MINNESOTA EXECUTIVE FUNCTION SCALE

MEFS® TECHNICAL REPORT 2026

v. 07.26..26

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Overview of the Minnesota Executive Function Scale

Executive function (EF) is the brain basis of self-control. Recent research has shown that EF is an essential foundation for academic readiness and achievement, as well as lifelong positive outcomes.

The Minnesota Executive Function Scale (*MEFS®*) is a standardized assessment of EF skills designed for children ages 2 and up with child-friendly graphics, avatars, and child-directed instructions (Figure 1). It is administered individually on a touch-screen tablet or a computer (fully browser based). The assessment is adaptive (starting point depends on age) and takes 2-7 minutes to complete (median ~ 4 minutes). The *MEFS* is easy to learn how to administer in a brief online training session.

The *MEFS* was developed by two of the world's leading researchers in the domain of executive function (Stephanie Carlson and Philip Zelazo) and is based on the latest developmental neuroscience. It has been used in hundreds of research studies around the world and has contributed to most current knowledge of EF development. The *MEFS* was normed in the United States in 2014 (*N* = 1,400 ages 2-6), updated in January 2017 (*N* = 7,410 ages 2-13, plus 553 adults), April 2019 (*N* = 32,800 ages 2-17.9, plus 1,370 adults), and December 2020 (*N* = 51,424 ages 2-17.9, plus 1,815 adults). This report summarizes the updated norms on data collected through December 2025 (*N* = 102,112 ages 2-17.9, plus 5,722 adults).

The *MEFS* has been...

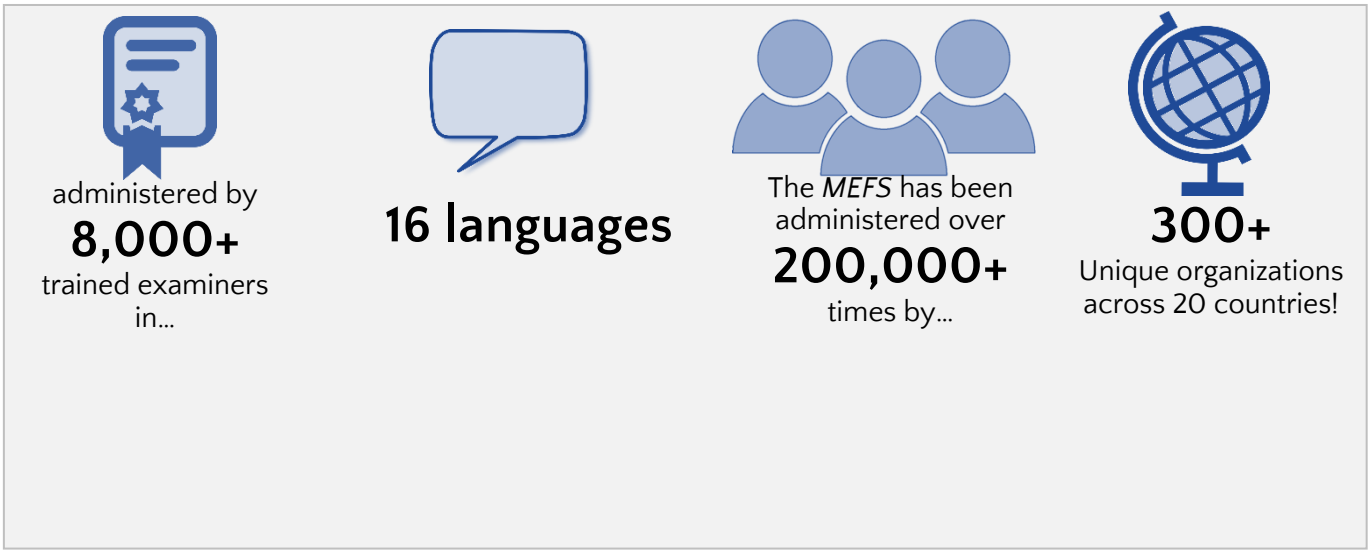
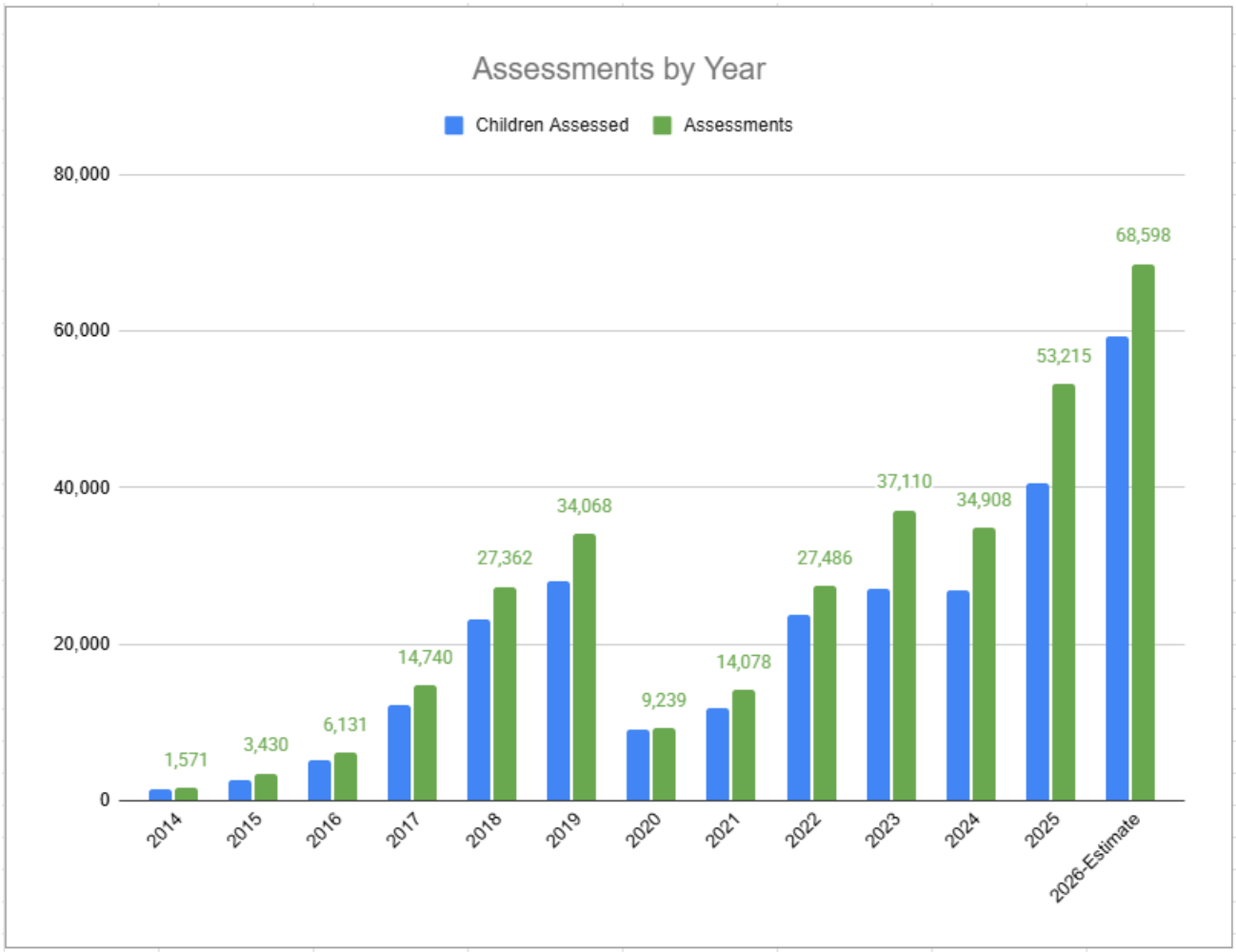


Figure 1. Example of the iPad version of the *MEFS*

Figure 2. MEFS Usage Since 1st Release



Both individual and group reports are automatically computed and immediately available following testing through a secure cloud-based web server (Figure 3).

