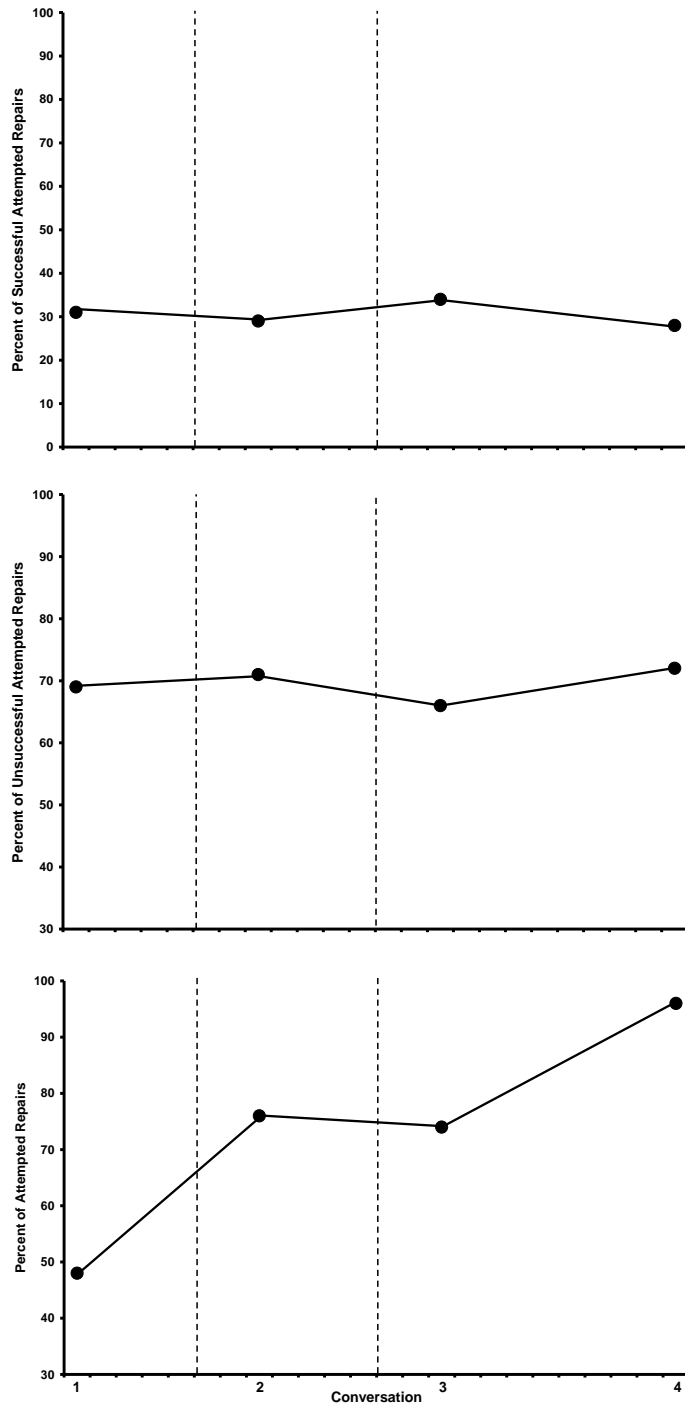
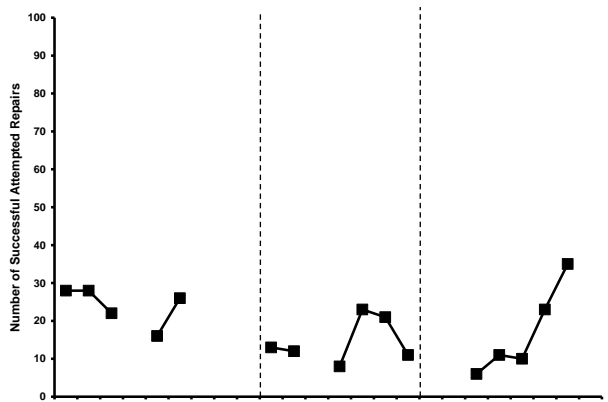


Figure 6. Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 1 During Each of the Four *Lucy* Tasks.



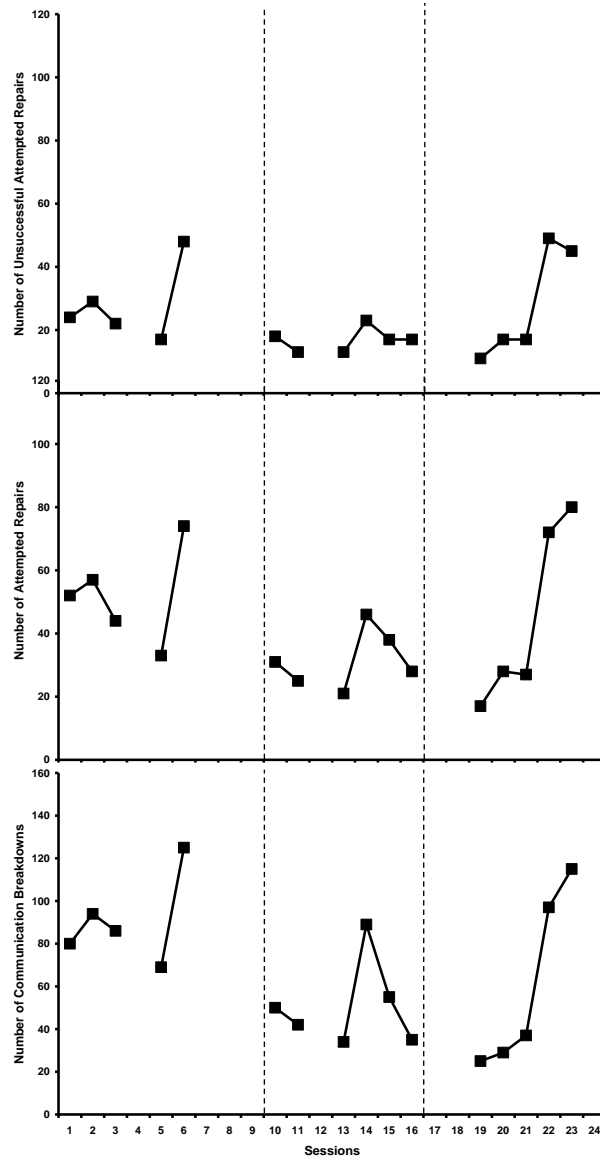


Figure 7. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 2 Tallied During Each Therapy Session.

