



**GEORGIA
POLICY LABS**



Appendix to:

Student Achievement Growth During the COVID-19 Pandemic

Insights from Metro-Atlanta School Districts

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This Appendix accompanies the report to further describe the detailed methodology and our supplementary results.

Data Context

The data we employ for analysis include both standard administrative data, such as enrollment and student demographics, as well as formative assessment data that measures student achievement, for school year (SY) 2017-18 through SY 2020-21. Unlike end-of-year summative assessments, such as Georgia Milestones, formative assessments are administered up to three times per year. This allows us to measure student achievement in winter of SY 2019-20, just prior to the onset of the pandemic and subsequent school closures. It also permits us to investigate changes in student achievement over the first half of SY 2020-21. The formative assessment data are crucial, as summative testing (Milestones assessments) did not occur in spring of SY 2019-20 and will likely not be taken by students who are still learning remotely in spring of SY 2020-21.

Variation in Assessments

While the use of formative assessment data has some clear advantages, the data also present some challenges for measuring student performance, particularly during the pandemic. First, the three participating districts in this study have not consistently used the same exam over time. As illustrated in Appendix Table A1, in recent years District A has administered the i-Ready assessment in grades K-8. They used a different exam at the high school level, one which cannot be aligned with i-Ready or other nationally normed formative assessments. Consequently, we can compare scores for high school students within SY 2020-21, but we cannot compare those scores to achievement levels of prior high-school cohorts.

Administration of the i-Ready exam in District A varied within years and over time by grade and subject. There were relatively few i-Ready test takers in math in fall and winter of SY 2017-18. Likewise, there were few test takers in reading in grades K-2 in SY 2017-18 and SY 2018-19. Thus, the potential analysis sample is limited to grades K-8 in SY 2018-19 through SY 2020-21 for math and grades 3-8 in SY 2018-19 through SY 2020-21 for reading. Given that prior-year test scores are needed to project what achievement growth would have been in the absence of the pandemic, COVID impact estimates are limited to grades 1-8 in math and grades 4-8 in reading. For these grades, over 90% of students were tested in fall of SY 2019-20 in math and in reading. Testing

was somewhat less comprehensive in fall of SY 2020-21, with about three-fourths of students in the estimation-sample grades being tested.

Since SY 2016-17, District B has administered the MAP formative assessments in math, reading, language usage, and science three times per year. As illustrated in Appendix Table A2, administration of the MAP exam has been relatively consistent over time and across subjects in grades 1-10. Through winter of SY 2019-20, most students were tested in each of the four subjects in the fall, winter, and spring of each school year. In fall of SY 2020-21, the number of elementary and middle school students who were tested declined by roughly 25% to 30%, relative to those tested in the same subject in fall of SY 2019-20. The drop-off was even larger at the high school level. In grades 9 and 10, the number of students tested fell by approximately 40%. Consequently, results for grades 9 and 10 should be viewed with caution. The sample of test takers in these grades may be different from the test takers in prior years, which could bias the results. Test taking dropped even further in winter of SY 2020-21. This was likely due to the district mandating that all students take the assessment on campus (more on this point below).

Since SY 2017-18, District C has administered two different formative assessments in math and reading, i-Ready and MAP Growth. Appendix Table A3 displays the number of students for which test-score data exist for each exam by school year and testing period. Formative assessments generally occurred twice a year, in fall and winter. In SY 2017-18 and SY 2018-19, only the i-Ready assessment was administered in grades K-8. A few schools in District C independently administered the i-Ready exam in fall of SY 2018-19, but districtwide use did not begin until winter of SY 2017-18. Roughly half of District-C students in grade K-8 were tested in that initial period. In SY 2018-19, there was near universal math testing of students in grades K-8; reading assessment in grades K-1 was much more limited. In fall of SY 2019-20 (fall of calendar year 2019), the MAP assessment began to be used, but i-Ready was still the dominant formative assessment. The vast majority of students in grades K-8 took the i-Ready test in math and most students in grades 2-8 were tested in reading with the i-Ready exam. Beginning in Winter of SY 2019-20, District C transitioned to using MAP Growth as the primary formative assessment. Usage was not universal; about half of elementary schools, all middle schools and two high schools in the district administered the assessment. For both math and reading, elementary school testing was limited to students in grades 2 and above. Further, less than two-thirds of students in grades 2-8 were tested.¹ The

¹ Fewer than 400 students in grades 9-12 were tested in winter of SY 2019-20. This increased to over 3,800 students in fall of SY 2020-21.

proportion of students taking the MAP Growth assessment in grades K-8 remained about the same in fall of SY 2020-21 (fall of calendar year 2020). Given the history of assessment in District C, the analysis sample is limited to students in grades 2-8 in SY 2018-19 through SY 2020-21. Because prior-year test scores are needed to compute impact on student achievement growth, estimates can only be produced for students in grades 3-8. Because the i-Ready and MAP Growth assessments have different scales, we used a crosswalk (Curriculum Associates, 2020b) to convert MAP Growth scale scores to i-Ready scale scores. Thus, our analyses are based on data from SY 2018-19 through SY 2020-21, with all scores expressed on the i-Ready scale.

Time of test-taking

Unlike the Milestones end-of-grade state assessments, which are administered during a fairly narrow testing window each spring, the timing of formative test administration can vary considerably both within and across districts. Test vendors specify date ranges over which assessments can be administered for the purpose of applying national norms and all of the assessments used in our analysis fit within those specified norming windows. However, given the norming windows are fairly broad, changes in test timing between years could distort year-to-year comparisons of scores. This is of particular concern during SY 2020-21, when some schools administered their fall assessments later than usual.

In District A, the timing of exam administration differed in fall of SY 2020-21, relative to prior years. In fall of SY 2019-20, school began on August 12 and over 90% of math assessments were administered by September 9. In contrast, in fall of SY 2020-21, the school year started on August 17 and the 90% mark was reached on September 22. In District B, 90% of fall math assessments in SY 2019-20 were administered by September 12. In SY 2020-21, school started on September 22 and the 90% test-administration mark was not achieved until November 2. Test timing is potentially an even greater issue in District C. In fall of SY 2019-20, over 90% of math assessments were administered to students between August 5 and August 20. In contrast, in fall of SY 2020-21, 90% of math assessments occurred between September 8 and October 6. Thus, actual impacts of the pandemic on student achievement growth could be understated by 4-6 weeks of typical learning growth if test timing is not considered.

In our main analysis of pandemic effects, we do not adjust for differences in the timing of assessments. However, to gauge the impact of test timing, we re-estimated the pandemic-induced achievement growth changes, controlling for the timing of exams. Results from these timing-adjusted models are presented in Appendix Figures A23-A43.

While the exact magnitudes vary somewhat from those reported in the report, the general trends stay the same.

Testing location

Another challenge with using SY 2020-21 formative assessment scores to evaluate the effects of the pandemic on student achievement growth is that many students took the exams at home, rather than at school, which was the standard practice prior to the COVID-19 pandemic. In District A, most students took their fall assessment at home, but as many students transitioned to in-person instruction during the fall semester, a much larger proportion took the winter assessment at school. In District B, all students took the fall assessment at home and all students took the winter math and reading assessments at school.² Finally, in District C, all learning was remote throughout the fall semester and consequently all fall and winter assessments were administered away from school.

Although the formative assessments are “low-stakes” exams that are not used for teacher or school accountability and do not affect student grades, it is still possible that well-meaning parents may have assisted their children during test taking at home. All four of the recent national learning-loss studies acknowledge that at-home test-taking may have affected test scores, particularly for students in early-elementary grades. In an analysis of i-Ready test scores in 25 states, Curriculum Associates (2020a) found that “students who took diagnostic assessments at home in the fall actually showed an improvement over previous years... the data likely reflect well-documented concerns about testing at home, even for low-stakes, diagnostic assessments.” Kuhfeld et al. (2020a) analyzed learning-loss estimates from MAP Growth tests and compared results for students in districts where no in-person instruction was available at the beginning of the fall 2020 semester with results for students in districts where in-person instruction was available. They found that students in grades 1 and 2 in remote-learning districts showed large improvements in their national percentile rank whereas first and second grade students in in-person learning districts, as well as students in grades 3-8 in either district type, either maintained their national percentile rank from fall 2019 to fall 2020 or experienced a decline. Bielinski (2020) notes that in the analysis of FastBridge scores by Bielinski, Brown, and Wagner (2020), they saw a significant jump in the proportion of students scoring in the 99th percentile between fall 2019 and fall 2020. Similarly, Renaissance Learning (2020) analyzed Spring 2020 data (when nearly all US schools

² Students in District B took language usage and science assessments at home.

were exclusively remote) and found unusually high levels of student performance in grades 1 and 2, and to a lesser extent, in grade 3.

All but the Renaissance study attempt to account for this potential bias in various ways. In their analysis of i-Ready scores, Curriculum Associates (2020c) only include students who self-reported taking the exam at school. For the MAP assessment, Kuhfeld et al. (2020b) eliminate early-elementary students and only report achievement growth changes for grades 4-8. Finally, Bielinski (2020) indicates that in their analysis of FastBridge scores, Bielinski, Brown, and Wagner (2020) trimmed the score distribution in each year, tossing out students with very high national percentile scores.

During SY 2020-21, the i-Ready assessment includes a “pop up” asking students to report the location in which they are taking the exam: “in school” or “other.” In Appendix Figures A21 and A22 we graphically illustrate the differences in the estimated effect of the pandemic on achievement growth by test location for the one district that used i-Ready in SY 2020-21, District A. In Appendix Table A4, we report the results of t-tests of hypothesis that changes in measured achievement growth do not vary by location. In fall of SY 2020-21, we can reject the notion that test location does not matter at better than the 95% confidence level for both math and reading in grades 5 and below. In winter, we can reject equality across locations at better than 95% confidence in all but grade 5 in math and grade 4 in reading. Given these results and the findings from national studies, we limit our analysis of pandemic-related reductions in achievement growth to students in grades 4 and above.

Variation in the pool of test-takers

As noted above, the number of test-takers generally fell in fall of SY 2020-21, relative to prior years. This may reflect reductions in enrollment from parents who decided to homeschool their children during the pandemic or parents who switched to private school. It could also reflect students disengaging from school during the pandemic and simply not taking exams. Potentially more problematic, however, is the large decrease in test takers in District B in winter of SY 2020-21. To determine if the composition of the pool of test takers in District B differed between fall and winter, we computed mean values of student characteristics by test taking pattern. The results are displayed in Appendix Table A5. In general, students who took the fall exam but not the winter exam, were less likely to be an English learner, more likely to experience disability, more likely to be Black, less likely to be Hispanic, and be lower achieving in the prior year.

Methodology

We follow a three-step procedure to estimate the pandemic's effects on student achievement growth. The description below describes the steps to estimate achievement growth from fall of SY 2019-20 to fall of SY 2020-21; the procedure to estimate achievement growth from winter of SY 2019-20 to winter of SY 2020-21 is analogous.

Step 1: Estimate the determinants of students' typical, pre-pandemic fall test scores.

We use regression analysis to estimate the relationship between individual-level fall test scores in calendar years 2018 and 2019 and the same students' test scores in fall and winter of the prior school year (i.e., SY 2017-18 and SY 2018-19). We also account for grade level and the observable characteristics of students.³

Step 2. Forecast what test scores in fall and winter of SY 2020-21 would have been in the absence of the pandemic.

We assume that students in fall of SY 2020-21 would have had the same test scores as students with the same observable characteristics and test-score histories as the prior cohorts of test takers in fall SY 2018-19 and fall SY 2019-20. Thus, to predict fall SY 2020-21 test scores, we take the estimated relationships developed in step #1 and insert the values of the fall and winter SY 2019-20 test scores and student characteristics of students enrolled in a district in SY 2019-20 to produce an expected test score in fall SY 2020-21 for each student. In other words, we use the patterns from the fall SY 2018-19 and fall SY 2019-20 cohorts—during normal times—and apply them to data on students in fall SY 2020-21 to estimate what scores students would have obtained in fall SY 2020-21, had the pandemic not occurred.

Step 3. Estimate achievement growth.

The actual scores of students taking the fall SY 2020-21 assessment are then compared to the projected achievement levels (in the absence of the pandemic). The difference between the actual and predicted achievement levels is our measure of pandemic-

³ The characteristics included: a set of racial/ethnic indicators, indicators for disability categories, indicators for gender, FRPM status and English learner status and then number of disciplinary incidents in the previous year.

related achievement growth for each student. This achievement growth measure includes both indirect non-school impacts of the pandemic, such as parental job loss and other family disruptions, as well as the direct effects of school closures and the rapid transition to remote learning. As typical summer learning loss is included in both the predicted and actual fall SY 2020-21 test scores, summer learning loss is netted out and the achievement growth estimates presented here represent changes in achievement growth beyond the typical summer learning loss. Because we account for prior test score histories and observable student characteristics, a student's achievement growth is not being compared to that of the average student in the district, but rather to what students with similar characteristics and test-score histories would be expected to obtain in a "normal" year.

The specifics of this three-step procedure are as follows. In order to estimate the impact on student achievement growth from the COVID-19 pandemic, we first forecast what achievement would have been in fall SY 2020-21 had the pandemic not occurred. To do this we use data from school years prior to SY 2019-20 and multivariate linear regression techniques to estimate equations of the form:

$$A_{igt}^{fall} = \beta_0 + \beta_1 A_{i,t-1}^{winter} + \beta_2 A_{i,t-1}^{fall} + \beta_3 \mathbf{X}_{i,t-1} + \gamma_g + \epsilon_{igt}. \quad (1)$$

A_{igt} represents the achievement level if student i in grade g in school year t (where t represents the calendar year of the end of the school year, i.e., 2020 refers to school year 2019-20). $\mathbf{X}_{i,t-1}$ is a vector of student characteristics in school year $t - 1$ (e.g., race and ethnicity, gender, special education status, English learner status, free or reduced-price meals status, and prior-year disciplinary incidents). γ_g is an indicator for grade g . Higher-order functions are used to present the impacts of prior scores by including squares of prior test scores.⁴

Using the estimated parameters from equation (1), $\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\gamma}_g$, and the actual values of A_{igt} and $\mathbf{X}_{i,t-1}$ from SY 2019-20, the predicted achievement level in fall SY 2020-21, had the pandemic not occurred, is:

$$\hat{A}_{igt=2021}^{fall} = \hat{\beta}_0 + \hat{\beta}_1 A_{i,t=2020}^{winter} + \hat{\beta}_2 A_{i,t=2020}^{fall} + \hat{\beta}_3 \mathbf{X}_{i,t=2020} + \hat{\gamma}_g + \epsilon_{igt}. \quad (2)$$

⁴ The model excludes year fixed effects because the time span of available pre-SY 2019-20 test-score data is typically short – only two or three years. Thus it would be difficult to establish any sort of time trend to produce a predicted school-year effect for SY 2020-21. By omitting school-year effects, we are assuming that in the absence of the pandemic, test scores would have been the same as the average over recent years.

The estimated achievement growth is the difference between the predicted achievement level in fall of SY 2020-21, $\hat{A}_{igt=2021}^{fall}$, and the actual achievement level, $A_{igt=2021}^{fall}$:

$$G_{igt=2021}^{fall} = \hat{A}_{igt=2021}^{fall} - A_{igt=2021}^{fall}.$$

To estimate the achievement growth from winter SY 2019-20 to winter SY 2020-21, we follow an analogous approach, replacing A_{igt}^{fall} with A_{igt}^{winter} in equation (1).

Summary Statistics

Appendix Table A1. Number of students tested by year in District A, by school year, test period, and grade level.

Math

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	Total
2017-18	Fall	227	240	230	389	349	382	0	0	0	1,817
2017-18	Winter	236	240	192	263	381	314	0	0	0	1,626
2017-18	Spring	1,202	1,743	1,613	2,122	1,890	1,725	888	727	447	12,357
2018-19	Fall	5,903	6,258	6,317	6,622	6,776	6,779	6,633	6,520	5,711	57,519
2018-19	Winter	3,707	4,104	4,414	4,737	4,853	4,937	4,824	5,247	4,211	41,034
2018-19	Spring	2,441	2,626	2,877	3,656	3,648	3,762	900	867	1,711	22,488
2019-20	Fall	5,960	6,115	6,317	6,347	6,606	6,716	6,398	6,638	6,566	57,663
2019-20	Winter	5,341	5,555	5,820	6,016	6,260	6,321	5,020	4,890	4,251	49,474
2019-20	Spring	93	106	122	146	119	132	376	325	229	1,648
2020-21	Fall	1,439	4,530	4,867	5,281	5,351	5,574	5,057	5,219	5,284	42,602
2020-21	Winter	1,530	4,657	4,977	5,288	5,350	5,533	5,005	5,090	5,334	42,764

Reading

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	Total
2017-18	Fall	169	177	264	4,563	6,205	6,393	5,282	4,966	5,199	33,218
2017-18	Winter	177	156	682	4,932	5,593	6,006	4,976	4,251	4,368	31,141
2017-18	Spring	136	84	732	782	1,019	1,037	550	982	742	6,064
2018-19	Fall	140	231	1,642	6,593	6,737	6,815	6,441	6,334	6,176	41,109
2018-19	Winter	<10	19	1,135	5,028	4,828	5,114	6,167	6,374	5,642	34,310
2018-19	Spring	37	26	883	3,898	3,472	3,859	1,413	1,091	1,962	16,641
2019-20	Fall	5,837	6,021	6,241	6,340	6,603	6,735	6,439	6,685	6,705	57,606
2019-20	Winter	5,174	5,459	5,736	6,058	6,214	6,295	4,910	5,016	5,189	50,051
2019-20	Spring	118	134	147	133	106	125	209	214	207	1,393
2020-21	Fall	1,458	4,543	4,874	5,258	5,355	5,568	5,099	5,247	5,502	42,904
2020-21	Winter	1,524	4,640	4,969	5,280	5,328	5,507	5,030	5,147	5,317	42,742

Appendix Table A2. Number of students tested by year in District B, by school year, test period, and grade level.