Figure 3a. User and Data Flow

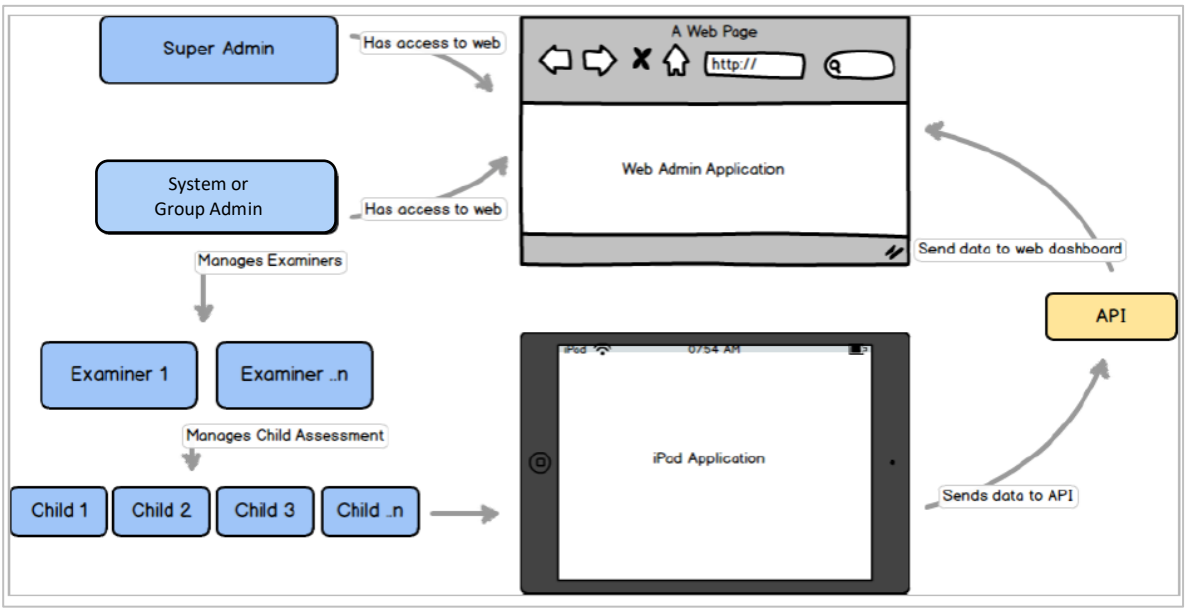
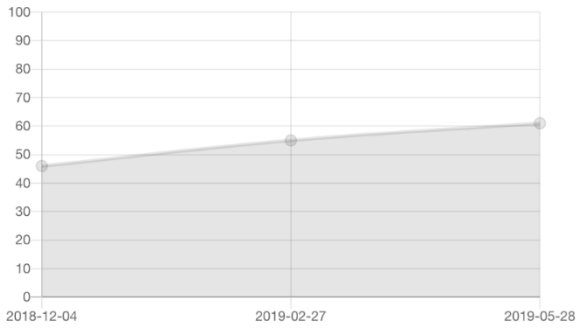
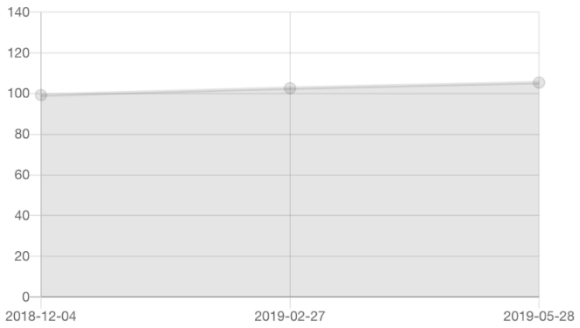


Figure 3b. Web Portal Display of Growth in Scores for an Individual Child

Total Score Trend



Standard Score Trend



Assessments

ID	Date	Total Score	Standard score	Total Assessment Time	Action
	2018-12-04	46	99	5m 14s	
	2019-02-27	55	103	4m 1s	
	2019-05-28	61	105	4m 26s	

⚠ : Indicates an invalid assessment.

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Technical Requirements

The *MEFS* operates on tablets (iPad and Android) and computers. Mobile phones are not recommended due to screen size. It can be downloaded from the iTunes App Store (search for *"MEFS"*) or the Google Play Store (search for "*Minnesota EFS"*). Only qualified users will receive a personal login from Reflection Sciences. The tablet must be connected to internet Wi-Fi for the *MEFS* to operate. A Wi-Fi "hotspot" is recommended for remote areas.

Performance Outcomes

Highest Level Passed
- Highest full level where child is correct on at least 80% (the passing criterion) of trials for both sets of rules, 0-7

Basal Level
- Lowest level administered where child was able to pass both sets of rules

Ceiling Level
- Highest level where the child fails

Total Score
- Takes both trial accuracy and response time into account using a proprietary algorithm, 0-100

U.S. National Percentile
- Comparison with national norms on the Total Scores of same-age children (in months), 0-100

National *z*-score
- Standardized score referencing the national norms

National Standard Score
- National *z*-score converted to a Standard Score (M = 100; SD = 15)

3 Subscale Scores (derived from the same single assessment)
- Working Memory; Impulse Control; Cognitive Flexibility

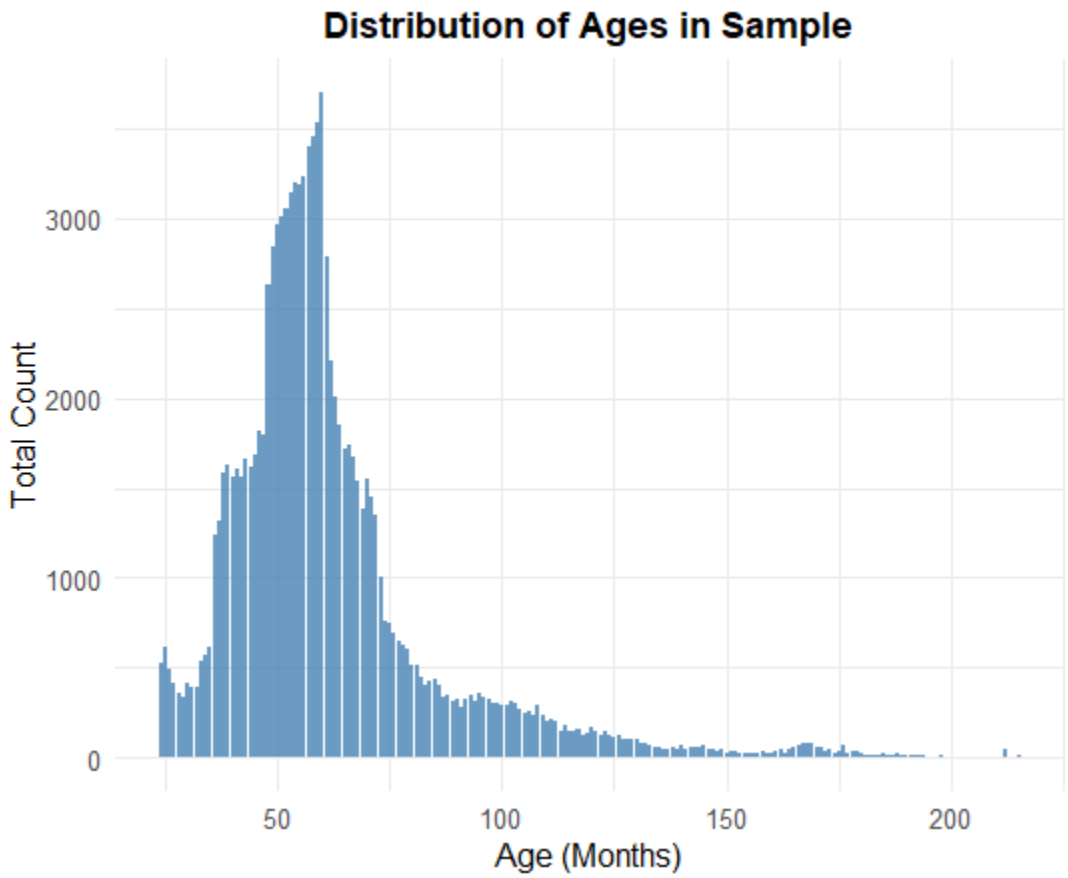
Local *z*-score
- Standardized score based on the local sample mean on Total Scores

Updated U.S. Norms in 2026

Youth Norms were computed based on data from typically developing children ages 2-17.9 years in the U.S. in the *MEFS* database as of December 31, 2025. Data were excluded for: locations outside of the U.S.; hospital/clinic settings; practice/training cases; examiner errors; non-English administration; and children receiving special education services or having a known developmental disorder. Only the first assessment per person was included. The resulting analytic samples included 102,112 cases for Youth Norms and 5,722 cases for Adult Norms.

Youth completed the *MEFS* between July 16, 2014 and December 31, 2025. Figure 4 shows a distribution of ages for data used in the norming.

Figure 4. Histogram of Ages (in months) included in the Youth Norms



From the plot, we see that the majority of youth tested were under 100 months (8.33 years) of age. The mean age was 62.44 months (median = 57 months) among youth records (under 18 years of age). Therefore, older ages were grouped into bands to create more reliable norms.

Basic demographic information about students was collected for the norming, including Gender, Race/Ethnicity, and Zip Code. Scores were weighted by Zip Code to create a geographically representative sample. As seen in Table 1, data from Minnesota, New Mexico, and Indiana were over-represented in the sample. Thus, the results were weighted accordingly to de-emphasize over-represented regions and weigh the other regions more heavily.

Next, a smoothing model was applied to remove any inconsistencies from the sample. The smoothing model utilized Age and the log-odds of the Total Score, resulting in a continuous matrix of percentiles representing each possible *MEFS* score (0-100) crossed with each age (in months) from 2-17.9 years (Youth Norms).

The **Gender** distribution of the Youth Norms was nearly even, with 49% identifying as female (Table 2). There was a small but statistically significant gender difference favoring girls, who scored 2.45 points higher than boys on the MEFS on average, $p < .001$. Gender explained only 0.27% of the variance in performance. Nonetheless, to provide the most accurate reference points for Standard Scores and National Percentiles, we computed separate norms for males and females. (Non-binary and non-specified gender reference combined overall norms.)

