INTRODUCTION

Stroke is one of the most prevalent, debilitating and costly chronic diseases in the United States (ASA, 2003). A common consequence of stroke is aphasia, a disorder that often results in increased dependence and decreased quality of life. The emotional and financial burden of aphasia on individuals, their caregivers, and society provides the impetus for studying the impact aphasia rehabilitation on communication ability.

ASHA's adoption of the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF) model (WHO, 2001) has expanded the focus of aphasia rehabilitation beyond level of impairment to include activity (execution of a discrete task or action) and participation (completion tasks required to fulfill life roles) levels of analysis. The consequence of this broadening view is a critical need for development of outcome measures that evaluate change in performance in these domains. One such measure is the Functional Outcome Questionnaire for Aphasia (FOQ-A), which assesses the impact of aphasia treatment on functional communication (Glueckauf, Blonder, Ecklund-Johnson, Maher, Crosson, & Gonzalez Rothi, 2003). The purpose of this study is to evaluate the measurement properties of the FOQ-A, in a sample of 127 individuals with aphasia subsequent to stroke, using Rasch analysis.

METHODS

Participants

The self-identified caregivers of 127 community-dwelling individuals with moderate to severe aphasia secondary to left hemisphere stroke participated in the study by completing the FOQ-A. Caregivers were native speakers of English who were in direct contact with the stroke patient for more than 10 hours per week over the previous six months. Individuals with aphasia were 30 males and 97 females, age 31-88 years, who were potential participants in one of four aphasia rehabilitation protocols.

Instrument

The FOQ-A is a 32-item caregiver questionnaire about the communication behaviors of individual's with aphasia. Four domains are assessed, including: 1) communication of basic needs, 2) making routine requests, 3) communicating new information, and 4) attention/other communication skills. Within each of the four domains, tasks are arranged hierarchically based on difficulty: a) makes gestures, b) makes one-word utterances, c) puts two or more words together, d) speaks in complete sentences, and e) corrects mistakes in communication. Each item is rated on five-point scale that indicates percent of time the individual with aphasia is successful in the communication behavior (1= 0%, 2= 25%, 3= 50%, 4= 75%, and 5= 100%). A "Don't Know" option is also available.

Data Collection and Analysis

The FOQ-A data was retrieved retrospectively from an IRB-approved research database. The ratings for each individual, along with gender and age, were submitted to Winsteps, a Rasch analysis computer software program (Linacre & Wright, 2000). Winsteps provided a means for assessing rating scale utilization, unidimensionality, item hierarchy, item redundancy, floor and ceiling effects, internal consistency, and person-item match.

RESULTS

Rating Scale Utilization

Rating scale utilization was assessed to ensure measure stability, measure accuracy, adequate description of the sample, and inference for the next sample (Linacre, 2002). The following criteria were imposed: 1) at least 10 observations in each category, 2) average measures advance numerically with category, 3) Outfit mean square < 2.0 (Linacre, 2002). Although the five-point FOQ-A met the criteria for rating scale effectiveness, two things were evident with regards to the data: 1) rating categories 4 and 5 had a higher observed count than rating categories 1-3 and 2) probability of responses for using a category 2 versus a category 3 rating was only slightly more probable as person ability increased. Based on these findings, rating categories 2 and 3 of the FOQ-A were collapsed. The 4-point FOQ-A met the criteria of rating scale effectiveness (See Table 1) and showed increasing probability of rating categories with increasing person ability (See Figure 1). All subsequent analyses were performed on the 4-point FOQ-A.

Unidimensionality

Unidimensionality, or measurement of a single construct, was assessed through analysis of Infit Mean Square (MnSq) residuals, standardized Z (ZStd) values, and point measure correlation. Analysis of individual item fit revealed that of the 32 items only one (item 23) fell slightly outside the acceptable values for Infit MnSq (0.6- 1.4) and ZStd (< 2.0) (Wright & Linacre, 1994). Additionally, the point measure correlation for the items (range= .39 to .85) indicated that the items were highly correlated with one another. See Table 2. Together, these results suggest that overall the FOQ-A is unidimensional.