Math

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	Total
17-18	Fall	7,242	7,311	7,350	7,811	7,439	7,445	6,515	6,366	6,574	6,481	5,544	1,371	564	78,013
17-18	Winter	7,391	7,376	7,428	7,893	7,546	7,526	6,634	6,408	6,544	6,213	5,267	1,163	648	78,037
17-18	Spring	7,422	7,360	7,470	7,884	7,587	7,533	6,467	6,268	6,270	5,863	4,854	959	312	76,249
18-19	Fall	5,016	6,592	6,636	6,930	7,227	7,011	6,480	6,052	6,007	6,306	5,009	631	230	70,127
18-19	Winter	<10	7,103	7,072	7,275	7,561	7,300	6,740	6,449	6,246	6,767	5,500	628	258	68,900
18-19	Spring	<10	7,158	7,171	7,249	7,525	7,285	6,610	6,497	5,724	5,818	4,399	403	173	66,013
19-20	Fall	7,042	6,906	6,931	7,152	6,938	7,175	6,675	6,639	6,451	6,693	5,557	1,019	483	75,661
19-20	Winter	7,174	6,977	7,050	7,238	6,993	7,241	6,618	6,663	6,507	6,478	5,477	751	387	75,554
19-20	Spring	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-21	Fall	1,950	5,595	5,744	5,747	5,870	5,753	5,114	5,138	5,163	3,785	3,333	355	250	53,797
20-21	Winter	1,325	3,646	3,700	3,821	3,657	3,676	2,837	2,872	2,925	2,455	1,865	184	114	33,077

Reading

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	Total
17-18	Fall	7,231	7,309	7,361	7,783	7,438	7,443	6,488	6,339	6,570	6,105	5,458	1,319	612	77,456
17-18	Winter	7,395	7,370	7,419	7,870	7,533	7,497	6,626	6,369	6,533	6,236	5,298	1,200	624	77,970
17-18	Spring	7,457	7,388	7,491	7,893	7,565	7,527	6,460	6,245	6,179	5,644	4,791	779	283	75,702
18-19	Fall	5,036	6,613	6,643	6,877	7,084	6,902	6,268	5,774	5,777	5,595	4,663	615	229	68,076
18-19	Winter	<10	7,114	7,095	7,290	7,536	7,310	6,670	6,447	6,200	6,522	5,266	546	219	68,216
18-19	Spring	<10	7,156	7,174	7,233	7,525	7,234	6,634	6,433	5,632	5,332	3,736	339	139	64,568
19-20	Fall	7,037	6,924	6,935	7,129	6,957	7,156	6,671	6,678	6,437	6,315	5,361	920	395	74,915
19-20	Winter	7,175	6,981	7,061	7,248	7,015	7,235	6,610	6,670	6,471	6,064	5,309	800	395	75,034
19-20	Spring	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-21	Fall	1,954	5,641	5,769	5,777	5,891	5,771	5,050	5,109	5,120	3,738	3,272	365	244	53,701
20-21	Winter	1,333	3,689	3,722	3,862	3,680	3,705	2,850	2,993	2,951	2,429	1,933	196	155	33,498

Language usage

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	Total
17-18	Fall	0	0	<10	7,775	7,414	7,419	6,432	6,208	6,500	5,973	5,370	976	390	54,462
17-18	Winter	0	0	0	7,844	7,482	7,500	6,435	6,251	6,419	6,004	5,232	745	312	54,224
17-18	Spring	0	0	0	7,858	7,559	7,493	6,505	6,225	5,652	5,553	4,762	606	73	52,286
18-19	Fall	0	3	378	6,869	7,071	6,913	6,428	5,924	5,825	5,935	4,857	304	58	50,565
18-19	Winter	0	0	<10	7,227	7,515	7,254	6,678	6,363	6,084	6,654	5,349	530	117	53,773
18-19	Spring	0	0	56	7,188	7,470	7,187	6,377	6,229	5,584	5,276	3,843	297	53	49,560
19-20	Fall	0	0	0	7,082	6,887	7,091	6,637	6,648	6,462	6,357	5,262	687	308	53,421
19-20	Winter	0	0	0	7,175	6,985	7,207	6,583	6,591	6,398	6,199	5,223	623	293	53,277
19-20	Spring	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-21	Fall	0	0	<10	5,617	5,725	5,625	5,020	5,124	5,011	3,615	3,203	335	213	39,489
20-21	Winter	0	0	<10	5,508	5,589	5,466	5,009	4,914	5,116	3,766	3,221	294	157	39,041

Science

School Year	Test Period	KG	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	Total
17-18	Fall	0	0	<10	7,747	7,407	7,411	6,430	6,232	6,483	<10	0	0	0	41,715
17-18	Winter	0	0	0	7,801	7,469	7,458	6,465	6,237	6,427	0	0	0	0	41,857
17-18	Spring	0	0	0	7,834	7,548	7,510	6,223	5,979	5,636	0	0	0	0	40,730
18-19	Fall	0	<10	<10	6,893	7,130	6,910	6,362	5,893	5,791	64	13	<10	0	39,064
18-19	Winter	0	0	<10	7,212	7,494	7,244	6,664	6,351	6,178	179	27	0	0	41,351
18-19	Spring	0	0	0	7,122	7,493	7,136	6,379	6,394	5,549	177	<10	<10	0	40,259
19-20	Fall	0	0	0	7,054	6,891	7,128	6,637	6,665	6,445	204	25	<10	13	41,067
19-20	Winter	0	0	0	7,179	7,007	7,182	6,542	6,609	6,418	0	0	0	0	40,937
19-20	Spring	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-21	Fall	0	0	<10	5,635	5,711	5,639	5,143	5,099	5,137	<10	0	0	0	32,372
20-21	Winter	0	0	<10	5,471	5,530	5,486	5,068	4,979	5,065	10	0	<10	0	31,611

Appendix Table A3. Number of students tested by year in District C, by school year, test period, and grade level.

Math

School Year	Test Period	Test	KG	G1	G2	G3	G4	G5	G6	G7	G8	Total
17-18	Fall	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	0	0	0	0	0	0	0
17-18	Winter	i-Ready	226	230	2,328	3,195	2,816	2,888	3,356	3,087	2,889	21,015
		MAP	0	0	0	0	0	0	0	0	0	0
17-18	Spring	i-Ready	204	150	1,483	2,265	1,860	1,922	2,628	2,386	2,269	15,167
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Fall	i-Ready	3,799	3,896	4,042	4,160	4,285	4,490	4,280	3,853	3,729	36,534
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Winter	i-Ready	3,630	3,686	3,783	3,906	4,047	4,206	3,621	3,324	2,957	33,160
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Spring	i-Ready	393	314	256	176	197	216	64	54	34	1,704
		MAP	0	0	0	0	0	0	0	0	0	0
19-20	Fall	i-Ready	3,754	3,635	3,670	3,975	4,155	4,258	4,113	4,082	3,759	35,401
		MAP	<10	<10	1,450	1,667	1,789	1,774	3,558	3,871	3,631	17,746
19-20	Winter	i-Ready	223	221	207	124	160	306	171	101	101	1,614
		MAP	0	<10	1,453	1,743	1,874	1,899	4,013	4,048	3,762	18,793
19-20	Spring	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	0	0	0	0	0	0	0
20-21	Fall	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	2,909	3,197	3,310	2,566	2,944	2,405	17,331
20-21	Winter	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	<10	3,023	3,341	3,430	2,958	3,009	2,619	18,381

Notes: MAP refers to the MAP Growth test.

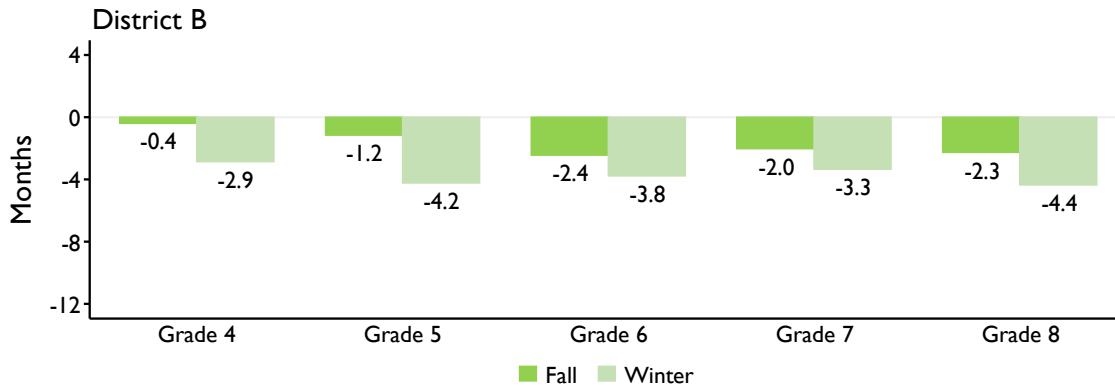
Reading

School Year	Test Period	Test	KG	G1	G2	G3	G4	G5	G6	G7	G8	Total
17-18	Fall	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	0	0	0	0	0	0	0
17-18	Winter	i-Ready	190	172	1,897	2,864	2,809	2,814	3,048	2,683	3,136	19,613
		MAP	0	0	0	0	0	0	0	0	0	0
17-18	Spring	i-Ready	154	117	1,304	1,955	1,742	1,820	2,795	2,430	2,248	14,565
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Fall	i-Ready	689	1,137	4,038	4,150	4,271	4,489	4,204	3,796	3,786	30,560
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Winter	i-Ready	324	632	3,803	3,917	4,054	4,244	3,543	3,133	3,274	26,924
		MAP	0	0	0	0	0	0	0	0	0	0
18-19	Spring	i-Ready	<10	46	321	286	361	367	77	81	58	1,606
		MAP	0	0	0	0	0	0	0	0	0	0
19-20	Fall	i-Ready	200	609	3,661	3,970	4,147	4,245	4,072	4,035	3,589	28,528
		MAP	<10	<10	1,414	1,645	1,720	1,764	3,401	3,569	3,369	16,893
19-20	Winter	i-Ready	11	<10	37	32	44	54	43	30	22	282
		MAP	0	<10	1,450	1,730	1,872	1,880	3,896	3,893	3,705	18,429
19-20	Spring	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	0	0	0	0	0	0	0
20-21	Fall	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	2,886	3,185	3,281	2,139	2,679	2,876	17,046
20-21	Winter	i-Ready	0	0	0	0	0	0	0	0	0	0
		MAP	0	0	0	3,038	3,316	3,419	2,713	2,878	3,114	18,478

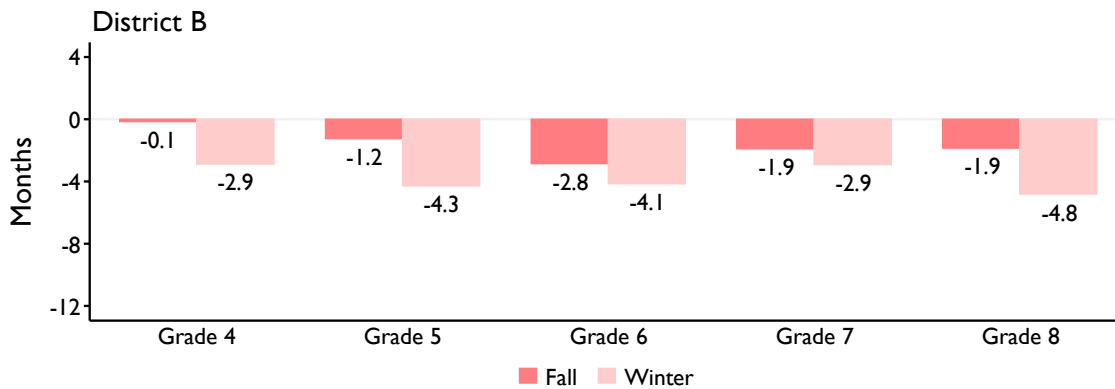
Notes: MAP refers to the MAP Growth test.

Supplemental Results

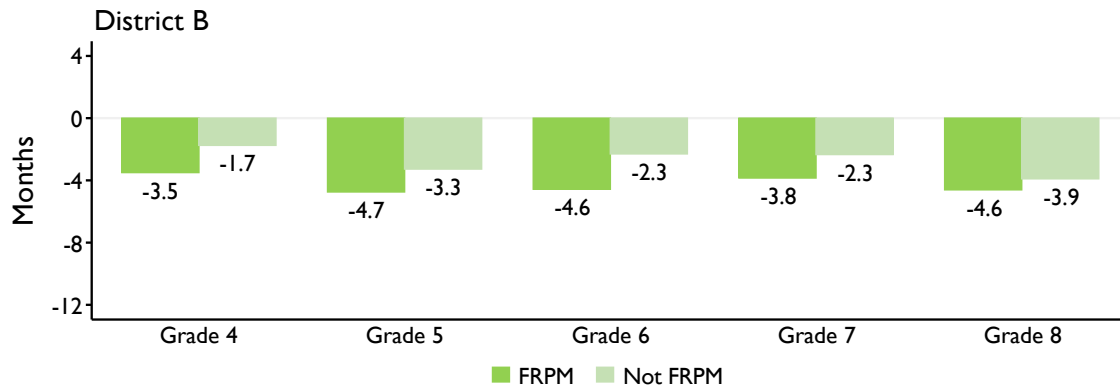
Appendix Figure A1. Average language usage achievement estimates from winter of SY 2019-20 to fall of SY 2020-21, and from winter of SY 2019-20 to winter of SY 2020-21, by district and grade level.



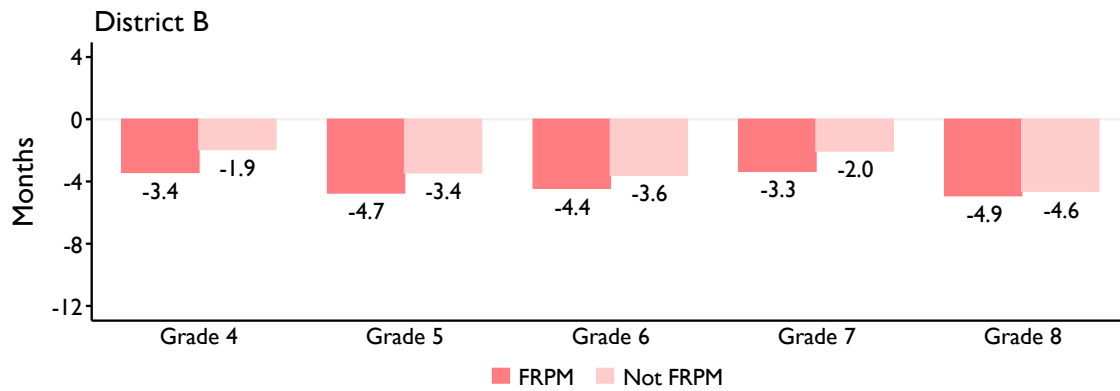
Appendix Figure A2. Average science achievement estimates from winter of SY 2019-20 to fall of SY 2020-21, and from winter of SY 2019-20 to winter of SY 2020-21, by district and grade level.



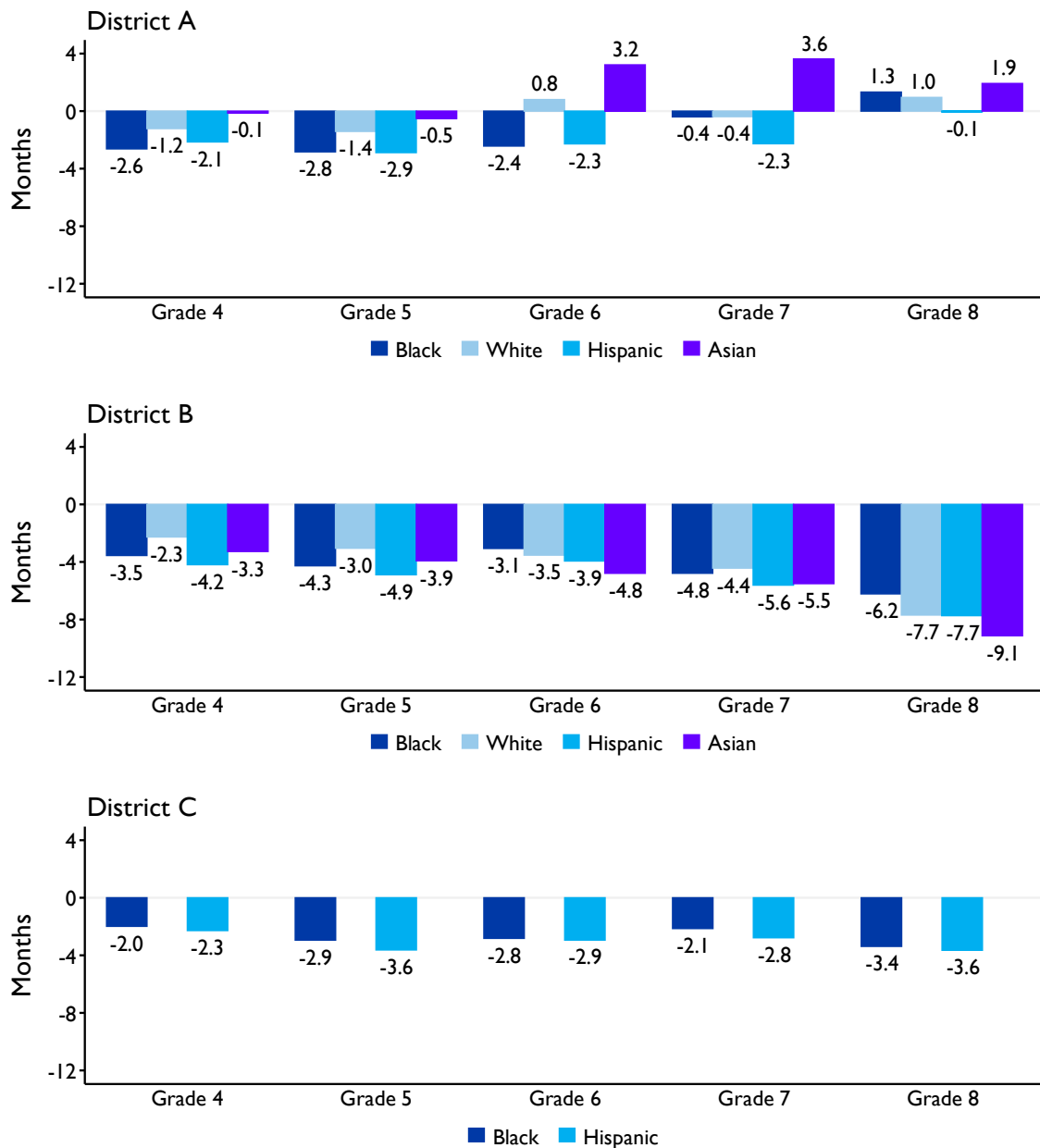
Appendix Figure A3. Average change in language usage achievement growth, by grade level and free or reduced-price meals eligibility status.