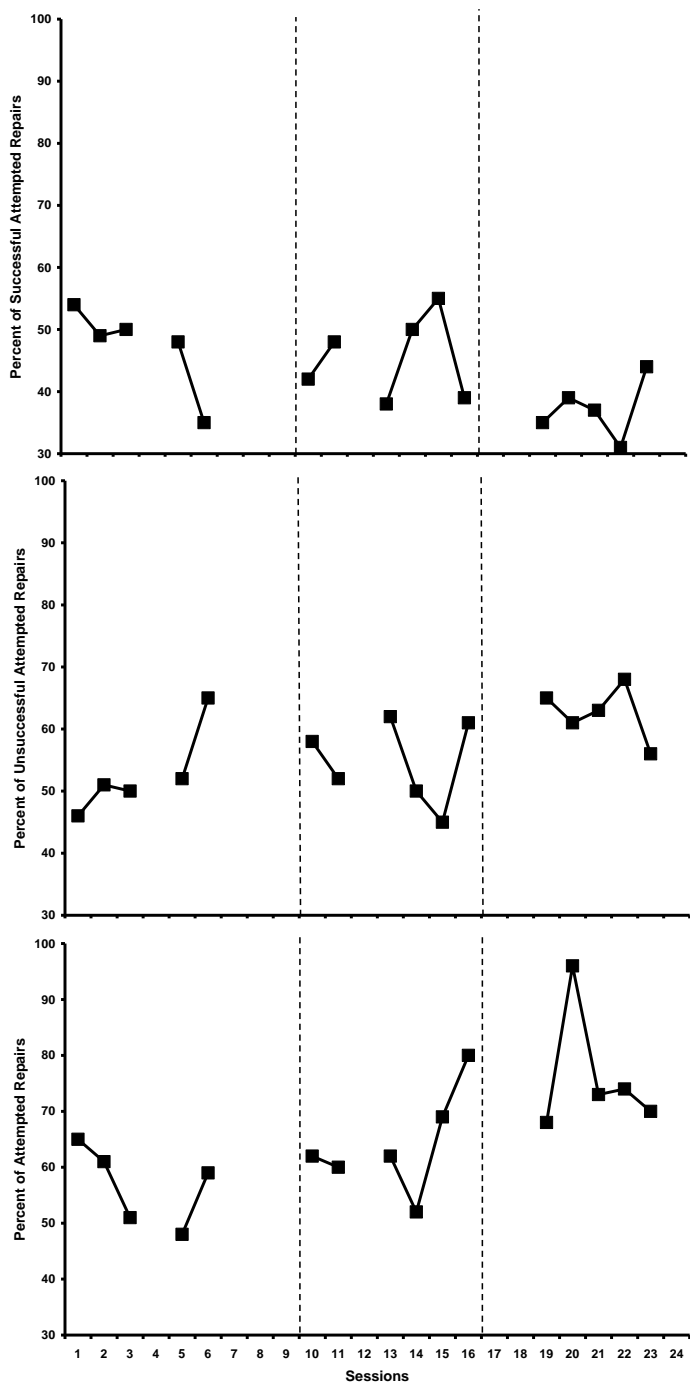
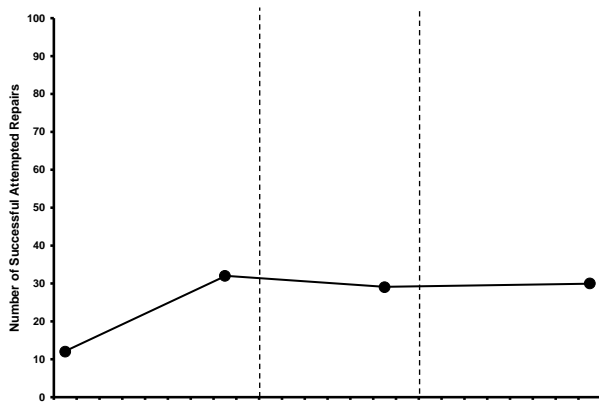


Figure 8. Percent of (PAR), Unsuccessful (PUAR) and Repairs (PSAR) for Each Therapy

Attempted Repairs
 Attempted Repairs
 Successful Attempted
 Participant 2 During
 Session.



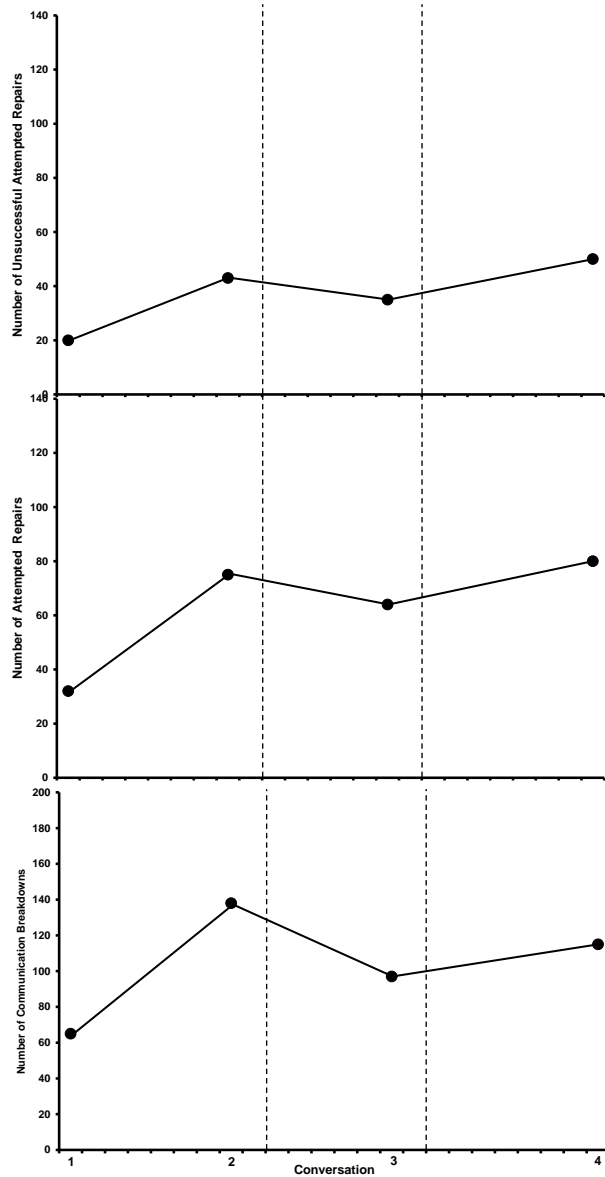


Figure 9. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 2 Tallied During the Four *Lucy* Tasks.

