Developing a Measure of Cognitive Flexibility for Idiographic Data Analyses

Dian Yu, Paul A. Chase, Yerin Park, and Richard M. Lerner, Tufts University

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Institute for Applied Research in Youth Development

Background

- Traditional developmental research infers individual-level findings from population-based averages (variable-centered).
- Findings from average or aggregated data analysis may not represent individuals, resulting in ineffective policies and interventions (Rose et al., 2013).
- Bornstein's (2017) Specificity Principle suggests that development is specific to individuals, times, domains, and contexts; therefore, developmental research should use idiographic (i.e., person-specific) methods to capture individuality before data aggregation

- To move toward an idiographic approach, we must adopt measures that are sensitive to intra-individual change.
- Cognitive flexibility is the ability to shift the focus of attention flexibly according to different demands, and it is associated with key youth adjustments (Garon et al., 2008).
- Studying cognitive flexibility idiographically requires a change-sensitive measurement tool. However, none of the existing measures have been used with intensive longitudinal measures.

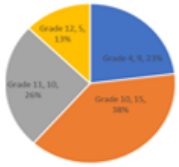
Research Goals

The Measures and Methods Across the Development Continuum (MMDC) project adapted a short version of the Dimensional Change Card Sort (DCCS) task (Zelazo et al., 2013). This study aims at examining the following two questions:

1. Can the short DCCS capture intra-individual variability across measurement occasions, and are individual trajectories sufficiently represented by trajectories of group-based averages?
2. Are there meaningful intra-individual variabilities on the day- and trial-level?

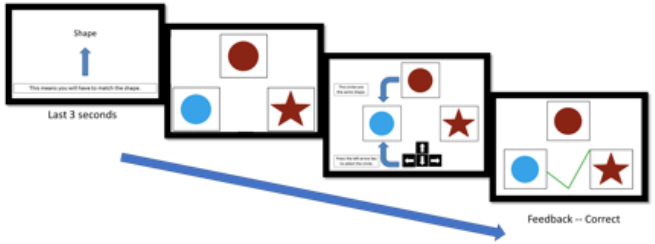
Participants & Procedure

- 39 participants from Grade 4, 10, 11, and 12 completed 30 or more measurement occasions (M = 34, SD = 2.99)
- About three times a week, participants completed the Short DCCS task on a computer in a classroom

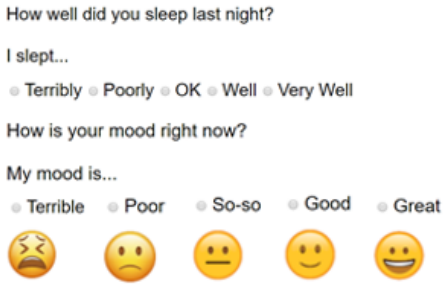


Measures

- **Cognitive flexibility** was measured via the Short DCCS Task
- The participants were asked to match the pattern either by color (5 trials) or shape (5 trials) in 10 randomized trials (see illustration below).
- Scores of the DCCS showed evidence of concurrent validity (DCCS scores were correlated with scores for another component of EF, i.e., score on a measure of response inhibition).
- The scores appeared developmentally meaningful (i.e., as expected older participants performed better than younger participants).
- Trials are categorized based on **type** as **color** (i.e., matching on color) and **shape** (i.e., matching on shape) or based on **relative order** as **shifted** (e.g., color followed by shape) and **non-shifted** (e.g., color followed by color).
- **Accuracy score** (Percentage of correct trials out of total valid trials * 10) and **median reaction time** were computed.