Race and Ethnicity of the individuals included in the Youth Norms were identified using the NIH taxonomy (Tables 4a and b; Figure 5). Because ethnicity is an optional field on the *MEFS* registration page, this information was unavailable for a substantial proportion of children (50,319; 49%). Among participants reporting race/ethnicity, relative to 2023 American Community Survey (ACS) estimates for

U.S. children and adolescents, the norming sample included comparable proportions of White and Asian youth, proportionally more Black/African American, Native/Aboriginal, and Hawaiian/Pacific Islander youth, and proportionally fewer Hispanic/Latino and multiracial youth (Table 3a). Because respondents could endorse multiple race/ethnicity categories, these comparisons should be interpreted as approximate benchmarks.

Socioeconomic Status was estimated using the Zip Code Tabulation Area (ZCTA) record of the proportion of residents with children under age 18 living below the federal poverty line in a given ZCTA in the 2023 American Community Survey (ACS) 5-year estimates (U.S. Census Bureau). These data are shown in Table 4. Among participants with valid ZIP code matches, 86.4% resided in areas with child poverty rates below 10%, and 13.6% resided in areas with poverty rates between 10% and 20%. Few participants were represented from areas with child poverty rates above 20%. These estimates should be interpreted cautiously, as some organizations using the *MEFS* will enter their institution's Zip Code either because they do not know the child's residential zip code or because they are required to mask Personally Identifiable Information.

Youth Norms

Table 1. Geographical Locations in the Youth Norms

State	*N*	Percent
Alabama	314	0.308%
Arizona	1,946	1.906%
Arkansas	956	0.936%
California	2,701	2.645%
Colorado	491	0.481%
Connecticut	3,946	3.864%
District of Columbia	1,421	1.392%
Delaware	153	0.150%
Florida	151	0.148%
Georgia	2, 217	2.171%
Illinois	1,778	1.741%
Indiana	10,592	10.373%
Iowa	102	0.100%
Kansas	248	0.243%
Kentucky	488	0.478%
Louisiana	66	0.065%
Maine	173	0.169%
Maryland	667	0.653%
Massachusetts	5,459	5.346%
Michigan	1,678	1.643%
Minnesota	13,390	13.113%
Mississippi	348	0.341%
Missouri	128	0.125%
Nebraska	9,276	9.084%
New Hampshire	35	0.034%
New Jersey	1,541	1.509%
New Mexico	14,910	14.602%
New York	6,439	6.306%
North Carolina	668	0.654%
Ohio	7,670	7.511%
Oklahoma	1,390	1.361%
Oregon	20	0.020%
Pennsylvania	705	0.690%
South Carolina	237	0.232%
Tennessee	14	0.014%
Texas	6,321	6.190%
Utah	311	0.305%
Virginia	255	0.250%
Washington	1,003	0.982%
Wisconsin	1,833	1.795%
Wyoming	68	0.067%
Not Specified	3	0.003%

Table 2. Gender in the Youth Norms

Gender	*N*	Percent
Female	49,628	48.606%
Male	48,894	47.887%
Gender Diverse	1,390	1.361%
Not Specified	9	0.009%
Prefer Not to Say	2,191	2.146%

Table 3a. Race/Ethnicity in the Youth Norms

Note. Race/Ethnicity was optional and therefore not reported on 50,319 (49.278%) of the norming sample.

Race/Ethnicity	*N*	Percent of Reported	U.S. ACS 2023 (Youth)
Asian	2,454	4.738%	5.30%
Black/ African	11,399	22.009%	13.90%
Hawaiian/ Pacific Islander	219	0.423%	0.20%
Hispanic or Latino	5,258	10.152%	26.50%
Multi-racial	630	1.216%	5.70%
Native/ Aboriginal	946	1.827%	1.00%
White/ Caucasian	25,013	48.294%	49.80%

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Table 3b. Details of the 2+ Races in Youth Norms

Ethnicity	*N*	Percent of Reported
White, Hispanic	2,808	5.422%
Asian, White	71	0.137%
Black, White	414	0.799%
Black, Hispanic	291	0.562%
Asian, Black	29	0.056%
Asian, Hawaiian	24	0.046%
Native Am, White	40	0.077%
Asian, Hispanic	43	0.083%
Black, White, Hispanic	4	0.008%
Hawaiian, White	18	0.035%
Native Am, Black	28	0.054%
Native Am, Black, White	8	0.015%
Asian, Black, White	14	0.027%
Asian, White, Hispanic	26	0.050%
Native Am, White, Hispanic	24	0.046%
Hawaiian, Hispanic	20	0.039%
Asian, Hawaiian, White	7	0.014%
Hawaiian, Black	6	0.012%
Native Am, Hispanic	148	0.286%
Asian, Black, White, Hispanic	4	0.008%
Native Am, Asian, White, Hispanic	3	0.006%
Asian, Black, Hispanic	3	0.006%
Hawaiian, Black, White	3	0.006%
Native Am, Black, White, Hispanic	4	0.008%

Figure 5. Ethnicity in Youth Norms

Note. Percentages reflect the distribution of reported race/ethnicity among youth participants. This information was missing or unreported for 49.3% of the total sample.

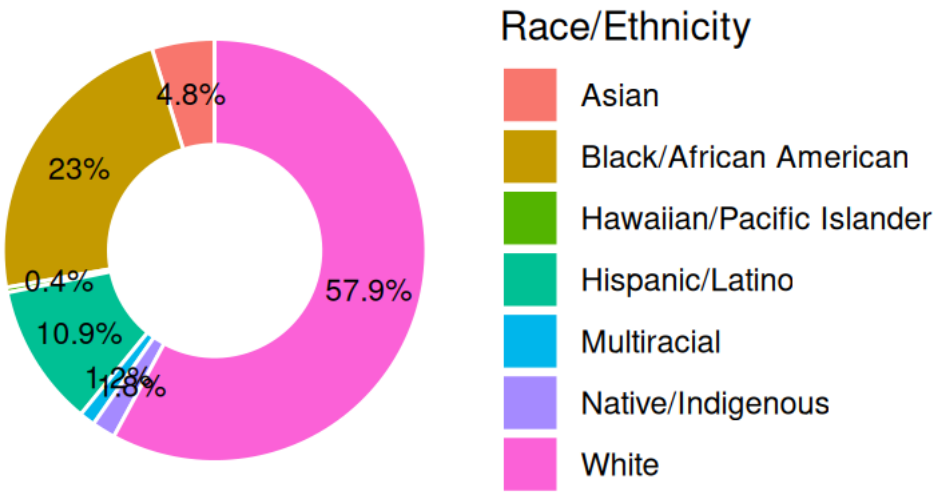


Table 4. Socioeconomic Status in Youth Norms

Note. Zip codes could not be matched in the 2023 U.S. Census Bureau American Community Survey (ACS) data on 27,807 (27.232%) of the norming sample.

Percent Poverty in ZCTA	*N*	Percent
0–10%	64,218	86.426%
10%–20%	10,086	13.574%
>20%	1	0.001%

Adult Norms

An additional sample of 5,722 adults also were included for separate Adult Norms on the *MEFS*. The same exclusion criteria pertained for adult norms. Geographical representation is shown in Table 5. As with the Youth sample, Minnesota was over-represented and thus under-weighted in the norming process. Given that most adults tested were parents or teachers who participated along with their students, the majority were female between the ages of 30-39 years (Tables 6 and 7). Nonetheless, *MEFS* Total Scores were sorted into age bins according to performance, then smoothed and converted into Standard Scores and Percentiles to create age-adjusted Adult Norms (not gender-adjusted).

Of the adults, 4,196 (73.33%) did not report their Race/Ethnicity. Among those who did, the non-White groups were over-represented compared to the 2023 U.S. American Community Survey (ACS) (Table 8). In terms of Socioeconomic Status, ZCTA-derived poverty estimates indicated that 38.85% of participants resided in low-poverty areas (<10% poverty). The remainder were distributed across moderate- to high-poverty areas, including 14.80% in 10–20% poverty, 11.15% in 20–30% poverty, 9.30% in 30–40% poverty, and 10.42% in areas with ≥40% poverty (Table 9).

