# Performance of New Cognitive Assessments with Head Start Children:

# Emerging Evidence from FACES and AIAN FACES 2019

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## Key findings

- We use data from the most recent round of the Head Start Family and Child Experiences Survey (FACES) and American Indian and Alaska Native (AIAN) Head Start FACES to examine the performance of four new cognitive assessments—the Minnesota Executive Function Scale App (MEFS App™) and the latest editions of the Peabody Picture Vocabulary Test (PPVT–5) and Woodcock-Johnson Applied Problems and Letter-Word Identification subtests (WJ IV).
- The MEFS App™ was more strongly correlated with cognitively demanding assessments (receptive vocabulary which may reflect general cognitive ability, early math) than it was with letter-word knowledge, but varied with expressive vocabulary depending on the sample.
  - This initial evidence of concurrent validity is consistent for the MEFS App™ across racial and ethnic groups for children in FACES and AIAN FACES.
- Because information on the different assessments' performance with AIAN preschoolers is limited, we examined the PPVT–5 and WJ IV subtests for any evidence of systematic item bias against AIAN children (in AIAN FACES) compared with White, non-Hispanic children (in FACES).
  - We found a few items with potential differences in difficulty for either AIAN or White, non-Hispanic children, but the differences favored the AIAN children for some items and White, non-Hispanic children for other items within the same assessment.

The Head Start Family and Child Experiences Survey (FACES) and the American Indian and Alaska Native Head Start Family and Child Experiences Survey (AIAN FACES) are separate studies done successively over time. One goal for these studies is to provide a national picture of children's readiness for school. In this research brief, we use data from the most recent round of FACES and AIAN FACES in fall 2019 to evaluate the performance of direct assessments of children that were used to provide that national picture. We conducted similar analyses using FACES 2014 and AIAN FACES 2015 data (Malone et al. 2018). We are replicating the previous analyses because the current FACES studies have new direct assessments—one added to measure executive function and three reflecting the latest editions of those direct assessments. The current analysis focuses on these new direct

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## What is FACES and AIAN FACES?

As part of its management of Head Start, the federal government divides Head Start programs into 12 regions. Ten of the regions are geographically defined. The other two are defined by the populations they serve: Region XI serves children and families in programs operated by federally recognized American Indian and Alaska Native (AIAN) tribes, and Region XII serves migrant and seasonal workers and their families. FACES describes the children, families, and programs in the 10 geographic regions. AIAN FACES describes the children, families, and programs in Region XI, and although the majority of children in Region XI are AIAN, not all of them are.

For more information on FACES and AIAN FACES, see the box at the end of this brief.

assessments (Box 1) to understand whether they are a fair estimate of children's skills and knowledge in the domains being measured. Specifically, we answer two key research questions:

1. How valid is the Minnesota Executive Function Scale App (MEFS App™) as an assessment of executive function for Head Start preschool children? That is, do we find evidence that the MEFS App™ measures executive function among children from families with low income?
2. Do the latest editions of the cognitive assessments used in AIAN FACES 2019 show any systematic item bias against AIAN preschool children compared with White, non-Hispanic[1] children in FACES 2019?

## Box 1. Cognitive assessments examined in this brief

We examined five direct cognitive assessments as part of this analysis. For more information, see the FACES 2019 (Kopack Klein et al. 2021) and AIAN FACES 2019 (Bernstein et al. 2021) Fall Data Tables and Study Design Reports.