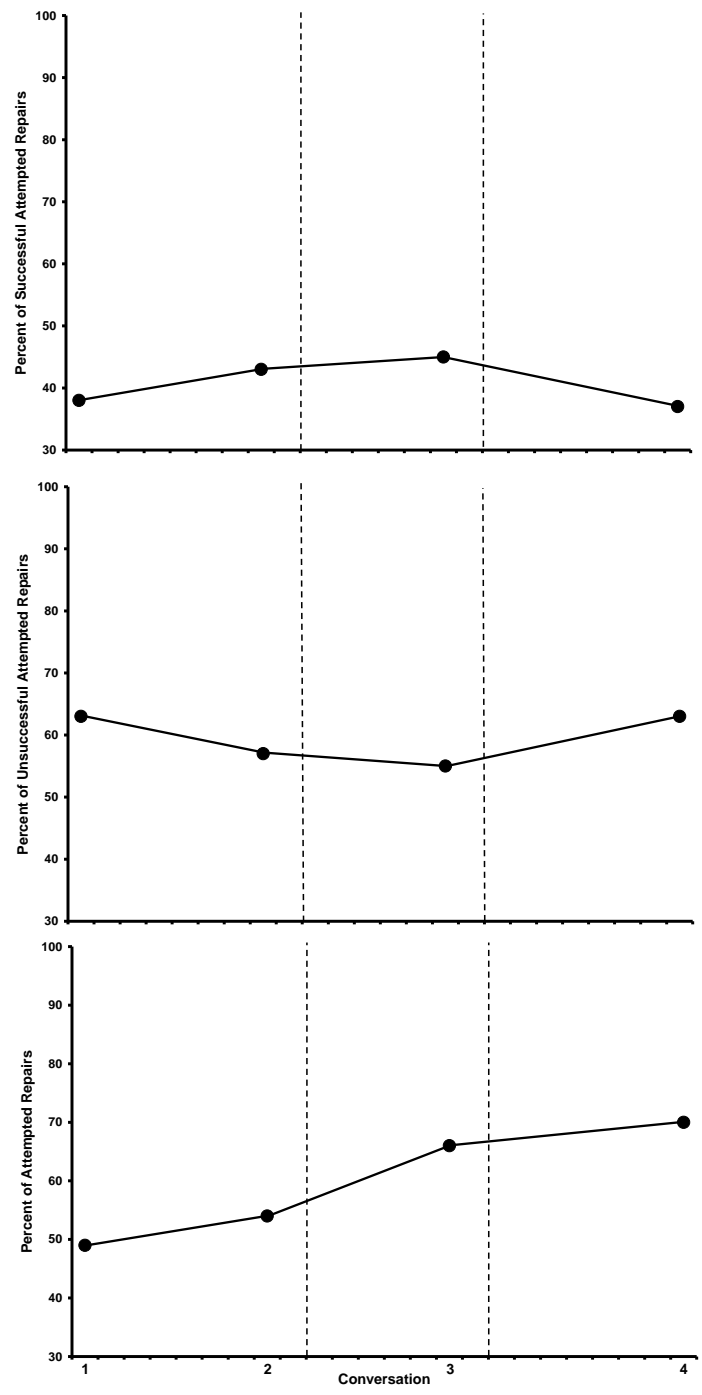
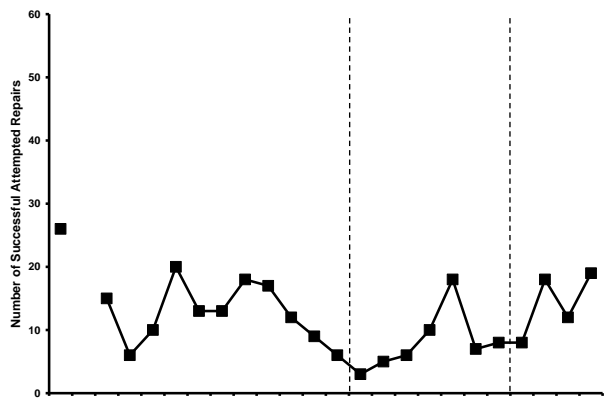


Figure 10. Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 2 During Each of the

Four Lucy Tasks.



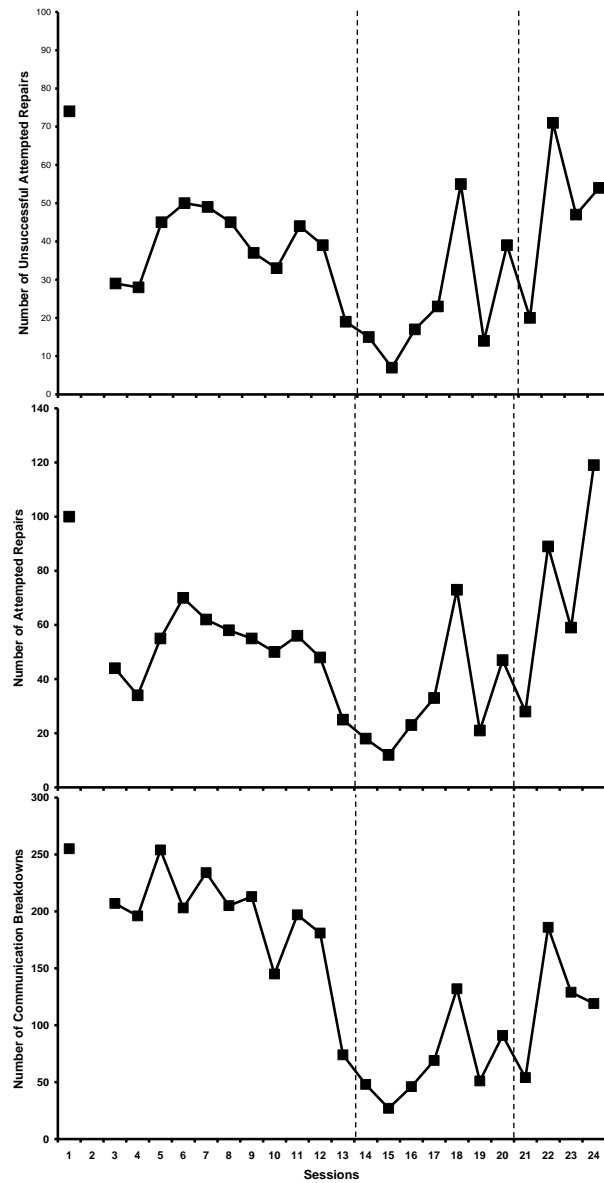


Figure 11. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 3 Tallied During Each Therapy Session.