Appendix Figure A4. Average change in science achievement growth, by grade level and free or reduced-price meals eligibility status.

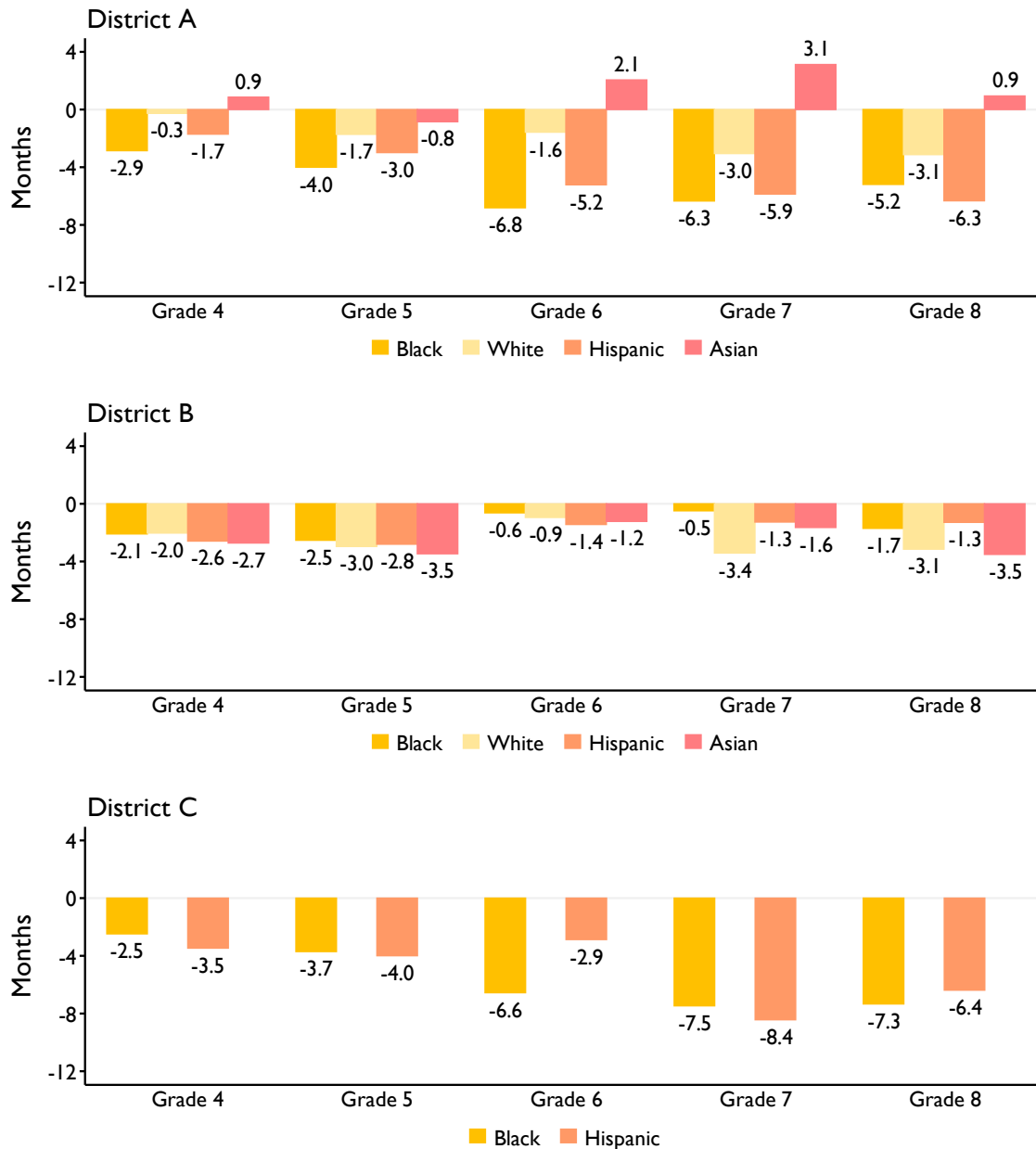


Appendix Figure A5. Average change in math achievement growth, by grade level and race and ethnicity.



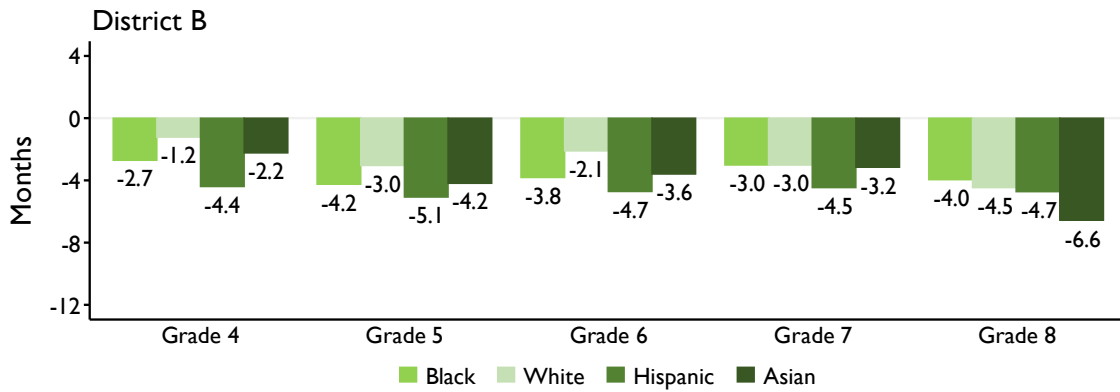
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic). For District C, Black students represent approximately 70% of the analysis sample and Hispanic students make up another roughly 22%; we therefore focus on these two groups. No other individual racial/ethnic group makes up more than three percent of the analysis sample in District C.

Appendix Figure A6. Average change in reading achievement growth, by grade level and race and ethnicity.



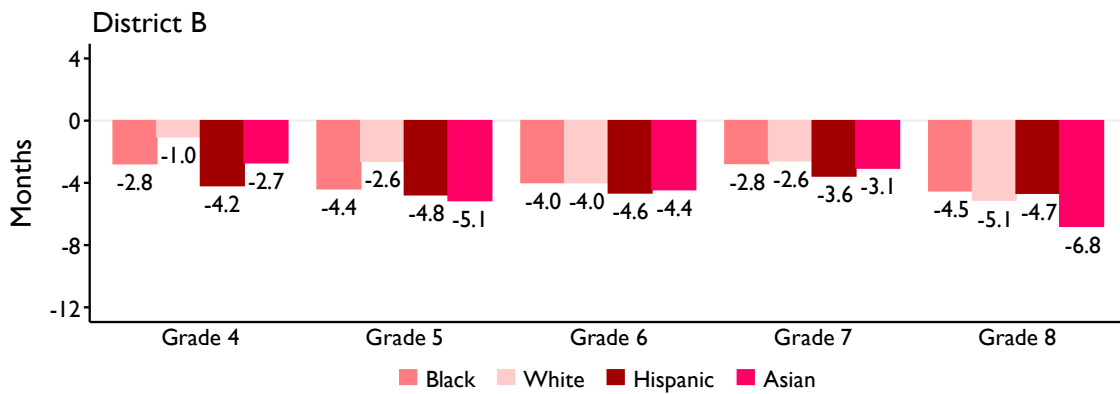
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic). For District C, Black students represent approximately 70% of the analysis sample and Hispanic students make up another roughly 22%; we therefore focus on these two groups. No other individual racial/ethnic group makes up more three percent of the analysis sample in District C.

Appendix Figure A7. Average change in language usage achievement growth, by grade level and race and ethnicity.



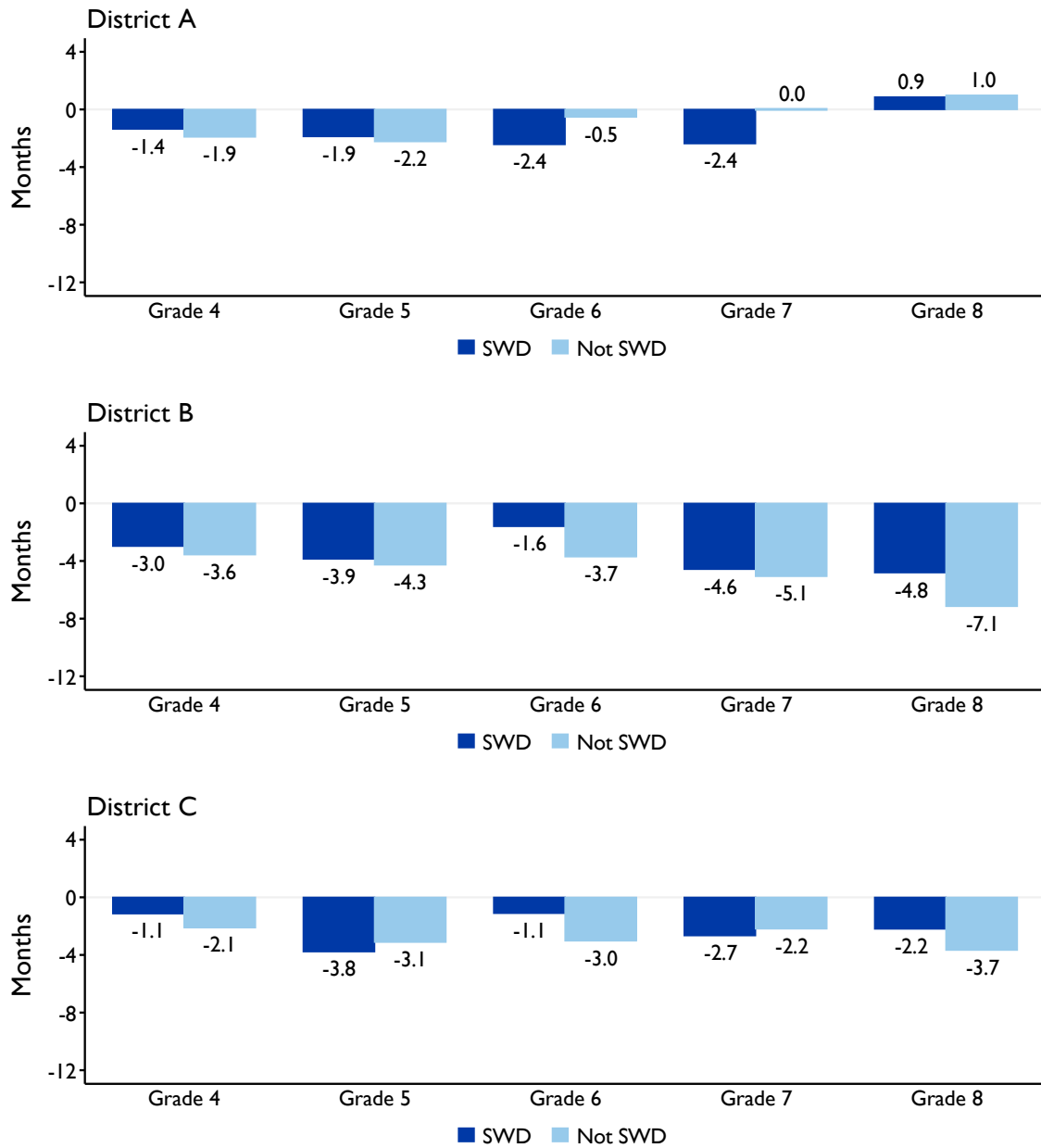
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic).

Appendix Figure A8. Average change in science achievement growth, by grade level and race and ethnicity.

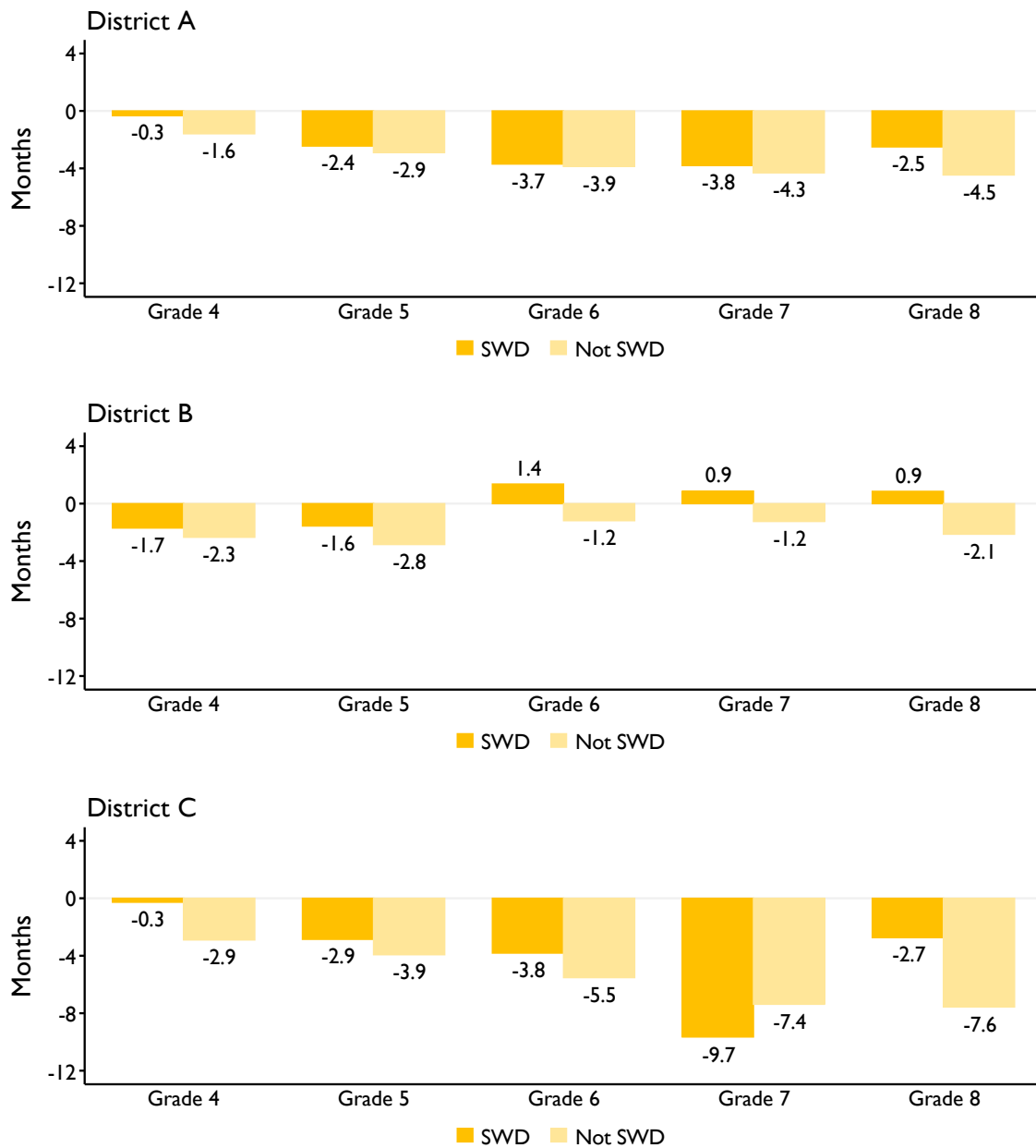


Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic).

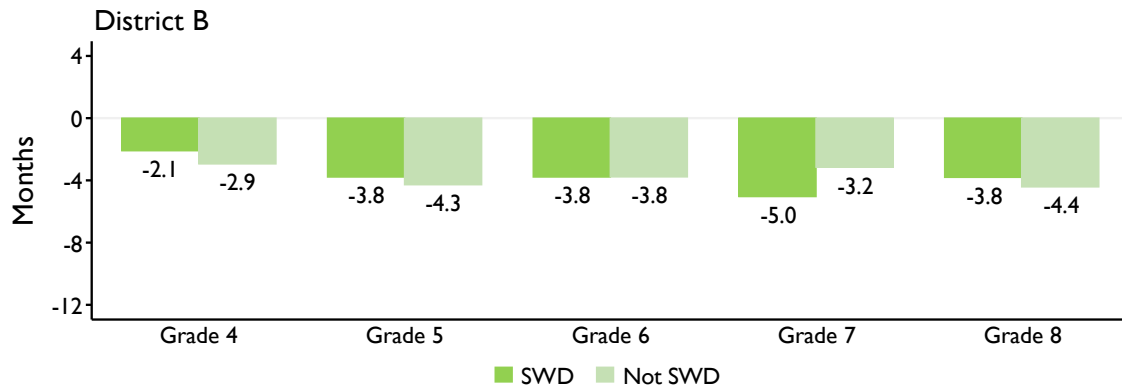
Appendix Figure A9. Average change in math achievement growth, by grade level and disability status.



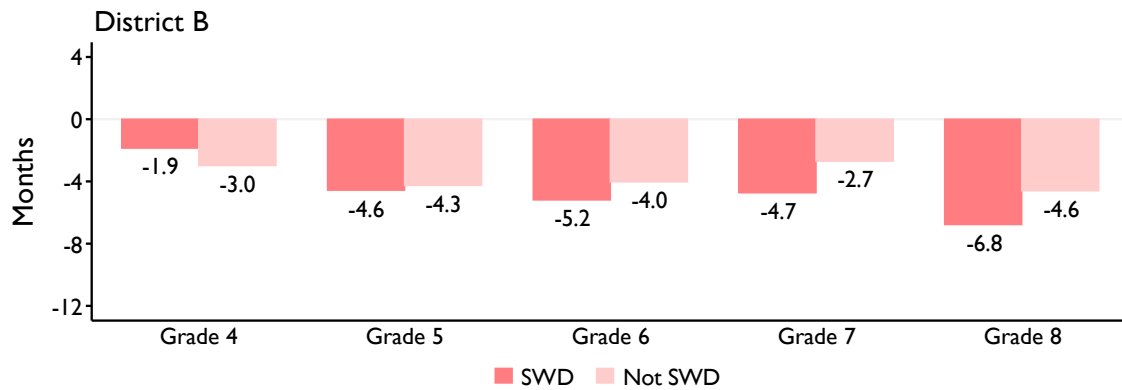
Appendix Figure A10. Average change in reading achievement growth, by grade level and disability status.