- Minnesota Executive Function Scale App (MEFS App™; Carlson and Zelazo 2014) measures children's ability to remember and apply instructions to a task (working memory), regulate their behavior to sort cards as instructed (inhibitory control), and switch their behavior to sort cards according to new rules when instructions change (cognitive flexibility).
- Peabody Picture Vocabulary Test–5 (PPVT–5; Dunn 2019) measures children's English receptive vocabulary by asking them to point to the one picture in four that best shows the meaning of a word that the assessor says aloud. The PPVT–5 can also be considered an assessment of general cognitive ability.
- Woodcock-Johnson (WJ) IV Applied Problems (Schrank et al. 2014) measures children's skills in solving practical math problems.
- Woodcock-Johnson (WJ) IV Letter-Word Identification (Schrank et al. 2014) measures children's skills in identifying isolated letters and words that appear on the children's screens as they take the assessment.*
- Expressive One Word Picture Vocabulary Test–4 (EOWPVT–4; Martin and Brownell 2010) measures the English expressive vocabulary of children. In FACES, this assessment was completed by children whose parents reported that English or an Other (non-English or English) language was the language used most often at home.** All children in AIAN FACES completed the EOWPVT–4. This assessment was used for evaluating the validity of the MEFS App™. Performance of the EOWPVT–4 was examined previously using FACES 2014 and AIAN FACES 2015 data (see Malone et al. 2018).

*The studies also used the WJ IV Spelling subtest as a measure of early writing skills. It was not included in our analyses because too few items had enough cases to examine.
**In FACES, children whose parents reported that Spanish was the language used most often at home completed the EOWPVT–4 Spanish Bilingual Edition and are not included in these analyses. See the FACES 2019 Fall Data Tables and Study Design Report (Kopack Klein et al. 2021) for information on the assessment pathways.

## Who are AIAN preschool children?

For AIAN FACES, American Indian and Alaska Native children include children whose parents reported they were American Indian or Alaska Native only or were AIAN in combination with another race or with Hispanic ethnicity.[2]

First, we set out to learn about the validity of the MEFS App™ for Head Start children (Box 2). The MEFS App™ publisher samples from prior studies are majority White, non-Hispanic children from middle-class families (see Beck et al. 2011 and Prager et al. 2016). The FACES and AIAN FACES samples are more diverse than the MEFS App™ developer's sample in terms of income status and race/ethnicity. The validity of an assessment determines whether the assessment measures what it intends to measure, and if it performs similarly for different groups.

In particular, we explored the convergent and divergent validity of assessments to examine the correlations and associations between the MEFS App™ and other validated cognitive assessments of varying domains within the FACES and AIAN FACES populations. Executive function is a cognitive construct, so we hypothesized that the MEFS App™ would be more strongly correlated with more cognitively demanding assessments of early math (Woodcock-Johnson [WJ] IV Applied Problems) and assessments of general cognitive ability (Peabody Picture Vocabulary Test–5 [PPVT–5] on receptive vocabulary) than with assessments of language and literacy (Expressive One Word Picture Vocabulary Test [EOWPVT–4], WJ IV Letter-Word Identification). Prior validity studies support our hypotheses, reporting moderate partial correlations (accounting for age) between MEFS App™ and various cognitive assessments used in FACES (Carlson 2020).

## What are convergent and divergent validity?

**Convergent validity** is supported by positive associations with assessments of the same or related constructs or by expected associations with outcomes.

**Divergent validity** is evident when we see a weak or no association between two assessments intended to measure different constructs.

Second, we conducted differential item functioning (DIF) analyses with other cognitive assessments (PPVT–5 and WJ IV) to examine whether there was any systematic item bias in the assessments between AIAN children and non-AIAN children (Box 2). Norming samples for most assessments of children do not include large numbers of AIAN children. Consequently, little is known about an assessment's performance when it is administered with AIAN children. Scores from these assessments may not accurately reflect abilities, skills, and knowledge for AIAN children living in Native communities, who may be very different from those of children who do not live in Native communities.

## What is DIF?

DIF, or differential item functioning, is a statistical property of a test item that suggests potential bias. An item shows DIF if children in different groups who have the same ability or level on the assessed trait have different probabilities of correctly answering the item.

## What is the validity of the MEFS App™ as an assessment of executive function for Head Start preschool children?

Next, we discuss the results for our research question for the full sample in FACES, racial/ethnic groups in FACES, the full sample in AIAN FACES, and AIAN children in AIAN FACES. We use standard scores in all the results presented here, which reflect a child's performance relative to other children the same age nationally. We summarize the results of these analyses in Exhibit 1. The full correlation matrices and regression model results are in the technical appendix. Additional analyses are also in the technical appendix, including sensitivity checks for different types of scores, which generally showed similar patterns to each other.