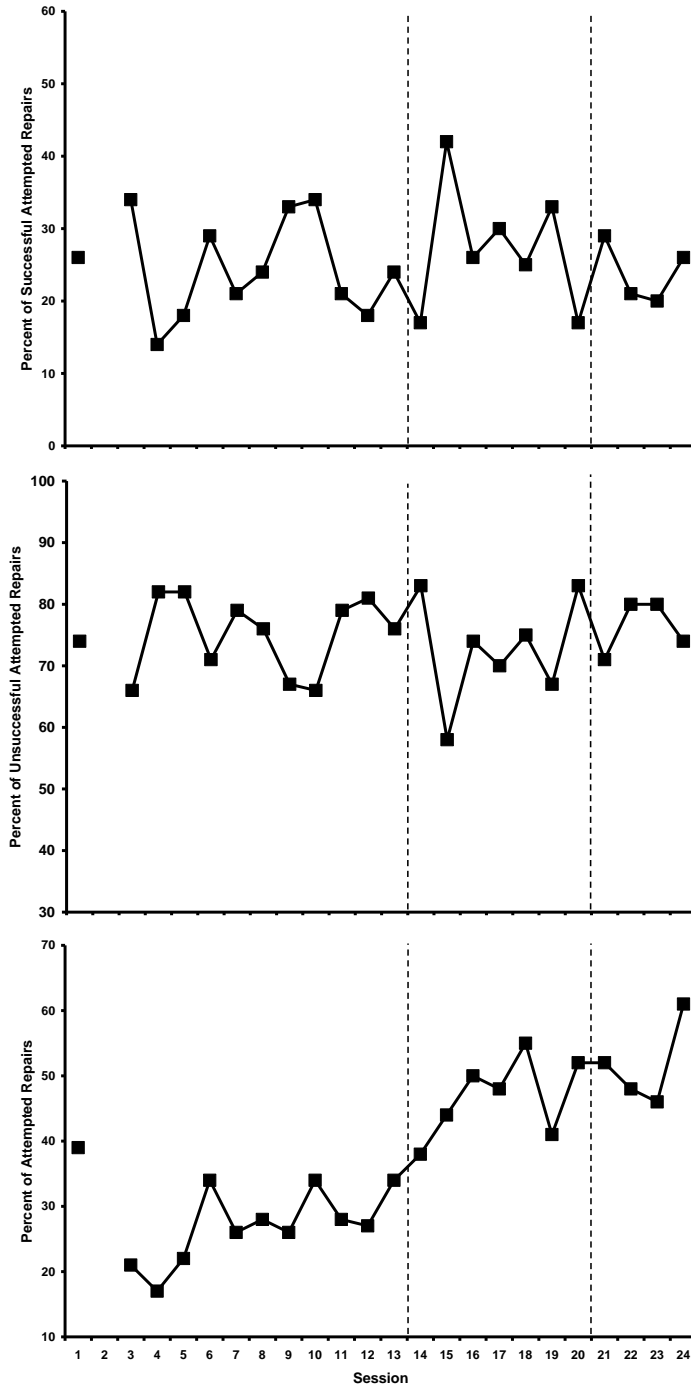
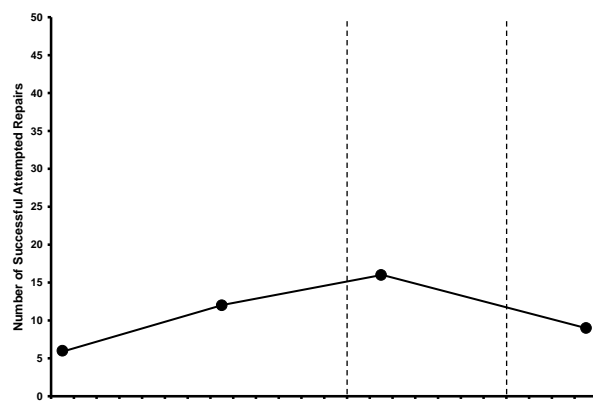


Figure 12. Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 3 During Each Therapy Session.



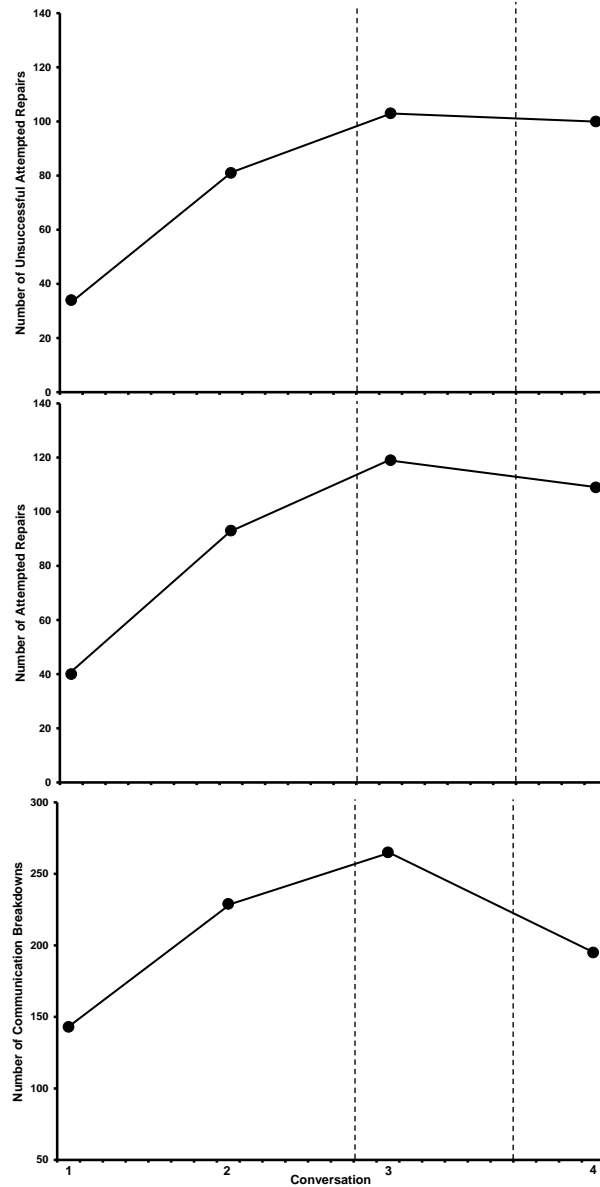


Figure 13. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 3 Tallied During the Four *Lucy* Tasks.