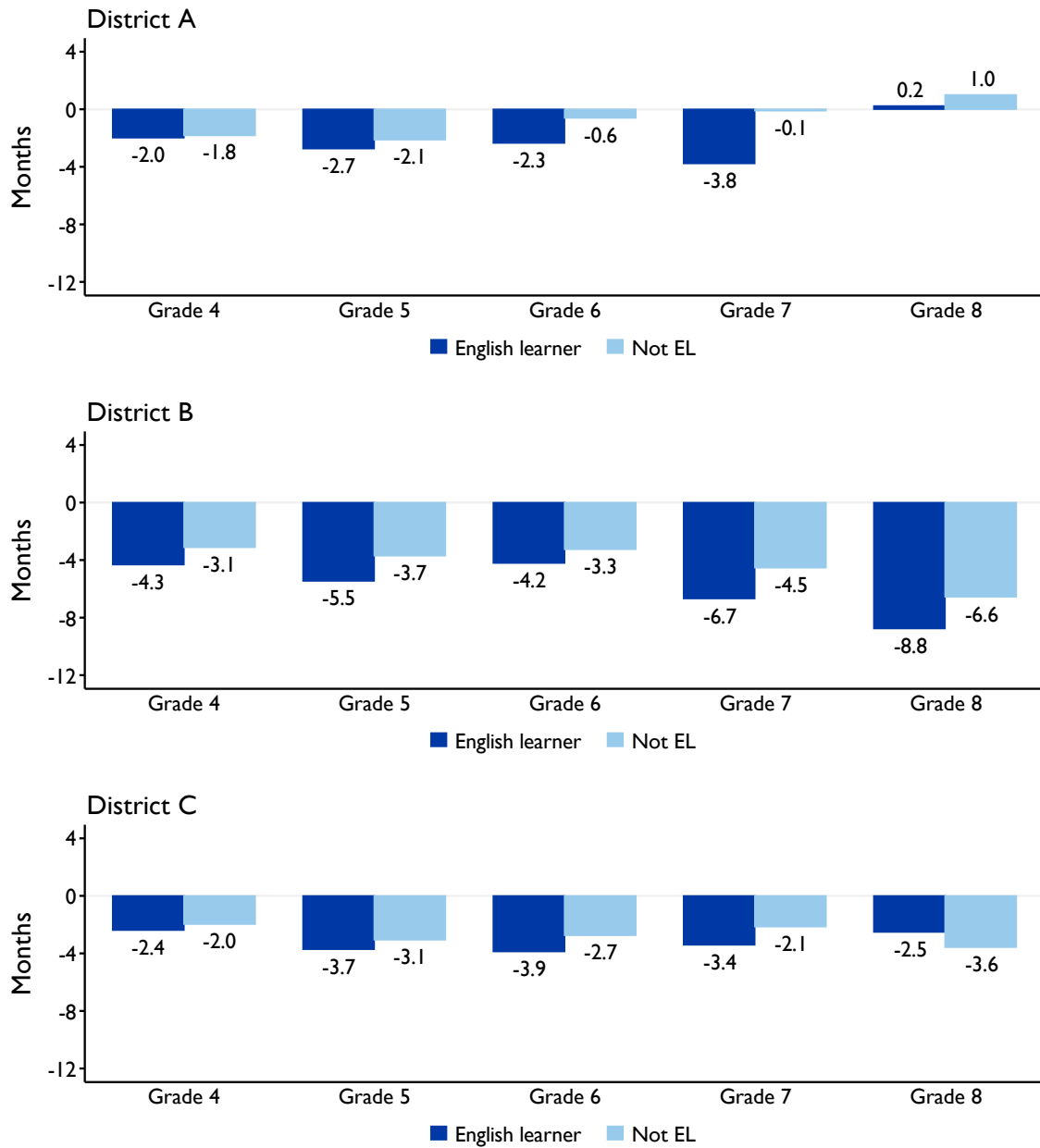
Appendix Figure A11. Average change in language usage achievement growth, by grade level and disability status.



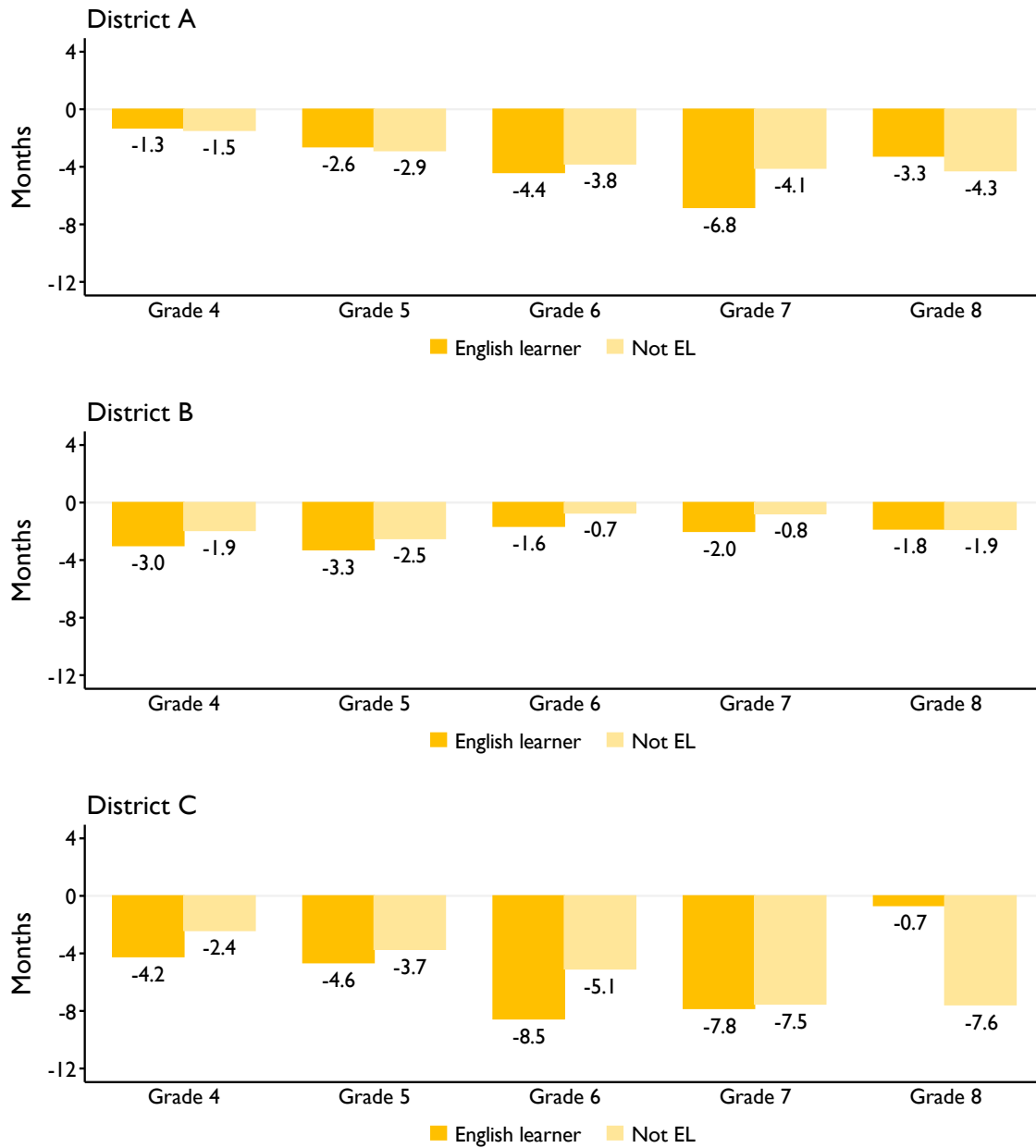
Appendix Figure A12. Average change in science achievement growth, by grade level and disability status.



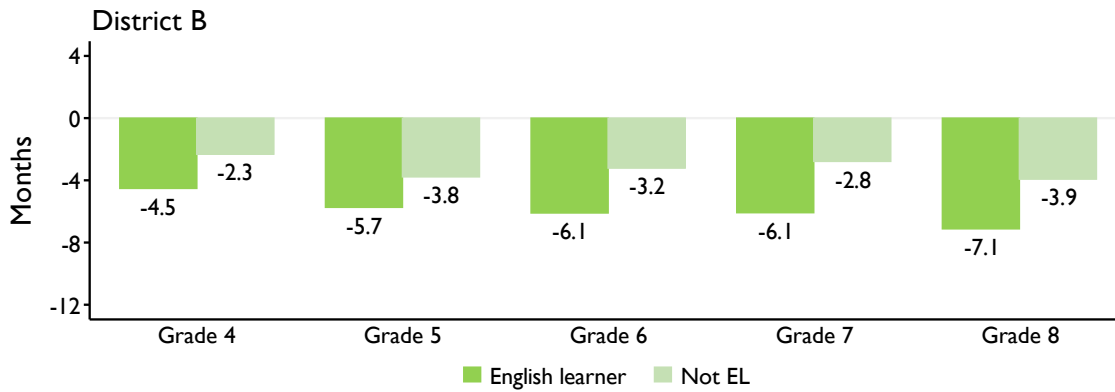
Appendix Figure A13. Average change in math achievement growth, by grade level and English learner status.



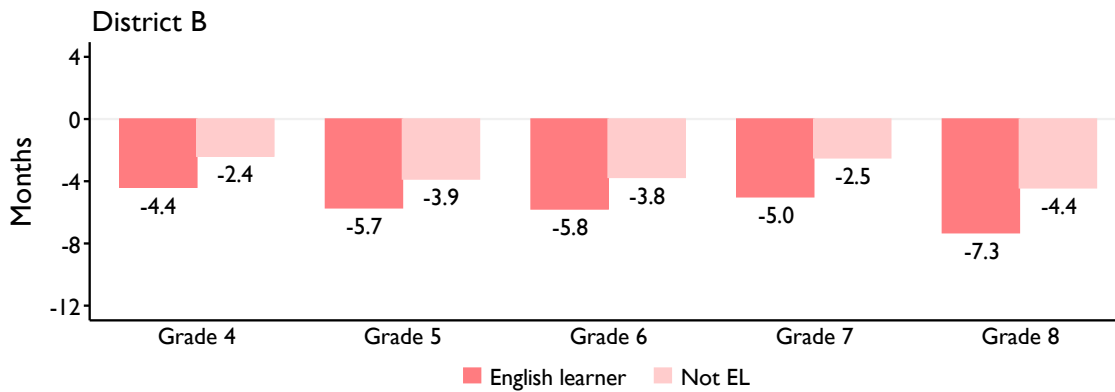
Appendix Figure A14. Average change in reading achievement growth, by grade level and English learner status.



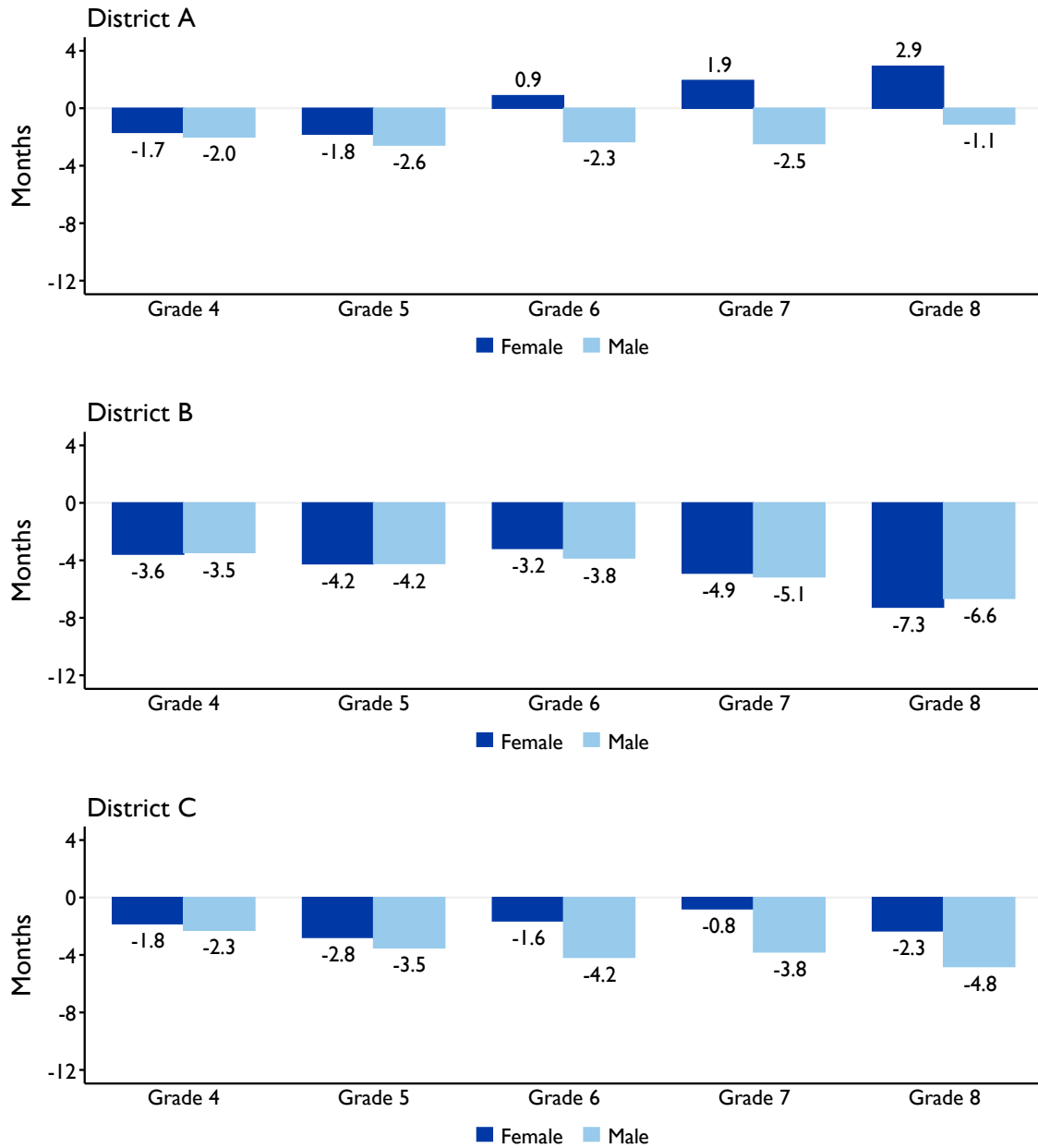
Appendix Figure A15. Average change in language usage achievement growth, by grade level and English learner status.



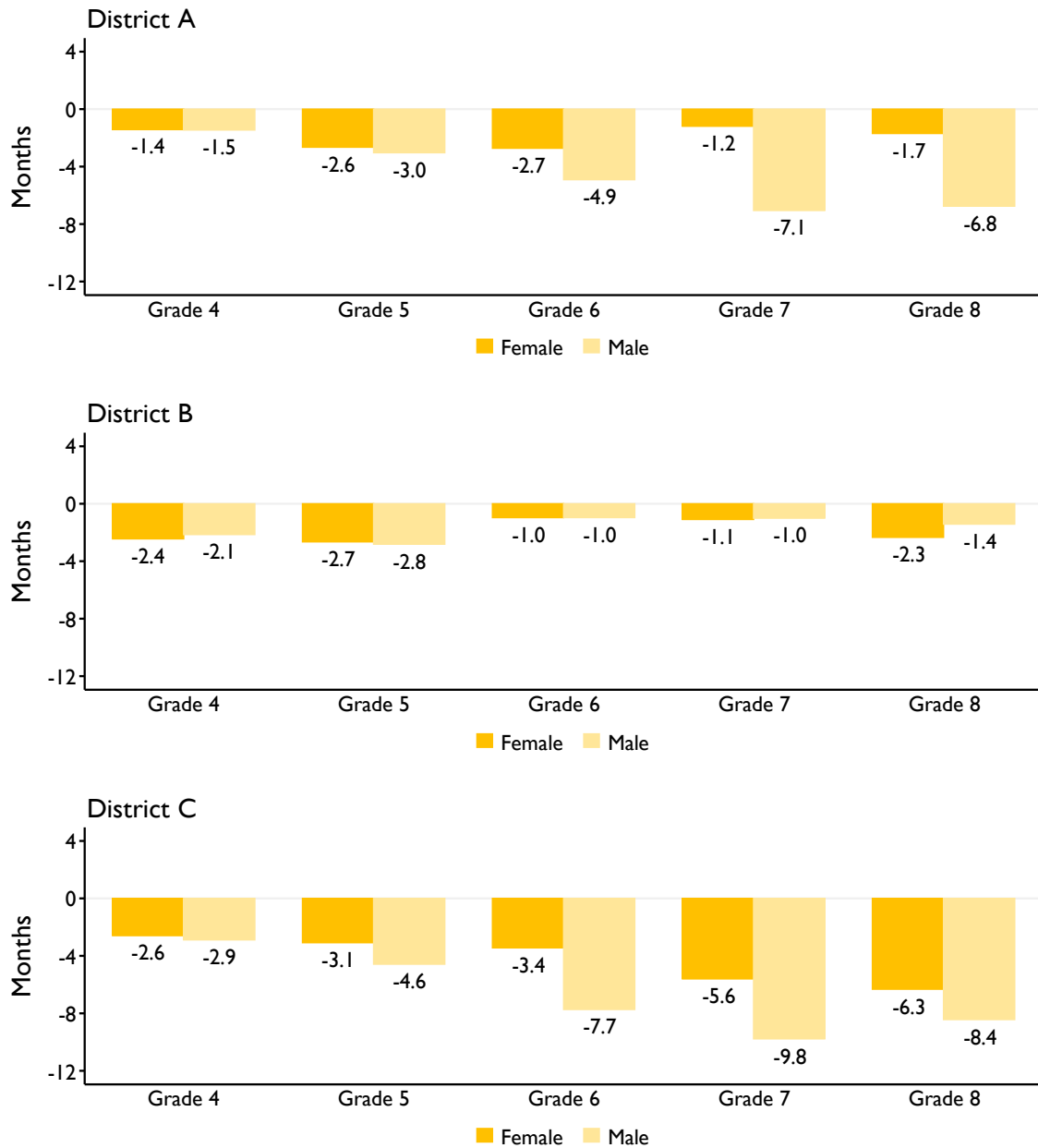
Appendix Figure A16. Average change in science achievement growth, by grade level and English learner status.



