Concurrent Validation of the Computerized Revised Token Test (CRTT) and Three Experimental Reading Versions (CRTT-R) in Normal Elderly Individuals and Persons With Aphasia

Introduction

The formal definition of aphasia proposed by McNeil and Pratt (2000) specifies that the language deficits cross language processing modalities so that a person with aphasia (PWA) show deficits both in primary input (reading and listening) and output (talking and writing) modalities: albeit to potentially different levels of severity and perhaps with differing underlying psycholinguistic mechanisms. There are, however, no published assessment tools with appropriate and established psychometric characteristics that make cross-modality comparisons transparent. That is, all currently published tests assess performance in one modality (e.g., auditory) or communication function (listening comprehension) with stimuli, tasks and scoring procedures that differ from those used to elicit or evaluate behavior in another modality (e.g., vision) or communication function (e.g., reading). These differences make modality and communication function comparisons difficult or impossible, despite the importance of these comparisons in defining and classifying aphasia and in making treatment decisions.

The *Revised Token Test* (*RTT*) (McNeil & Prescott, 1978) is one standardized assessment tool that is based on an assumption of preserved linguistic representation and rules but impaired access to this knowledge in persons with aphasia. While the *RTT* was originally developed as a test of auditory comprehension, the theoretical basis for it is equally applicable to reading comprehension. Reading comprehension is a cognitive-linguistic task that, while involving another modality, entails similar task demands such as perceptual analysis and interpretation, lexical, semantic, and phonologic activation and access. Most of the psycholinguistic variables that affect auditory comprehension also affect reading comprehension such as stimulus length, word frequency, semantic, syntactic complexity, etc. Recently, the *RTT* has been computerized (*Computerized Revised Token Test*, *CRTT*), which allows for increased control over test administration and response scoring and quantification. With this increased control, there is even greater potential for development of an equivalent reading version of the test (*Computerized Revised Token Test – Reading*, *CRTT-R*).

The overall purpose of this research program is to provide the clinical and research communities with a valid, reliable, sensitive and clinically accessible measurement tool for the detection, quantification, and differential assessment of auditory and reading language comprehension/processing in persons with aphasia. The specific aims of this study were to investigate three reading versions of the *CRTT-R* that varied by stimulus presentation, and to compare performance on each version with results obtained from the acoustically presented *CRTT* in order to establish their concurrent validity for both NEI and PWA. In addition, the data from the *CRTT* and the three *CRTT-R* versions were compared for both participant groups to their performance on two other language tests; the *Porch Index of Communicative Ability* (*PICA*) (Porch, 1981) and *Reading Comprehension Battery for Aphasia* (*RCBA*) (LaPointe & Horner, 1998).

Methods

Sixty individuals (30 NEI and 30 PWA) participated in the study. The ages of the NEI ranged from 38 to 83 (*mean=65, SD=12*). They passed hearing, vision, memory, and language screens, and reported no history of communication, neurological, or psychiatric disorder. The PWA ranged in age from 38 to 90 (*mean*=63, *SD*=13) and were defined by their performance on the *PICA*, the *RTT* (McNeil & Prescott, 1978) and on an immediate and delayed language recall task of the *Assessment Battery of Communication in Dementia* (Bayles & Tomoeda, 1993). In addition, all participants were given the *RCBA* and the *PICA*. Biographical and selection data are summarized for the PWA in **Table 1** and for the NEI in **Table 2**.

