A comparison of left versus right hand, and mouse versus touchscreen access methods on the *Computerized Revised Token Test* in normal adults and persons with aphasia

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Abstract

This study examined the effect of hand used to access mouse vs. touchscreen in both normal adult individuals (NAI) and persons with aphasia (PWA) on the overall score from the *Computerized Revised Token Test* (CRTT) (McNeil et al., 2008). Both access modes were highly correlated with each other in both groups. PWA performed significantly worse than the NAI on both access modes, regardless of hand used. The touchscreen access mode generated significantly higher scores than the mouse for both groups independent of hand. The correlation coefficients within hand and between access modes were significant and high for both groups.

Introduction

The *Revised Token Test* (RTT) has been used for more than thirty years to evaluate auditory processing deficits of individuals stemming from various etiologies (McNeil & Prescott, 1978). A computerized version of the RTT (CRTT) has recently been developed (McNeil, et al, 2008) using a touchscreen. The assumption underlying the selection of this access method was that it would reduce the cognitive level of abstraction and the fine motor control demands compared to the mouse, and thereby reduce the response difficulty helping to isolate the locus of the performance deficit to that of auditory language processing. However, touchscreens are expensive, not readily available in most clinical settings, and virtually unavailable in home environments where Telehealth services are frequently delivered.

Studies comparing touchscreen to mouse are few and those that are available have produced inconsistent findings. Some studies have reported no difference in performance between a mouse and stabilized touchscreen, along with moderate to high correlations between them (Edwards et al., 2005; Sears & Shneiderman, 1991). Other studies have found that individuals prefer the mouse over the touchscreen (Wood et al., 2004), and using a mouse results in more accurate responses (Mahmud & Kurniawan, 2005) than the touchscreen. Petheram (1988) found that both the touchscreen and the mouse yielded lower performance compared to other input devices for persons with aphasia (PWA). Recently Heilman, McNeil, Hill and Pratt (2008) examined the effects of mouse versus touchscreen access on CRTT performance for normal young adult participants using their non-dominant hand. Unlike the majority of previous studies, the results showed a significant touchscreen preference over the mouse and higher subtest and overall scores. This study also found that the test-retest reliability of the CRTT was high and equally reliable for both access versions. However, these variables have not been evaluated in normal adult individuals (NAI) or in PWA.

The long term goal of this research is to develop a reliable and clinically valid tool for assessing language comprehension/processing in NAI and PWA. The specific purpose of the present study was to investigate the effects of mode of access (mouse vs. touch screen) and hand used to respond on the overall scores (OA) of the CRTT in both NAI and PWA.

Methods

Thirty-nine individuals (20 NEI and 19 PWA) participated in the study. The ages of the NAI ranged from 35 to 84 (*mean*=62, *SD*=14). Participants passed hearing, vision, memory, and language screening examinations and reported negative histories of communication, neurological, and psychiatric disorder. The PWA ranged in age from 40 to 91 (*mean*=61, *SD*=14) passed hearing and vision screenings. They also met the definition and clinical criteria for aphasia specified by McNeil and Pratt (2001) as evidenced by their performance on the *Porch Index of Communicative Ability* (*PICA*) (Porch, 2001) and on the immediate and delayed story recall task from the *Assessment Battery of Communication in Dementia* (Bayles & Tomoeda, 1993). In addition, all participants were given the Edinburgh Handedness Inventory (Oldfield, 1971). Biographical and selection data are summarized for the PWA in Table 1 and for the NAI in Table 2.

All participants completed four randomly assigned conditions of the 100-item CRTT: 1) right-hand touchscreen, 2) left-hand touchscreen, 3) right-hand mouse, and 4) left-hand mouse. In the touchscreen conditions, participants responded to the verbal commands by manually touching and moving objects displayed on a 15-inch touchscreen with their designated hand. In the mouse condition, participants accessed the objects on the screen using a computer mouse. The acoustically presented stimuli were delivered in a quiet environment at 75 dB SPL via loudspeaker.

Results

In order to address the experimental contrasts of interest, a three-way ANOVA was computed with the mode (Touchscreen vs. Mouse) and hand (Rt. vs. Lt) as within-subject factors and the group (PWA vs. NAI) as a between-subject factor. Overall mean scores for the access mode by hand used for each group are summarized in Table 3. There were significant ($p<.05$) main effects for mode with the touchscreen generating significantly better performance than the mouse for both groups, and for group with significantly poorer performance in the PWA than NAI for both access modes. There was no significant main effect for hand and no significant interactions.

Pearson correlation coefficients were computed among the four experimental conditions and the PICA overall score. The correlation coefficients within hand and between access modes were significant and high for both subject groups (Table 4 for NAI and Table 5 for PWA). The correlation coefficients among the CRTT conditions and the PICA were moderate and significant in all conditions except for the right-hand mouse condition for the PWA. The PICA was not significantly correlated with any of the CRTT conditions in NAI due to the restricted range of the scores in that group. Additionally, a principal component analysis was performed for each group in order to examine whether the four conditions shared a common underlying source of variance. A single factor solution accounted for 81% of the total variance for the NAI group and 88% of the variance for the PWA group.

