Adapted Trails-Making Task: A Developmentally Sensitive Measure for Children with Diverse Language Experiences

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INTRODUCTION

- The Trail-Making Task (TMT) is an executive function measure in adults requiring numeric and alphabetic sequencing (Tombaugh, 2004).
- The TMT is challenging for children because of their developing automaticity in identifying letters (Bialystok, 2010).
- The following trends can be observed in the TMT:
  1. response time decreases with age in children (Anderson, 2001).
  2. response time increases with alternating representations as compared to single representations reflecting the increased cognitive demands. (Anderson, 2001).

OBJECTIVE:

The present study explored the efficacy of a new, adapted, TMT for children from diverse language backgrounds who may not have automatized the English alphabetic sequence.

HYPOTHESIS:

1. Linear developmental trajectory in the adapted TMT in children.
2. Longer response times in trials with alternating representations relative to single representations.
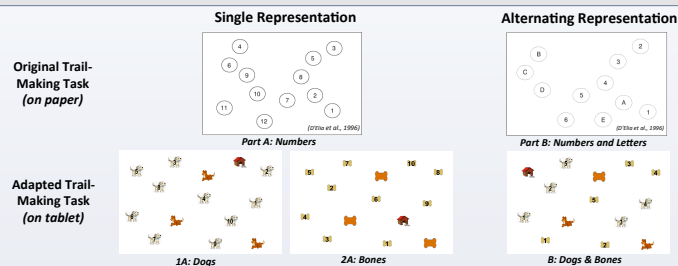3. No association between performance in adapted TMT and Verbal IQ.

METHODS

PARTICIPANTS:
- 41 children K – 2nd grade (6-8 yrs. old, m= 7 yrs., 4 mo.)
- Children attended a summer program for English Language Learners.
- Heterogeneous levels of English proficiency :
  - KBIT Verbal standard score m=75.95, IQR= 62-85.5
- Diverse Home Language Backgrounds
  - 10 Non-English Home Languages
- 25 adults (18-40 yrs. old, m=27 yrs., 8 mo.) as the comparison group

MEASURES:
- KBIT-2 (Kaufmann Brief Intelligence Test, 2nd ed., Kaufman & Kaufman, 2004), Verbal Reasoning
- Home Language Questionnaire
  - In children & adults (Luk & Bialystok, 2013)
- Experimental Tablet-based Trails Task (adapted TMT)
  - 2 stimulus sets – stars/asteroids and dogs/bones
    - Total of 9 trials per set: 3 subsets of 2 single and 1 alternating representation
    - Presented with PsychoPy software (Pierce, 2007) touchscreen tablet
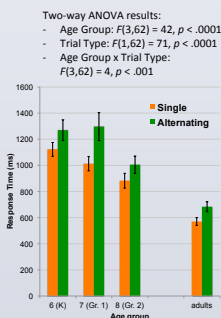   - Extracted latency in ms to each accurate touch

TRAILS TASK

Single Representation

Alternating Representation

Original Trail-Making Task *(on paper)*

Part A: Numbers

Part B: Numbers and Letters

Adapted Trail-Making Task *(on tablet)*

1A: Dogs

2A: Bones

B: Dogs & Bones

RESULTS

Result 1. There was a linear association of response time in the adapted TMT, with older children performing faster than younger ones; adults' overall performance was significantly faster than children's (p<.001, d= 2.7)

Median Reaction Time by Child Age in Months, n=41

Adult vs Child Adapted Trails Reaction Time
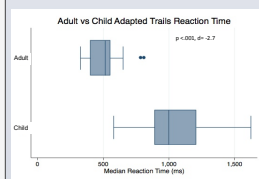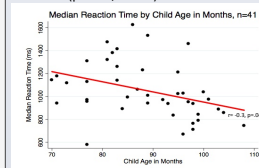
Result 2. All participants responded slower on the alternating representation trials compared to the single representation trials. The interaction suggests that trial type effect was stronger for 6- and 7-year-olds than 8-year-olds and adults.

Two-way ANOVA results:
- Age Group: $F(3,62) = 42$, $p < .0001$
- Trial Type: $F(1,62) = 71$, $p < .0001$
- Age Group x Trial Type: $F(3,62) = 4$, $p < .001$

- Single
- Alternating

Result 3. Overall, standardized scores on KBIT-2 were not associated with median response time on adapted TMT.

Child Median RT and Verbal Standard Score, n=41

Adult Median RT and Verbal Standard Score, n=25
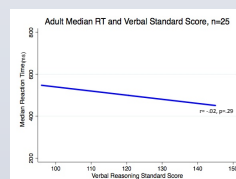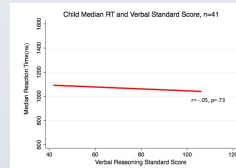
CONCLUSIONS

- Faster response times on adapted TMT has a positive relationship with child age consistent with other measures of TMT.
- Findings from adapted TMT indicate increased cognitive demands in conditions with alternating representations, consistent with traditional TMT.
- English language proficiency was not significantly associated with Trails performance in either condition.
- Results suggest that the adapted TMT is sensitive to developing executive function in children with diverse language backgrounds.

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