

The Trails-X™: Development and Validation of a Novel Trail-Making Test

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Overview of the Trails-X

Trail-making tasks, that is, rapidly connecting objects on a page according to a certain plan, are some of the most widely used neuropsychological tests.

The Trails-X improves upon previously developed trail-making tasks by removing literacy and numeracy requirements.

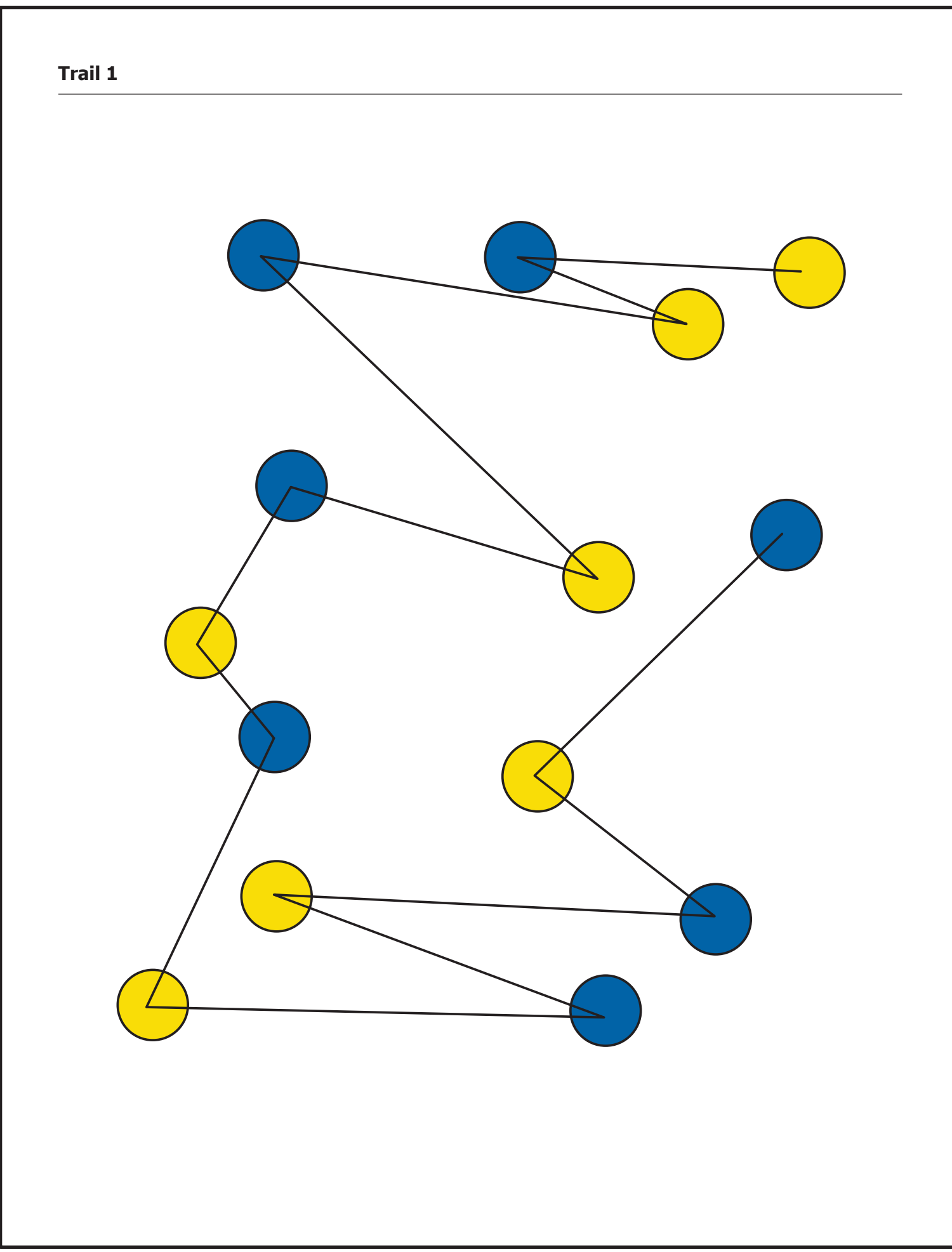
Increases executive function demands by eliminating the predetermined trail sequence common to trail-making tasks.

