Supplementary Material

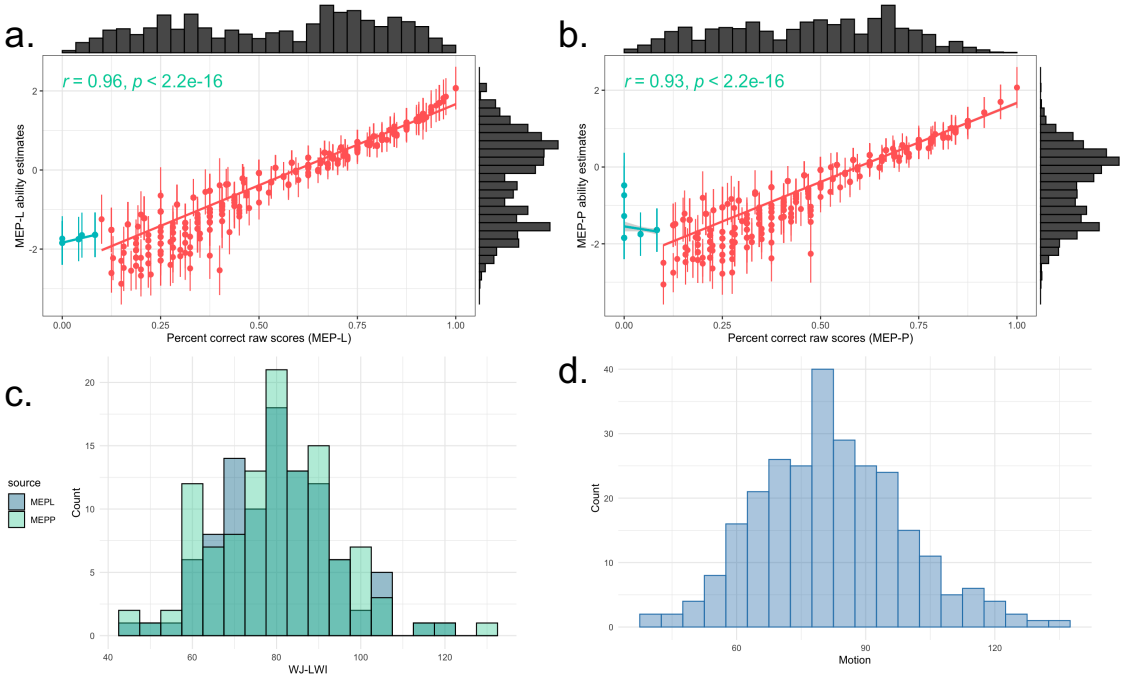

Figure S1. a. shows how ability estimates from MEP-L task relate to raw percent correct scores in the same task. The green dots represent those children with low raw scores whose ability estimates were overestimated. We removed those children in green to avoid a bimodal distribution in the ability distributions. **b.** shows the same for the MEP-P task. **c.** shows the reading outcome distributions of those children (green dots) who were excluded from all analyses. The reading outcome distribution suggests that the excluded children in both the MEP-L and MEP-P tasks were not categorically poor readers. **d.** shows the distribution of reading outcomes for those children who were excluded based on the task understandability cut-off defined for the motion task.