Table 5. Geographical Locations in the Adult Norms

State	N	Percent
Alabama	550	9.61%
Arizona	19	0.03%
Arkansas	2	0.33%
California	53	0.93%
Colorado	4	0.07%
Connecticut	29	0.51%
Delaware	2	0.03%
Florida	3	0.05%
Georgia	36	0.63%
Idaho	1	0.02%
Illinois	202	3.53%
Indiana	7	0.12%
Maryland	76	1.33%
Massachusetts	50	0.87%
Minnesota	2871	50.17%
Missouri	196	3.43%
Nebraska	101	1.77%
New Jersey	5	0.09%
New York	1485	25.95%
Ohio	3	0.05%
Oregon	1	0.02%
Pennsylvania	3	0.05%
Washington	20	0.35%
Wisconsin	1	0.02%
Not Specified	2	0.03%

Adult Norms Continued

Table 6. Gender in the Adult Norms

Gender	N	Percent
Female	5,014	88.618%
Male	644	11.382%

Table 7. Ages in the Adult Norms

Age (Years)	N	Percent
<20	107	1.87%
20 - 24	373	6.52%
25 - 29	861	15.05%
30 - 34	1132	19.78%
35 - 39	1100	19.22%
40 - 44	1024	17.90%
45 - 49	590	10.31%
50 - 54	256	4.47%
55 - 59	120	2.10%
60 - 64	73	1.28%
65 - 69	41	0.72%
70+	45	0.79%
Total	5,722	100%

Table 8. Race/Ethnicity in the Adult Norms

Note. Race/Ethnicity was optional and therefore not reported on 4,196 (73.33%) of the norming sample.

Race/Ethnicity	N	Percent of Reported	U.S. ACS 2023 (Adult)
Asian	61	3.997%	6.7%
Black/African	449	29.423%	12.3%
Hawaiian/Pacific Islander	2	0.131%	0.25%
Hispanic or Latino	244	15.990%	18.8%
Multiracial	1	0.066%	2.8%
Native/Aboriginal	37	2.425%	0.7%
White/Caucasian	723	47.379%	60.5%

Table 9. Socioeconomic Status in the Adult Norms

Note. Zip codes could not be matched in the 2023 U.S. Census Bureau American Community Survey (ACS) data on 886 (15.484%) of the norming sample.

Percent Poverty in ZCTA	N	Percent
0-10%	2,223	38.850%
10%-20%	847	14.803%
20%-30%	638	11.150%
30%-40%	532	9.297%
40%>	596	10.416%

Reliability

The former table-top *MEFS* showed excellent test-retest reliability (*N* = 151 children ages 2.5-5 years, *ICC* = .93), meaning that results for a child tested twice within a short period of time (same day) tended to remain exactly the same, and there are no practice or fatigue effects (Beck et al., 2011). The table-top and tablet versions of the *MEFS* have been tested on the same group of children ages 2-5 (*N* = 85) and the results were nearly identical (*ICC* = .95), suggesting the digital version is similarly reliable.

A computerized version of Levels 4 and 5 have been subjected to retest reliability with a 2-week gap in children ages 3-15 years and was found to be reliable, *ICC*(48) = .92 (NIH Toolbox; Zelazo & Bauer, 2013).

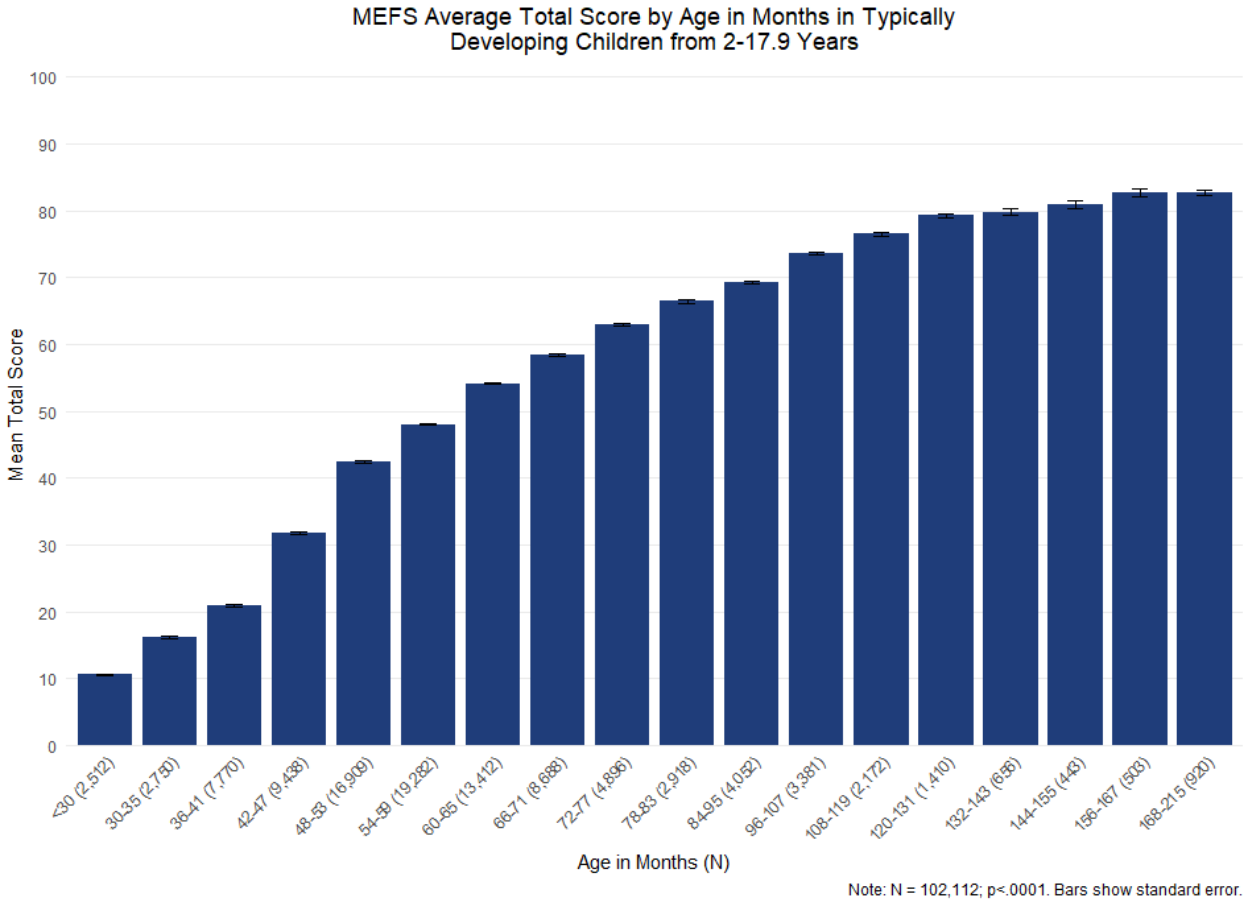
The *MEFS* norming database contains some children aged 2+ years who were re-tested. We selected the sample that was re-assessed between 11 and 90 days after the first test (to limit the effects of age changes). The results for Total Scores met reliability standards, *ICC*(2,034) = .73, $p < .0001$. It should be noted that these children were enrolled in a variety of research studies and/or early childhood programs that could be considered interventions for EF, which will tend to reduce reliability estimates.

Validity

The *MEFS®* is shown to be a valid measure of EF across both laboratory and field based studies.

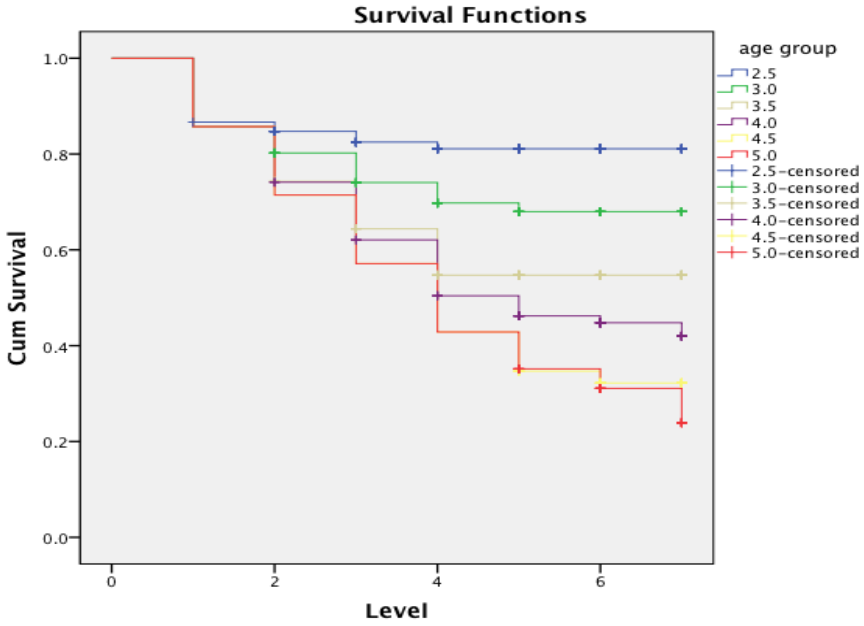
Construct Validity. The *MEFS* reliably captures the well-known age trends in EF (Figure 6).

Figure 6. Age-related improvement on *the MEFS®*



A study in which children were given all 7 levels of the *MEFS* regardless of their age showed that the scale of difficulty is ordered correctly and evenly, as illustrated in this survival analysis (*N* = 86) (Figure 7).

Figure 7. Scale Analysis of the *MEFS* in Preschool Children



Convergent Validity. Performance on the *MEFS* is significantly correlated with the most commonly used research measures of EF, even after controlling for age and IQ, including the NIH Toolbox DCCS, the 60-minute EF battery developed by researchers at NYU and UNC-Chapel Hill (referred to here as EF Touch), and the Head-Toes-Knees-Shoulders (HTKS) task (Table 10).