Discussion

As expected, the PWA performed significantly more poorly than the NAI on both access modes, regardless of hand used. The finding that the CRTT touchscreen access mode generated significantly higher scores than the mouse version in both participant

groups is consistent with the results obtained by Heilman et al (2008) with young normal adults. Importantly, these results were evident regardless of the hand used. Both access modes were highly correlated with each other in both participant groups. The significant correlations of the CRTT conditions with overall PICA scores for the PWA suggest that these conditions may be measuring similar language processing deficits regardless of the mode with which the visual test-stimuli were manipulated. Finally, the mean score differences between access modes for both participant groups was within the standard error of measurement of both access test versions, and therefore do not represent meaningful differences. These results will be discussed relative to their implications for constructing independent test standardization procedures for each access method for this test.

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Table 1. Descriptive and criteria measures for the PWA

	PICA (%ile)	Age (Yrs.)	Education (Yrs.)	MPO	Gender	Handedness
1	84	54	18	360	F	Right
2	71	46	14	33	F	Right
3	71	68	13	216	M	Left
4	66	41	18	24	M	Right
5	79	74	14	468	F	Right
6	90	49	18	9	F	Right
7	81	66	12	220	M	Right
8	89	57	18	46	M	Right
9	86	91	13	80	M	Right
10	93	53	18	10	F	Right
11	85	51	16	80	F	Right
12	77	83	16	120	M	Right
13	75	63	16	63	M	Right
14	54	61	14	100	M	Ambi
15	74	66	13	487	F	Right
16	54	40	16	46	M	Right
17	69	62	16	51	M	Right
18	41	78	12	UD	M	Right
19	78	63	14	13	M	Right
Mean	74.58	61	15	135	(F; 7/ M; 12)	(17 Right / 1 Ambi / 1 Left)
SD	13.53	14	2	154		

PICA=*Porch Index Communicative Ability* (Porch, 2001); MPO=Months Post Onset; UD=Unrecorded Data (with the average based on 18 participants); M=male; F=female; Ambi=Ambidextrous

Table 2. Descriptive and criteria measures for the NAI

	PICA (%ile)	Age (Yrs.)	Education (Yrs.)	Gender	Handedness
1	25	68	12	M	Right
2	25	61	13	M	Right
3	20	40	12	M	Right
4	55	54	18	F	Right
5	13	81	16	M	Right
6	30	84	18	F	Right
7	40	53	16	M	Ambi
8	20	54	14	F	Right
9	35	54	16	M	Right
10	20	35	12	M	Right
11	37	75	16	F	Right
12	55	76	18	M	Right
13	35	55	14	F	Right
14	22	79	12	M	Right
15	25	77	12	F	Right
16	25	55	14	M	Right
17	23	57	18	F	Right
18	17	69	14	M	Ambi
19	30	58	14	F	Right
20	35	49	16	M	Right
Mean	29.35	62	15	(F; 8/ M; 12)	(18 Right/ 2 Ambi)
SD	11.32	14	2		

PICA (%ile) for NAI is based on Duffy and Keith (1980)'s data on normal adults (N=131); MPO=Months Post Onset; M= male; F=female; Ambi=Ambidextrous

Table 3. Overall mean scores and Standard Error (in parentheses) for condition, hand and groups

	Mouse Left	Mouse Right	Touch Left	Touch Right
Aphasic	13.19 (.20)	13.11 (.21)	13.50 (.21)	13.43 (.19)
Normal Elderly	14.06 (.16)	14.28 (.17)	14.36 (.17)	14.43 (.15)

*: $p<.05$; **: $p<.01$; Touch = touchscreen

Table 4. Correlation coefficients among the mouse and touchscreen CRTT-conditions and the PICA for the NAI.

	PICA	Mouse Left	Mouse Right	Touch Left	Touch Right
PICA	1.00				
Mouse Left	-0.18	1.00			
Mouse Right	0.26	0.67**	1.00		
Touch Left	-0.12	0.71**	0.77**	1.00	
Touch Right	-0.13	0.72**	0.71**	0.89**	1.00

*: $p<.05$; **: $p<.01$; PICA = Porch Index of Communicative Ability; Touch = touchscreen

Table 5. Correlation coefficients among the mouse and touchscreen CRTT-conditions and the PICA for the PWA.

	PICA	Mouse Left	Mouse Right	Touch Left	Touch Right
PICA	1.00				
Mouse Left	0.61**	1.00			
Mouse Right	0.20	0.74**	1.00		
Touch Left	0.65**	0.94**	0.76**	1.00	
Touch Right	0.66**	0.91**	0.85**	0.94**	1.00

*: $p<.05$; **: $p<.01$; Touch = touchscreen