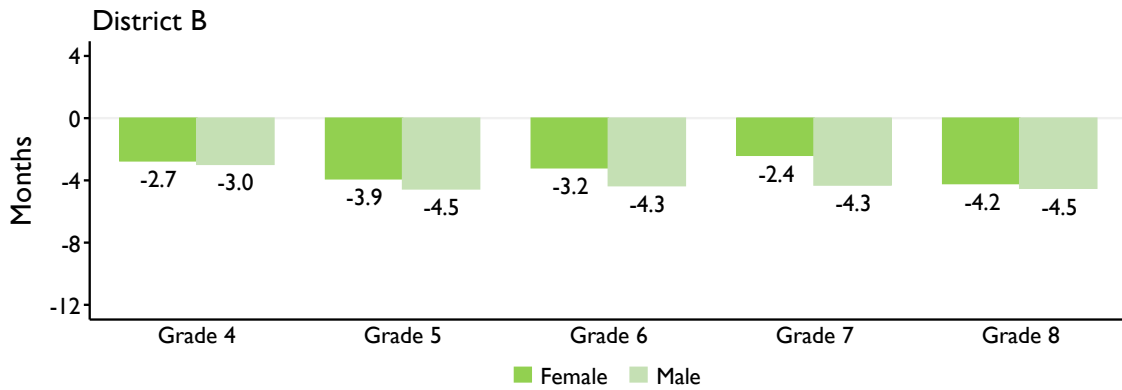
Appendix Figure A17. Average change in math achievement growth, by grade level and gender.



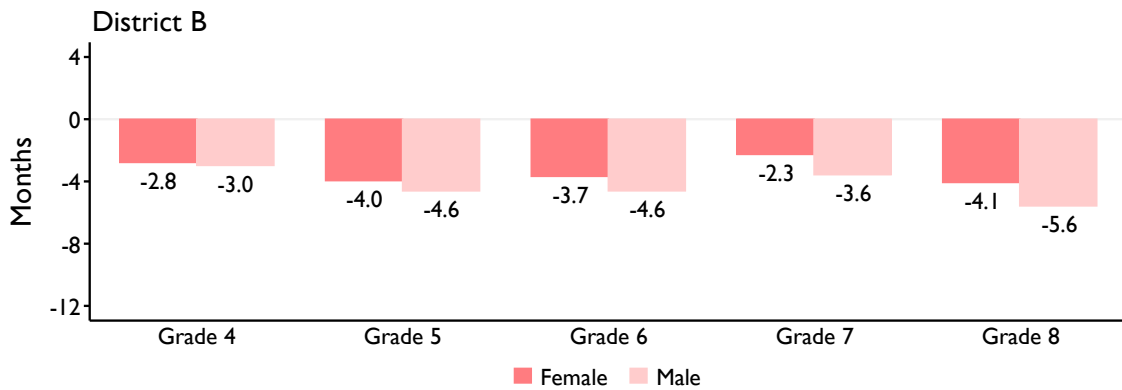
Appendix Figure A18. Average change in reading achievement growth, by grade level and gender.



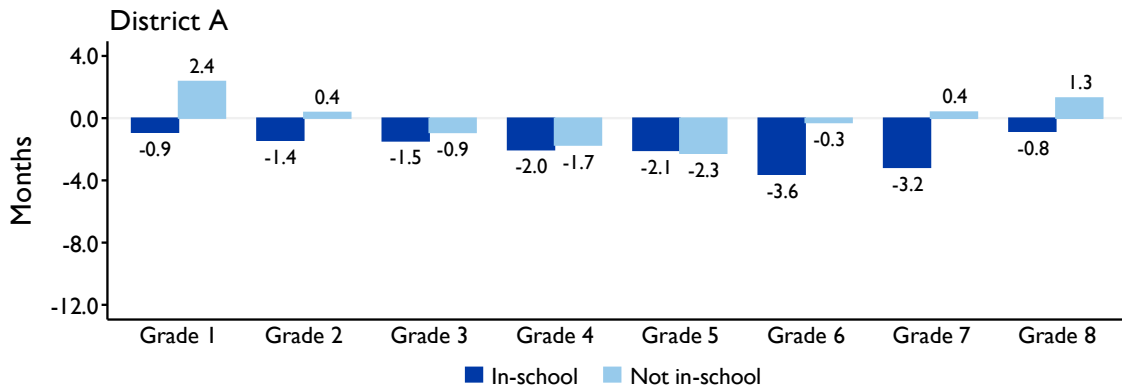
Appendix Figure A19. Average change in language usage achievement growth, by grade level and gender.



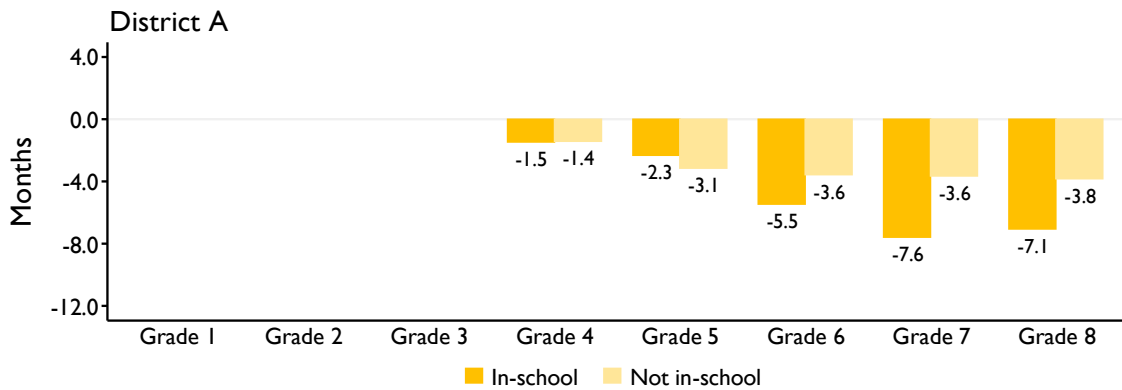
Appendix Figure A20. Average change in science achievement growth, by grade level and gender.



Appendix Figure A21. Average change in math achievement growth, by grade level and test-taking location.

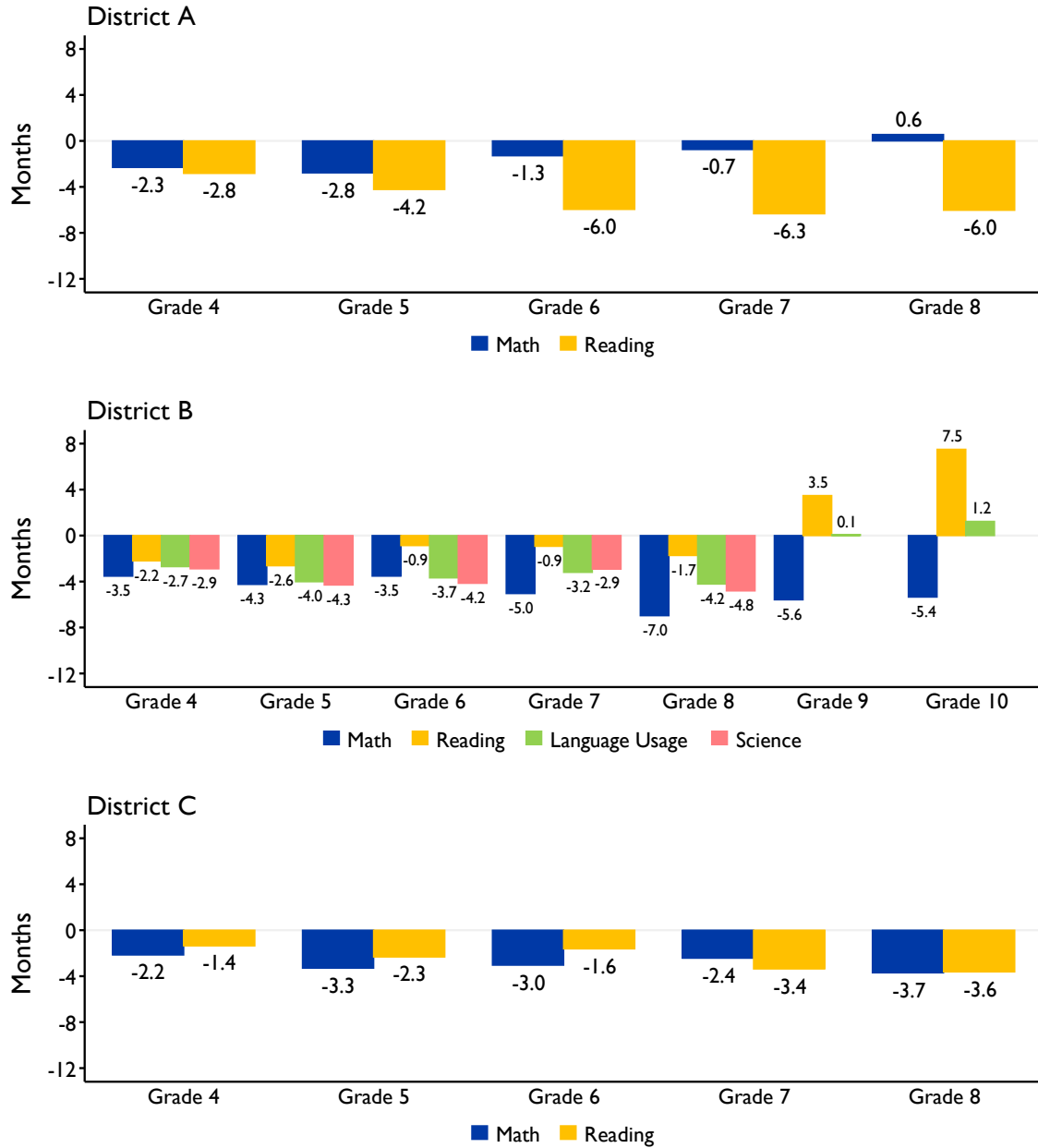


Appendix Figure A22. Average change in reading achievement growth, by grade level and test-taking location.

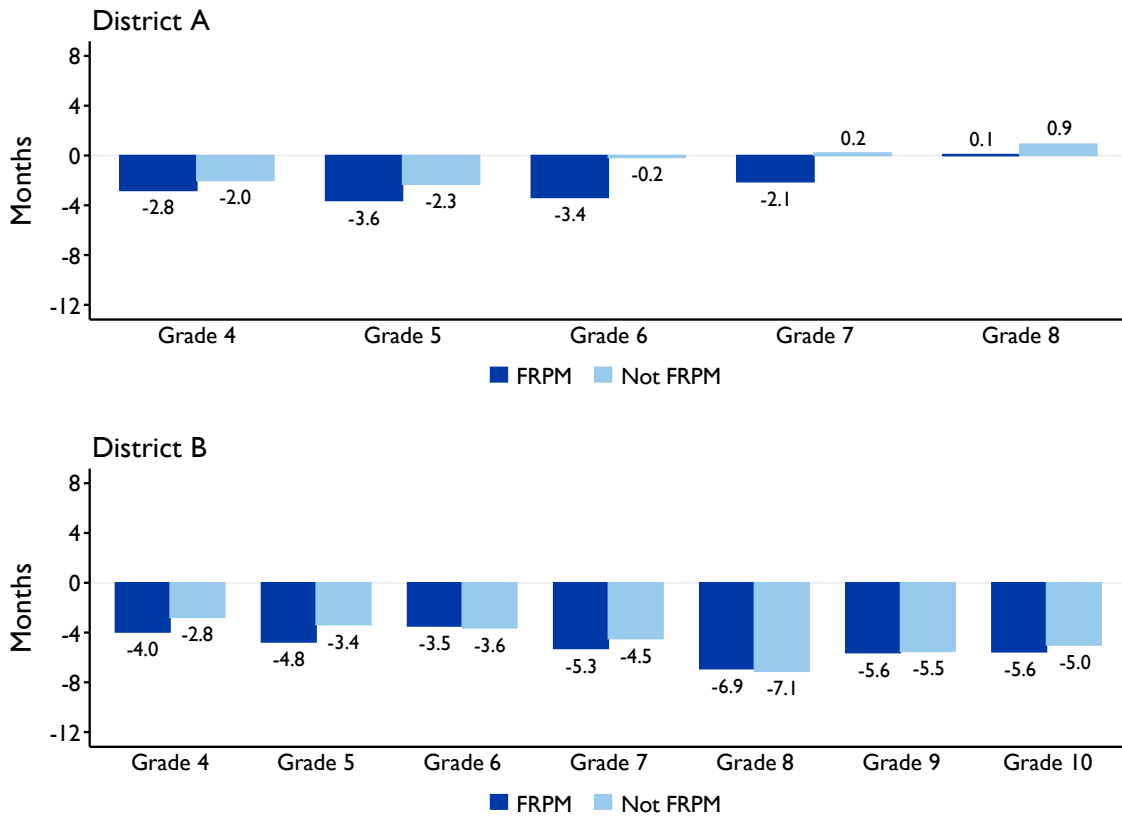


Robustness Checks

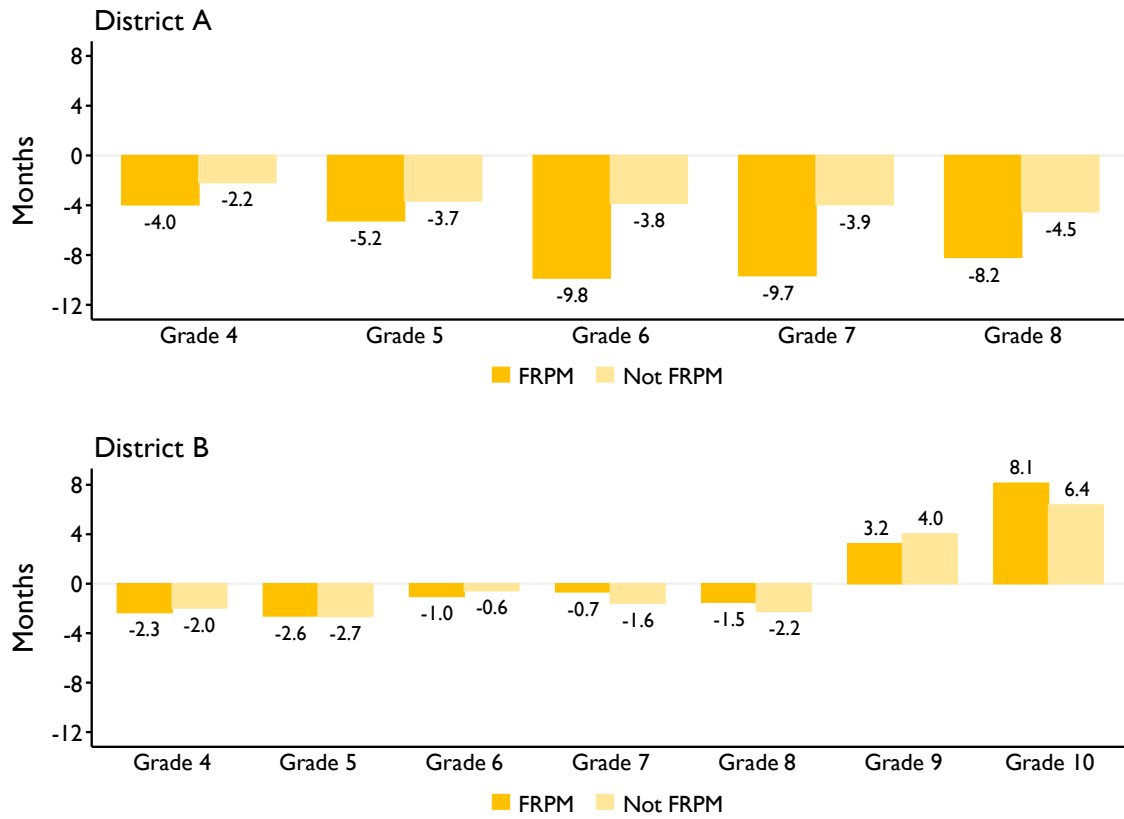
Appendix Figure A23. Average change in achievement growth, adjusting for variation in test-taking dates, by subject and grade level.



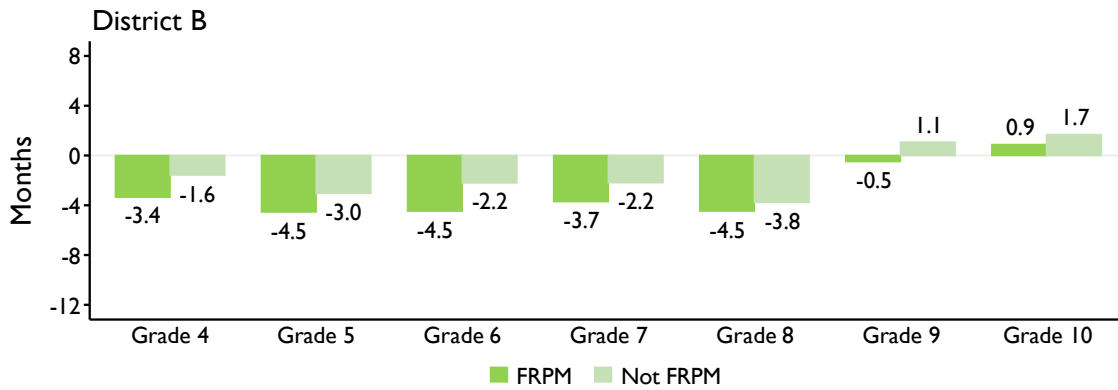
Appendix Figure A24. Average change in math achievement growth, adjusting for variation in test-taking dates, by grade level and free or reduced-price meal status.