**In FACES, the more cognitively demanding assessments—the PPVT–5 and the WJ IV Applied Problems—demonstrated moderate correlations with the MEFS App™ for the full sample.** The WJ IV Letter-Word Identification was weakly correlated with the MEFS App™. Contrary to our expectations, the EOWPVT–4 was also moderately correlated with the MEFS App™.

**After we accounted for families' and children's characteristics in our regression models in FACES for the full sample, we found that cognitive assessments were still positively associated with the MEFS App™.** These

## Box 2. Sample and methods

Below, we describe the sample used for each research question along with a brief description of our methods. More details are in the technical appendix.

### Research Question 1 on validity of the MEFS App™

We examined the validity of the MEFS App™ for children in FACES and AIAN FACES who completed the assessments in English and had scores on the MEFS App™ and at least one of the cognitive assessments (the PPVT–5, WJ IV Letter-Word Identification, WJ IV Applied Problems, or EOWPVT–4). In total, we examined the scores of 1,586 children in FACES and 466 children in AIAN FACES.

First, we calculated the correlations between the MEFS App™ standard scores and standard scores on the cognitive assessments. We did this separately for the full sample of children in FACES and AIAN FACES who were assessed in English. For FACES, we then examined these correlations separately for racial and ethnic groups. For AIAN FACES, we also examined these correlations for AIAN children only.

Next, we ran regression models to test the associations between the MEFS App™ and the cognitive assessments, accounting for certain characteristics of children and families. In these models, we accounted for children's age, race/ethnicity, sex, language always or usually spoken in the home, level of household poverty, and maternal education. This allowed more realistic comparisons with the publisher estimates (the MEFS App™ developers adjusted for children's and families' characteristics in looking at associations with other, similar cognitive assessments). We estimated a separate model for each cognitive assessment as a predictor of the MEFS App™. We conducted separate analyses for FACES and AIAN FACES samples. For both sets of analyses, we weighted the estimates to represent all children enrolled in Head Start in fall 2019.

### Research Question 2 on item bias in cognitive assessments for AIAN preschoolers

We examined item functioning for AIAN children compared with non-AIAN children. The analytic sample included 693 children—404 AIAN children from AIAN FACES and 289 non-AIAN children—limited to White children—from FACES. This approach kept the analysis focused on the comparison of AIAN children to the majority group used in most publishers' norming samples (that is, White children).

To examine differential item functioning (DIF), we used a Rasch dichotomous model. We used DIF analysis to evaluate whether the items on the assessments have the same meaning for respondents in the two different groups—that is, AIAN children versus White children. All items were included in the analysis; however, to examine items for potential DIF, items needed to have responses from a minimum of 30 children in each group (AIAN and White). The DIF analyses were conducted with unweighted data because the goal of the analyses was not to produce representative estimates of children's ability, but to examine group differences in the difficulty of the items.

characteristics included the child's age, race/ethnicity, sex, language always or usually spoken to the child in the home, household poverty, and maternal education.[3] As expected, the PPVT–5 and the WJ IV Applied Problems had similarly strong regression coefficients relative to the WJ IV Letter-Word Identification. The EOWPVT–4 again was similar to the PPVT–5 and WJ Applied Problems in the strength of its association with the MEFS App™.

**In FACES, correlations between the MEFS App™ and the cognitive assessments varied with the child's race and ethnicity, but showed the same pattern of stronger correlations with the PPVT–5 and WJ IV Applied Problems than with WJ IV Letter-Word Identification.** Comparisons of correlations of the MEFS App™ with other racial/ethnic groups in FACES revealed lower correlations for Black and Hispanic children compared with White children. Both Black and Hispanic children had lower correlations on all of the assessments with the MEFS App™.[4]

**In AIAN FACES, the PPVT–5 and the WJ IV Applied Problems demonstrated stronger correlations with the MEFS App™ than with EOWPVT–4 and WJ IV Letter-Word Identification, which was expected.** This was true for the full sample in AIAN FACES and AIAN children only in AIAN FACES. The first three assessments were moderately correlated with the MEFS App™, so the EOWPVT–4 was slightly higher than we expected.