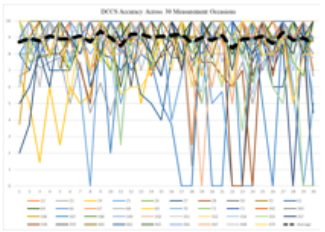
- **Sleep and mood** were measured via single Likert items
- Participants select the item that best describes how they feel at the moment (see illustration on the right)

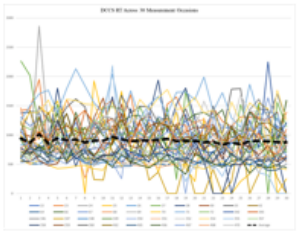


Results

Research Question 1

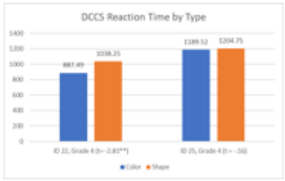
- Line graphs (on the right) of **daily DCCS accuracy scores** (correct trials out of 10) and **daily DCCS median reaction times** were created using the first 30 measurement occasions for all individuals as well as group-based average
- Trajectories of averages appeared to be stable across 30 measurement occasions, **but trajectories of individuals were fluctuating with different patterns across 30 measurement occasions!**



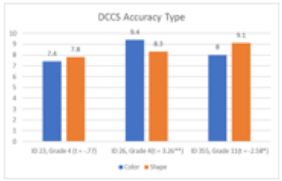


Research Question 2

- **On the day-level**, bivariate correlations between sleep and mood and DCCS performance were conducted for each individual
- Quality of sleep and mood contributed to some participants' performance variability
  - E.g., for participant #24, better mood and sleep was correlated with higher accuracy, but not correlated with reaction time
  - E.g., for participant #28, better mood and sleep was correlated with faster reaction time but not accuracy
- **On the trial-level**, independent t-tests were conducted for all trials across all measurement occasions based on trial type or relative order for each participant, respectively (see illustrations on the right).



- About half of the participants responded significantly faster to color trials than shape trials (e.g., ID 22)
- The rest did not respond differently (e.g., ID 25)



- Most participants did not demonstrate different accuracy for color and shape trials (e.g., ID 23)
- Some participants showed higher accuracy for color than shape trials (e.g., ID 26)
- Some participants shower higher accuracy for shape than color trials (e.g., ID 355)

- The order of trials did not impact the reaction time for most participants (e.g., ID 67)
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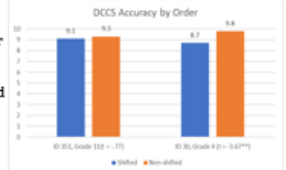

- The order of trials did not impact the accuracy for the majority of participants (e.g., ID 351)
- Several participants had higher accuracy for non-shifted than shifted trials (e.g., ID 30).

Discussion and Conclusions

- The Short DCCS task appeared to be change-sensitive and captured intra-individual variability across time
- Individual trajectories cannot be represented by trajectories of group-based averages.
- Individual variance across time are not errors that we should get rid of by creating group-based averages; instead, individual variance across time provides meaningful information!
- Specific factors (e.g., mood and sleep) can contribute to daily individual variability, and how such factors contribute to individual variability may vary from person to person.
- Developing change-sensitive tools and using idiographic approaches are necessary for developmental science, as they allow researchers to disaggregate data and draw conclusions based on individuals specifically instead of inferring group-based information.

Poster presented at the Society for Research on Adolescence on March 20, 2020. Address correspondence to: dian.yu@tufts.edu *This study is supported by a grant from the Chan Zuckerberg Initiative.*

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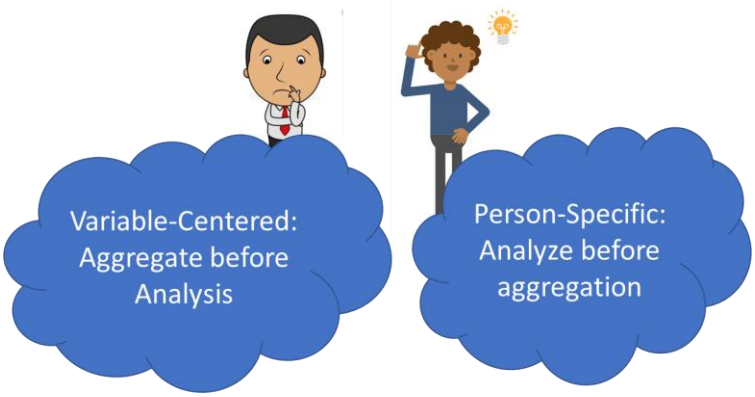