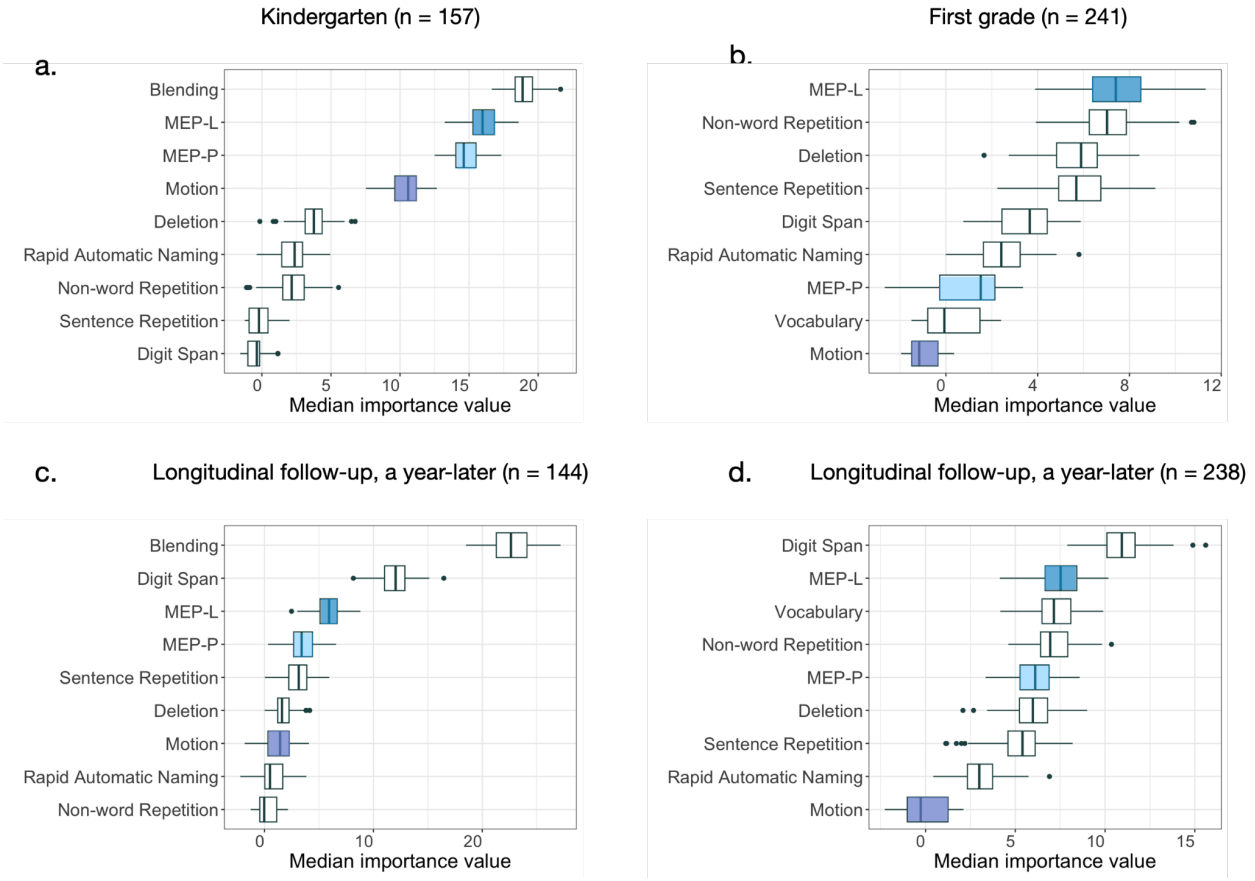

Figure S2. a-d. shows feature importance plots for simulated class-balanced data to be compared to the class imbalance data presented in Figure 4; **a, b.** shows feature importance plots for predicting risk at end-of-the-same-year across both grades; and **c, d**. shows feature importance plots for predicting risk a year later for the same kids who were longitudinally followed up. Across both the class-balanced and imbalanced datasets the MEP measures are important predictors of risk alongside other language-based measures.