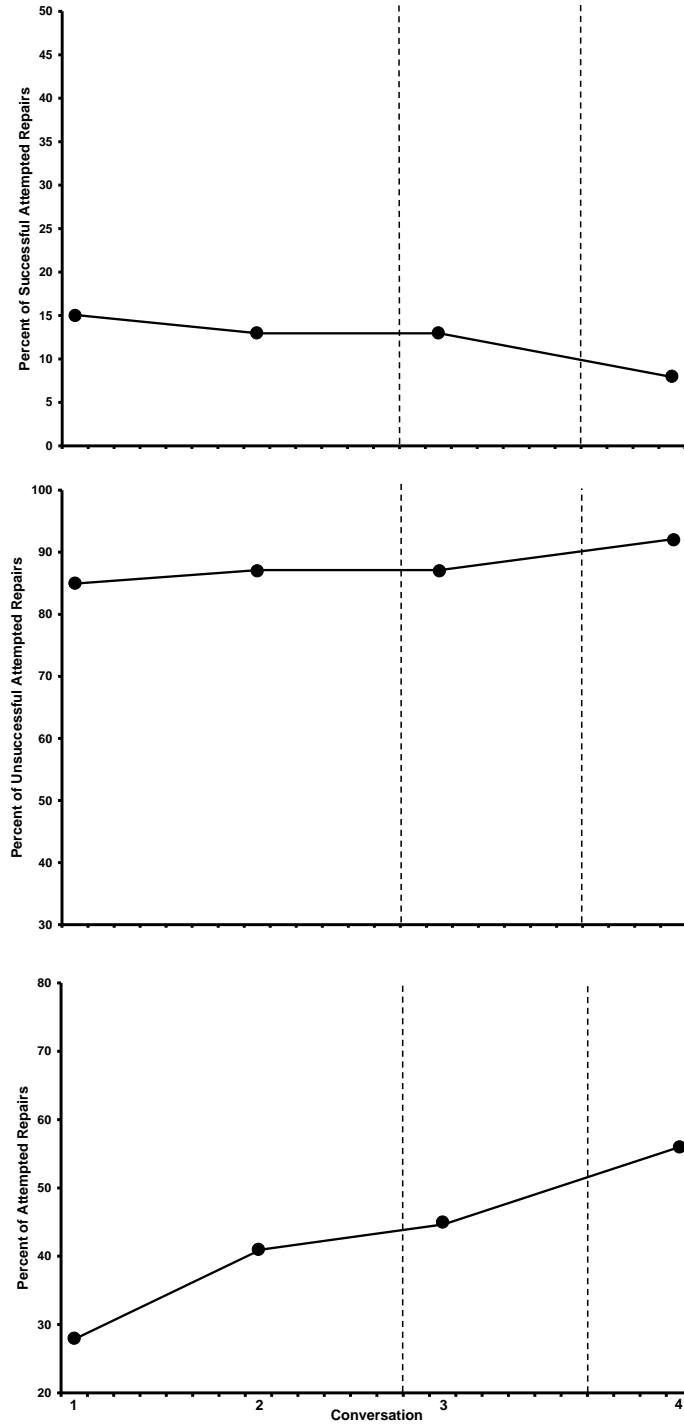
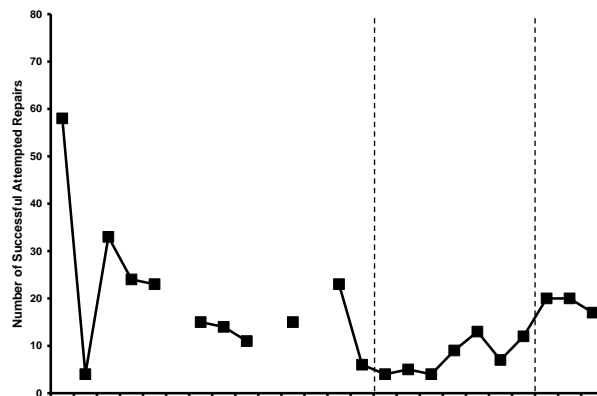


Figure 14. Percent of (PAR), Unsuccessful (PUAR) and Repairs (PSAR) for Each of the Four *Lucy*

Attempted Repairs
 Attempted Repairs
 Successful Attempted
 Participant 3 During
 Tasks.



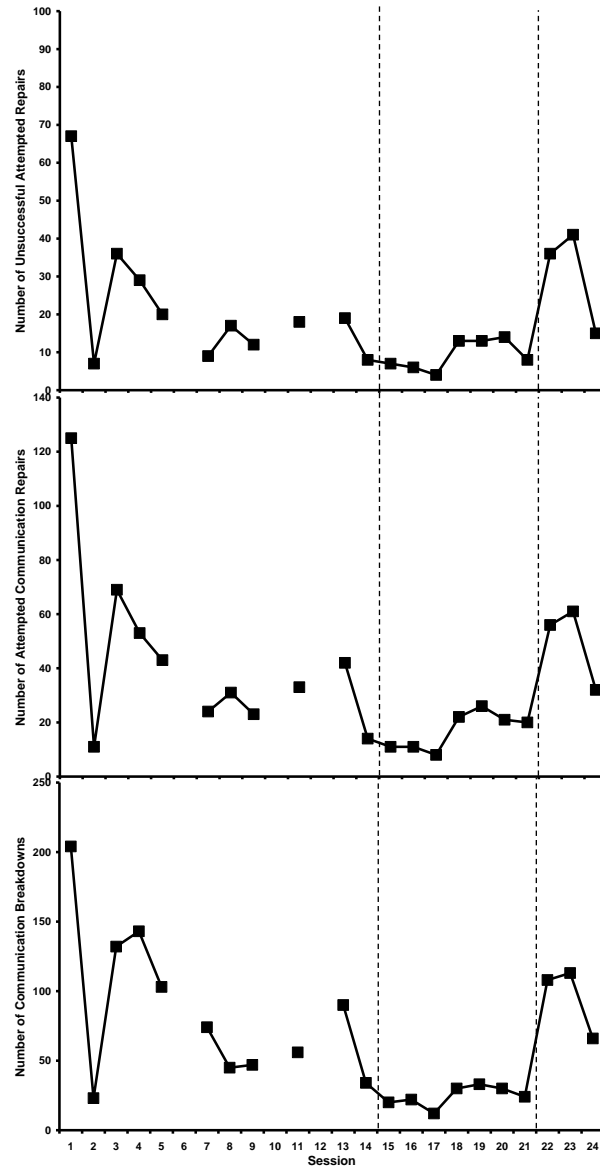


Figure 15. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 4 Talled During Each Therapy Session.