All of the participants completed four experimental conditions that consisted of the *CRTT* with the commands presented acoustically, and three versions of the *CRTT-R* with the commands presented in printed text. In the auditory condition, all of the commands were pre-recorded and presented acoustically via loudspeakers at 75dB SPL as measured at the level of each participant's ear. In the reading conditions, the printed commands were presented in a textbox at the bottom of a touch-screen under three different stimulus presentation methods: 1) The full-sentence (*CRTT-R-FS*), 2) participant-determined word-by-word with each word remaining on the screen (word constant, *CRTT-R-WC*), and 3) participant-determined word-by-word condition with each previous word disappearing with the onset of the following word (word fade, *CRTT-R-WF*). The *CRTT-R-WC* condition was based on the self-paced reading method with each word presented immediately after a touch in the textbox and with accumulation of the words across successive touches. The *CRTT-R-WF* condition was same as the *CRTT-R-WC* condition except for the word accumulation, and was designed to control for participants who selected all words before reading the sentence, thus diminishing important chronometric information available with the *CRTT-R-WF* condition, such as time spent on each word in the sentence. This condition also more closely parallels the auditory condition in which the stimuli are fleeting and appear and disappear over time.

Results

In order to examine whether the four different test conditions loaded on the same factor, a factor analysis was performed for each group. In PWA, a one-factor solution accounted for 89% of the variance, indicating that all four conditions loaded substantially on one factor. A two-factor solution accounted for a majority of the variance (76%) in NEI with the *CRTT* and the *CRTT-R-FS* conditions grouping as a factor, and the *CRTT-R-WC* and *CRTT-R-WF* conditions as another.

Pearson correlation coefficients were obtained between the overall scores for the *CRTT* and those from the reading conditions. The *CRTT-R-FS* and the *CRTT-R-WC* conditions were most highly correlated with the *CRTT* (*r=0.85 and 0.84*) in PWA, although the *CRTT-R-WF* condition was highly correlated with the *CRTT* as well (r=0.78) (**Table 3**). For the NEI the *CRTT-R-FS* condition produced the highest correlation with the *CRTT* (*r=0.34*) (**Table 4**). A two-way repeated measures ANOVA was performed to examine any significant differences among the conditions. None were found among the four conditions for the PWA. In contrast, the scores on the *CRTT* were significantly higher than all three reading conditions for the NEI, but there was no differences between the reading conditions for this group ($p>0.01$) (**Table 5**).

Further correlation coefficients were calculated to investigate the relationship between performance on the *CRTT* and the *CRTT-R* conditions, and the performance on the *PICA* and *RCBA*. In PWA all four test conditions were highly correlated with the *PICA* and *RCBA* (*0.72 <r < 0.89*), whereas only the *CRTT* was significantly correlated with the *PICA* for the NEI (**Table 6**).

Discussion

The results of this study suggested that the *CRTT* and the three versions of the *CRTT-R* are highly related and likely reflect similar linguistic processing difficulties in PWA. In contrast, the performance of the NEI on the four conditions was largely unrelated and likely represented different processing skills or strategies than that reflected by the performance of the PWA. The high correlations among the *CRTT and CRTT-R* conditions and the *PICA* and *RCBA* for the PWA also indicated that these conditions are measuring similar language processing difficulties regardless of modality and language function. Furthermore, the validity of the four conditions was supported for PWA but largely unsupported for the NEI. An issue, however, in interpreting the NEI data was the limited by a restricted distribution of scores across participants, which could have restricted the correlations.

References

LaPointe, L. & Horner, J. (1978). *Reading Comprehension Battery for Aphasia*-2 (revised edition), Austin, TX: Pro-Ed. 1998.

McNeil, M.R. & Pratt, S.R. (2001). Defining aphasia: Some theoretical and clinical implications of operating from a formal definition. *Aphasiology*, *15*, 901-911.

Porch, B.E. (1967). *The Porch Index of Communicative Ability*. Palo Alto, CA: Consulting Psychologists Press.