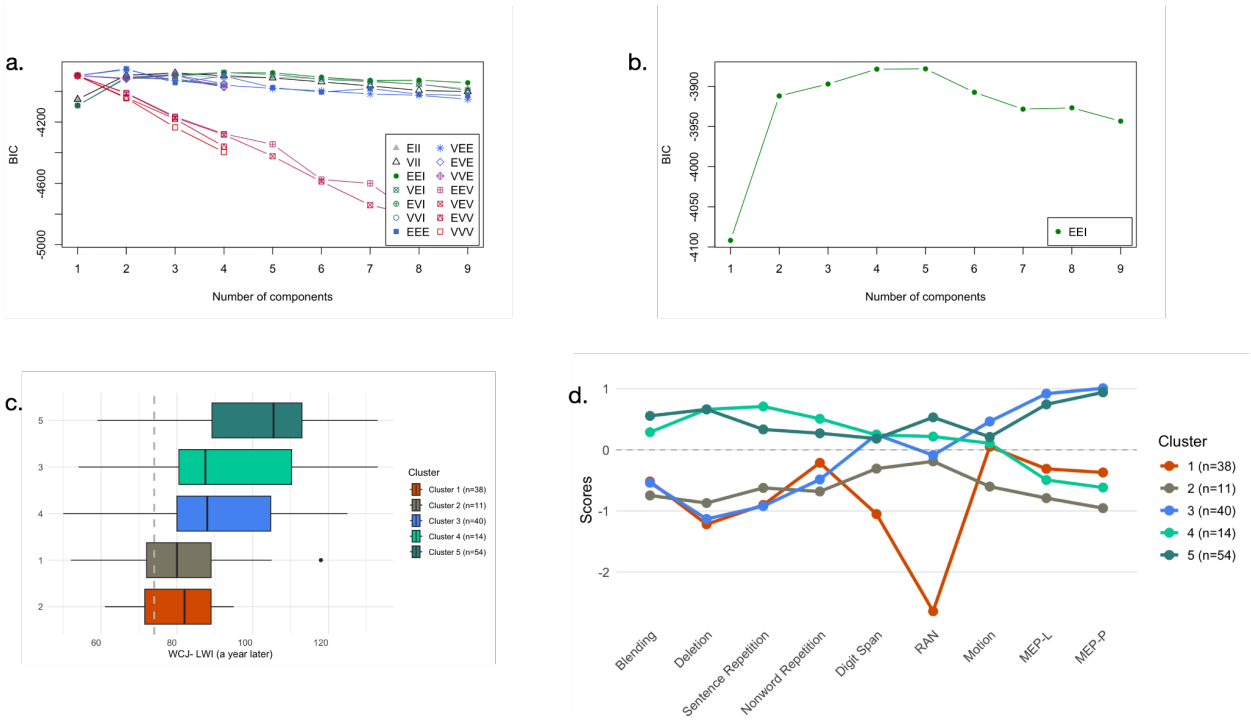

Figure S3. a. shows Bayesian Information Criterion (BIC) values for models with different numbers of profiles and covariance structures, estimated using *Mclust*. The EEI model — which assumes that clusters are similar in size and shape and spread out independently along each axis — provided the best fit to the data, suggesting a simple and interpretable profile structure. **b.** shows the BIC values for the EEI model with different numbers of profiles. **c.** shows the distribution of WJ–LWI scores at follow-up one year later, showing continued stratification in reading ability just as in Figures 5b and 6b. **d.** shows the performance profiles for each of the clusters that provided the guidance for our performance-based classification.