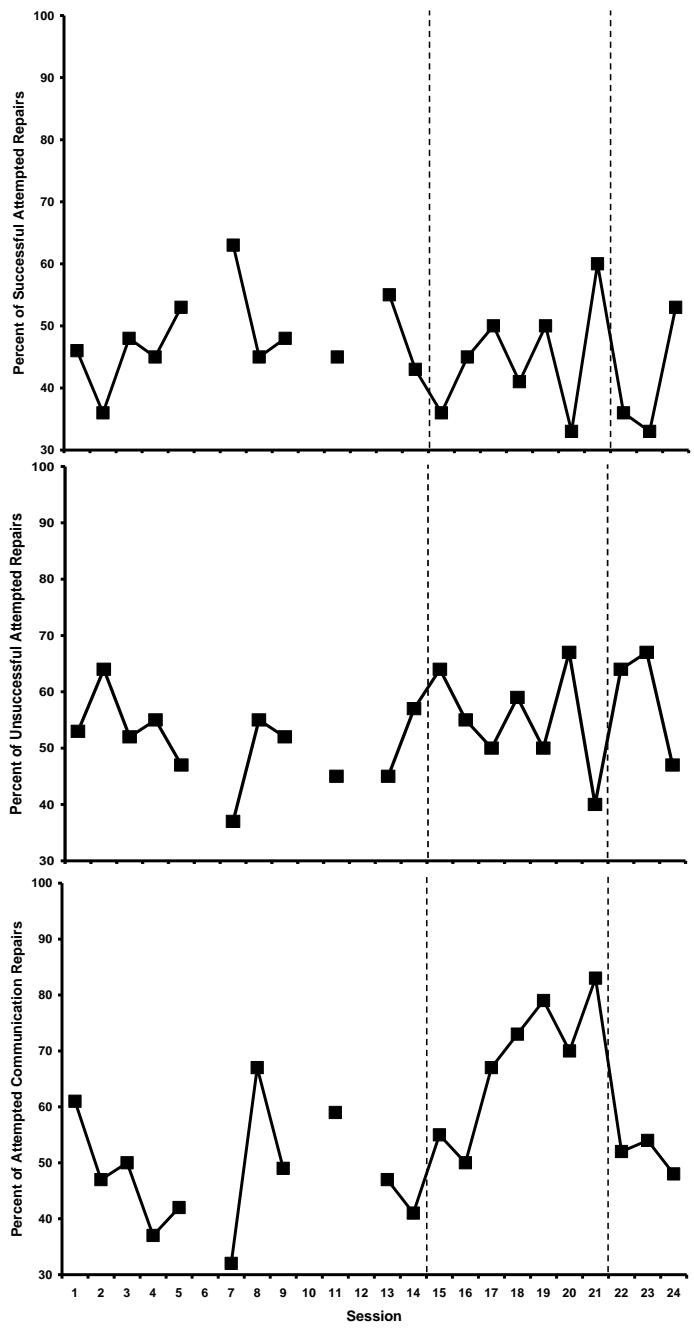
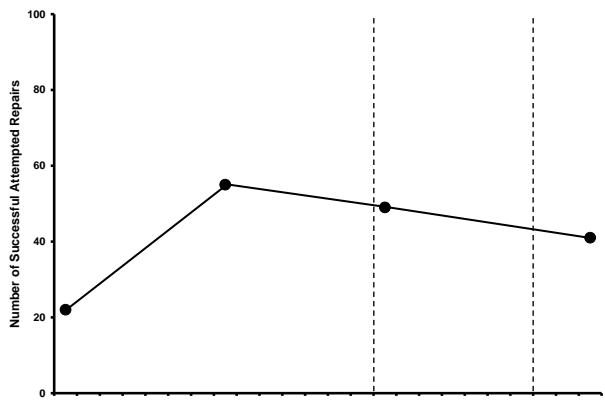


Figure 16. Percent of Successful Attempted Repairs (PAR), Percent of Unsuccessful Attempted Repairs (PUAR) and Percent of Attempted Communication Repairs (PSAR) for Each Therapy

of Attempted Repairs Unsuccessful Attempted Successful Attempted Participant 4 During Session.



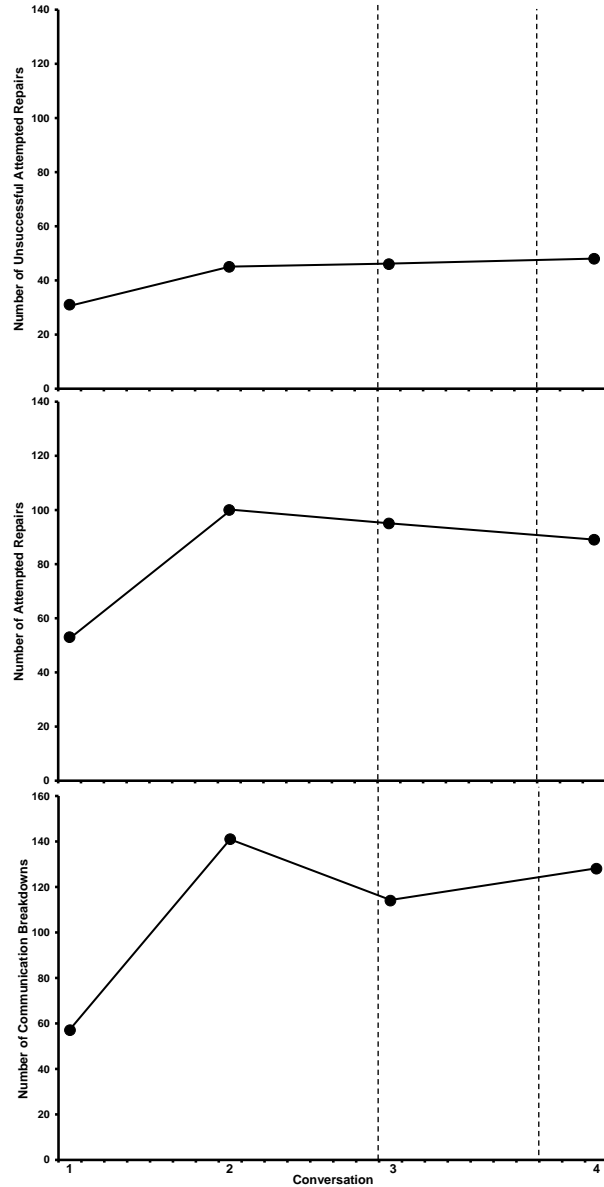


Figure 17. Tally of Communication Breakdowns (CB), Total Attempted Repairs (TAR), Unsuccessful Attempted Repairs (UAR) and Successful Attempted Repairs (SAR) for Participant 4 Tallied During the Four *Lucy* Tasks.