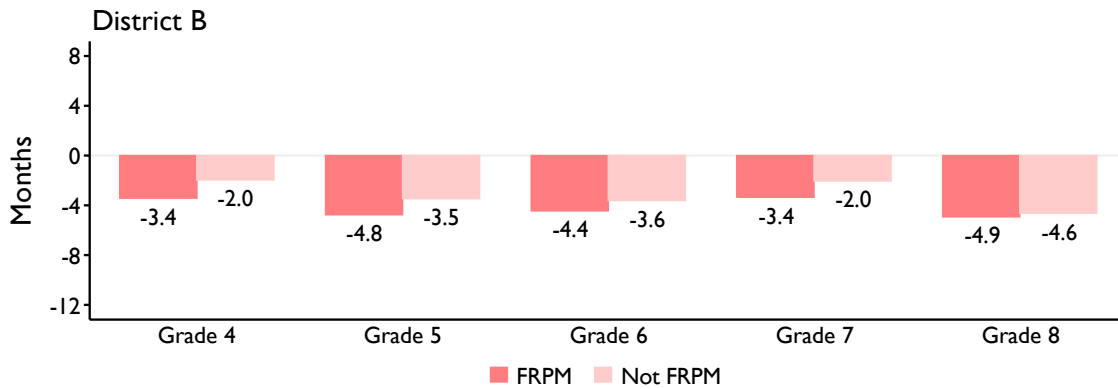
Appendix Figure A25. Average change in reading achievement growth, adjusting for variation in test-taking dates, by grade level and free or reduced-price meal status.



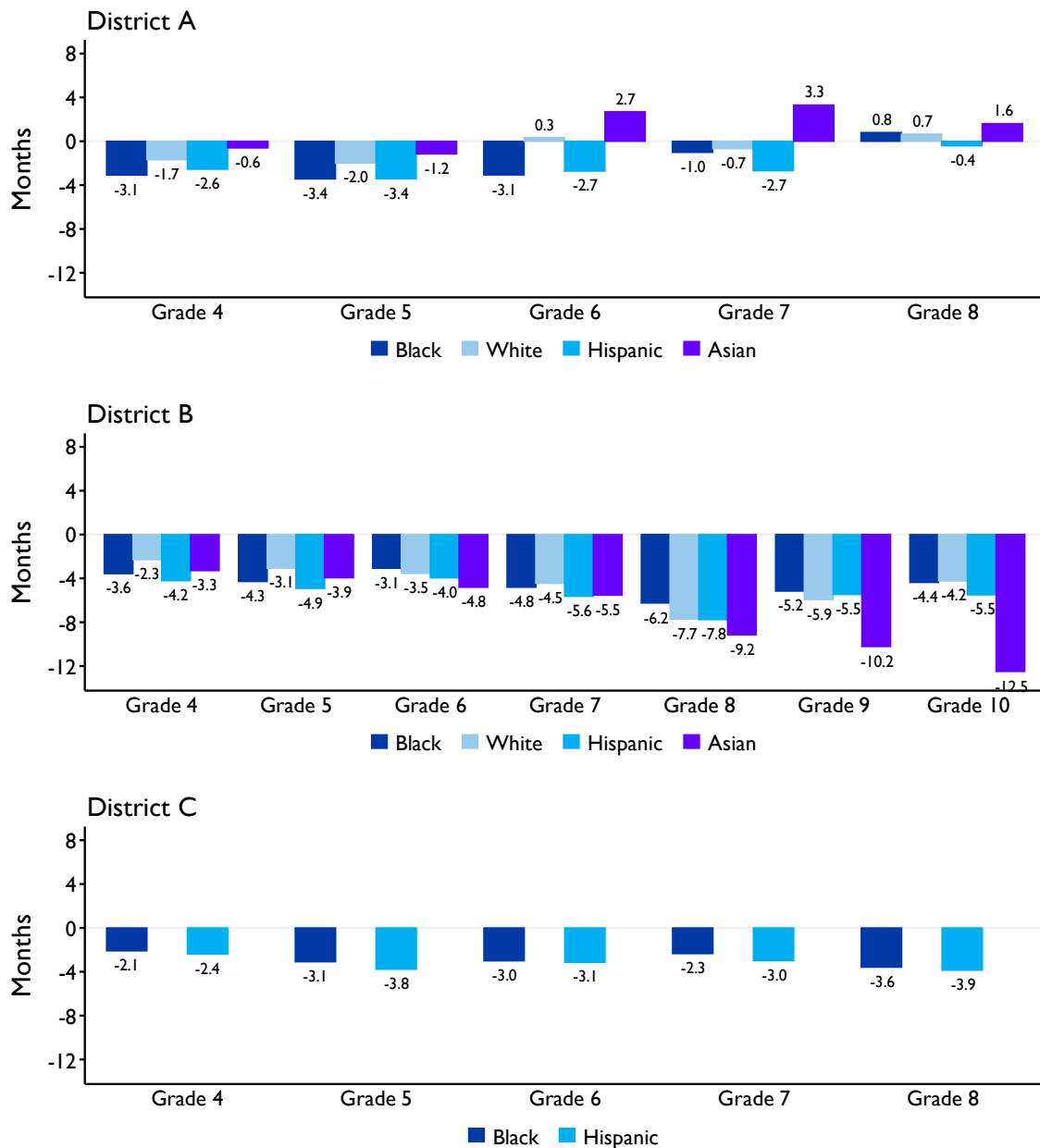
Appendix Figure A26. Average change in language usage achievement growth, adjusting for variation in test-taking dates, by grade level and free or reduced-price meal status.



Appendix Figure A27. Average change in science achievement growth, adjusting for variation in test-taking dates, by grade level and free or reduced-price meal status.

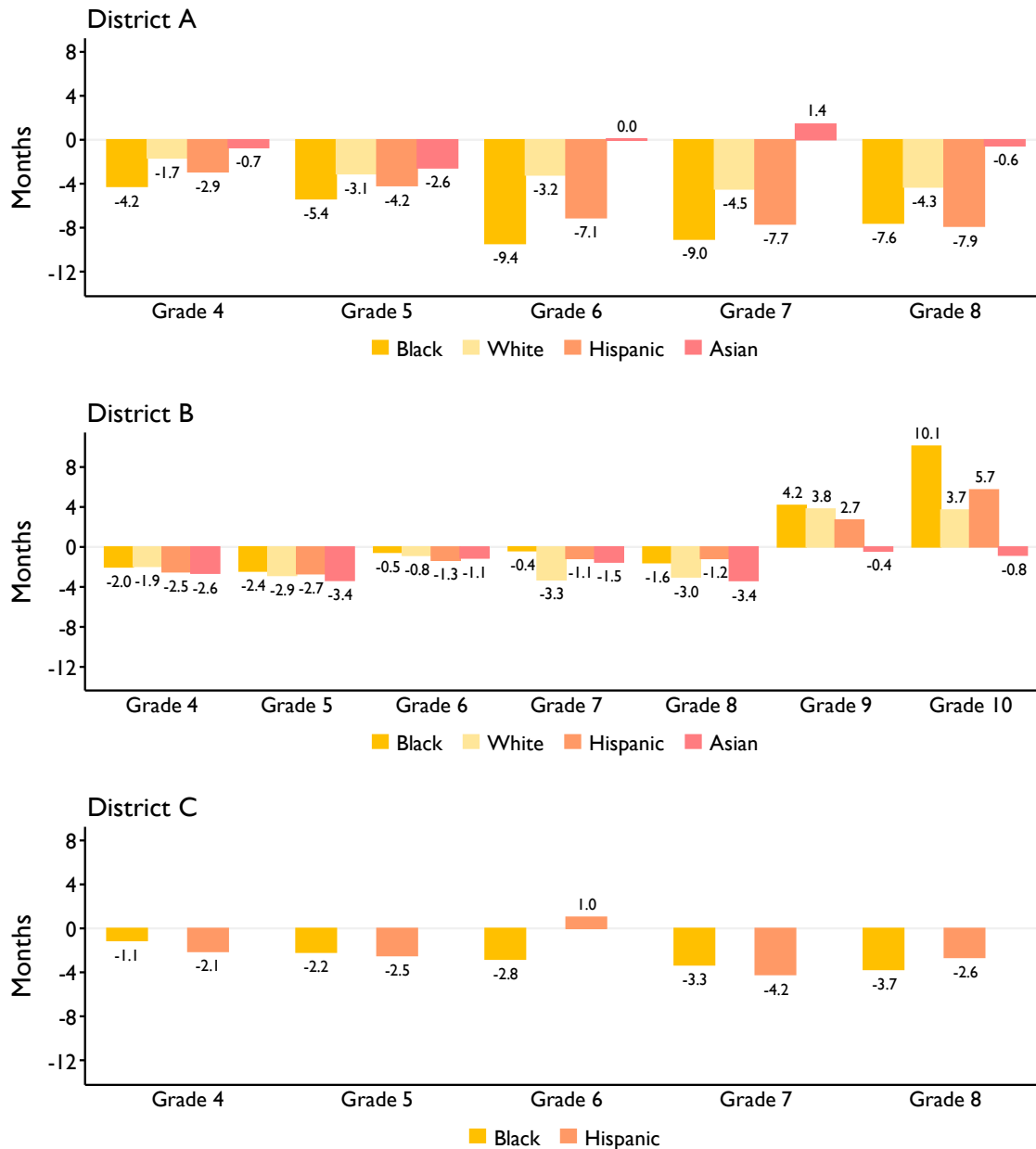


Appendix Figure A28. Average change in math achievement growth, adjusting for variation in test-taking dates, by grade level and race and ethnicity.



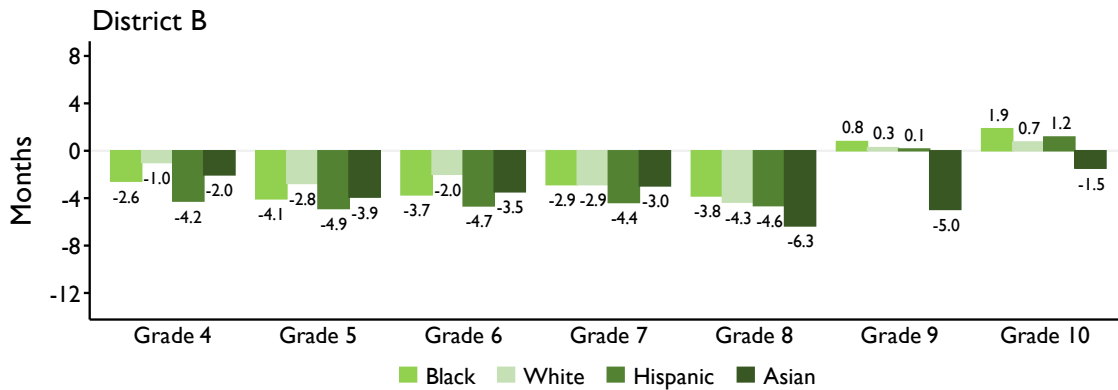
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic). For District C, Black students represent approximately 70% of the analysis sample and Hispanic students make up another roughly 22%; we therefore focus on these two groups. No other individual racial/ethnic group makes up more than three percent of the analysis sample in District C.

Appendix Figure A29. Average change in reading achievement growth, adjusting for variation in test-taking dates, by grade level and race and ethnicity.



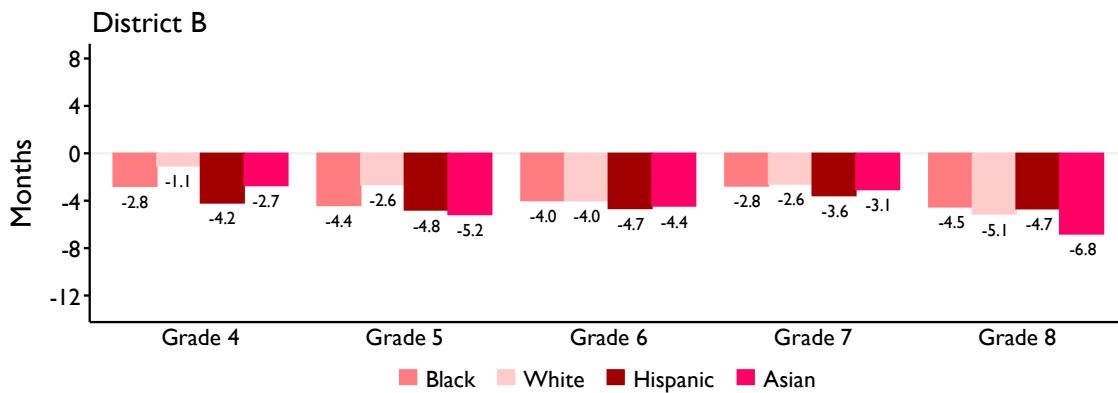
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic). For District C, Black students represent approximately 70% of the analysis sample and Hispanic students make up another roughly 22%; we therefore focus on these two groups. No other individual racial/ethnic group makes up more than three percent of the analysis sample in District C.

Appendix Figure A30. Average change in language usage achievement growth, adjusting for variation in test-taking dates, by grade level and race and ethnicity.



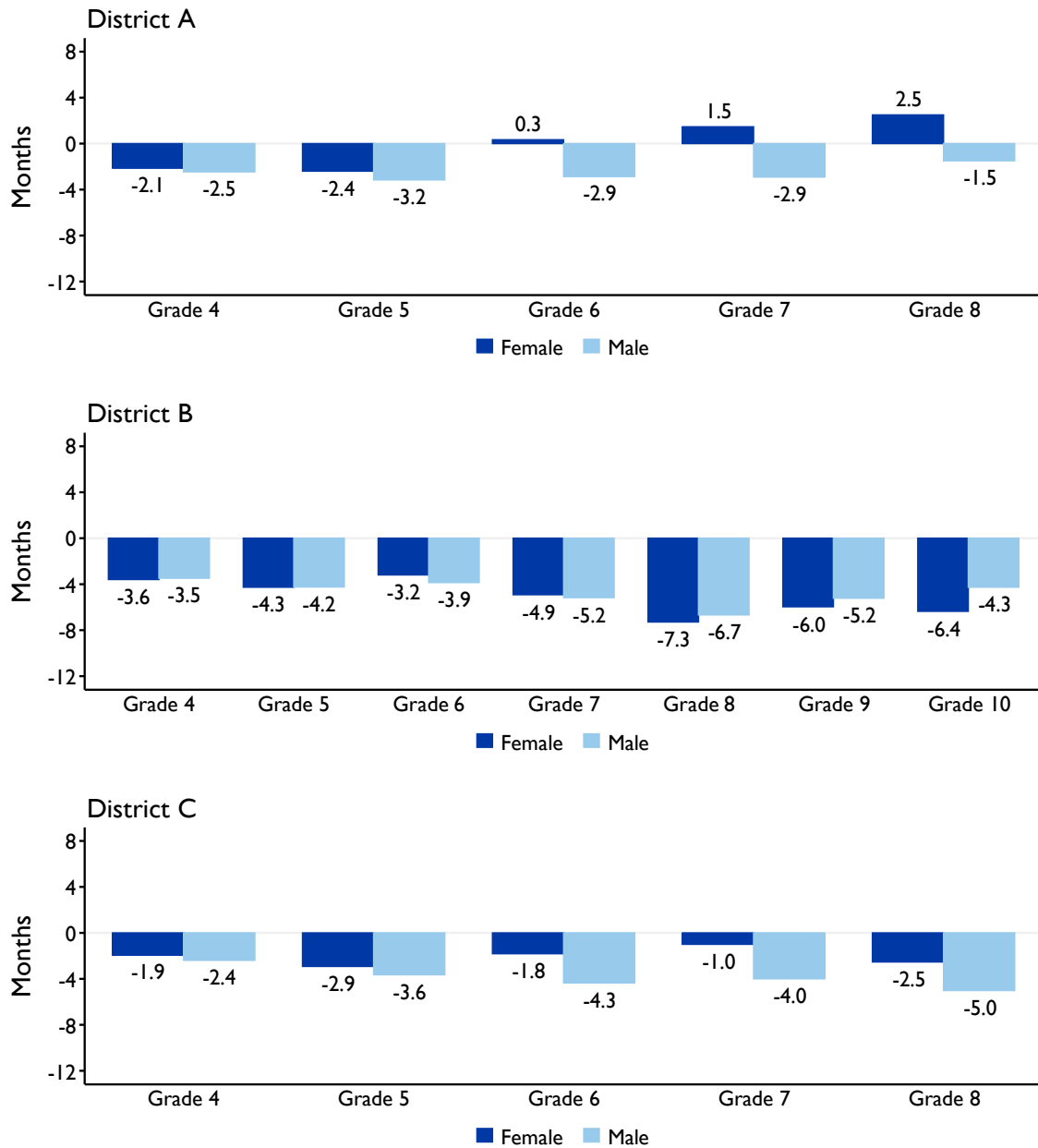
Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic).

Appendix Figure A31. Average change in science achievement growth, adjusting for variation in test-taking dates, by grade level and race and ethnicity.

