Multicomponent Analysis of a Novel Digital Trail Making Task

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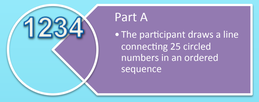
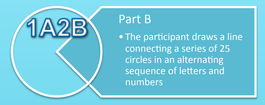
Background

- Trail Making Tests are commonly used in neuropsychological assessments
- They are sensitive to a variety of neurological disorders
- The original Trail Making Test is comprised of two conditions, Part A and Part B
- Conditions are scored based on total time to completion and number of errors committed

Original Paper Based Trail Making Test



Part A
- The participant draws a line connecting 25 circled numbers in an ordered sequence

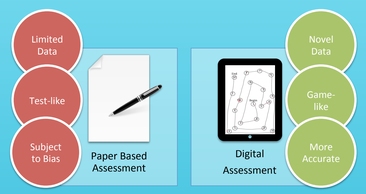


Part B
- The participant draws a line connecting a series of 25 circles in an alternating sequence of letters and numbers

Motivation

Computerized Cognitive Assessments have the potential to utilize existing test constructs while capturing novel data

Existing Digital Trail Making Tasks do not fully realize automatic novel data collection by taking advantage of digital interfaces



Methods & Procedure

Participants were 14 community-dwelling adults between the ages of 50 and 80 who completed a comprehensive neuropsychological assessment in addition to the newly developed Digital Trail Making Task.

Correlation analyses (Spearman rho) were computed to establish construct validity with traditional paper-and-pencil measures. Digital Trail Making Task components were also examined to identify relevant features.

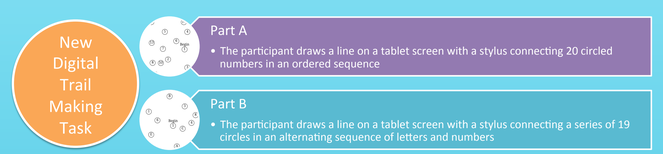


Table 1. Participant Characteristics (N = 14)

	Mean (SD) or %
Age	65.6 (10.4)
Education	15.1 (1.83)
Sex (% Female)	71.4
Handedness (% Right)	92.9
Diagnosis	
Normal (%)	64.3
Parkinson's (%)	28.6
TBI (%)	7.1

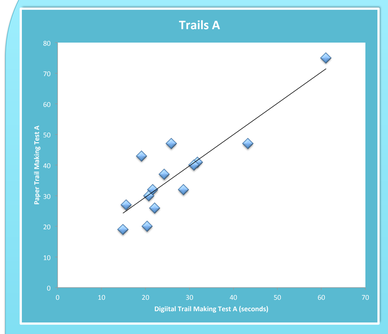


Figure 1

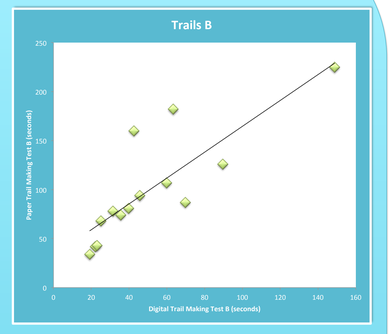


Figure 2

Table 2. Correlations between Neuropsychological Measures

	dTMT A	dTMT B	pTMT A	pTMT B	SDMT	SDMT O.	Dig. Span	Spat. Sp.
Digital Trails A								
Digital Trails B	**.714**							
Paper Trails A	**.733**	**.696**						
Paper Trails B	**.591**	**.908**	**.648**					
Symbol Digit MT	**-.703**	-.486	**-.809**	-.432				
SDMT Oral	**-.580**	**-.717**	**-.799**	**-.761**	**.734**			
Digit Span	-.192	-.512	-.185	**-.657**	.089	.281		
Spatial Span	**-.621**	**-.823**	-.478	**-.786**	.248	**.622**	.319	
Design Fluency	**-.600**	**-.733**	**-.917**	**-.629**	**.706**	**.815**	.295	.501

Note. Bold values indicate significant correlation, p <.05.

Table 3. Executive Functioning Correlations with Digital and Paper Trails

	Digital TMT A	Digital TMT B	Paper TMT A	Paper TMT B
Stroop Color	0.295	0.430	0.526	0.383
Stroop Word	0.011	0.227	0.396	0.256
Stroop Inhibition	0.180	**0.647**	0.527	**0.724**
Stroop Switching	0.235	0.240	**0.595**	0.305

Note. Bold values indicate significant correlation, p < .05. The Stroop Test is from the Delis-Kaplan Executive Functioning System.

Technology

Participants completed the Digital Trail Making Task by drawing on the tablet screen using a stylus.

The Digital Trail Making Task was created as an Android application using the Eclipse Integrated Development Environment.

Table 4. Correlations Between Digital Trails Components, Design Fluency Trials, and Stroop Conditions

	DF Trial 1	DF Trial 2	DF Trial 3	Color	Word	Inhibition	Switching
Avg. Time in Node B	-.292	**-.705**	**-.826**	.496	.223	**.689**	.389
Avg. Time in Nodes A	-.433	**-.580**	-.554	.256	.260	.279	.442
Trails A Pauses	-.467	**-.772**	**-.661**	**.628**	.476	.361	.546
Trails B Pauses	-.104	**-.577**	**-.764**	.497	.404	.538	.252

Note. Bold values indicate significant correlation, p <.05. DF = Design Fluency.

Table 5. Correlations Between Digital Trails Components, Grooved Pegboard, and Grip Strength (N = 9)

	Pegs DH	Pegs NDH	Grip DH	Grip NDH
Trails A Lifts	.429	.206	**-.739**	**-.704**
Trails B Lifts	.613	.468	**-.826**	**-.672**
Trails A Pauses	**.850**	**.850**	-.467	-.533
Trails B Pauses	.400	.300	-.417	-.267

Note. Bold values indicate significant correlation, p <.05. DH = dominant hand; NDH = non-dominant hand.

Results & Discussion

The primary aim of this preliminary study was evaluate the construct validity of a Digital Trail Making Task. The results show a strong correlation between the digital and paper-based versions, as well as other measures of visual-spatial processing speed, which provides initial support for the construct validity of the digital trail making task.

Correlation analyses revealed appropriate convergent validity between digital Trails B and Stroop response inhibition, as well as divergent validity between digital Trails A and all Stroop conditions.

Further analyses revealed digital Trails pauses and average time inside nodes were more strongly associated with complex executive functioning tasks (i.e., Design Fluency Trials 2,3 and Stroop-Inhibition) than simpler processing speed conditions (i.e., Design Fluency Trial 1; Stroop-Word) which indicates the potential of digital test components to isolate cognitive processes.

Conclusions

In summary, these results suggest that the digital Trail Making Task is comparable to the paper-and-pencil version. In addition, digital task components may be used to further isolate cognitive processes while maintaining the structure and length of the test. More research is needed in larger samples to identify the clinical utility, discriminant validity, and test-retest reliability of the digital Trail Making Task.

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