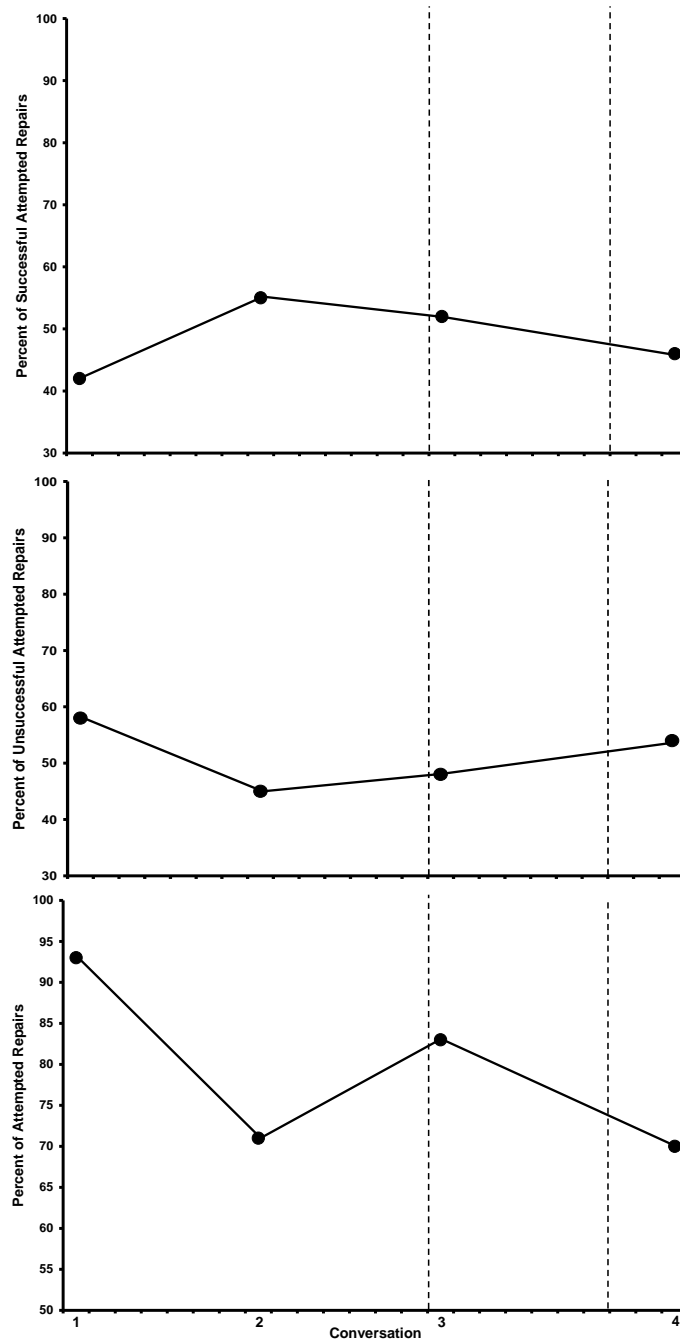
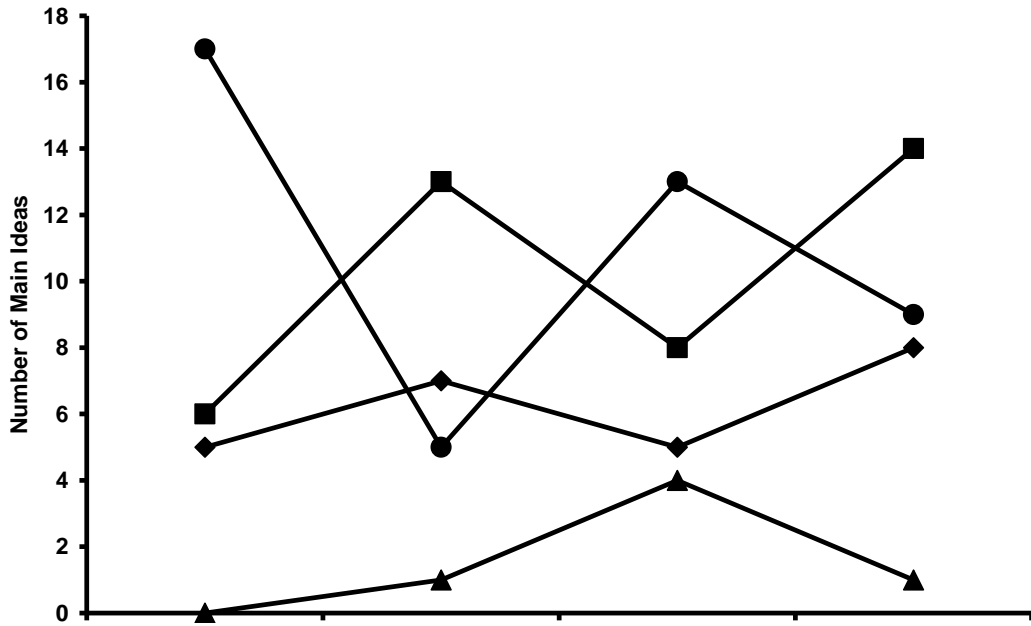


Figure 18. Percent of Attempted Repairs (PAR), Unsuccessful Attempted Repairs (PUAR) and Successful Attempted Repairs (PSAR) for Participant 4 During Each of the Four *Lucy* Tasks.