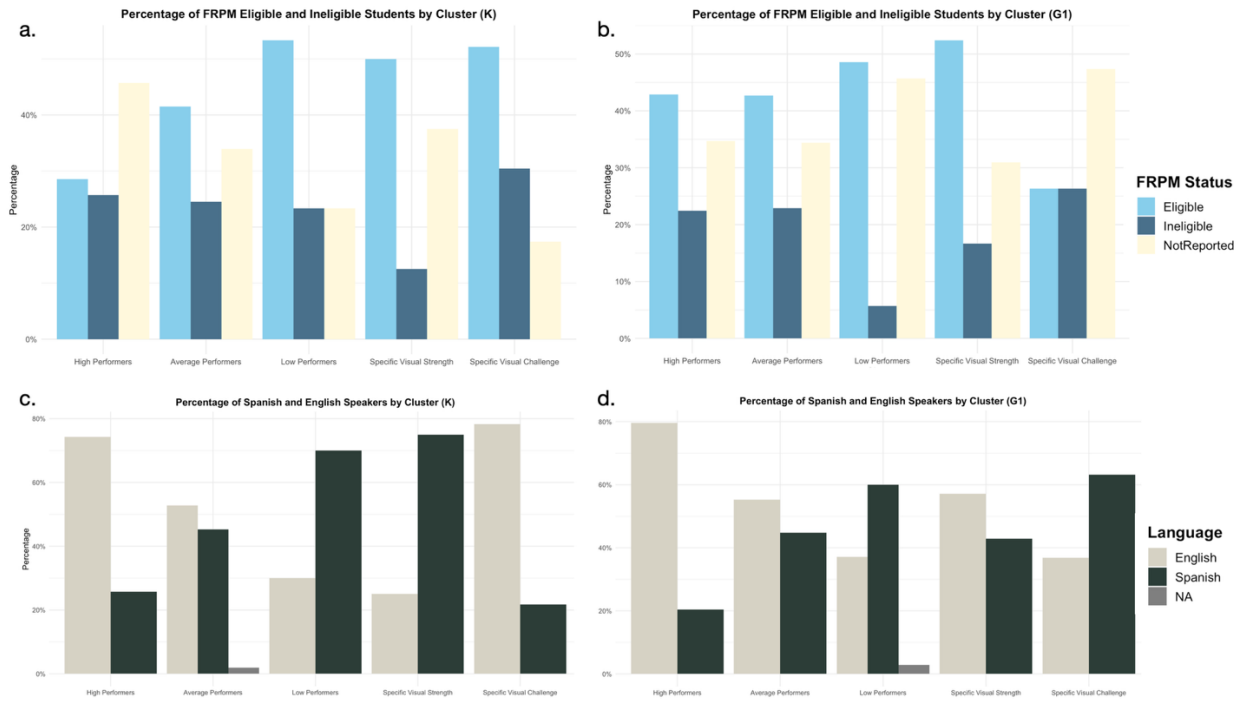

Figure S4. Sociodemographic composition of latent reading profiles across Kindergarten (K) and Grade 1 (G1) cohorts. a, b. Percentage of students eligible, ineligible, or not reported for Free and Reduced-Price Meals (FRPM) within each of the five subgroups in kindergarten (a) and first grade (b). While FRPM eligibility was prevalent across all groups, the Low Performers consistently showed the highest proportion of FRPM-eligible students; **c, d.** Percentage of English- and Spanish-speaking students within each subgroup in kindergarten (c) and first grade (d). High Performers were predominantly English-speaking, and Low Performers were largely Spanish-speaking across both cohorts. Notably, the two visually-defined subgroups—Specific Visual Strength and Specific Visual Challenge—show distinct and shifting language profiles. In Kindergarten, the Specific Visual Strength group was majority Spanish-speaking, while the Specific Visual Challenge group was predominantly English-speaking. This pattern reversed in Grade 1, highlighting a developmental shift in the intersection of language background and visual processing profiles. All data reflect cross-sectional comparisons and do not represent longitudinal tracking of individual students.

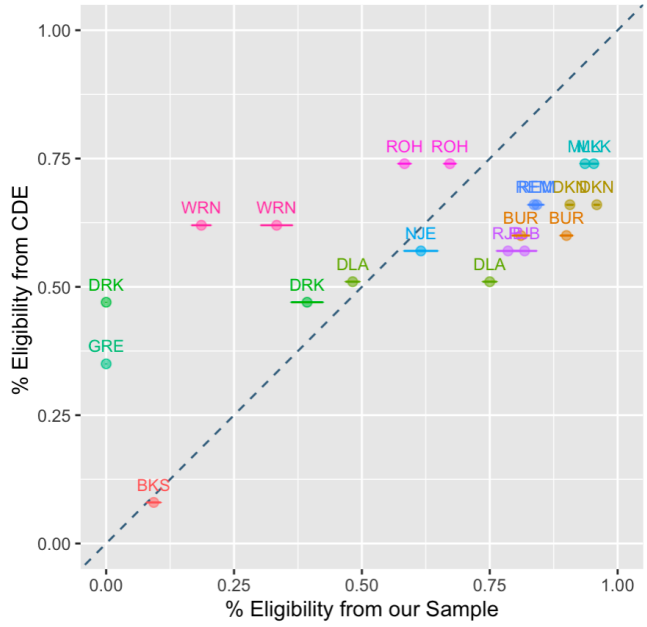

Figure S5. shows the percentage of children eligible for FRPM for each school across kindergarten and first grade (that's why each school has 2 data points) compared to the percent reported as eligible by the school district in the CDE record. If our sample and the CDE data matched, we expect the dots to be close to the diagonal. The spread presented in this figure is the reason why we present analysis using CDE data as shown in Figures 1c and 2c respectively.