**Exhibit 1.** Correlations and regression coefficients between standard scores[a] on the MEFS App™ and cognitive assessment

| | Correlation | | | | Regression coefficient | | | |
|---|---|---|---|---|---|---|---|---|
| | PPVT–5 | WJ IV Applied Problems | WJ IV Letter-Word Identification | EOWPVT–4 | PPVT–5 | WJ IV Applied Problems | WJ IV Letter-Word Identification | EOWPVT–4 |
| **FACES 2019** | | | | | | | | |
| Full sample | 0.28*** | 0.30*** | 0.16*** | 0.30*** | 0.21*** | 0.17*** | 0.13*** | 0.18*** |
| White, non-Hispanic | 0.43*** | 0.35*** | 0.24* | 0.37*** | n.a. | n.a. | n.a. | n.a. |
| Black, non-Hispanic | 0.27*** | 0.31*** | 0.11* | 0.25** | n.a. | n.a. | n.a. | n.a. |
| Hispanic/Latino | 0.24*** | 0.28*** | 0.23* | 0.35*** | n.a. | n.a. | n.a. | n.a. |
| **AIAN FACES 2019** | | | | | | | | |
| Full sample | 0.37*** | 0.39*** | 0.23*** | 0.31*** | 0.24*** | 0.20*** | 0.18** | 0.17*** |
| AIAN[c] | 0.38*** | 0.38*** | 0.26*** | 0.32*** | n.a. | n.a. | n.a. | n.a. |

**Source:** Fall 2019 FACES and AIAN FACES Direct Child Assessment.
**Note:** Statistics are weighted to represent all children enrolled in Head Start (for FACES in Regions I-X) and in Region XI Head Start (in AIAN FACES) in fall 2019. Statistical significance is the probability that the results are caused by something other than chance. We indicate statistical significance using the following convention: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.
[a] The standard score reflects a child's performance relative to children in the same age group nationally. Assessments may differ in how they group children's ages when estimating the standard scores.
[b] Regression models adjusted for children's and families' characteristics, including the child's age, race/ethnicity, sex, language always or usually spoken to the child in the home, household poverty, and maternal education.
[c] AIAN = American Indian or Alaska Native. In AIAN FACES, AIAN children includes children whose parents reported they were American Indian or Alaska Native only or were AIAN in combination with another race or Hispanic ethnicity.
MEFS App™ = Minnesota Executive Function Scale Application™; PPVT–5 = Peabody Picture Vocabulary Test–5; WJ IV = Woodcock-Johnson IV; EOWPVT–4 = Expressive One-Word Picture Vocabulary Test–4.
n.a. = not applicable; children's race/ethnicity indicators were included as covariates only.

**After we accounted for the characteristics of families and children in our regression models in AIAN FACES for the full sample and for AIAN children, cognitive assessments were still positively associated with the MEFS App™.** Results from the regression models showed positive associations between the MEFS App™ and all of the cognitive assessments for the full sample and AIAN children. The EOWPVT–4 was similar to the PPVT–5 and WJ IV Applied Problems in the strength of its association with the MEFS App™.

## Do cognitive assessments show any systematic item bias against AIAN preschoolers?

Assessing potential bias in items on assessments involves examining whether some items are easier for a particular group than they are for other groups. We examined item functioning for AIAN children compared with White children for the latest editions for three assessments in the 2019 studies. DIF occurs when children with the same estimated ability have a different probability of giving a correct answer, indicating that the item could be biased.

DIF alone is not proof of bias or proof that the item is unfair to one group of children or another, as there could be real differences between the two groups that account for their responses to an item. Further examination is needed to determine whether the items assess dimensions that are relevant to the construct, and that the differences in performance are true differences in the trait or construct being measured. Such analyses are important to ensure that scores obtained from the assessments are unbiased and reflect the same construct for everyone assessed.