Table 10. Correlations between the *MEFS* and Other Measures of EF

	MEFS App ™	**NIH DCCS**	**NIH FLNK**	**EF Touch**
DCCS	.64** (.30*)			
FLNK	.57** (.19)	.60** (.35**)		
EF Touch	.73** (.34**)	.52** (.06)	.57** (.18)	
HTKS	.77** (.53**)	.63** (.36**)	.48** (.12)	.66** (.32**)

N = 124; Ages = 2.5-5; Partial correlations controlling for age and IQ are shown in parentheses.

Another form of convergent evidence suggests that the brain is working the same way when performing the *MEFS* as when performing other well-established laboratory measures of EF, and better performance is correlated with more mature frontal EEG power (lower theta; higher beta) after controlling for age (Perone, Palanisamy, & Carlson, 2018). Furthermore, when children are trained on EF, they perform better on an early version of the *MEFS* and their brains show more mature patterns of activity (Espinet, Anderson, & Zelazo, 2013).

Divergent Validity. The *MEFS* is moderately related to IQ (Stanford Binet Early 5 Abbreviated IQ), but predicts achievement over and above IQ (Tables 12 and 19).

Criterion Validity. The *MEFS* is much briefer, easier to administer, and is more strongly predictive of kindergarten readiness (Woodcock Johnson NU-III literacy and math subtests) than other measures, even when controlling for age and IQ (Table 11).

Table 11. Concurrent Prediction of Academic Achievement

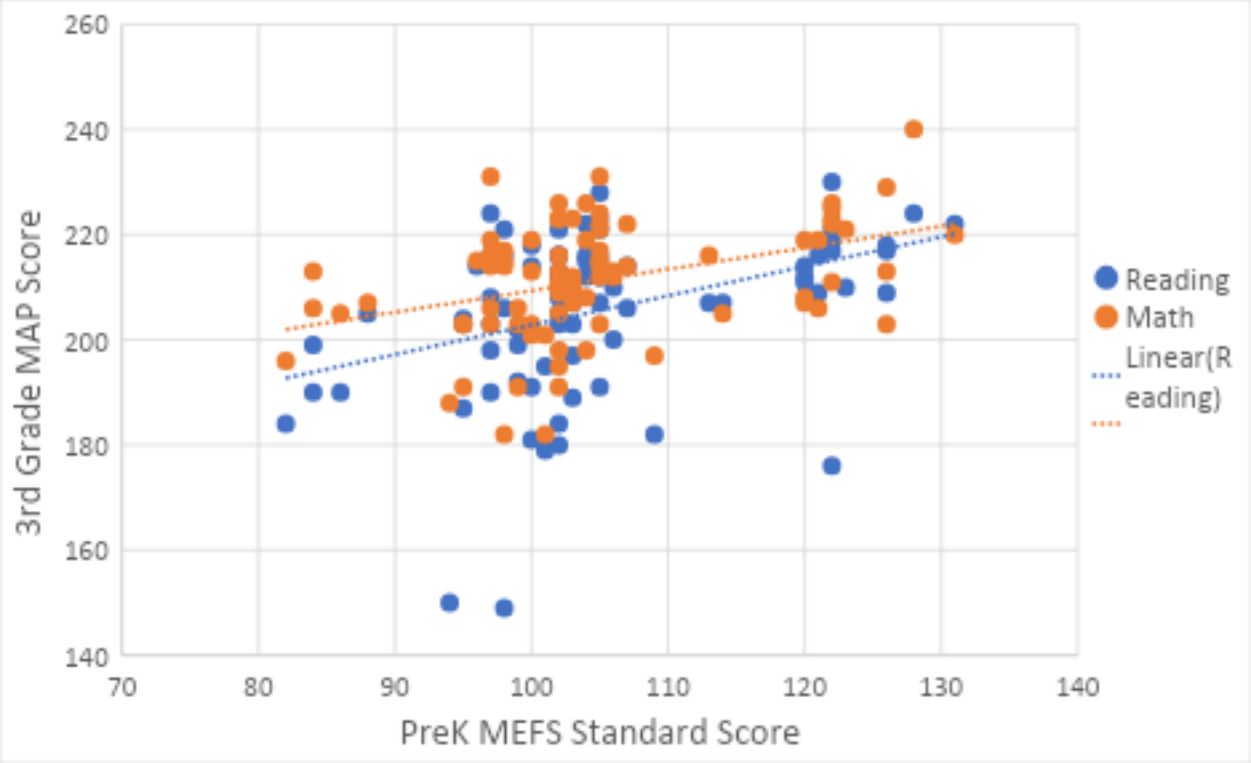
	Age	Sex	SB-IQ	M Educ	Income	WJ-Letter/Word	WJ-Applied Probs
MEFS App™	.75**	.01	.08	-.06	-.12	.64** (.29**)	.75** (.38**)
NIH DCCS	.61**	-.07	.12	-.12	.05	.48** (.11)	.58** (.16)
NIH FLNK	.58**	.04	.16	-.27*	.08	.50** (.17)	.57** (.16)
EF TOUCH	.73**	.08	.18	-.10	.03	.57** (.16)	.70** (.24)
HTKS	.66**	-.03	.06	-.03	-.10	.59** (.28*)	.64** (.26*)

N = 124; Ages = 2.5-5; Partial correlations controlling for age and IQ are shown in parentheses.

The *MEFS* has been proven to predict Kindergarten reading level, math, and concentration skills (NYC Case Study). Grenell and Carlson (2021) found that children with stronger EF as measured by the *MEFS* were able to learn new STEM material more readily, even when controlling for age, IQ, and prior knowledge. An independent lab also showed that the *MEFS* predicted 1st grade math achievement, over and above kindergarten math performance (Hassinger-Das et al., 2014). This finding implies that children with higher *MEFS* scores actually learn more over the course of the year than other children in the same classroom. Thus, the *MEFS* can be accurately described as a valid "readiness" indicator.

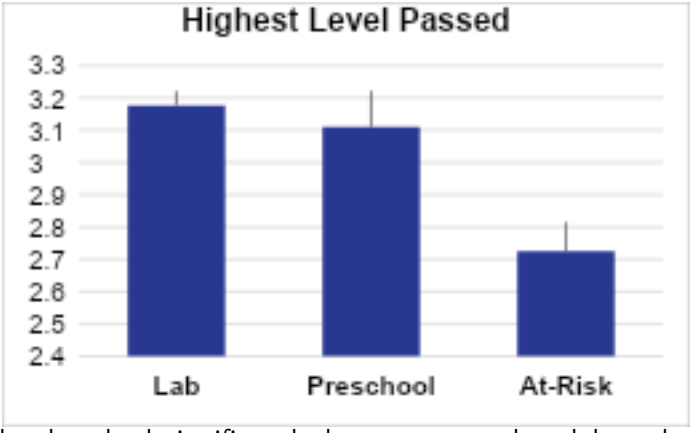
In a school district that administered the *MEFS* to all its incoming preschool students during Kindergarten Round-up (Spring and Summer before starting school), they found that it significantly predicted 3*rd* grade reading (*r* = .39) and math (*r* = .39) achievement, as measured by the Measures of Academic Progress (MAP by NWEA), four years later (Figure 8; *N* = 82). For every 1-point increase on the *MEFS* Standard Score, MAP Reading scores increased by .56, and Math scores increased by .41. These results held true for girls (*n* = 39) and boys (*n* = 43) and for Free/Reduced Lunch (25%) as well as non-subsidized students. These results are important because Grade 3 is considered a major milestone in the prediction of all later academic achievement and educational attainment (Hernandez, 2011).

Figure 8. MEFS in Preschool Predicts 3rd Grade Reading and Math



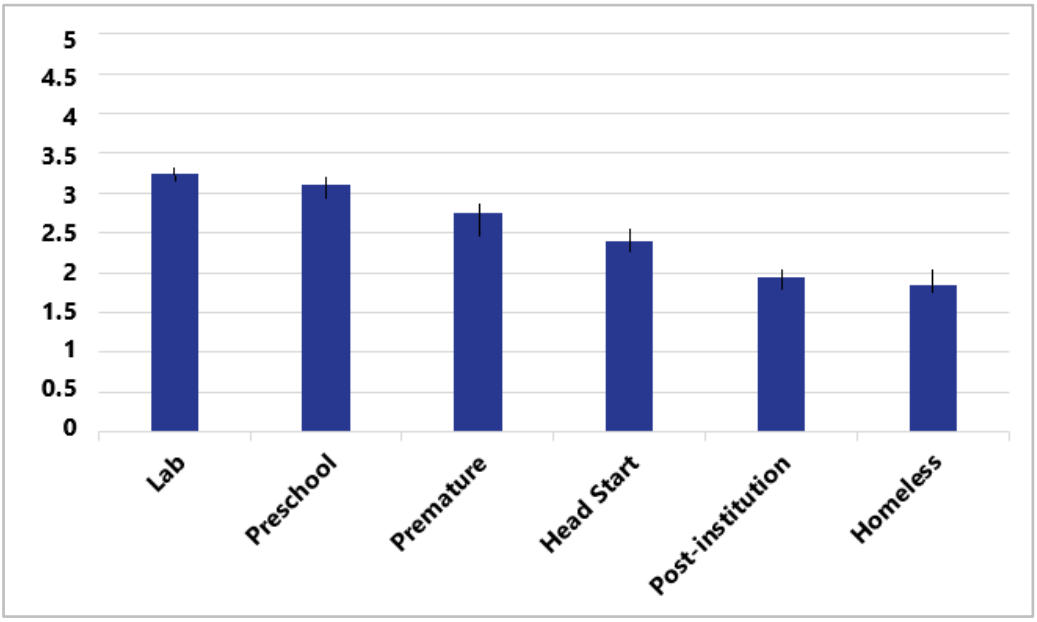
External Validity. Preschool children who are at-risk for poor EF development perform worse than typically developing children on the *MEFS*, as expected, even after controlling for age and IQ (Figures 9 and 10). At-risk samples include children who are homeless, children in Head Start, children with ADHD symptoms, post-institutionalized adopted children, and children born prematurely (Carlson & Harrod, 2013; Doom et al., 2014; Fuglestad et al., 2014; Hostinar et al., 2012). This serves as another form of validation of the measure.

