MAT+EF Battery (Executive Function and Math Learning)
MAT EF R&D Team
Last updated 11.5.25

MAT+EF Battery (Executive Function Skills and Math Learning)

This measure assesses students' performance on tasks related to executive functions and math skills.

Purpose
- The MAT+EF Battery provides app and web-based assessment tasks which provide insight to students' executive function skills (across domain-general and math-specific contexts), as well as their mathematics knowledge.
- The battery aims to increase equitable assessment of cognitive skills, streamline research efforts for classroom administration, and generate actionable information for educators and students to inform instruction.

Measure Details
- The MAT+EF Battery consists of 11 possible assessments, each addressing a different cognitive or mathematical process:
    - Visual Serial Attention Task: attentional control and arithmetic ability
    - Simple Corsi (Memory Span): working memory capacity
    - Complex Corsi (Memory Span): working memory processing and distraction resistance
    - Flanker: response inhibition
    - Rule Switch: set shifting, cognitive flexibility
    - Cancellation: concentration ability
    - Countermanding: inhibitory control
    - Numerical Stroop: inhibitory control
    - Magnitude Comparison: magnitude understanding and inhibitory control
    - Number Line Estimation: rational number
    - Math Fact Fluency: fluency via speed and accuracy on arithmetic problems
- Within each task, students experience multiple demonstration and practice trials before beginning the assessment.
- Data collected within each task depends on the construct under measurement, and can include speed, accuracy, and scores of earned points.

Contribution to the Field
- The creation of this battery of assessments advances the existing executive function measures in the field through access and feasibility. Research efforts on executive function skills often use clinical assessments, and research has primarily been conducted outside of classroom learning contexts. This set of measures aims to increase the ability for researchers and educators to gather data regarding students' executive function skills through streamlined apps or web browsers and their associated technical systems for gathering and analyzing student data.

- In addition, this set of measures provides a direct link between executive function skills and mathematics knowledge. The battery allows for data to be collected from students on both sets of measures, affording more precise analyses of relationships between constructs. The set of executive function skill assessments also provide a mix of domain-general and math-specific contexts for the tasks students complete, which enables exploration of hypotheses around the context-dependent nature of executive function skills and questions of transfer.

Development History and Previous Uses
- While also available as a standalone assessment, a subset of the MAT+EF battery of assessments has been integrated within an app-based math learning product for elementary students, demonstrating the feasibility of a seamless assessment process that can mitigate assessment bias and minimize data loss, especially for younger research participants.
- The assessment battery has also tested an integrated adaptive machine learning algorithm, which offers the possibility to optimize the assessments and subsequent trials needed to gather a predictive model of student performance.
- Several of the MAT+EF battery of assessments have been used in researcher-led efficacy studies of the above-mentioned math learning product, MathFluency+, to understand their executive functioning skills in domain-general and math-specific contexts, alongside their development of math fact fluency. In addition, the integrated version of the app has been used within a mid-to-large scale evaluation study of the product. All of these studies have been conducted with demographically and geographically diverse samples of 4th and 5th grade students.
- Ten unique assessments in the web-based MAT+EF battery have been validated against the app-based version with a population of undergraduate students, alongside usability and feasibility testing.
- Several of the assessments in the battery have been co-designed with elementary students and educators to improve interest, engagement, and utility in supporting learning.

Accessing the Measure

- To access the measure, please contact:
  - [The Brain Game Center for Mental Fitness and Well-Being](#) at bgc@northeastern.edu
  - Dr. Susanne Jaeggi at s.jaeggi@northeastern.edu
  - Dr. Aaron Seitz at a.seitz@northeastern.edu

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Associated Publications

Buschkuehl, M., Feng, Y., Pahor, A., & Jaeggi, S.M. (2024, November 21-24). On the relationship of math and executive functions [Poster Presentation]. Psychonomic Society Annual Meeting. New York, NY.

Buschkuehl, M., Feng, Y., Ramani, G.B., Grose, G., & Jaeggi, S.M. (2023, June). ST Math Fluency+: The impact of combined math fact fluency and executive function. In G. Ramani (Chair), Equity-focused programs to measure and promote math learning and executive functioning. [Paper Presentation]. The 6th Annual Meeting of the Mathematical Cognition and Learning Society (MCLS), Loughborough, United Kingdom.

Collins, C. L., Pina, A., Carrillo, A., Ghil, E., Smith-Peirce, R. N., Gomez, M., Okolo, P., Chen, Y., Pahor, A., Jaeggi, S. M., & Seitz, A. R. (2022). Video-Based Remote Administration of Cognitive Assessments and Interventions: a Comparison with In-Lab Administration. Journal of cognitive enhancement : towards the integration of theory and practice, 6(3), 316−326. https://doi.org/10.1007/s41465-022-00240-z

- ○ Also available at:
  https://pmc.ncbi.nlm.nih.gov/articles/PMC8806014/pdf/13428_2021_Article_1765.pdf

Feng, Y, Buschkuehl, M., Grose, G., Jaeggi, S. M., Ramani, G., Ghil, E., DePascale, M. (2022, June 1-3). Testing the benefits of an embedded math fluency and executive function intervention in children [Poster Presentation]. Annual Mathematical Cognition and Learning Society Conference, Antwerp, Belgium.

Pahor, A., Mester, R.E., Carillo, A.A., Ghil, E., Reimer, J.F., Jaeggi, S.M., & Seitz, A.R. (2022). UCancellation: A new mobile measure of selective attention and concentration. Behavior Research Methods, 54, 2602-2617. https://doi.org/10.3758/s13428-021-01765-5

Pahor, A., Seitz, A.R. & Jaeggi, S.M (2023). Author Correction: Near transfer to an unrelated N-back task mediates the effect of N-back working memory training on matrix reasoning. *Nature Human Behavior, 7,* 292. https://doi.org/10.1038/s41562-022-01514-4