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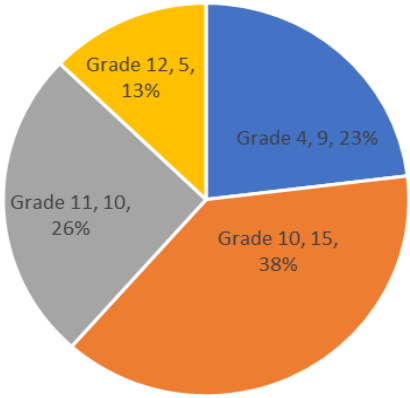

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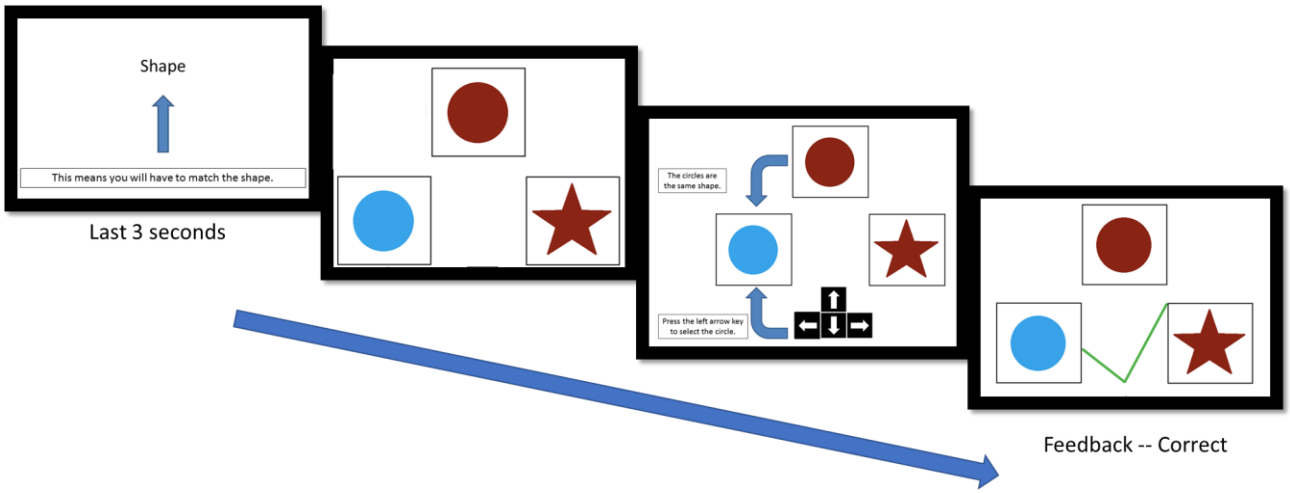

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How well did you sleep last night?

I slept...

Terrible Poorly OK Well Very Well

How is your mood right now?

My mood is...

Terrible Poor So-so Good Great

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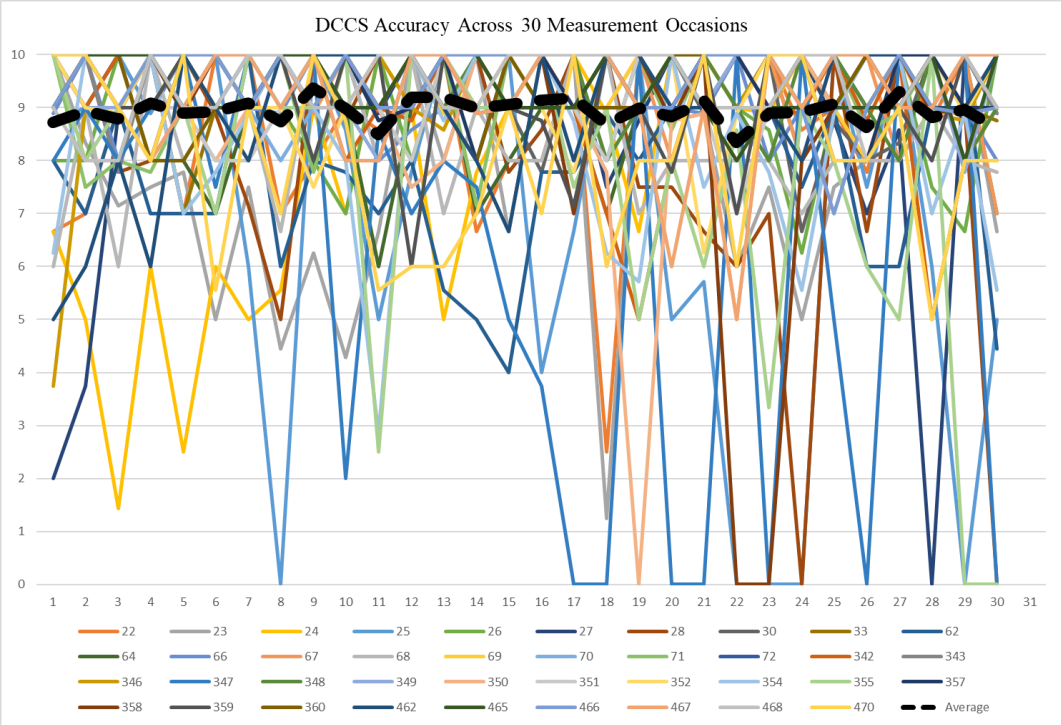