Item Hierarchy

Item hierarchy was assessed by comparing the hypothesized item hierarchy to the item measure order. Based on the data, it is evident that several discrepancies in the hierarchy exist. Specifically, some of the items hypothesized to be more difficult were found at the bottom of the order, indicating they were easier. See Table 3.

Item Redundancy

Item redundancy was determined by model SE in the item measure order (See Table 3) and examining the item map (See Figure 2). Based on the results, it appears that at least nine items (28%) were redundant in their level of difficulty.

Floor and Ceiling Effects

Results indicate that 25% of this sample of individuals with aphasia were not measured because they received a rating of 4 (successful 100% of time) on all 32 questions (See Figure 2). The FOQ-A did not demonstrate a floor effect.

Internal Consistency

Internal consistency was determined by examining separation index and reliability for persons and items. See Tables 4 and 5. The person separation index for the FOQ-A is 4.75, indicating that it categorizes individuals into 6 distinct strata (or levels of ability) with centers three measurement errors apart. Person reliability index, analogous to Cronbach's alpha, was .96. The item separation index for the FOQ-A is 7.76, which allows for categorization into 10

distinct strata. Item reliability index was .98. Thus, the FOQ-A demonstrates good internal consistency.

Person-Item Match

Person-item match was determined by comparing mean measure and standard deviation (SD) of persons and items. See Tables 4 and 5. The mean measure for the FOQ-A is .77, which is higher than the mean of items (anchored at 0). This indicates that individuals in the sample were slightly more able than the scale. When taking into account the SD, overlap in the spread suggests that persons and items are relatively well matched on the FOQ-A.

DISCUSSION

The negative social, emotional, and financial consequences of aphasia endorse the notion that rehabilitation efforts should have an influence beyond the impairment level. The FOQ-A was born out the need for a measure of participation. The purpose of this study is to evaluate the measurement properties of the FOQ-A, in a sample of 127 individuals with aphasia subsequent to stroke, using Rasch analysis.

Results indicate the FOQ-A has good measurement properties. It is unidimensional and appears appropriate for measuring the communicative ability of individuals with moderate to severe aphasia. Furthermore, the scale has good internal consistency, as indicated by the person and item separation and reliability indices. High person separation is critical for measuring change after rehabilitation, and the FOQ-A demonstrates the ability to categorize persons into 6 distinct levels of ability, allowing for meaningful interpretation of change in performance. While the scale has good measurement properties, further development of the scale, including attention to item hierarchy and item redundancy could improve its usefulness to clinicians and researchers.

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APPENDIX

Table 1. Rating Scale Utilization Summary for FOQ-A

```
+------------------------------------------------
|CATEGORY    OBSERVED|OBSVD SAMPLE|INFIT OUTFIT|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ|
|------------------+-----------+-----------+
|  1   1     540  14| -1.71 -1.49|  .71   .76|
|  2   2     950  25|  -.21  -.33| 1.01  1.01|
|  3   3     882  23|  1.02   .85|  .89  1.17|
|  4   4    1354  36|  2.30  2.40| 1.26  1.26|
|------------------+-----------+-----------+
```

Figure 1. Graph showing probability of response based on person ability for the FOQ-A

```
P       ++---------+---------+---------+---------+---------+---------++
R   1.0 +                                                            +
O       |                                                            |
B       |                                                            |
A       |                                                       444|
B   .8 +111                                                444    +
I       |    111                                             44     |
L       |       11                                         44       |
I       |         11                                      44        |
T   .6 +           11                                   44         +
Y       |           11         2222                   44           |
    .5 +          1   2222     22222          44              +
O       |             2**              22          4              |
F   .4 +           222   11              2*3333333**33              +
        |            22         11         333 22   44     333       |
R       |       222          1       33       224      333          |
E       |      22               11 333      4422         333         |
S   .2 +2222                  3*11       44    22          333      +
P       |                  333   11   44         222        3333|
O       |              3333        4***1            222              |
N       |         33333333      44444     111111      2222222        |
S   .0 +********444444444444444         1111111111111111******+
E       ++---------+---------+---------+---------+---------+---------++
        -3        -2        -1         0         1         2         3
           PERSON [MINUS] ITEM MEASURE
```