Table 1. Descriptive and criteria measures for the PWA

PWA	PICA (%ile)	RCBA (OA)	Age (Yrs.)	Education (Yrs.)	MPO	Gender
1	73	178	63	14	456	F
2	76	172	66	12	192	M
3	49	158	70	12	96	F
4	66	181	72	14	444	F
5	72	178	60	16	24	M
6	86	185	66	13	25	F
7	52	179	45	16	13	F
8	84	184	49	16	71	F
9	66	186	61	16	15	F
10	76	179	65	12	201	M
11	53	160	38	14	25	M
12	57	166	76	12	564	F
13	88	187	43	14	91	M
14	69	174	62	16	60	M
15	89	190	53	18	88	F
16	71	176	69	10	453	F
17	71	162	59	12	24	M
18	88	182	56	18	31	M
19	29	86	83	12	30	F
20	69	166	40	18	12	M
21	89	190	51	18	139	F
22	83	189	90	12	58	M
23	59	184	63	18	46	M
24	70	157	70	12	29	F
25	76	179	82	16	106	M
26	41	102	77	12	MD	M
27	66	185	64	18	68	M
28	48	175	75	12	180	M
29	26	124	69	12	59	M
30	66	175	49	14	6	M
Mean	66.93	169.63	62.87	14.30	124.34	(F; 13/ M; 17)
SD	16.80	24.63	12.95	2.48	155.08	

MPO=Months Post Onset

MD = Unrecorded data with the average based on 29 participants

Table 2. Descriptive and criteria measures for the NEI

ID	PICA (%ile)	RCBA (OA)	Age (Yrs.)	Education (Yrs.)	Gender
1	10	179	55	11	F
2	55	190	74	18	M
3	27	186	71	14	M
4	30	189	59	13	M
5	4	186	50	12	M
6	10	188	77	16	M
7	20	186	66	14	M
8	25	187	70	12	M
9	12	187	64	18	M
10	95	188	69	12	F
11	5	189	68	18	F
12	7	189	56	12	F
13	2	183	77	12	M
14	25	190	64	14	F
15	7	183	77	12	F
16	4	188	70	12	M
17	3	187	76	14	F
18	25	188	71	16	M
19	25	188	83	18	F
20	10	187	81	14	M
21	4	189	78	12	M
22	22	172	71	12	M
23	22	189	52	18	M
24	20	190	76	12	F
25	3	181	42	12	M
26	35	188	54	18	F
27	35	189	38	13	F
28	58	190	56	18	F
29	2	190	50	18	M
30	7	189	48	13	M
Mean	20.30	186.83	64.77	14.27	(F;12/ M; 18)
SD	20.42	3.89	12.14	2.56	

Table 3. Correlation coefficients among the four test conditions for the PWA

	CRTT	*CRTT-R-FS*	*CRTT-R-WC*	*CRTT-R-WF*
CRTT	1.00	0.85**	0.84**	0.78**
CRTT-R-FS		1.00	0.84**	0.88**
CRTT-R-WC			1.00	0.88**
CRTT-R-WF				1.00

Table 4. Correlation coefficients among the four test conditions for the NEI

	CRTT	*CRTT-R-FS*	*CRTT-R-WC*	*CRTT-R-WF*
CRTT	1.00			
CRTT-R-FS	0.34	1.00		
CRTT-R-WC	0.27	-0.002	1.00	
CRTT-R-WF	0.31	-0.021	0.55**	1.00

Note: **significant at *p=.01*

Table 5. Mean and standard deviations for the overall scores from each experimental condition for both participant groups

	CRTT	*CRTT-R-FS*	*CRTT-R-WC*	*CRTT-R-WF*
NEI (n=28)	14.59 (0.34)	13.99 (0.40)	13.78 (0.55)	14.11 (0.42)
PWA (n=30)	13.06 (1.49)	12.68 (1.08)	12.65 (1.20)	12.76 (1.39)

Note: Numbers in parenthesis are standard deviations.

Table 6. Correlation coefficients between experimental conditions and the overall scores from the PICA and RCBA for the NEI and PWA Groups

		CRTT	*CRTT-R-FS*	*CRTT-R-WC*	*CRTT-R-WF*
NEI	PICA	0.39*	0.17	-0.29	-0.06
	RCBA	0.21	0.18	0.33	-0.03
PWA	PICA	0.81**	0.73**	0.77**	0.72**
	RCBA	0.89**	0.83**	0.84**	0.79**

Note: *significant at *p <.05*
** significant at *p<.01*