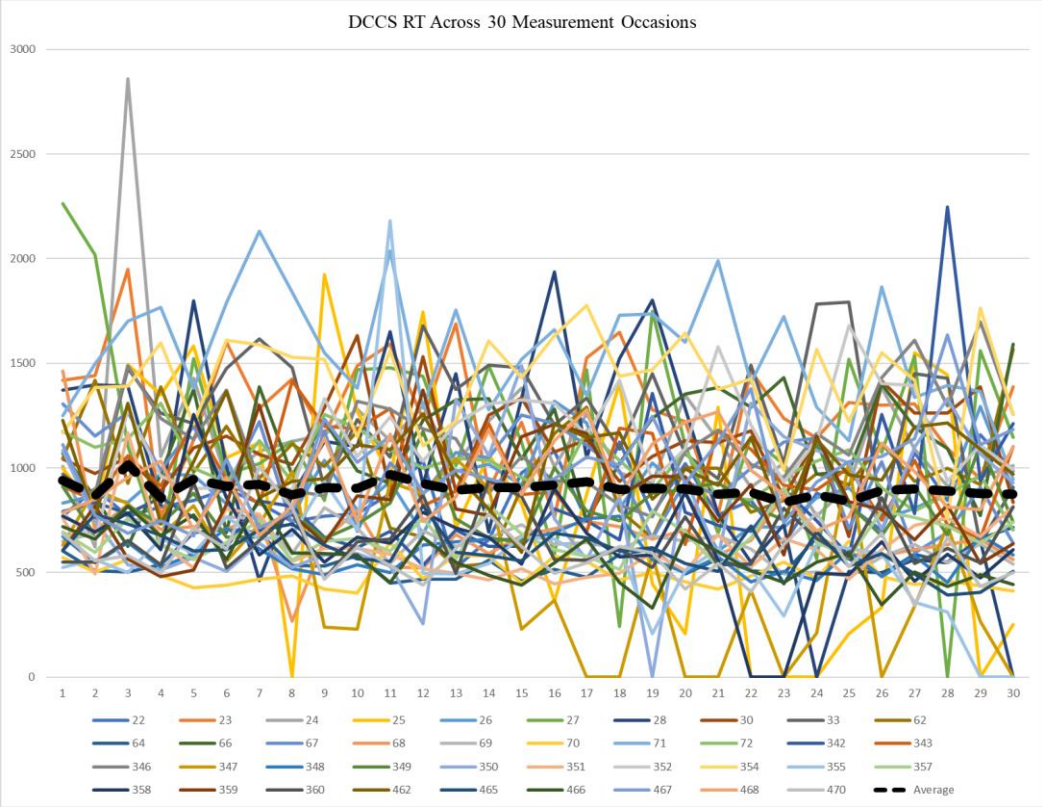

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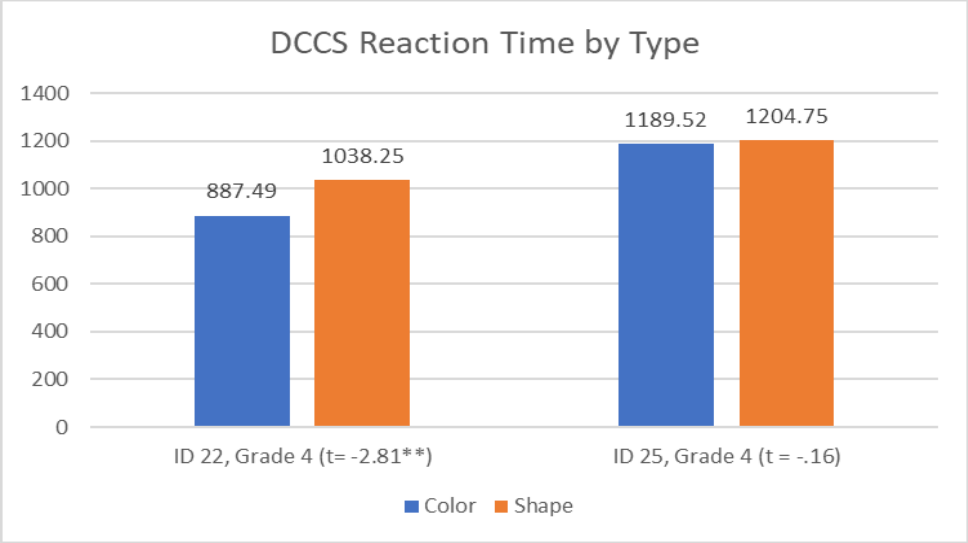