Table 2. Fit Statistics for FOQ-A

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	ITEM
23	401	119	-1.16	.15	1.44	2.8	2.78	4.7	A .43	pac-attn
26	396	116	-1.25	.15	1.23	1.5	2.46	3.8	B .47	pac-recog-cues-conv
32	323	111	-.13	.14	1.39	2.7	1.80	3.6	C .54	pac-corr-follow-directions
24	304	117	.49	.13	1.30	2.2	1.52	3.0	D .65	pac-taketurns
31	406	119	-1.27	.15	1.26	1.7	1.49	1.6	E .47	pac-corr-follow-simple-inst
6	368	116	-.66	.14	1.17	1.2	1.43	1.8	F .56	needs-recs-errors
27	430	118	-2.01	.18	1.40	2.1	1.18	.6	G .39	pac-attemp-y/n
13	345	115	-.25	.13	1.28	2.1	1.23	1.2	H .59	req-recs-errors
19	315	116	.26	.13	1.26	2.0	1.21	1.3	I .65	newinfo-recs-errors
4	318	116	.23	.13	1.24	1.8	1.10	.7	J .68	needs-no-gaps
28	379	119	-.72	.14	1.15	1.1	1.17	.8	K .55	pac-corr-y/n
5	271	118	1.10	.13	1.13	1.0	1.05	.4	L .75	needs-compl-sent
22	294	116	.59	.13	1.08	.7	1.12	.8	M .71	pac-opinions
8	411	117	-1.55	.16	1.05	.4	.84	-.4	N .53	req-gesture
29	324	118	.18	.13	1.02	.2	.96	-.2	O .69	pac-corr-resp-5w's
30	423	119	-1.69	.17	.99	.0	1.01	.2	P .49	pac-attmpt-resp-simple-inst
11	277	114	.80	.13	.92	-.6	.93	-.4	p .75	req-no-gaps
25	381	118	-.83	.14	.92	-.6	.89	-.4	o .62	pac-endconvrstion
2	379	118	-.77	.14	.91	-.7	.76	-1.1	n .65	needs-one-word
1	439	119	-2.19	.19	.90	-.5	.64	-.8	m .48	needs-gesture
18	225	117	1.90	.14	.83	-1.3	.90	-.6	l .82	newinfo-compl-sent
15	261	107	.76	.14	.90	-.7	.87	-.9	k .77	newinfo-one-word
3	351	118	-.26	.13	.88	-.9	.74	-1.5	j .71	needs-two+words
12	245	116	1.47	.14	.85	-1.2	.79	-1.5	i .81	req-compl-sent
21	234	114	1.59	.14	.84	-1.2	.79	-1.4	h .82	pac-story-logically
10	325	116	.09	.13	.78	-1.8	.69	-2.0	g .74	req-two+words
9	337	113	-.27	.14	.75	-2.0	.65	-2.0	f .72	req-one-word
7	293	118	.70	.13	.73	-2.3	.75	-1.8	e .78	needs-corr-errors
16	271	117	1.02	.13	.75	-2.1	.70	-2.3	d .81	newinfo-two+words
17	242	118	1.60	.14	.59	-3.6	.67	-2.5	c .85	newinfo-no-gaps
14	278	115	.89	.13	.60	-3.7	.62	-3.0	b .81	req-corr-errors
20	256	118	1.33	.13	.55	-4.1	.56	-3.6	a .84	newinfo-corr-errors

Table 3. Items from FOQ-A shown in measure order.