Requires examinees to connect circles of alternating colors without a predetermined start or end point and produces several scores.

Standardized on a nationally-representative sample of 732 individuals ages 8 to 79 years, including 336 children and adolescents.

Trails-X Scores	
Time to Discontinue	Time to Discontinue is the time (in seconds) spent on each trail. The Time to Discontinue for each trail is summed to obtain the Total Time to Discontinue, or the total time the examinee spent on the Trails-X.
Connected Circles	Connected Circles refers to the number of correctly connected circles on each trail. The Connected Circles score for all trails is summed to obtain the Total Connected Circles score.
Matrix	A matrix score for each trail is derived from a matrix of raw Time to Discontinue and Connected Circles scores. Each trail's matrix score is summed for the Total Matrix raw score, which is converted to a <i>T</i> score. It is the scaling of the intersection between time on task and number of circles the examinee could connect correctly in that time.

Demographic of the Pediatric Standardization Sample	
N	336
Age (years)	
Range	8-18
<i>M</i>	11.83
<i>SD</i>	3.13
Gender (%)	
Male	51.8
Female	48.2
Ethnicity (%)	
Caucasian	49.4
African American	15.5
Hispanic	24.4
Other	10.7



Reliability

Reliability refers to a test's stability, consistency, and accuracy. Reliability was studied on the Trails-X through examining: internal consistency, test-retest reliability, and inter-scorer reliability.

Internal consistency

- Internal consistency was assessed via Cronbach's alpha
- With children ages 8 to 18:
 - Time to Discontinue score = .91
 - Connected Circles score = .68
 - Matrix score = .74

Test-retest reliability

- Refers to the extent to which an individual's test performance is constant over time.
- Assessed on a sample of 26 individuals (11 children, ages 8 to 18 years) who were retested on the Trails-X 2 to 4 weeks after the first test.
- The correlation between Time 1 and Time 2 on the Matrix *T* score was .80.

Inter-scorer reliability

- Involves the amount of test error due to examiner variability in scoring.
- Two staff members at PAR independently scored a set of 30 completed protocols.
 - Intraclass correlation coefficients (ICCs) were calculated using a two-way random effects model (consistency type). The ICCs ranged from .86 to 1.00 (perfect consistency) for the trail-level raw scores, and .99 to 1.00 for the Total raw scores.
- On a timed test such as the Trails-X, there may be some error surrounding when an examiner begins and ends the timing process.
 - A second examiner timed each trail on 10 administrations of the Trails-X.
 - The ICCs for each trail were 1.00, and the two timers never differed by more than 2 seconds on any of the 90 administrations of trails (i.e., 10 administrations of 9 trails each).
- The size of the resulting coefficients provide convincing evidence of the reliability of scoring the Trails-X by trained examiners.

Validity

Validity refers to the ability of a test to measure what it claims to measure. Validity was studied on the Trails-X through examining relationships to other measures and performance of clinical groups.

Trails-X correlations with other measures

- Children's Color Trails Test (CCTT)* (Llorente, Williams, Satz, & D'Elia, 2003)
 - Correlations with CCTT scores ranged from .16 to .44, indicating those who performed well on the Trails-X also performed well on the CCTT.
- Behavior Rating Inventory of Executive Function, Second Edition (BRIEF2)* (Gioia, Isquith, Guy, & Kenworthy, 2015)
 - Moderate to large negative correlations were found between Trails-X scores and BRIEF2 scores, indicating those who performed better on the Trails-X had lower scores on the BRIEF2 (i.e., lower levels of executive function difficulties).

Performance of clinical groups

- The performance of children with acquired and developmental disorders was compared to a demographically-matched control group
- The ID and TBI groups scored significantly below the control group ($p < .01$), with large effect sizes ($d = 2.04$ and 1.41 , respectively). The LD and ADHD group did not score significantly below the control group.

Clinical group	<i>n</i>	<i>M</i>	<i>SD</i>	Mean difference	<i>d</i>
Intellectual disability (ID)	11	32.45	10.28	-17.27**	2.04
Traumatic brain injury (TBI)	10	44.90	9.04	-9.50**	1.41
Learning disabilities (LD)	11	47.64	8.95	-5.09	0.69
Attention-deficit/hyperactivity disorder (ADHD)	13	49.46	4.81	0.00	0.00