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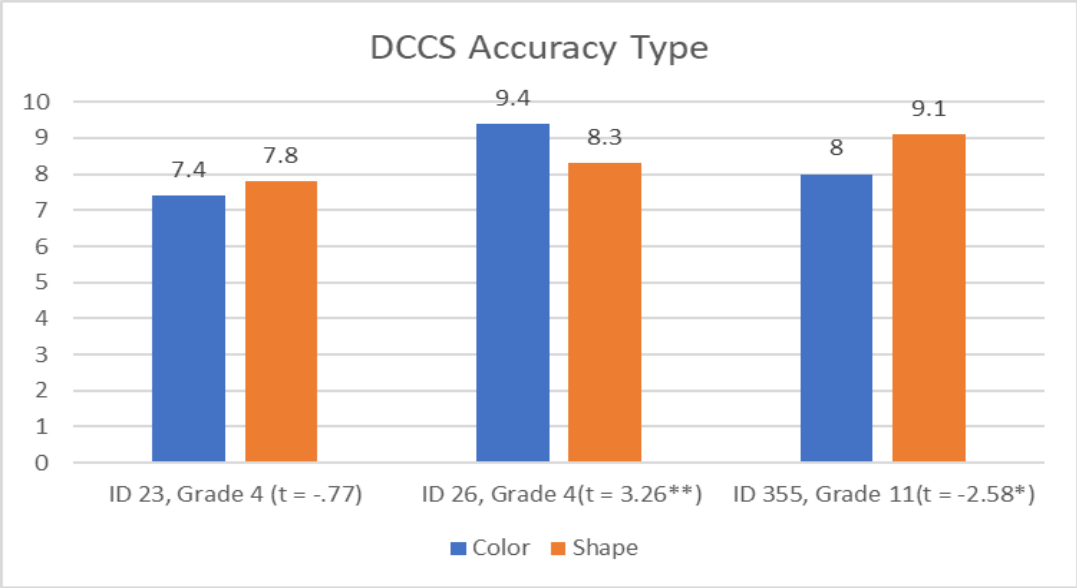