Figure 9. Performance on the *MEFS* by Study Population after Adjusting for Age and IQ



N = 812. At-risk preschoolers had significantly lower scores than lab and community preschool samples ($p < .001$). Bars show standard error.

Figure 10. Highest Level on the *MEFS* by Study Population after Adjusting for Age



$F(5, 1045) = 27.42$, $p < .0001$, partial eta^2 = .12.
All contrasts significant except Lab and Preschool.

Low-Income Youth Sub-sample

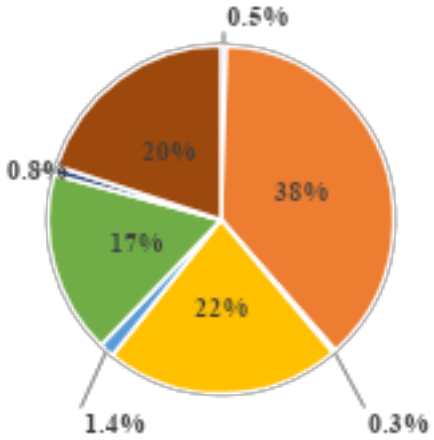
We analyzed the subset of *MEFS App™* users who are serving primarily low-income children (Table 12; Figure 11).

Table 12. **Low-Income Youth Sub-sample**

Asian	0.5%
Black/African American	38%
Hawaiian/Pacific Islander	0.3%
Hispanic/Latino	22%
Native/Aboriginal	1.4%
White/Caucasian	17%
Multi-racial	0.8%
Not Reported	20%

N = 1,918	49% Female; 51% Male	21 - 114 months	***M Age*** = 52.26 ***SD*** = 14.55

Figure 11. **Ethnicity in Low-Income Youth Sub-sample**

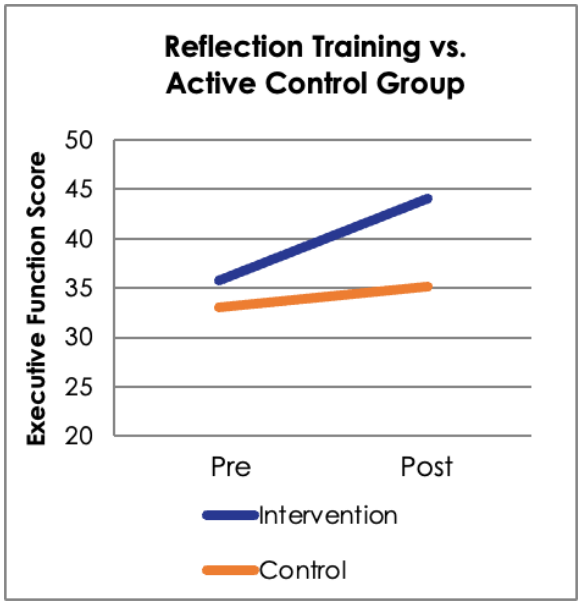


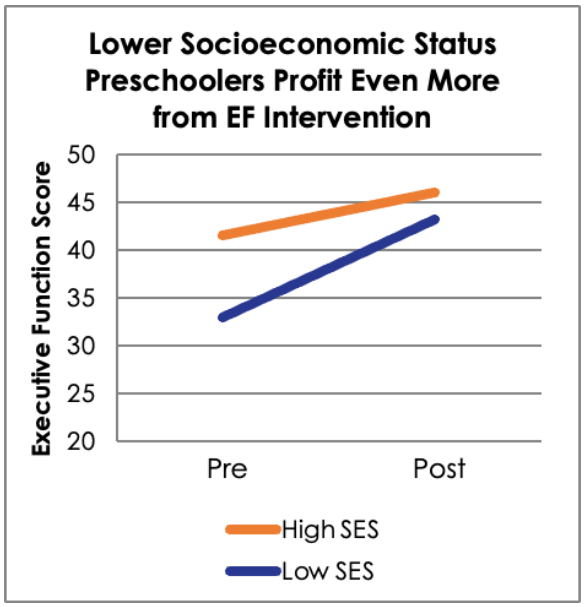
Low-income youth ages 2-9 years were at the 38th percentile nationally (range = 0-99; *M* = 37.98, *SD* = 19.44). This is .3 standard deviations below the mean for age. The range on Total Score was 0-92, *M* = 32, *SD* = 17.5.

In a study by Schubert (2016), preschool children (*N* = 134) from a range of socioeconomic backgrounds were either trained using reflection prompts (Espinet et al., 2013) or read stories with a researcher, across three brief sessions. Those in the reflection training group improved significantly on the *MEFS*, whereas the control group did not (Fig. 12a). Moreover, among the children in the training group, those from a relatively lower SES background improved the most on the MEFS (Fig.

12b). This illustrates sensitivity of the tool to interventions, especially for those who can benefit the most.

Figure 12a and 12b. The MEFS is responsive to EF Interventions





New York City Independent Schools Case Study

To identify and overcome early challenges in bringing the *MEFS* to scale, 10 private schools in New York City participated in a pilot program for the 2014-15 admissions season (K entry Fall 2015). Preparation and training of examiners took place in late August-early September, 2014.

These 10 schools included a description and consent statement about the *MEFS* in their on-line applications. The schools provided a link from their application to a *MEFS* Registration page for parents to register their child. This information was automatically sent to Reflection Sciences and the registered children would then appear on both the iPad *MEFS* and web portal for each school. (Note that ID numbers may be used instead of names.) Schools tested children on-site during applicant visits throughout the Fall. Results are shown in Tables 13 and 14.

Table 13. Participating Schools and Number of Applicants Tested

Schools	N Assessors	N of Children Tested	N of Results Shared
10	25	1340	2480*

* Larger than the number of children tested because some families applied to more than one school.

Table 14. Descriptive Statistics

Age Range	48 to 77 months
Average Age	56 months (4 years, 8 months)
***N* Males**	609
***N* Females**	730
Average Total Test Time	4 min
Average Highest Level Passed (0-7)	*Omitted for privacy*
Average National Percentile (0-100)	*Omitted for privacy*
Average Total Score (0-100)	*Omitted for privacy*

Invariance Tests

The pilot study enabled us to address questions related to variance in test results.

Were there gender differences in performance?

No. Boys and girls performed equivalently on all *MEFS* results.

Were there differences according to who administered the test?

We restricted this analysis to the examiners who tested more than just a few children to get a more reliable indicator, and compared examiners within schools because we know they are testing the same population of applicants (whereas samples across schools might differ to begin with). There were no major outliers; all examiners had similar results.

Did it matter what time of day children were tested?

Although there are some studies suggesting there are optimal testing times for children of different ages, we found no differences in *MEFS* results for children tested in the morning (*N* = 676) versus afternoon (*N* = 664).

Prediction of Kindergarten Achievement

Reflection Sciences later received four schools' end-of-kindergarten achievement data for 232 students who applied for enrollment in the Fall of 2015, 2016, or 2017.

Analyses suggested that the *MEFS* was not redundant with the other admissions measures, but rather added a unique contribution:

- Applicants who enrolled scored 10 points higher on average (out of 100) on the *MEFS* than those who did not. This is a statistically significant difference ($p < .05$) and suggests that the yield included students with higher EF skills.

- The *MEFS* was significantly correlated with admissions measures of math ($p < .05$) and social-emotional skills ($p < .01$).

- When all admissions variables were pitted against one another in a regression analysis, only the *MEFS* ($p < .05$) and academic knowledge (literacy and math composite) ($p < .01$) were significant and unique predictors of Kindergarten Reading Level (Fountas & Pinnell assessment).

- Applicants with higher *MEFS* scores went on to have higher scores in Kindergarten on decoding text, phonemic awareness, alphabet recognition, reading accuracy, number identification, and teacher ratings of concentration.