Our analyses do not suggest systematic bias in the scores for AIAN preschoolers (Table 1). WJ IV Applied Problems had no items exhibiting DIF, whereas PPVT–5 and WJ IV Letter-Word Identification had some items exhibiting DIF. We would expect to find DIF for 5 percent of the items just by chance. For the items that do reveal DIF, it is important to consider whom the item favors. We discuss this in detail below.

Four of the items on the PPVT–5 indicated potential DIF. Fewer items exhibited DIF than would have been expected by chance. Of the four items that exhibited DIF, two were easier for AIAN children than for White children, and two were more difficult for AIAN children than for White children. Because the PPVT–5 is a national assessment of vocabulary, some items will be easier for preschoolers who have had experiences with different environments or have been exposed to books that portray different environments.

**Table 1. Summary of DIF results**

| Assessment | Number of items examined for DIF[a] | Number of items exhibiting DIF |
|---|---|---|
| PPVT–5 | 147 out of 200 analyzed | 4 out of 147 examined |
| WJ IV Letter-Word Identification | 16 out of 78 analyzed | 3 out of 16 examined |
| WJ IV Applied Problems | 15 out of 56 analyzed | 0 out of 15 examined |

**Source:** Fall 2019 FACES and AIAN FACES Direct Child Assessment.

**Note:** DIF analyses were unweighted because the goal of the analyses was not to produce representative estimates of children's ability but to examine group differences in the difficulty of the items.
[a] All items were included in the analysis of DIF, but only items with at least 30 responses in each group were included in our interpretation.

Three of the items on WJ IV Letter-Word Identification demonstrated DIF. The number of items with DIF is more than we would expect by chance. Of the three items with DIF, one was easier for AIAN children than for White children, and two were more difficult for AIAN children than they were for White children. The two easier items for White children involved identifying letters that were presented individually in different font types. It may be that the different fonts presented an additional challenge for many preschoolers. The item that was easier for AIAN children compared with White children had a higher item difficulty that required reading a word. Most White and AIAN children gave incorrect answers to this item and the other word items near the difficulty of this item. Of the children who read this word, more AIAN than White children recognized this particular word. The items requiring children to read words were all presented in the same way. Nothing about this particular word suggests it is unfair to one group or the other. The technical appendix discusses the DIF statistics in more detail.

# Conclusions

Our analyses of the four newly added or updated direct cognitive assessments administered in FACES 2019 and AIAN FACES 2019 provide support that the scores are valid estimates for diverse preschoolers from families with low incomes who took the assessments in English. Items did not unfairly favor any single group. Though we found weaker correlations with the MEFS App™ for Black and Hispanic children, the pattern of correlations was similar.

## Evidence of validity of the MEFS App™

Overall, the strength of correlations between the MEFS App™ and the direct cognitive assessments is in an expected pattern across groups. While the EOWPVT–4 showed correlations in FACES similar in size to the PPVT–5 and WJ IV Applied Problems, this finding may reflect that in FACES the children completing the EOWPVT–4 are a subset of the children completing the other cognitive assessments. Additionally, although correlations for all assessments were lower for Hispanic and Black children in FACES, they are generally in the same range (weak or moderate) as White children.

The regression analyses accounted for the demographic characteristics of children and families, but future research is needed with other assessments of executive function and exploring other factors related to development that may explain group differences. It is possible that familiarity with the method of administration poses more difficulty for some groups, which could introduce method bias that affects performance on all items. Alternatively, there could be differences in environmental factors influencing the strength of their abilities in different cognitive tasks.

## No evidence of systematic bias in cognitive assessments for AIAN preschoolers

Our analyses and review of items suggested no systematic item bias against AIAN preschoolers on the PPVT–5 or WJ IV Applied Problems or Letter-Word Identification. With large sample sizes and many items analyzed, some DIF is expected. No DIF was found for WJ IV Applied Problems. For the two assessments with DIF found, the PPVT–5 demonstrated minimal DIF—less than expected by chance—and WJ IV Letter-Word Identification demonstrated only a few items with DIF, though more than expected. Review of the items show that DIF favoring White children was detected in the area where many children were establishing their ceiling of six in a row incorrect where the adaptive testing stopped. With a limited number of choices, children may have randomly selected a response.