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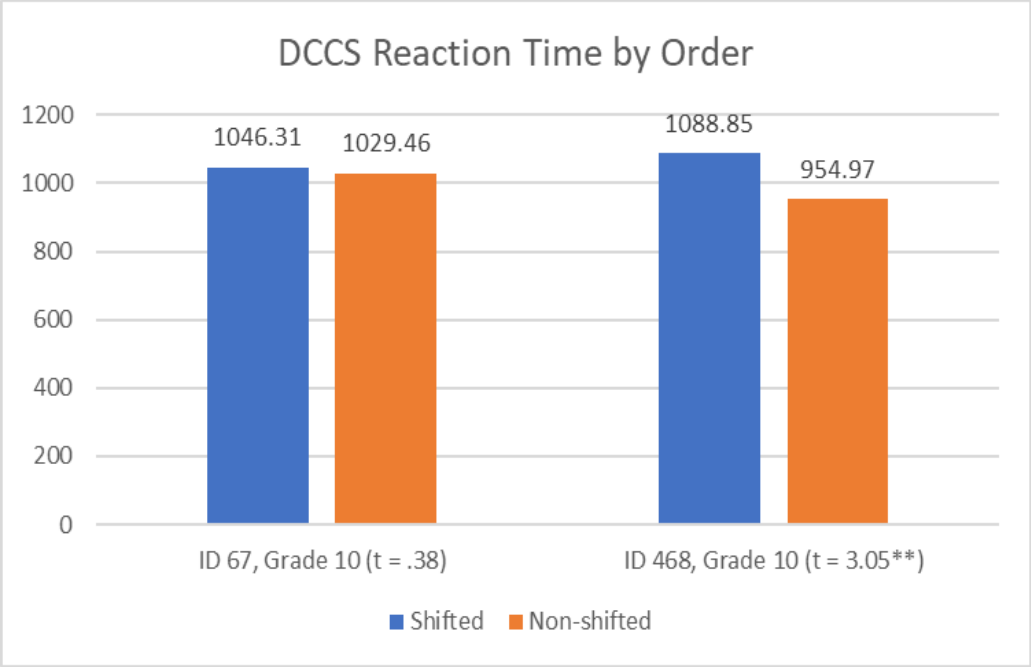

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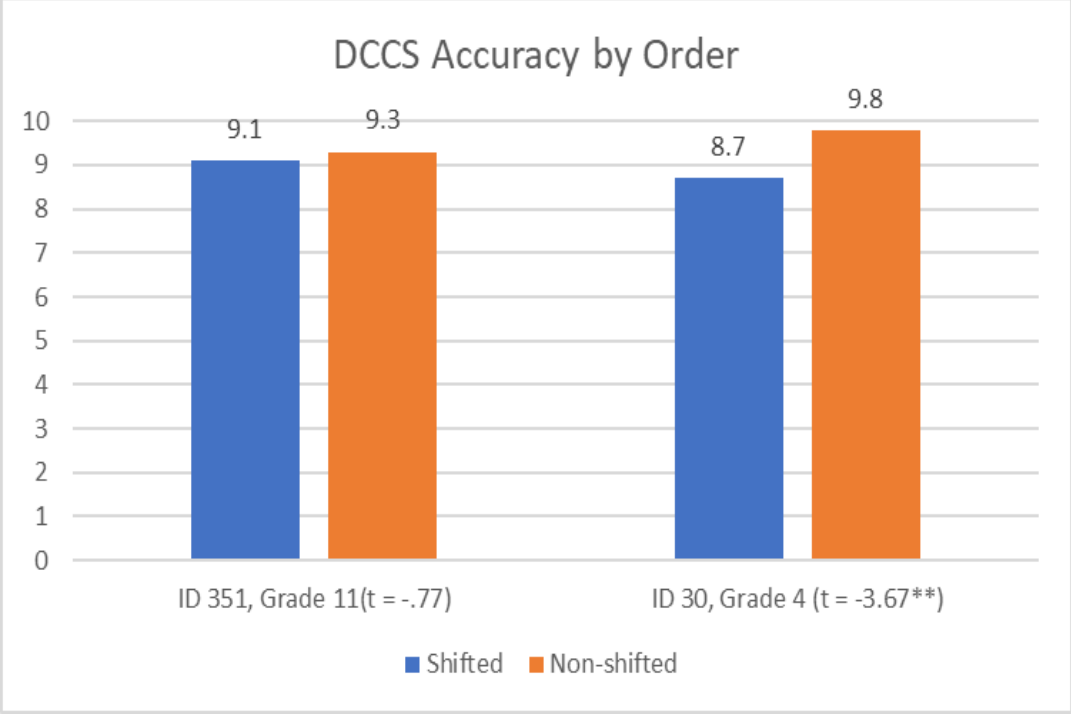

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