Table S1. Regression models with each of the visual measures as predictors of end of year reading outcome.

	Kindergarten (n = 157)			First Grade (n=381)		
Variable	Reading outcome ~ MEP-L	Reading outcome ~ MEP-P	Reading outcome ~ Motion	Reading outcome ~ MEP-L	Reading outcome ~ MEP-P	Reading outcome ~ Motion
(Intercept)	-0.105 (0.060)	-0.127 (0.061)*	-0.142 (0.062)*	0.038 (0.052)	0.050 (0.053)	0.061 (0.054)
MEP-L	0.297 (0.059)***			0.365 (0.052)***		
MEP-P		0.239 (0.058)***			0.273 (0.054)***	
Motion			0.202 (0.060)***			0.144 (0.055)**
Multiple R^2	0.139	0.098	0.069	0.115	0.063	0.018
F-statistic	25.06 (1,155)***	16.83 (1,155)***	11.50 (1,155)***	49.25 (1,379)***	25.28 (1,379)***	6.80 (1,379)**

	Kindergarten (n = 157)			First Grade (n=381)		
Variable	Reading outcome ~ MEP-L	Reading outcome ~ MEP-P	Reading outcome ~ Motion	Reading outcome ~ MEP-L	Reading outcome ~ MEP-P	Reading outcome ~ Motion
(Intercept)	-0.105 (0.060)	-0.127 (0.061)*	-0.142 (0.062)*	0.038 (0.052)	0.050 (0.053)	0.061 (0.054)
MEP-L	0.297 (0.059)***			0.365 (0.052)***		
MEP-P		0.239 (0.058)***			0.273 (0.054)***	
Motion			0.202 (0.060)***			0.144 (0.055)**
Multiple R^2	0.139	0.098	0.069	0.115	0.063	0.018
Standard errors are in parentheses. Significance levels: *** p<0.001, ** p<0.01, * p<0.05, . p<0.1						

Table S2. shows the combination of predictors that result in maximum Area under the curve (AUC) with maximum model accuracy for risk prediction.

Reading outcome	**Grade**	**Predictors**									**AUC**	**Accuracy**
		MEP-P	**Motion**	**Deletion**	**Blending**	**SR**	**NWR**	**Vocab**	**DGS**	**RAO**		
WCJ LWI (end-of-same-school-year)	0		*X*	*X*	*X*				*X*		0.764	0.8
WCJ WA (end-of-same-school-year)	0		*X*			*X*	*X*				0.722	0.729
WCJ LWI (a year after)	0	*X*		*X*	*X*					*X*	0.702	0.753
WCJ WA (a year after)	0				*X*	*X*			*X*		0.748	0.8
WCJ BRS (a year after)	0	*X*		*X*	*X*						0.688	0.794
WCJ Broad Reading Skills (a year after)	0		*X*		*X*	*X*	*X*		*X*		0.649	0.718
WCJ Reading (a year after)	0		*X*	*X*							0.660	0.771
WCJ LWI (end-of-same-school-year)	1	*X*						*X*		*X*	0.637	0.761
WCJ WA (end-of-same-school-year)	1						*X*		*X*		0.674	0.843
WCJ LWI (a year after)	1			*X*			*X*		*X*		0.700	0.769

WCJ WA (a year after)	1	*X*	*X*			*X*	*X*		*X*		0.646	0.765
WCJ BRS (a year after)	1	*X*		*X*				*X*			0.644	0.739
WCJ Broad Reading Skills (a year after)	1	*X*					*X*	*X*			0.698	0.799
WCJ Reading (a year after)	1		*X*	*X*			*X*				0.655	0.791