These results showed that the *MEFS* administered as a screener while children were in preschool predicted several aspects of achievement over one year later in reading and math, as well as concentration skills, and that it did so over and above other admissions measures. Measuring Executive Function skills with *MEFS* adds value to Kindergarten readiness screening processes.

Carlson and Zelazo Lab Studies

We pooled our data across 17 studies from September 2014-March 2017. The results follow:

- *N* children = 1,550, all typically developing

- Age Range = 21 – 115 months

- *N* Male = 760; *N* Female = 790

- Large range of SES, including 831 children from lab samples and 719 children from samples targeting low-income families

- There was a highly significant linear effect of age (in months) on *MEFS* (Total Scores), $F(1, 1536) = 549.02$, $p < .0001$, accounting for 26% of the variance.

- Retest reliability among the subset that took the *MEFS* twice was high, *ICC*(333) = .829, but tended to decline with longer delays. It should be noted that this analysis included only children in the control condition if they were enrolled in an intervention study.

Table 15. Test-Retest Reliability (on Total Scores)

Delay	*N*	*ICC*	*p*
< 1 month	180	.863	< .0001
1 month	22	.845	< .0001
2 months	31	.853	< .0001
5 months	76	.713	< .0001
6 months	17	.701	< .0001

- Individual differences in the table-top version of *MEFS* at 3 years predicted iPad *MEFS* performance at 5 years, $r(86) = .246$, $p < .05$

- **Gender**: Girls scored about 2.5 points (out of 100) higher than boys ($t = -2.87$, $p < .01$)

- **SES**: Children in low-income samples had significantly lower scores than children in middle/upper-income samples
  - After controlling for age, $F(2, 1534) = 172.08$, $p < .001$

- Within lab samples, reported family income was associated with *MEFS* scores
  - After controlling for age, $r(596) = .199$, $p < .001$

Correlations with Other EF Measures

Table 16. Correlations with Other EF Measures

EF Task	N	Partial Correlation (*r*) with *MEFS* controlling for Age
Head-Toes-Knees-Shoulders	415	.387**
Backward Word Span	62	.435**
Forward Word Span	59	.269*
Gift Delay (Bow) Peek Score (reversed)	83	.198[a]
Simon Says	84	.204[a]
Peg Tapping	203	.300**
Theory of Mind Scale	226	.443**

Note: a = $p < .10$

Correlations with IQ and Achievement Tests

Table 17. Correlations with IQ and Achievement Tests

Task	N	Partial Correlation (*r*) with *MEFS* controlling for Age
Stanford-Binet Verbal Subscale	376	.399**
Stanford-Binet Nonverbal Subscale	201	.430**
Woodcock-Johnson Letter Word Subscale	368	.367**
Woodcock-Johnson Applied Problems Subscale	345	.522**

Peabody Picture Vocabulary Test (PPVT)	82	.512**

The *MEFS* remained significantly correlated with Achievement after also controlling for verbal ability on the PPVT: WJ Letter/Word $r(81) = .29$, $p < .01$; WJ Applied Problems $r(81) = .42$, $p < .0001$.

Advantages of the *MEFS*

- Based on the most respected science on neurocognitive development
- Fast (average 4 min)
- Easy
- Automated
- Objective
- Spans age 2 through adulthood without floor or ceiling effects
- Correct answers cannot be memorized (no false positives due to test prep)
- Nationally normed in the U.S.
- Local (state/district/school/organization) norms can be computed
- Reflects progressive, evidence-based education to focus on foundations for learning
- Provides early detection of EF difficulties, leading to earlier intervention
- Can be used to evaluate programs and curricula, aids in decision-making
- Can be used formatively in an assess → intervene → assess → intervene cycle

Research Findings on the *MEFS*

Psychometrics and Validation:

Beck, D. M., Schaefer, C., & Pang, K., & Carlson, S. M. (2011). Executive function in preschool children: Test-retest reliability. *Journal of Cognition and Development, 12*, 169-193. https://doi.org/10.1080/15248372.2011.563485

Carlson, S. M., & Harrod, J. (2013, April). Validation of the Executive Function Scale for Early Childhood. In J. Griffin (Chair), *Developing the Next Generation of Preschool Outcome Measures: The Interagency School Readiness Measurement Consortium*. Poster symposium presented at the biennial meeting of the Society for Research in Child Development. Seattle, WA.

Doebel, S., & Zelazo, P. D. (2015). A meta-analysis of the Dimensional Change Card Sort: Implications for developmental theories and the measurement of executive function in children. *Developmental Review, 38*, 241-268. https://doi.org/10.1016/j.dr.2015.09.001

Carlson, S. M., Faja, S., & Beck, D. M. (2016). Incorporating early development into measurement approaches: The need for a continuum of measures across development. In J. A. Griffin, P. McCardle, & L. S. Freund (Eds.), *Executive function in preschool age children: Integrating measurement, neurodevelopment, and translational research* (pp. 45-64). Washington, DC: American Psychological Association. https://doi.org/10.1037/14797-003

Meuwissen, A. S., et al. (2017). The psychometrics of the Minnesota Executive Function Scale. In P. Morris (Chair), *Strengthening the Measurement Toolbox: Development and Validation of Technology-based Executive Function and Cognitive Assessments*. Paper symposium presented at the biennial meeting of the Society for Research in Child Development. Austin, TX.

Perone, S., Anderson, A., & Youatt, E. (2020). Don't forget your lunch: Age and individual differences in how children perform everyday tasks. *Cognitive Development*, 54, 100879. https://doi.org/10.1016/j.cogdev.2020.100879

MEFS is correlated with academic skills:

Chu, F. W., vanMarle, K., & Geary, D. C. (2013). Quantitative deficits of preschool children at risk for mathematical learning disability. *Frontiers in Psychology, 4*, 1-10. [includes a prior research version of the MEFS] https://doi.org/10.3389/fpsyg.2013.00195

vanMarle, K., Chu, F. W., Li, Y., & Geary, D. C. (2014). Acuity of the approximate number system and preschoolers' quantitative development. *Developmental Science*. [includes a prior research version of the MEFS] https://doi.org/10.1111/desc.12143

Prager, E. O., Sera, M., & Carlson, S. M. (2016). Executive function and magnitude skills in preschool children. *Journal of Experimental Child Psychology*, *147*, 126-139. https://doi.org/10.1016/j.jecp.2016.01.002

Mazzocco, M. M., Chan, J. Y., & Bock, A. M. (2017). Early executive function and mathematics relations: Correlation does not ensure concordance. *Advances in Child Development and Behavior, 53*, 289-307. https://doi.org/10.1016/bs.acdb.2017.05.001

Grenell, A., & Carlson, S.M. (2021). Individual differences in executive function and learning: The role of knowledge type and conflict with prior knowledge. *Journal of Experimental Child Psychology, 206.* https://doi.org/10.1016/j.jecp.2020.105079

Ernst, J., Grenell, A., & Carlson, S. (2022). Associations between executive function and early math and early math and literacy skills in preschool children. *International Journal of Educational Research Open, 3,* 100201. https://doi.org/10.1016/j.ijedro.2022.100201

Hwang, H., Choi, S., Guha, M., McMaster, K., Harsch, R., & Kendou, P. (2024). Indirect and direct contributions of executive function to reading comprehension. *Journal of Experimental Child Psychology, 243*. https://pubmed.ncbi.nlm.nih.gov/38608513/

MEFS predicts later academic achievement:

Hassinger-Das, B., Jordan, N. C., Glutting, J., Irwin, C., & Dyson, N., (2014). Domain-general mediators of the relation between kindergarten number sense and first-grade mathematics achievement. *Journal of Experimental Child Psychology, 118*, 78-92. https://doi.org/10.1016/j.jecp.2013.09.008

Reflection Sciences Technical Report (2017). Prediction of admissions measures to kindergarten reading level. *Report to Marymount School* (2014-2016).