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	ITEM
18	225	117	1.90	.14	.83	-1.3	.90	-.6	.82	newinfo-compl-sent
17	242	118	1.60	.14	.59	-3.6	.67	-2.5	.85	newinfo-no-gaps
21	234	114	1.59	.14	.84	-1.2	.79	-1.4	.82	pac-story-logically
12	245	116	1.47	.14	.85	-1.2	.79	-1.5	.81	req-compl-sent
20	256	118	1.33	.13	.55	-4.1	.56	-3.6	.84	newinfo-corr-errors
5	271	118	1.10	.13	1.13	1.0	1.05	.4	.75	needs-compl-sent
16	271	117	1.02	.13	.75	-2.1	.70	-2.3	.81	newinfo-two+words
14	278	115	.89	.13	.60	-3.7	.62	-3.0	.81	req-corr-errors
11	277	114	.80	.13	.92	-.6	.93	-.4	.75	req-no-gaps
15	261	107	.76	.14	.90	-.7	.87	-.9	.77	newinfo-one-word
7	293	118	.70	.13	.73	-2.3	.75	-1.8	.78	needs-corr-errors
22	294	116	.59	.13	1.08	.7	1.12	.8	.71	pac-opinions
24	304	117	.49	.13	1.30	2.2	1.52	3.0	.65	pac-taketurns
19	315	116	.26	.13	1.26	2.0	1.21	1.3	.65	newinfo-recs-errors
4	318	116	.23	.13	1.24	1.8	1.10	.7	.68	needs-no-gaps
29	324	118	.18	.13	1.02	.2	.96	-.2	.69	pac-corr-resp-5w's
10	325	116	.09	.13	.78	-1.8	.69	-2.0	.74	req-two+words
32	323	111	-.13	.14	1.39	2.7	1.80	3.6	.54	pac-corr-follow-directions
13	345	115	-.25	.13	1.28	2.1	1.23	1.2	.59	req-recs-errors
3	351	118	-.26	.13	.88	-.9	.74	-1.5	.71	needs-two+words
9	337	113	-.27	.14	.75	-2.0	.65	-2.0	.72	req-one-word
6	368	116	-.66	.14	1.17	1.2	1.43	1.8	.56	needs-recs-errors
28	379	119	-.72	.14	1.15	1.1	1.17	.8	.55	pac-corr-y/n
2	379	118	-.77	.14	.91	-.7	.76	-1.1	.65	needs-one-word
25	381	118	-.83	.14	.92	-.6	.89	-.4	.62	pac-endconvrstion
23	401	119	-1.16	.15	1.44	2.8	2.78	4.7	.43	pac-attn
26	396	116	-1.25	.15	1.23	1.5	2.46	3.8	.47	pac-recog-cues-conv
31	406	119	-1.27	.15	1.26	1.7	1.49	1.6	.47	pac-corr-follow-simple-inst
8	411	117	-1.55	.16	1.05	.4	.84	-.4	.53	req-gesture
30	423	119	-1.69	.17	.99	.0	1.01	.2	.49	pac-attmpt-resp-simple-inst
27	430	118	-2.01	.18	1.40	2.1	1.18	.6	.39	pac-attemp-y/n
1	439	119	-2.19	.19	.90	-.5	.64	-.8	.48	needs-gesture
MEAN	328.2	116.4	.00	.14	1.00	-.1	1.07	-.1		
S.D.	62.1	2.5	1.11	.01	.24	1.9	.50	2.0		