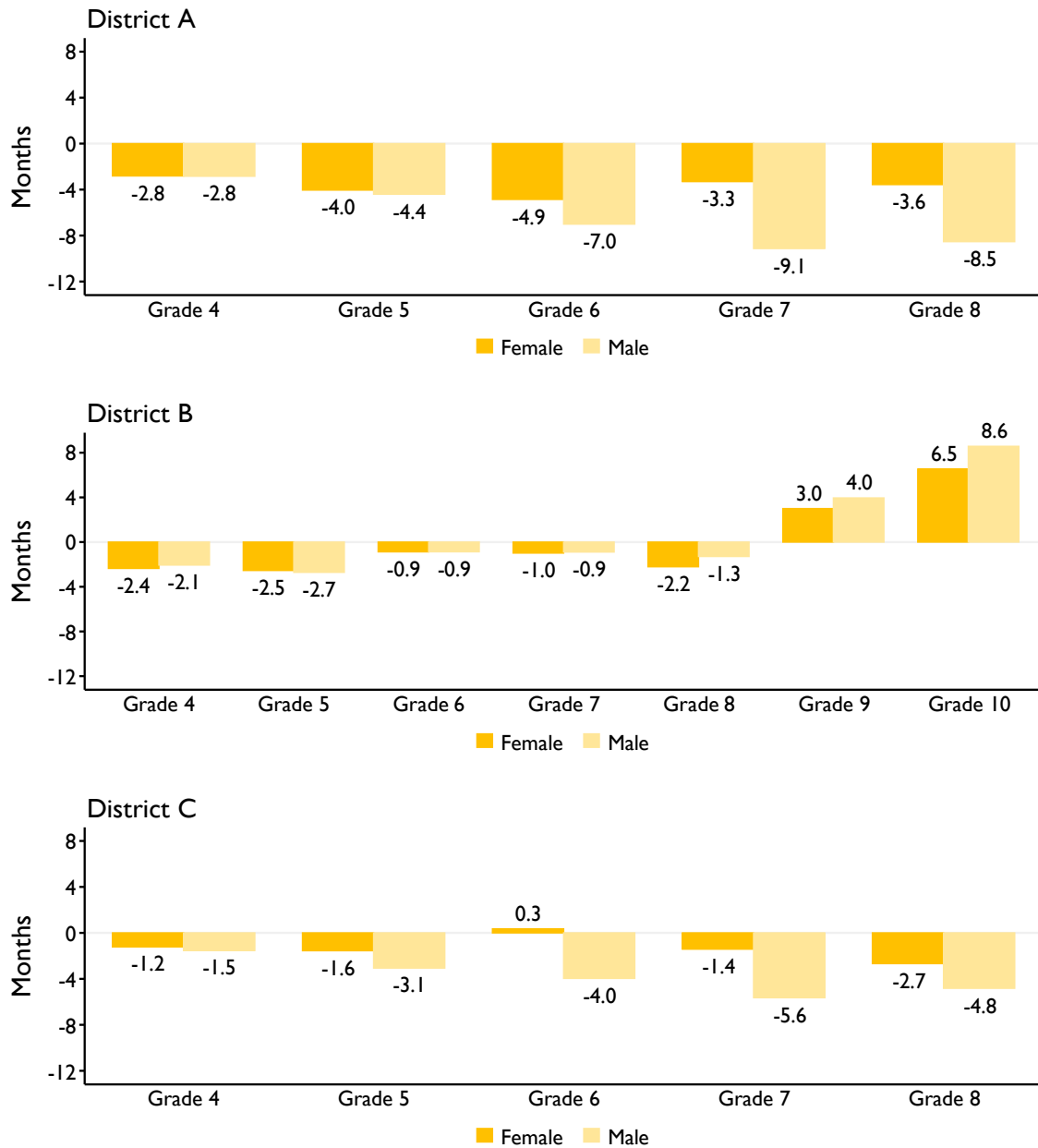


Notes: Race and ethnicity categories are mutually exclusive. Each racial group represents non-Hispanics (e.g., “Black” includes students who identify as Black but do not identify as Hispanic).

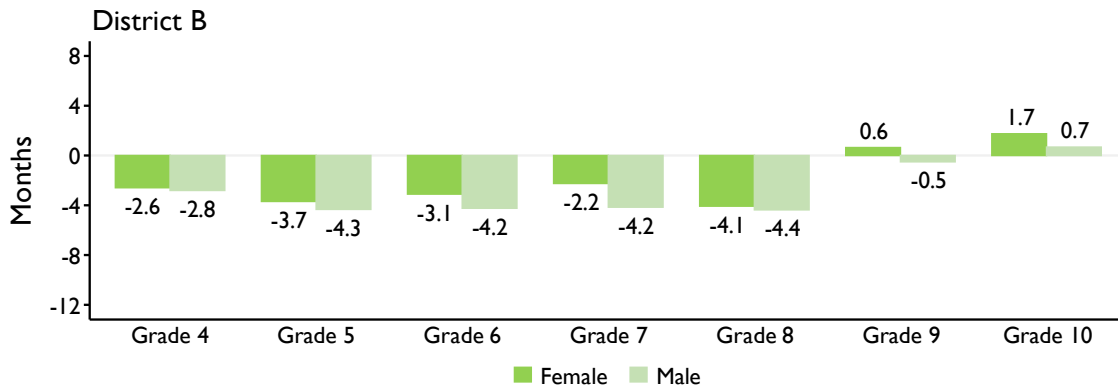
Appendix Figure A32. Average change in math achievement growth, adjusting for variation in test-taking dates, by grade level and gender.



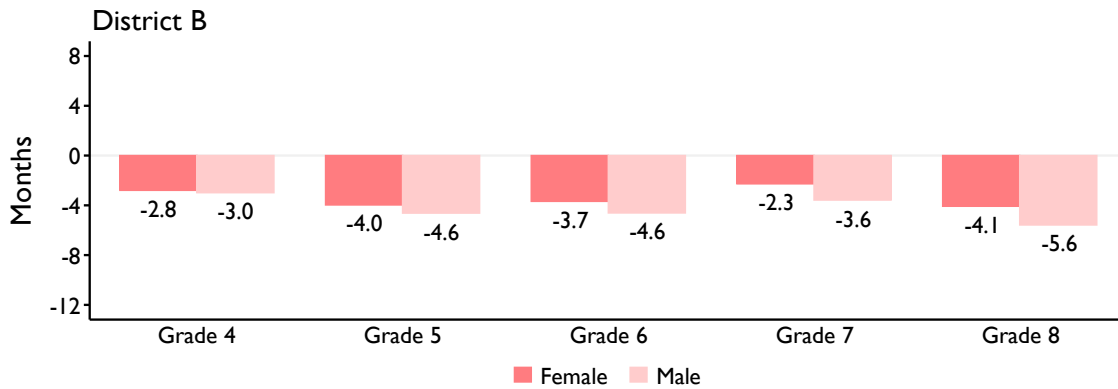
Appendix Figure A33. Average change in reading achievement growth, adjusting for variation in test-taking dates, by grade level and gender.



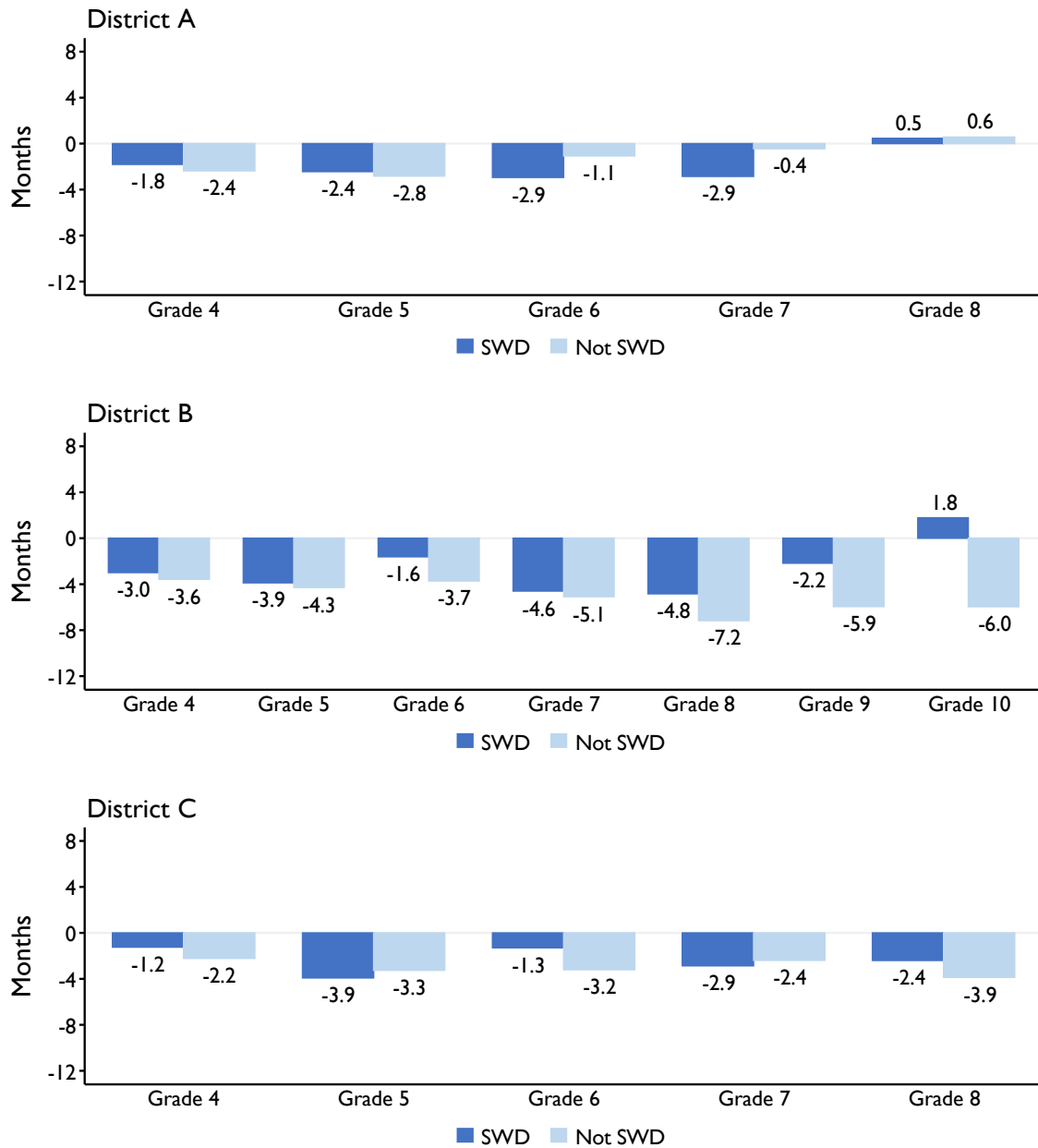
Appendix Figure A34. Average change in language usage achievement growth, adjusting for variation in test-taking dates, by grade level and gender.



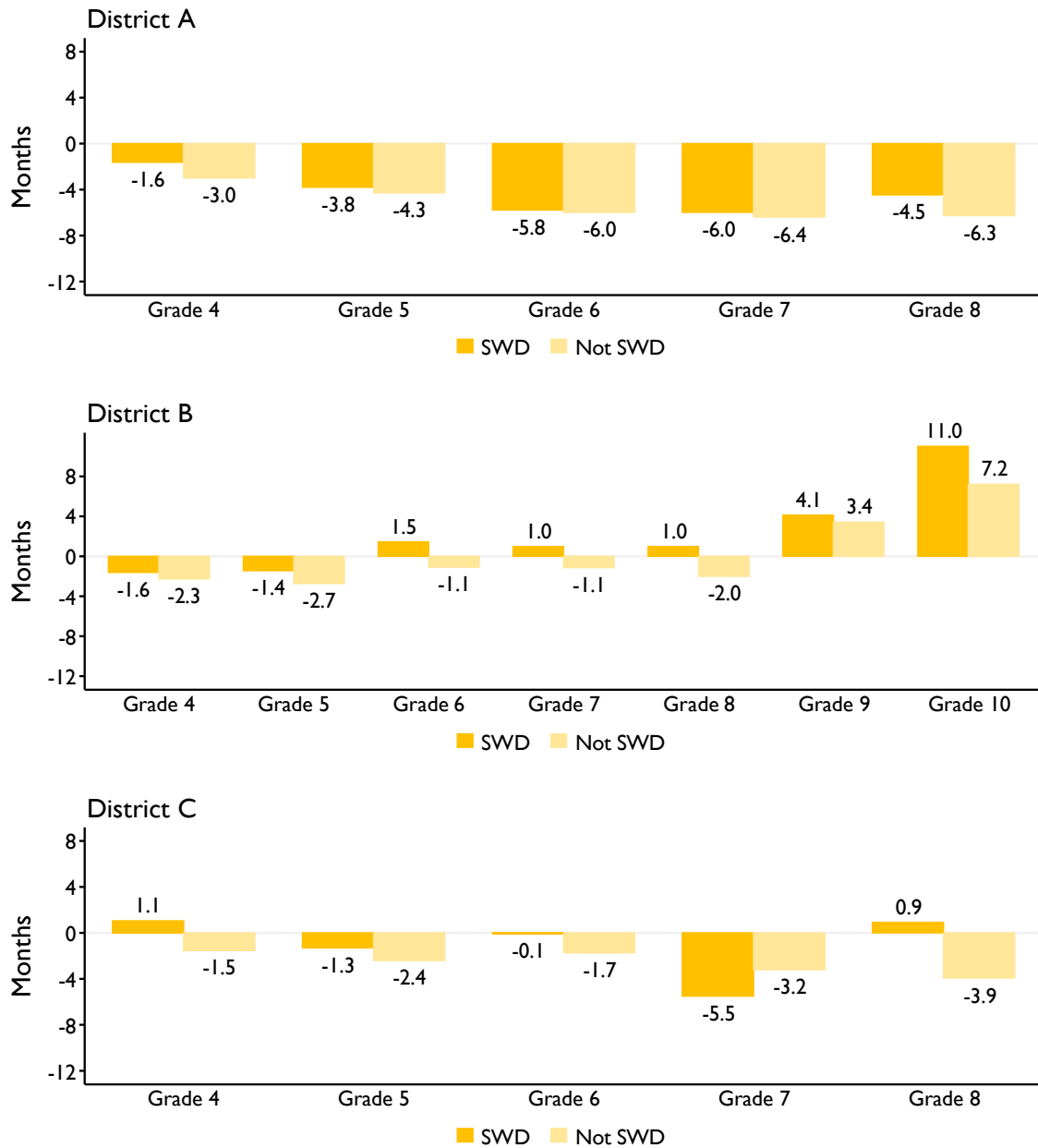
Appendix Figure A35. Average change in science achievement growth, adjusting for variation in test-taking dates, by grade level and gender.



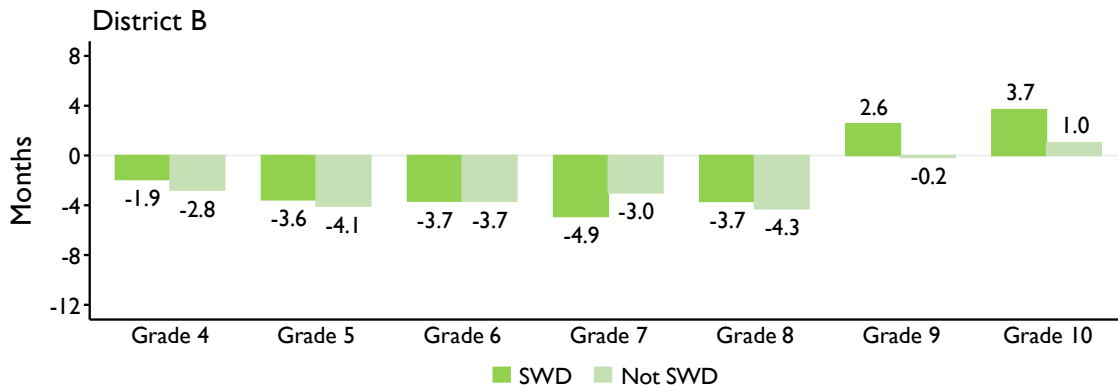
Appendix Figure A36. Average change in math achievement growth, adjusting for variation in test-taking dates, by grade level and disability status.



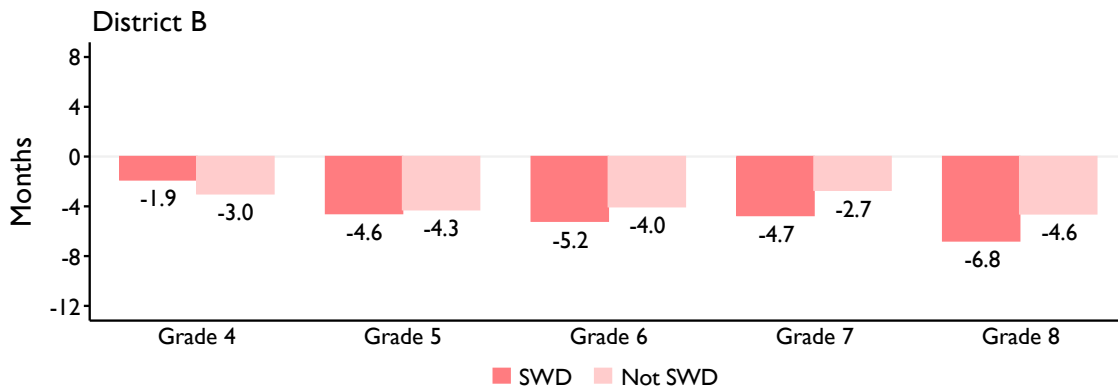
Appendix Figure A37. Average change in reading achievement growth, adjusting for variation in test-taking dates, by grade level and disability status.



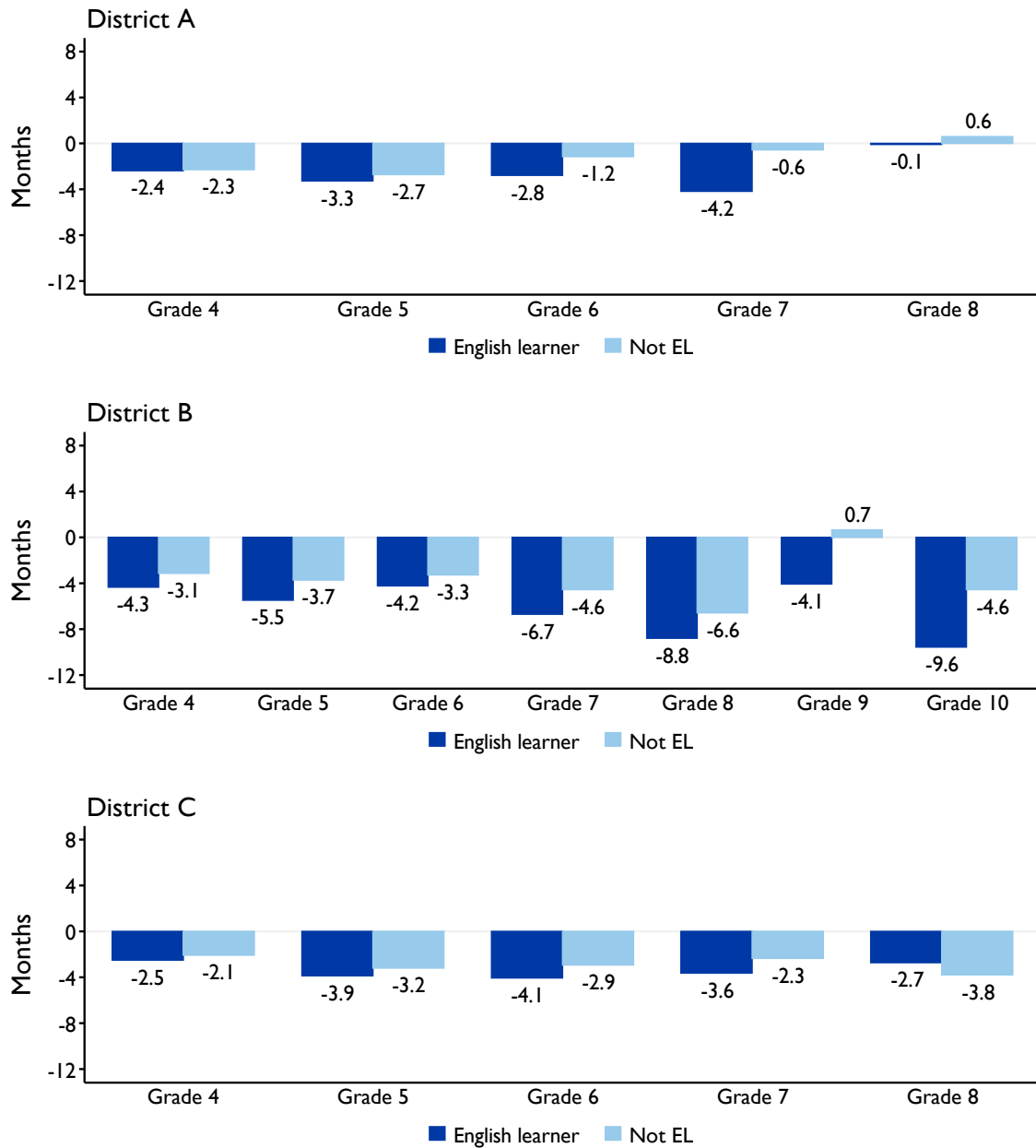
Appendix Figure A38. Average change in language usage achievement growth, adjusting for variation in test-taking dates, by grade level and disability status.



