Background

Phonology is a sub-field of linguistics concerned with patterning of sounds in language and is a medium by which sound information is mapped onto higher levels of language such as words. There are theoretical notions supporting phonology in normal language (Nadeau, 2000; Blumstein, 1998). Impaired phonologic processes in adult aphasia have been linked to reading (de Partz, 1986; Kendall et al, 1998, 2003; Conway et al, 1998), language comprehension (Blumstein, 1998; Milberg et al, 1988), speech production (Nadeau, 2000; Kendall et al, 2003; Kendall et al, 2008; Browman and Goldstein, 1992) and working memory (Baddley and Hitch, 1974; Friedman et al, 2000) dysfunction. While there are existing measures to determine the severity of and change in semantic and syntactic impairments, there is no standardized measure of phonologic deficits for adults with aphasia. The long-term goal of this research is to develop a valid and reliable impairment level measure of phonology in aphasia that is sensitive in detecting clinical change and will differentiate between patterns of phonologic dysfunction. The short-term goal, and focus of this abstract, is to 1) outline procedures regarding item development for 3 domains (or subtests) of this assessment: reading, repetition and perception; and 2) present psychometric properties of these items from data collected from individuals with aphasia.

Methods

Item response theory (IRT) formed the basis for development of this phonologic assessment. The following procedures were employed: 1) a theory of phonology in aphasia was identified (Nadeau, 2001); 2) three constructs within the theory were delineated (reading, perception, repetition); 3) items were developed for each construct employing psycholinguistic principles thought to be relevant to performance (e.g. frequency, length, etc); 4) professionals in the field reviewed the items; 5) items were revised; 6) data were collected from individuals with aphasia; 7) IRT statistics were generated for each of the 3 constructs to answer research questions directed toward the integrity of the items.

Item Development

<u>Construct #1 Reading:</u> A total of 69 items across 4 categories (real words, nonwords, words with irregular orthography, pseudohomophones) were constructed. Real words (1-5 syllables) were nouns controlled for number of graphemes and phonemes, frequency, and complexity. Frequency was equated within and

across all categories (Thorndike-Lorge). Complexity was defined as clusters and blends. Irregular real word (1-3 syllables) nouns were divided into high and low frequency groups (Thorndike-Lorge)(HF 1-100, LF 800-2000). Pseudohomophones were real words converted using Thorndike-Lorge to determine the written word frequency. Nonword items (1–3 syllables) were created by combining consonants and vowels based on frequency (Shriberg & Kent, 1982). Each syllable length category contained low and high frequency words. The sum of all biphone probabilities within each item was calculated as well as average biphone probability for each syllable length category.

<u>Construct #2 Repetition</u>: A total of 113 items across 6 categories (real and nonword repetition, parsing and blending real and nonwords) were constructed. Real word and nonword repetition items were divided into 1- (2-4 phonemes), 2- (5-7 phonemes), and 3- (8-10 phonemes) syllable words. Phonotactic probability and frequency (Kucera & Francis, 1982) were controlled within and across all categories. Parsing and blending noun items were divided into 6 groups based on the division of the word for parsing or blending: compound words, 2-syllable non-compound words, onset-rime, body-coda, and individual phonemes. Only compound words and 2-syllable non-compound words were allowed to have clusters. Syllable structure was controlled within each category. Phonotactic probability and frequency (Kucera & Francis, 1982) were controlled within and across all categories.

<u>Construct #3 Perception</u>: A total of 216 items across 4 categories (real and nonword rhyme, lexical decision, minimal pairs) were constructed. Real Word and Nonword Rhyme pairs included the same grammatical class. Nonword items were created using high- and low-frequency phoneme 1- and 2-syllable combinations. Foils were created so participants could not identify a pattern of rhyming. Rhyming pairs were created by changing the initial phoneme only (*reason/season*). Lexical Decision items from the real and nonword rhyme tasks were used for the lexical decision task and were divided by syllables (1-2). Each syllable group was divided into high- (2-3 phonemes) and low- (5-6 phonemes) frequency items. Phonotactic probability was controlled across and within syllable categories. Minimal pair items contained the same vowel and followed either CV or VC patterns. Pairs differed only by consonant, based on one measure of articulation: voice, place, or manner.