Table 16

Number of Main Ideas Tallied and Percentage of Potential Main Ideas in the Transactional Success Tasks for All Subjects During the Four Lucy Tasks

Conversations	Participant			
	1	2	3	4
1				
Number of Ideas	5	6	0	17
Percent of Ideas	56	100	0	94
2				
Number of Ideas	7	13	1	5
Percent of Ideas	39	54	11	83
3				
Number of Ideas	5	8	4	13
Percent of Ideas	83	89	22	54
4				
Number of Ideas	8	14	1	9
Percent of Ideas	34	78	17	100



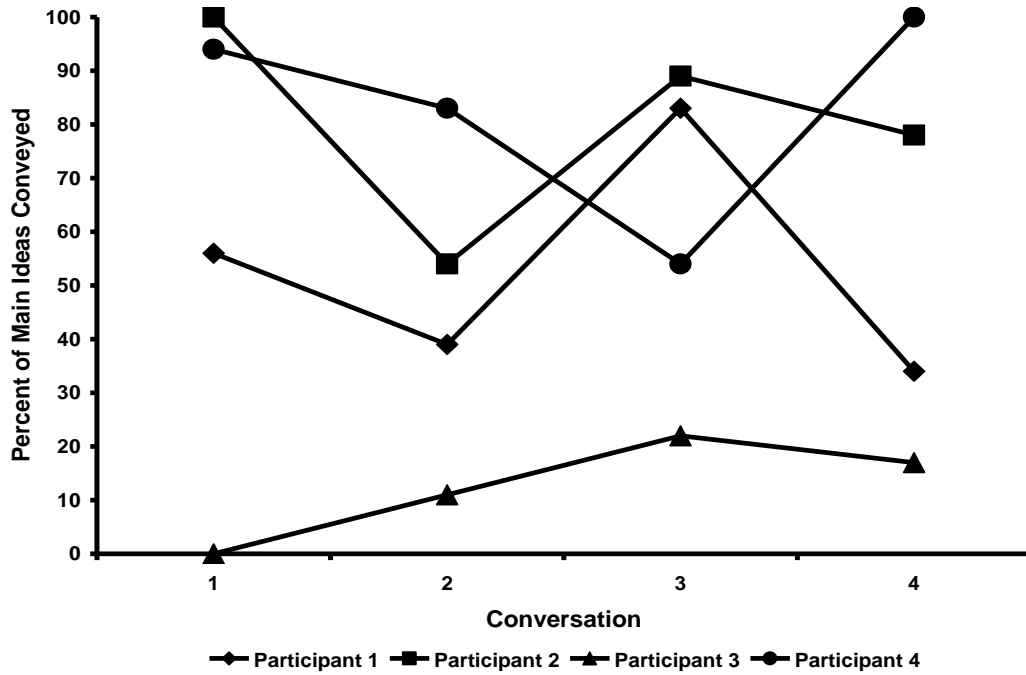


Figure 19. Number of Main Ideas Tallied and Percentage of Potential Main Ideas in the Transactional Success Tasks for All Subjects During the Four *Lucy* Tasks.

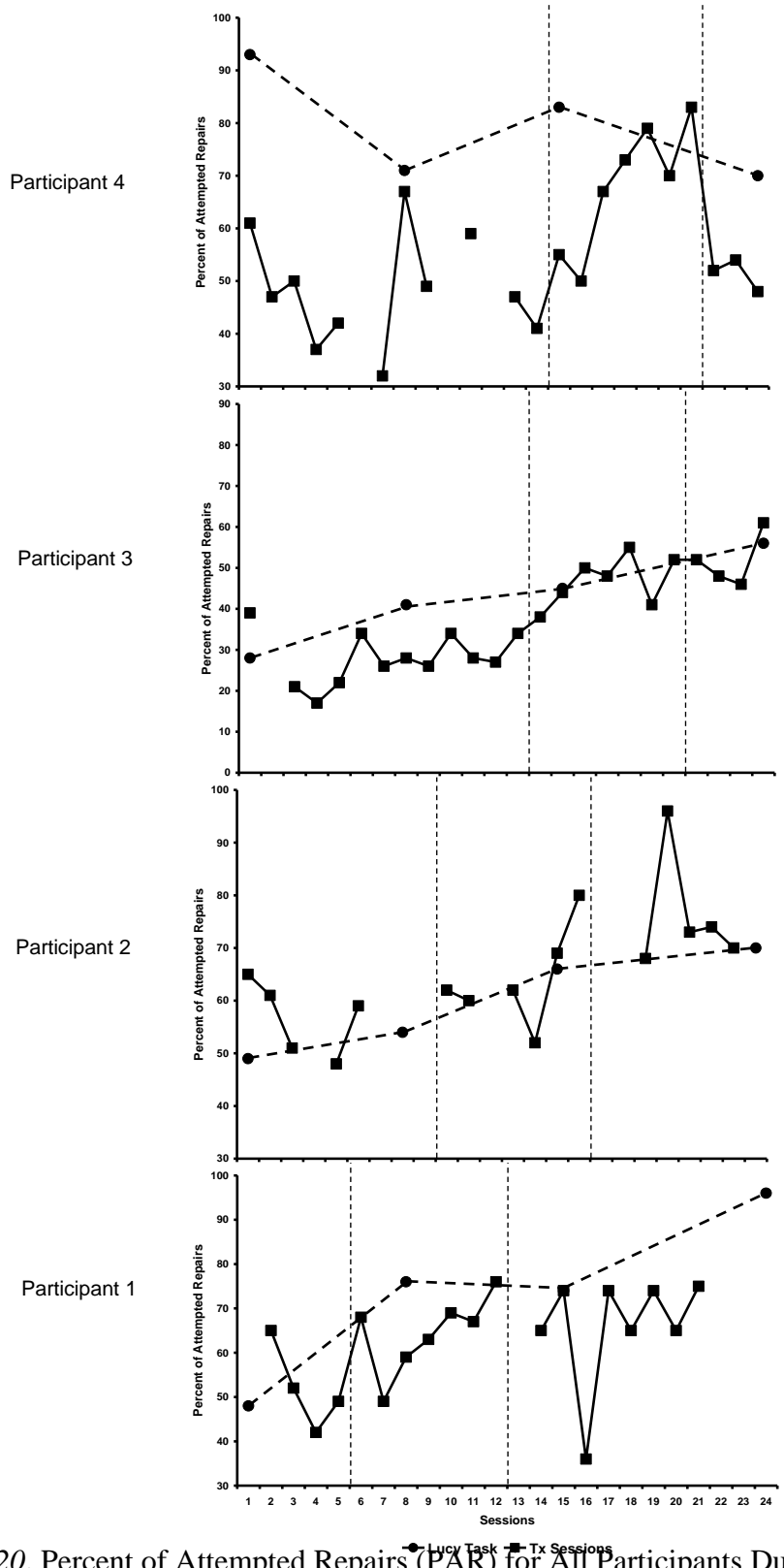


Figure 20. Percent of Attempted Repairs (PAR) for All Participants During Each Therapy Session and the Lucy task.