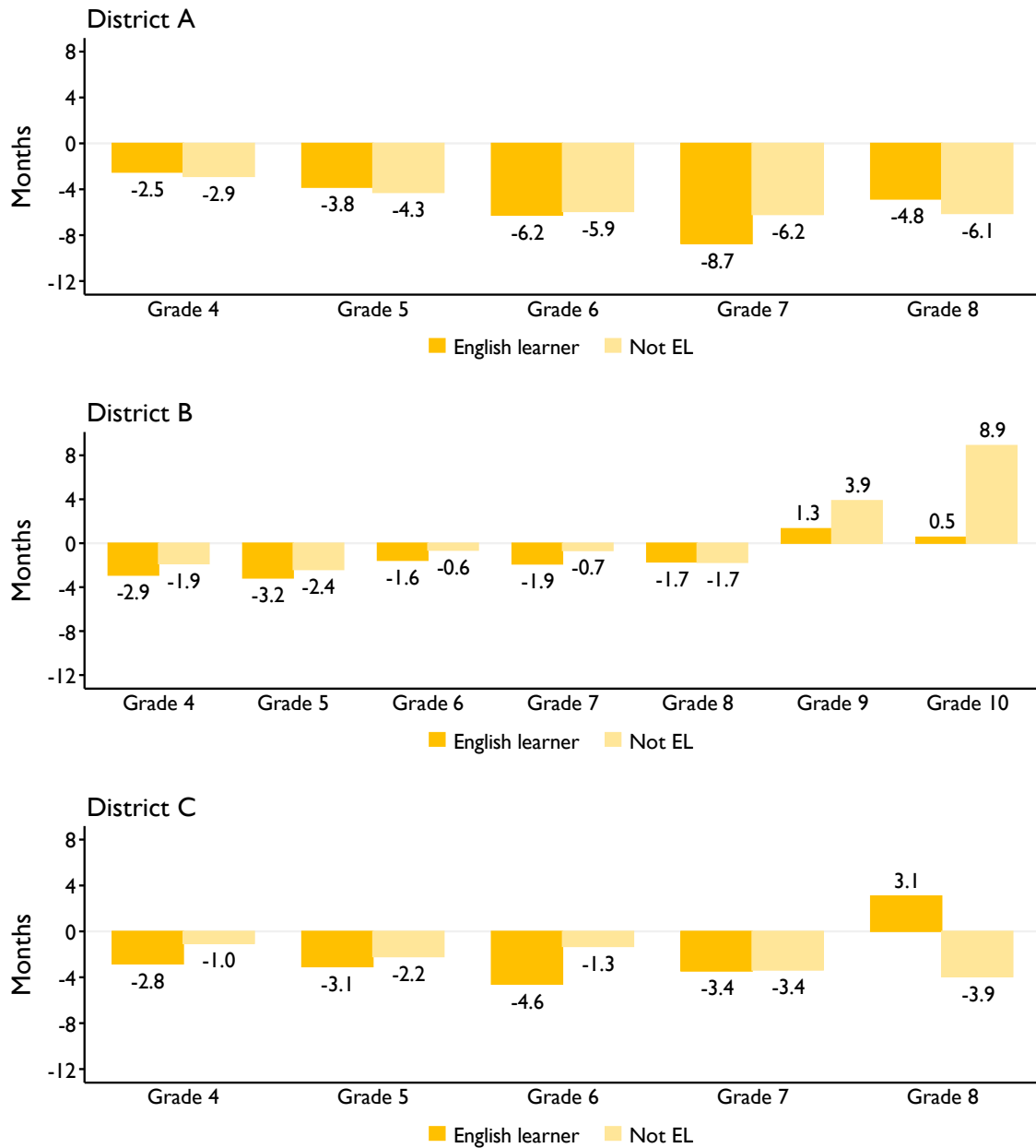
Appendix Figure A39. Average change in science achievement growth, adjusting for variation in test-taking dates, by grade level and disability status.



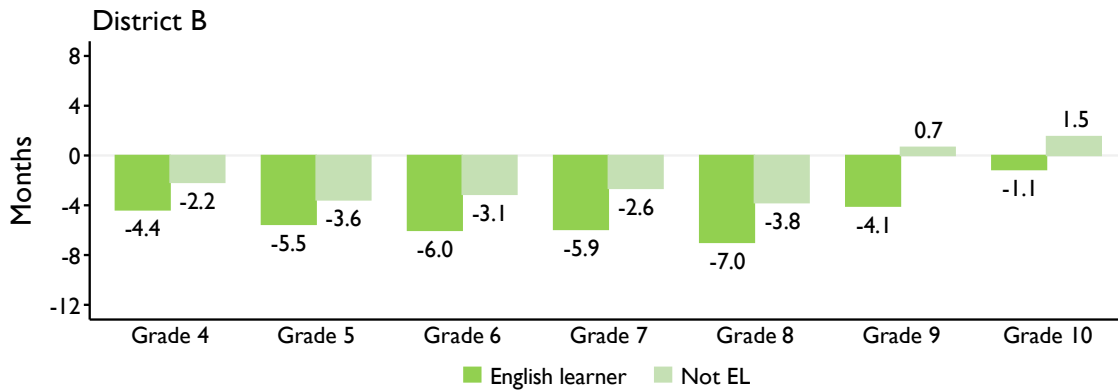
Appendix Figure A40. Average change in math achievement growth, adjusting for variation in test-taking dates, by grade level and English learner status.



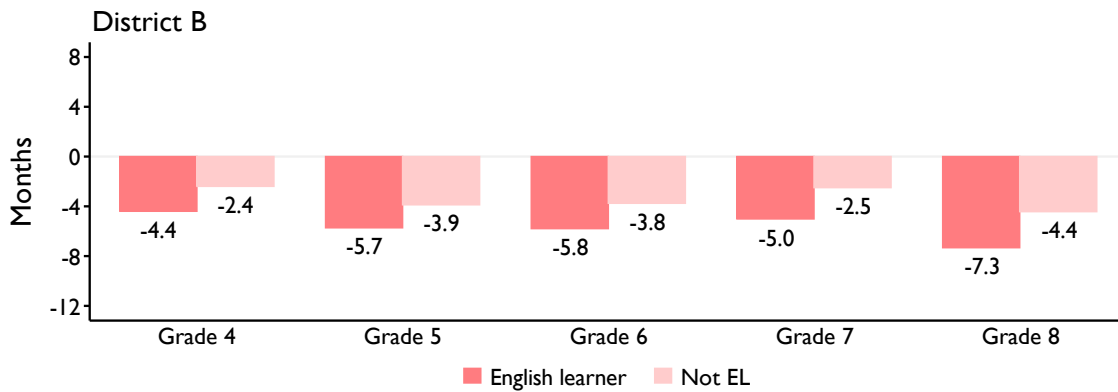
Appendix Figure A41. Average change in reading achievement growth, adjusting for variation in test-taking dates, by grade level and English learner status.



Appendix Figure A42. Average change in language usage achievement growth, adjusting for variation in test-taking dates, by grade level and English learner status.



Appendix Figure A43. Average change in science achievement growth, adjusting for variation in test-taking dates, by grade level and English learner status.



Test Location

Appendix Table A4a. Average change in achievement growth by testing location, fall of SY 2020-21, for District A.

Subject-grade	In School	Other	Difference = 0 p-value
Math			
Grade 1	-0.089 [877]	4.143 [2,703]	0.000
Grade 2	-0.495 [469]	2.254 [3,432]	0.000
Grade 3	-0.275 [353]	0.786 [4,322]	0.000
Grade 4	-1.134 [322]	0.028 [4,578]	0.000
Grade 5	-2.010 [199]	-0.246 [4,989]	0.000
Grade 6	-1.752 [118]	-0.721 [4,371]	0.095
Grade 7	-1.256 [128]	-0.184 [3,673]	0.429
Grade 8	0.128 [85]	0.859 [3,526]	0.660
Reading			
Grade 4	-1.031 [305]	0.255 [4,625]	0.000
Grade 5	-2.568 [221]	-0.333 [4,919]	0.000
Grade 6	-3.746 [119]	-1.464 [4,356]	0.013
Grade 7	-5.700 [124]	-2.118 [3,645]	0.077
Grade 8	-8.253 [77]	-1.761 [3,787]	0.011

Notes. Number of test-takers is in square brackets. "Other" refers to any out-of-school test-taking location.

Appendix Table A4b. Average change in achievement growth by testing location, winter of SY 2020-21, for District A.

Subject-grade	In School	Other	Difference=0 p-value
Math			
Grade 1	-0.904 [2,076]	2.359 [1,799]	0.000
Grade 2	-1.415 [1,906]	0.368 [2,267]	0.000
Grade 3	-1.464 [1,944]	-0.918 [2,650]	0.000
Grade 4	-2.029 [1,863]	-1.728 [2,944]	0.043
Grade 5	-2.071 [1,744]	-2.250 [3,329]	0.310
Grade 6	-3.606 [634]	-0.280 [3,825]	0.000
Grade 7	-3.162 [710]	0.393 [3,004]	0.000
Grade 8	-0.841 [551]	1.297 [3,055]	0.000
Reading			
Grade 4	-1.466 [2,001]	-1.419 [2,818]	0.821
Grade 5	-2.319 [1,834]	-3.147 [3,175]	0.000
Grade 6	-5.459 [660]	-3.566 [3,800]	0.011
Grade 7	-7.584 [559]	-3.649 [3,124]	0.000
Grade 8	-7.058 [438]	-3.827 [3,224]	0.001

Notes. Number of test-takers is in square brackets. "Other" refers to any out-of-school test-taking location.

Student Characteristics by Test-Taking Pattern

Appendix Table A5a. Average student characteristics by math test-taking pattern, for District B.

Student characteristic	Fall test only	Fall & winter test	p-value
Female	0.501	0.495	0.235
FRPM	0.651	0.650	0.857
English learner	0.112	0.288	0.000
SWD	0.089	0.063	0.000
White	0.117	0.123	0.048
Black	0.680	0.480	0.000
Asian	0.050	0.102	0.000
American Indian	0.003	0.004	0.038
Pacific Islander	0.001	0.001	0.740
Hispanic	0.126	0.268	0.000
Multiracial	0.023	0.022	0.406
Fall 2020 math national percentile	41.404	45.209	0.000
Winter 2020 math national percentile	40.469	45.412	0.000

Appendix Table A5b. Average student characteristics by reading test-taking pattern, for District B.

Student characteristic	Fall test only	Fall & winter test	p-value
Female	0.500	0.495	0.221
FRPM	0.648	0.649	0.866
English learner	0.115	0.288	0.000
SWD	0.090	0.063	0.000
White	0.123	0.123	0.950
Black	0.666	0.479	0.000
Asian	0.049	0.102	0.000
American Indian	0.003	0.004	0.061
Pacific Islander	0.001	0.001	0.695
Hispanic	0.133	0.268	0.000
Multiracial	0.023	0.022	0.423
Fall 2020 reading national percentile	44.937	46.004	0.000
Winter 2020 reading national percentile	44.158	45.882	0.000

Appendix Table A5c. Average student characteristics by language usage test-taking pattern, for District B.

Student characteristic	Fall test only	Fall & winter test	p-value
Female	0.492	0.503	0.156
FRPM	0.700	0.639	0.000
English learner	0.154	0.209	0.000
SWD	0.102	0.080	0.000
White	0.109	0.128	0.000
Black	0.652	0.559	0.000
Asian	0.053	0.077	0.000
American Indian	0.001	0.003	0.000
Pacific Islander	0.001	0.002	0.115
Hispanic	0.167	0.210	0.000
Multiracial	0.018	0.022	0.058
Fall 2020 language national percentile	36.850	44.977	0.000
Winter 2020 language national percentile	35.332	43.980	0.000

Appendix Table A5d. Average student characteristics by science test-taking pattern, for District B.

Student characteristic	Fall test only	Fall & winter test	p-value
Female	0.479	0.498	0.067
FRPM	0.721	0.650	0.000
English learner	0.186	0.222	0.000
SWD	0.101	0.082	0.002
White	0.092	0.122	0.000
Black	0.661	0.564	0.000
Asian	0.049	0.073	0.000
American Indian	0.002	0.004	0.156
Pacific Islander	0.001	0.001	0.595
Hispanic	0.176	0.214	0.000
Multiracial	0.018	0.022	0.138
Fall 2020 science national percentile	36.724	47.788	0.000
Winter 2020 science national percentile	35.497	47.393	0.000

Determinants of Average Change in Achievement Growth

Appendix Table A6a. Determinants of average change in math achievement growth from winter 2020 to winter 2021, by district.

Variable	District A	District B	District C
Female	2.329*** (0.14)	0.033 (0.089)	2.122*** (0.181)
FRPM	-0.841*** (0.169)	-0.357*** (0.106)	NA NA
English learner	-0.343 (0.281)	-1.475*** (0.127)	-0.325 (0.345)
SWD	0.129 (0.217)	1.216*** (0.157)	1.114*** (0.323)
White	0.982*** (0.195)	0.122 (0.161)	-0.876 (0.703)
Asian	2.777*** (0.255)	-0.126 (0.174)	2.611*** (0.525)
American Indian	-3.108 (1.907)	-0.135 (0.698)	-2.731 (1.738)
Pacific Islander	3.245 (2.846)	-2.887** (1.123)	3.882 (4.895)
Hispanic	-0.152 (0.22)	-0.029 (0.127)	-0.295 (0.236)
Multiracial	0.47 (0.419)	0.352 (0.321)	-1.8*** (0.619)
Grade 5	-0.504** (0.206)	-0.772*** (0.13)	-1.081*** (0.322)
Grade 6	0.941*** (0.214)	-0.095 (0.14)	-0.913*** (0.335)
Grade 7	1.585*** (0.226)	-1.647*** (0.139)	-0.312 (0.288)
Grade 8	2.891*** (0.228)	-3.643*** (0.14)	-1.616*** (0.294)

Notes: Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

Appendix Table A6b. Determinants of average change in reading achievement growth from winter 2020 to winter 2021, by district.

Variable	District A	District B	District C
Female	2.525*** (0.214)	-0.148 (0.151)	2.651*** (0.517)
FRPM	-2.092*** (0.258)	0.019 (0.18)	NA NA
English learner	0.239 (0.424)	-1.04*** (0.217)	-0.675 (1.02)
SWD	1.868*** (0.331)	1.828*** (0.267)	2.182** (1.032)
White	2.716*** (0.297)	-0.849*** (0.274)	-3.898* (1.99)
Asian	5.427*** (0.384)	-0.449 (0.295)	3.558*** (1.366)
American Indian	-0.001 (3.064)	-0.374 (1.154)	-3.438 (5.014)
Pacific Islander	5.794 (4.331)	-1.117 (1.877)	-12.315 (13.227)
Hispanic	1.228*** (0.336)	0.157 (0.216)	0.492 (0.651)
Multiracial	2.129*** (0.637)	0.009 (0.543)	-0.955 (1.723)
Grade 5	-1.374*** (0.315)	-0.498** (0.222)	-1.102 (0.908)
Grade 6	-3.216*** (0.325)	1.209*** (0.238)	-2.896*** (0.979)
Grade 7	-3.269*** (0.344)	1.063*** (0.236)	-5.043*** (0.829)
Grade 8	-3.03*** (0.344)	0.2 (0.238)	-4.766*** (0.816)

Notes: Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

Appendix Table A6c. Determinants of average change in language usage achievement growth from winter 2020 to winter 2021, by district.

Variable	District A	District B	District C
Female		0.772*** (0.124)	
FRPM		-1.193*** (0.145)	
English learner		-2.582*** (0.195)	
SWD		0.304 (0.209)	
White		0.022 (0.218)	
Asian		0.529** (0.262)	
American Indian		-0.194 (1.00)	
Pacific Islander		-0.018 (1.631)	
Hispanic		0.398** (0.189)	
Multiracial		0.376 (0.426)	
Grade 5		-1.403*** (0.189)	
Grade 6		-1.034*** (0.193)	
Grade 7		-0.655*** (0.195)	
Grade 8		-1.773*** (0.194)	

Notes: Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

Appendix Table A6d. Determinants of average change in science achievement growth from winter 2020 to winter 2021, by district.

Variable	District A	District B	District C
Female		0.789*** (0.131)	
FRPM		-0.757*** (0.154)	
English learner		-2.325*** (0.206)	
SWD		-0.678*** (0.22)	
White		0.159 (0.231)	
Asian		0.054 (0.276)	
American Indian		0.956 (1.071)	
Pacific Islander		-2.599 (1.728)	
Hispanic		0.648*** (0.199)	
Multiracial		-0.294 (0.448)	
Grade 5		-1.433*** (0.2)	
Grade 6		-1.366*** (0.204)	
Grade 7		-0.2 (0.206)	
Grade 8		-2.187*** (0.206)	

Notes: Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

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