Data Collection

Subject recruitment: Fifty individuals with aphasia participated in standardizing the reading subtest and 37 individuals with aphasia participated in the repetition and perception subtests. All individuals met inclusion criteria of a single left hemisphere stroke at least 6 months prior to enrollment, right-handed, monolingual English speaking, presence of aphasia determined by < 94.8 WAB AQ (Kertesz, 1982). Exclusion criteria included prior CVA, pre-existing neurological illness or severe impairment in vision or hearing and presence of developmental speech-language impairment. (See Table 1 for demographics)

Experimental Task: Tasks and stimuli were randomized and presented with ISI of 8.0 seconds on a Dell Lattitude X1 Laptop. For the reading task, participants were asked to read each word aloud. Verbal responses were recorded digitally for subsequent analysis. Repetition and perception stimuli were recorded by a male speaker using a Marantz Digital Audio Recorder within a soundproof booth. Patient responses for repetition were recorded digitally for subsequent analysis. For the perception subtest a button box – labeled with two buttons corresponding with "Yes/Rhyme" in red and "No/Does Not Rhyme" in green – was connected to a Dell Latitude X1 laptop with E-Prime software .

Analysis

Subject responses were scored for accuracy (defined as no phonemic, semantic or verbal paraphasias). Distortions were scored as correct. Data were analyzed using WINSTEPS Rasch analysis (Bond & Fox, 2001;Linacre, 2005; 1994).

Results/Discussion

Results for items misfit, person separation reliability, person strata, Chronbach's alpha and item floor/ceiling effects are presented in Table 2 for all 3 constructs. Overall, the assessment of phonology in aphasia demonstrates a reasonable fit to the Rasch model. Characteristics for each construct will be briefly reviewed here. The items in the reading section demonstrate good measurement qualities, good point measure correlation, are separating people into at least 2 strata. There were ceiling effects (real words) and floor effects (nonwords, pseudohomophones, irregular). The items in repetition, parsing and blending demonstrate adequate measurement qualities. The range of misfitting items was low (0-2), they demonstrated good point measure correlation and separated people into at least 2 groups (except for nonword parsing and blending). There were significant floor effects for all tasks and one ceiling effect (real word repetition). The floor effects were particularly significant for parsing/blending nonwords. The items in the perception showed a range of misfitting items between 0-4 (low). There was good point measure correlation for all tasks except lexical decision where 14 of the 36 showed correlations below .30. Across all tasks, the ability of the individuals was higher than the items, but only one of the tasks showed a significant ceiling effect (real word rhymes). Future research will focus on the creation of a short form that will eliminate redundant items and the creation of new items to address the ceiling and floor effects.

Table 1: Patient demographics. Average and (standard deviation) for age, months post onset, education, Western Aphasia Battery, AQ and Boston Naming Test performance.

Domain	**Age**	**Months post onset of stroke**	**Education**	**WAB AQ**	**BNT (spontaneous correct)**
Repetition and Perception N=37	65.2 (10.6)	59.8 (41.9)	13.7 (2.9)	80.0 (11.4)	34.1 (13.0)
Reading N=50	67.3 (10.1)	84.2 (42.2)	13.4 (3.0)	77.0 (23.2)	31.5 (19.8)

Table 2: IRT results for 3 constructs of the Standardized Assessment of Phonology in Aphasia

Construct	Task	% items misfit (expectation <5%)	Person separation reliability (strata) (Person separation strata expectation >2.0)	Cronbach's alpha (expectation $\geq$ .70)	Floor and/or ceiling effect (expectation <5%)
READING ALOUD N=69 items N=50 aphasics	Real word	No misfit items	.90 (4.37)	.97	Ceiling = 12%
	Irregular word	No misfit items	.87 (3.79)	.94	Floor = 16%
	Pseudo-homophones	8%	.70 (2.39)	.89	Floor = 29%
	Nonwords	No misfit items	.67 (2.23)	.89	Floor = 37%
REPETITION, PARSING, BLENDING N=113 items N=37 aphasics	Real word	6%	.78 (2.81)	.92	Ceiling = 23% Floor = 7%
	Nonword	11%	.82 (3.2)	.92	Floor = 17%
	Parsing real words	6%	.76 (2.73)	.90	Floor = 27%
	Parsing nonwords	No misfit items	.29 (1.17)	.78	Floor = 43%
	Blending real words	No misfit items	.78 (2.81)	.85	Floor = 17%
	Blending nonwords	No misfit items	.13 (.84)	.76	Floor = 50%
PERCEPTION N=216 items N=37 aphasics	Lexical decision	3%	.67 (2.23)	.78	No
	Minimal pairs	13%	.77 (2.75)	.82	No
	Real word rhyme	8%	.62 (2.03)	.85	Ceiling = 17%
	Nonword rhyme	No misfit items	.77 (2.77)	.86	Ceiling = 7%

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