Figure 2. Item map showing item redundancy and ceiling/floor effects.

```
     PERSONS MAP OF ITEMS
          <more>|<rare>
  6     XXXXXXXX  +
                  |
                  |
                  |
                  |
               X  |
  5              +
                  |
                  |
                  |
              XX  |
                  |
  4               +
                  |
             XXX T|
                  |
               X  |
               X  |
  3          XXX  +
               X  |
                  |
             XXX  |
         XXXXXXX S|
             XXX  |T
  2          XXX  +
               X  |  newinfo-compl-sent
             XXX  |  newinfo-no-gaps              pac-story-logically
           XXXXX  |  req-compl-sent
           XXXXX  |  newinfo-corr-errors
               X  |S needs-compl-sent
  1          XXXXX  +  newinfo-two+words
            XXXX M|  newinfo-one-word             req-corr-errors
                  |  req-no-gaps
  XXXXXXXXXXXX    |  needs-corr-errors            pac-opinions
           XXXXX  |  pac-taketurns
            XXXX  |  newinfo-recs-errors
            XXXX  |  needs-no-gaps                pac-corr-resp-5w's
                  |  req-two+words
  0 XXXXXXXXXXXX  +M
             XXX  |  pac-corr-follow-directions   req-recs-errors
           XXXXX  |  needs-two+words              req-one-word
           XXXXX  |
             X S|  needs-recs-errors            pac-corr-y/n
             XXX  |  needs-one-word               pac-endconvrstion
 -1          XXX  +
             XXX  |S pac-attn
              XX  |  pac-corr-follow-simple-inst  pac-recog-cues-conv
             XXX  |  req-gesture
                  |  pac-attmpt-resp-simple-inst
                  |
 -2               +  pac-attemp-y/n
           XX T|T needs-gesture
               X  |
               X  |
                  |
                  |
                  |
 -3               +
          <less>|<frequ>
```
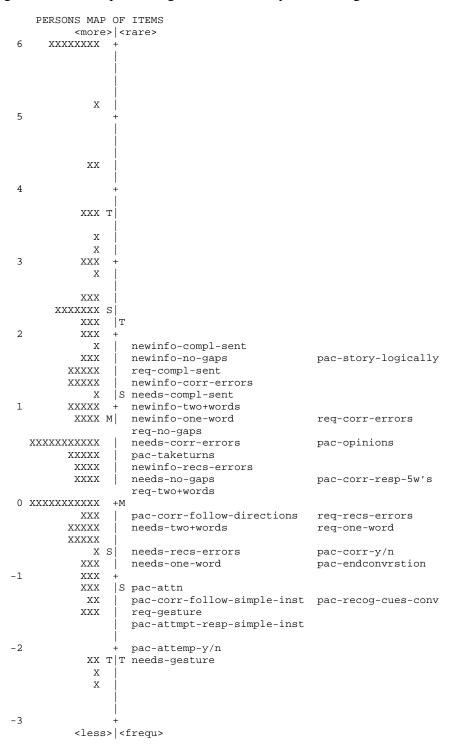
Table 4. Summary Statistics for Person Separation and Person Reliability

```
SUMMARY OF 119 MEASURED (NON-EXTREME) PERSONS
+--------------------------------------------------------------------------------+
|           RAW                      MODEL       INFIT        OUTFIT   |
|          SCORE     COUNT   MEASURE  ERROR   MNSQ   ZSTD   MNSQ   ZSTD |
|--------------------------------------------------------------------------------|
| MEAN      88.3      31.3      .76    .29     .99    -.2   1.07    .0  |
| S.D.      21.2       1.6     1.49    .10     .49    1.7    .67   1.6  |
| MAX.     127.0      32.0     5.12   1.00    3.61    6.9   3.80   6.9  |
| MIN.      44.0      23.0    -2.53    .24     .27   -4.1    .30  -3.7  |
|--------------------------------------------------------------------------------|
| REAL RMSE   .33  ADJ.SD   1.46  SEPARATION  4.43  PERSON RELIABILITY  .95 |
| MODEL RMSE  .31  ADJ.SD   1.46  SEPARATION  4.75  PERSON RELIABILITY  .96 |
| S.E. OF PERSON MEAN = .14                                            |
+--------------------------------------------------------------------------------+
   MAXIMUM EXTREME SCORE:     8 PERSONS
        VALID RESPONSES:  97.8%
```

Table 5. Summary Statistic for Item Separation and Item Reliability

```
SUMMARY OF 32 MEASURED (NON-EXTREME) ITEMS
+--------------------------------------------------------------------------------+
|           RAW                      MODEL       INFIT        OUTFIT   |
|          SCORE     COUNT   MEASURE  ERROR   MNSQ   ZSTD   MNSQ   ZSTD |
|--------------------------------------------------------------------------------|
| MEAN     328.2     116.4      .00    .14    1.00    -.1   1.07   -.1  |
| S.D.      62.1       2.5     1.11    .01     .24    1.9    .50   2.0  |
| MAX.     439.0     119.0     1.90    .19    1.44    2.8   2.78   4.7  |
| MIN.     225.0     107.0    -2.19    .13     .55   -4.1    .56  -3.6  |
|--------------------------------------------------------------------------------|
| REAL RMSE   .15  ADJ.SD   1.10  SEPARATION  7.36  ITEM   RELIABILITY  .98 |
| MODEL RMSE  .14  ADJ.SD   1.10  SEPARATION  7.76  ITEM   RELIABILITY  .98 |
| S.E. OF ITEM MEAN = .20
```