Further, examination of items did not indicate they were measuring content other than intended (for example, a single representation of a letter or word). For the WJ IV Letter-Word Identification, two of the items with DIF used letters in different fonts. These differences in fonts may present an additional challenge for preschoolers just learning letter names. One item's fit statistics also suggest that children in both groups were responding in unexpected ways—answering it correctly when their overall ability levels suggested that they would not or when their ability level suggested that they would answer correctly they did not. Researchers and assessors might consider including additional assessments of letter recognition and naming beyond the WJ IV Letter-Word Identification when making instructional or placement decisions for individual preschoolers.

# Final Takeaways

The current analyses provide preliminary evidence that the cognitive assessments examined are valid for Head Start preschoolers for research purposes. The analyses in this study are limited to the set of items examined (those with at least 30 responses). Future research on the item functioning of the assessments examined in this brief is needed for older children and those with stronger skills to confirm our findings. It is also important to note that because our analyses focus on children who completed the assessments in English, our results may not be generalizable outside of this particular population. Although these analyses provide initial evidence, more research is needed about these assessments for children from diverse backgrounds. Researchers should remember that the reliability and validity of an assessment are not entirely inherent in the assessment but depend on how they use the assessment in their own studies.

## Head Start

Head Start is a national program designed to promote children's readiness for school by enhancing their social-emotional, physical, and cognitive development. The program provides educational, health, nutritional, social, and other services to enrolled children and their families. Head Start places special emphasis on helping preschoolers develop the reading, language, social-emotional, mathematics, and science skills they need to be successful in school. The program also seeks to engage parents in their children's learning and to promote progress toward the parents' own educational, literacy, and employment goals (Administration for Children and Families 2020). Head Start works to achieve these goals by providing comprehensive child development services to economically disadvantaged children and their families through grants to local public agencies and to private nonprofit and for-profit organizations. Region XI AIAN Head Start programs also offer traditional language and cultural practices based on community needs, wishes, and resources.

## FACES 2019

For FACES 2019, a sample of Head Start programs was selected from the 2017–2018 Head Start Program Information Report, with two centers per program and two classrooms per center. Within each classroom, 12 children were randomly selected for the study. In total, 59 programs, 115 centers, 221 classrooms, and 2,260 children participated in the study in fall 2019. More information on the study methodology and the measurement in FACES 2019 is available in the FACES Fall 2019 Data Tables and Study Design Report (Kopack Klein et al. 2021).

## AIAN FACES 2019

For AIAN FACES 2019, a nationally representative sample of Region XI Head Start programs was selected from the 2016–2017 Head Start Program Information Report, with one or two centers per program and two to four classrooms per center. Within each classroom, we randomly selected 13 children for the study. Twenty-two programs, 40 centers, 85 classrooms, and 720 children participated in the study in fall 2019. More information on the study methodology and the measurement in AIAN FACES 2019 is available in the AIAN FACES Fall 2019 Data Tables and Study Design Report (Bernstein et al. 2021).

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# Endnotes

[1] For ease in reading, we use "White" to refer to White, non-Hispanic children and "Black" to refer to Black, non-Hispanic, and "Hispanic" to refer to Hispanic/Latino.

[2] This includes children who are (1) only American Indian or Alaska Native and not Hispanic/Latino, (2) American Indian or Alaska Native and Hispanic/Latino, and (3) American Indian or Alaska Native and another race but not Hispanic/Latino.

[3] Coefficients for these characteristics' associations with executive function scores can be found in the technical appendix.

[4] Hispanic children whose parents indicated that they most often use English or an Other (non-Spanish or English) language at home take the EOWPVT–4 to assess their English expressive vocabulary.


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