Reflection Sciences Blog (2020). *MEFS in Preschool Predicts Third Grade Reading and Math Achievement on the Measures of Academic Progress (MAP).* https://reflectionsciences.com/pre-k-executive-function-predicts-3rd-grade-academic-achievement/

Kalstabakken, A.W., Desjardins, C.D., Anderson, J.E., Berghuis, K.J., Hillyer, C.K., Seiwert, M.J., Carlson, S.M., Zelazo, P.D., Masten, A.S. (2021). Executive function measures in early childhood screening: concurrent and predictive validity. *Early Childhood Research Quarterly*, 57, 144-155. [includes a prior research version of the MEFS] https://doi.org/10.1016/j.ecresq.2021.05.009

Distefano, R., Palmer, A. R., Kalstabakken, A. W., Hillyer, C. K., Seiwert, M. J., Zelazo, P. D., Carlson, S. M., & Masten, A. S. (2023). Predictive validity of the NIH toolbox executive function measures with developmental extensions from early childhood to third grade achievement. *Developmental neuropsychology*, *48*(8), 373-386. [includes a prior research version of the MEFS] https://doi.org/10.1080/87565641.2023.2286353

MEFS performance is lower in at-risk populations (but not at floor):

Hostinar, C. E., Stellern, S. S., Schaefer, C. M., Carlson, S. M., & Gunnar, M. R. (2012). The impact of early life adversity on executive function in children adopted internationally from orphanages. *Proceedings of the National Academy of Sciences*, *109*, 17208-17212. [includes a prior research version of the MEFS] https://doi.org/10.1073/pnas.1121246109

Doom, J., Gunnar, M. R., Georgieff, M. K., Kroupina, M. G., Frenn, K., Fuglestad, A. J., & Carlson, S. M. (2014). Beyond stimulus deprivation: Iron deficiency and cognitive deficits in post-institutionalized children. *Child Development*, *85*, 1805-1812. [includes a prior research version of the MEFS] https://doi.org/10.1111/cdev.12231

Fuglestad, A. J., Whitley, M. L., Carlson, S. M., Boys, C. J., Eckerle, J. K., Fink, B. A., & Wozniak, J. R. (2015). Executive functioning deficits in preschool children with Fetal Alcohol Spectrum Disorders. *Child Neuropsychology*, 21(6), 716-731. [includes a prior research version of the MEFS] https://doi.org/10.1080/09297049.2014.933792

Rockhold, M., Kruger, A., de Water, E., Lindgren, C., Sandness, K., Eckerle, J., Schumacher, M., Fink. B., Boys, C., Carlson, S. M., Fuglestad, A., Mattson, S., Jones, K., Riley, E., & Wozniak, J. (2020). Social functioning across development in children and adolescents with prenatal alcohol exposure. *Alcoholism: Clinical and Experimental Research*. Online DOI: 10.1111/acer.14538

Tamm, L., Loren, R., Peugh, J., & Ciesielski, H. (2021). The association of executive functioning with academic, behavior, and social performance ratings in children with ADHD. *Journal of Learning Disabilities*, 54(2), 124-138. https://pubmed.ncbi.nlm.nih.gov/32996376/

Weger, C., Boonstra, F., & Goossens, J. (2021). Differences between children with Down syndrome and typically developing children in adaptive behavior, executive functions, and visual acuity. *Scientific Reports*, 11(1), 7602. https://doi.org/10.1038/s41598-021-85037-4

Cuartas, J., Hanno, E., Lesaux, N. K., & Jones, S. M. (2022). Executive function, self-regulation skills, behaviors, and socioeconomic status in early childhood. *PLoS One, 17*. https://doi.org/10.1371/journal.pone.0277013

Derbie, A.Y., Altaye, M., Wang, J., Allahverdy, A., He, L., Tamm, L., & Parikh, N. A. (2025). Early life brain network connectivity antecedents of executive function in children born preterm. *Commun Biol* **8**, 345. https://doi.org/10.1038/s42003-025-07745-1

MEFS is sensitive to EF interventions and SEL curricula:

White, R. E., & Carlson, S. M. (2016). What would Batman do? Social psychological distance improves executive function performance in young children. *Developmental Science*, *19*, 419-426. [includes a prior research version of the MEFS] https://doi.org/10.1111/desc.12314

Schubert, E. C. (2016). *Examining moderators of response to executive function reflection training: Initial skill and socioeconomic status*. Doctoral dissertation, University of MN, Minneapolis, MN. https://hdl.handle.net/11299/190500

Zelazo, P. D., Forston, J. L., Masten, A. S., & Carlson, S. M. (2018). Mindfulness plus reflection training: Effects on executive function in early childhood. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00208

Grenell, A., Prager, E. O., Schaefer, C., White, R., Kross, E., Duckworth, A. L., & Carlson, S. M. (2018). Individual differences in the effectiveness of self-distancing for young children's emotion regulation. *British Journal of Developmental Psychology*, *37*, 84-100. http://dx.doi.org/10.1111/bjdp.12259

Anderson, K. L., Weimer, M., & Fuhs, M. W. (2020). Teacher fidelity to Conscious Discipline and children's executive function skills. *Early Childhood Research Quarterly, 51*, 14-25. https://doi.org/10.1016/j.ecresq.2019.08.003

Oeri, N., & Roebers, C. (2020). Regulating disappointment can impair cognitive performance in kindergarten children: Individual differences in ego depletion. *Journal of Experimental Child Psychology*, *190*. https://doi.org/10.1016/j.jecp.2019.104728

Prager, E. O., Ernst, J., Mazzocco, M. M., & Carlson, S. M. (2023). Executive function and mathematics in preschool children: Training and transfer effects. *Journal of Experimental Child Psychology, 232*. https://doi.org/10.1016/j.jecp.2023.105663

MEFS performance is linked to brain function and psychophysiology:

Perone, S., Palanisamy, J., & Carlson, S. M. (2018). Age-related change in brain rhythms from early to middle childhood: Links to executive function. *Developmental Science*. https://doi.org/10.1111/desc.12691

Rudd, K., Roubinov, D., Jones-Mason, K., Alkon, A., & Bush, N. (2021). Developmental consequences of early life stress on risk for psychopathology: Longitudinal associations with children's multisystem physiological regulation and executive functioning. *Development and Psychopathology*, 33(5), 1759-1773. https://doi.org/10.1017/S0954579421000730

MEFS is related to parenting quality:

Meuwissen, A. S., & Carlson, S. M. (2015). Fathers matter: The role of father parenting in preschool children's executive function. *Journal of Experimental Child Psychology*, *140*, 1-15. [includes a prior research version of the MEFS] https://doi.org/10.1016/j.jecp.2015.06.010

Distefano, R., Galinsky, E., McClelland, M. M., Zelazo, P. D., & Carlson, S. M. (2018). Autonomy supportive parenting and associations with child and parent executive function. *Journal of Applied Developmental Psychology*, *58*, 77-85. https://doi.org/10.1016/j.appdev.2018.04.007

Meuwissen, A. S., & Carlson, S. M. (2018). The role of father parenting in child school readiness: A longitudinal follow-up. *Journal of Family Psychology*. https://doi.org/10.1037/fam0000418

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Almutairi, S. M. (2019). The role of parenting factors in accelerating or hindering the development of EF in preschool children. Doctoral dissertation, Miami University, Oxford, OH. http://rave.ohiolink.edu/etdc/view?acc_num=miami1554984908299487

Castelo, R. J., Meuwissen, A. S., Distefano, R., McClelland, M. M., Galinsky, E., Zelazo, P. D., & Carlson, S. M. (2022). Parent provision of choice is a key component of autonomy support in predicting child executive function skills. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2021.773492

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MEFS reveals significant effects of the COVID-19 pandemic:

Jones, S. M., Dermody, C. M., Mozaffari, A. F., Acosta, J., & Lesaux, N. K. (2026). The impact of the COVID-19 pandemic on young children's executive function: A longitudinal, population-based study. *Child Development*. https://doi.org/10.1093/chidev/aacag003

Johns, E., Forbes, S. H., Delgado Reyes, L. M., Buck, C., & Spencer, J. P. (2026). Tracking the trajectory of executive function from 2.5 to 6.5 years of age and the impact of COVID-19. *Child Development*. https://doi.org/10.1093/chidev/aacag002

Other research using the MEFS:

Martins, E. C., Osorio, A., Verissimo, M., & Martins, C., (2014). Emotion understanding in preschool children: The role of executive functions. *International Journal of Behavioral Development*. [includes a prior research version of the MEFS] https://doi.org/10.1177/0165025414556096

Lee, W. S. C., & Carlson, S. M. (2015). Knowing when to be "rational:" Economic decision-making and executive function in preschool children. *Child Development*. [includes a prior research version of the MEFS] https://doi.org/10.1111/cdev.12401

Ernst, J. & Burcak, F. (2019). Young children's contributions to sustainability: The influence of nature play on curiosity, executive function skills, creative thinking, and resilience. *Sustainability*, *11*, 4212. https://doi.org/10.3390/su11154212

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Rooney, L. J., & Claxton, L. J. (2026). The relation between fine motor skills and executive function in two-year-old children. *Behavioral Sciences*. https://doi.org/10.3390/bs16081262

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contributors, research needs and assessment options. *ETS Research Report Series*, 2017(1), 1–24. https://doi.org/10.1002/ets2.12148

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McCoy, D. C. (2019). Measuring young children's executive function and self-regulation in classrooms and other real-world settings. *Clinical Child and Family Psychology Review*, 22, 63-74. https://doi.org/10.1007/s10567-019-00285-1

About the Developers

Stephanie M. Carlson, PhD, is a developmental psychologist and Distinguished McKnight University Professor at the Institute of Child Development, University of Minnesota, and Co-Founder of Reflection Sciences. She is an internationally recognized leader in the measurement of executive function in preschool children and conducts research on ways to promote its healthy development in children and caregivers.

Philip David Zelazo, PhD, is a developmental neuroscientist and Lindahl Professor at the Institute of Child Development, University of Minnesota, and Co-Founder of Reflection Sciences. He catalyzed the field of developmental research on executive function with his Dimensional Change Card Sort (DCCS) task, upon which the *MEFS* is built. He is a world-renowned investigator of the development and neural correlates of executive function in childhood and across the lifespan.

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