

Abstract Title Page
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Title:

Replicating the Moderating Role of Income Status on Summer School Effects across Subject Areas:
A Meta-analysis.

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Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Summer school is frequently used as a policy lever to improve academic outcomes for low-achieving students and low-income students (Jacob & Lefgren, 2004; Mariano & Martorell, 2013; Marsh, Gershwin, Kirby, & Xia, 2009; Matsudaira, 2008; McCombs, Augustine, Schwartz, Bodilly, McInnis, Lichter, & Cross, 2011). One reason academic summer programs are proposed for students from low income backgrounds is that disadvantaged students fall behind their higher income peers academically over the summer vacation months (e.g. Burkam, Ready, Lee, & LoGerfo, 2004; Cooper et al., 1996; Downey, von Hippel, & Broh, 2004). Although effective summer math and reading interventions have the potential to prevent summer slide for low income students (Cooper et al., 2000), there is also concern that compensatory interventions widen, rather than narrow, income-based test score gaps because privileged students sometimes benefit more from such programs than do underprivileged students (Ceci & Papierno, 2005). In their meta-analytic review, Cooper et al. (2000) found that this may in fact be the case for academic summer interventions; their evidence showed that higher income students benefitted more from summer school than did low income students. However, in our recent meta-analysis (Kim & Quinn, 2013) of studies published after Cooper et al.'s (2000) review, we found the opposite: summer reading programs were more effective for low income students than for higher income students.

One possible explanation for why Cooper et al.'s (2000) result differed from ours (Kim & Quinn, 2013) relates to the academic subject matter: Cooper et al. (2000) combined both math and reading outcomes in their meta-analysis, while we (Kim & Quinn, 2013) analyzed only reading outcomes. Different patterns of summer learning in math and reading support different predictions about the moderation of summer program effects by student income status. Using relative measures of change, middle class students make more progress in reading over the summer than do low income students ($d=0.06$ for middle income students compared to $d=-0.21$ for low income students according to Cooper et al., 1996). For math, however, the amount of relative summer change does not differ by income status (Cooper et al., 1996). In a summer school study, then, posttest treatment-control contrasts in reading may be greater for low income students even if summer schools promote the same spring-to-fall reading gain, on average, for students of all income groups (Kim & Quinn, 2013). The same may not be true for math. It is therefore important to test whether the moderation we observed for recent summer reading studies replicates for recent math studies.

A related question is whether summer school has similar effects on math and reading outcomes in general. Descriptively, Cooper et al. (2000) found that math effects tended to be slightly larger than reading effects; however, the magnitude and statistical significance of this difference was sensitive to model specifications (with effects ranging from $d=0.22$ to 0.26 for reading and from 0.26 to 0.30 for math). In another review of the out-of-school time literature, Lauer and colleagues (Lauer, Akia, Wilkerson, Apthorp, Snow, & Martin-Glenn, 2006) found slightly smaller summer school effects on reading than math ($d=0.05$ for reading compared to $d=0.09$ for math), though they did not conduct a formal hypothesis test on this difference (nor did they test the moderating role of student income status).

Purpose / Objective / Research Question / Focus of Study:

The finding that academic summer programs are effective for low income students has replicated across meta-analytic reviews. However, these reviews have yielded contradictory evidence about whether summer programs are more effective for lower- or higher-income

students. This discrepancy may be due to income-based differences in the summer counterfactual that exist for reading but not for math. Additionally, the related question of whether the effects of summer school differ for math and for reading in general has not yielded robust findings to date and bears replication with updated studies. In the present study, we therefore extend our previous research on summer learning programs in two ways: 1) We conduct a comprehensive meta-analysis of the literature on math summer school programs (from 1998 to 2011), and test whether the moderating role of income that we observed in reading over this period replicates for math; 2) We ask whether the effect of summer programs on student outcomes differs for math compared to reading.

Research Design:

Literature Search Procedures, Selection Criteria, Coding, and Analysis

We searched the literature through three primary channels: (1) online academic research databases (Academic Search Premier, Education Abstracts, ERIC, PsycINFO, EconLit, ProQuest Dissertations and Theses) and targeted internet sites (Child Trends LINKS, What Works Clearinghouse, Harvard Family Research Project’s Out-of-School Time Database, MDRC, NBER, RAND, Mathematica, SEDL, Wallace Foundation); (2) reference lists of previous review articles (Bodilly & Beckett, 2005; Lauer et al., 2006; McCombs et al. 2011; Terzian, Moore, & Hamilton, 2009); and (3) soliciting research reports from government education agencies. We conducted our search in June 2011 for studies that were released after August 1998, which was the final month included in Cooper et al.’s (2000) review.

The studies included in our review met 5 selection criteria. We required that studies: (1) evaluate the effects of a classroom- or home-based summer reading or school-based math intervention in the United States or Canada, (2) administer a standardized math or reading test, (3) provide sufficient empirical information to compute an effect size (Cohen’s *d*), (4) include students who were in Kindergarten to Grade 8 prior to enrollment in a summer math or reading intervention, and (5) compare the performance of students in a treatment group to the performance of students in a control group who did not participate in the treatment or systematically receive an alternative intervention. We searched the electronic data bases with the following key words: “summer program*,” “summer school*,” “summer reading,” “summer literacy,” “summer enrichment,” “summer remedia*,” “summer instruction*,” “summer education*,” “summer learning,” “math*,” “*algebra*,” “STEM,” “*experiment*,” “control*,” “regression discontinuity,” “compared,” “comparison,” “field trial*,” “effect size,” “evaluation”.

We included reading studies that administered a variety of literacy assessments. In cases where a study tested multiple reading skills (e.g. vocabulary, comprehension, and fluency), we combined the results from each reading assessment into a single “reading total” effect size (none of the math studies reported separate effect sizes for different math sub-domains). When results were reported separately for grade-level subgroups within a study, we took the mean effect size across grade levels.

To conduct the income status moderator analyses, we coded the study samples based on the percent of participating students who were low income, or free/reduced-price lunch (FRL) eligible. Samples that included over 50% FRL students were coded as “low income”; samples with less than 50% were coded as “mixed income” samples.

To synthesize the results of these studies, we use random effects meta-analysis. Specifically, we fit the model:

$$d_j = \gamma_0 + \gamma_s W_{sj} + \mu_j + \epsilon_j ,$$

where d_j represents the effect size for study j , W_{sj} represents an indicator for whether the sample was low- or mixed-income, μ_j represents the study-level error, and ϵ_j represents the error due to sampling of students within study.

Findings / Results:

The Moderating Role of Income Status

Our search resulted in 35 studies of summer reading programs, which reported the effects of 41 different interventions, and 12 studies of summer math programs.

In Table 1, we present the meta-analytic results for the math studies, both overall and separately by student income status. Overall, summer math programs have a significant positive effect on students' math scores ($d=0.08$). However, the pattern of effects differs by income status. In low income samples, students enjoyed a significant positive treatment effect of $d=0.11$, while in mixed income samples, the pooled effect size was negatively-signed and not statistically different from zero ($d=-0.02$). Due to the small number of studies, however, we have limited statistical power for detecting whether effects were statistically different for each group ($p=0.09$).

<Insert Table 1 about Here>

Within-Study Analyses

In Table 2, we present the results of within-study analyses (using fixed effect meta-analytic models). Because some programs included both math and reading components, we were able to conduct a within-study moderator analysis addressing the question of whether the pooled effects on math and reading were the same, after controlling for program. These results indicate that program effects on math and reading were similar. In Figure 1, we demonstrate the similarity in studies' math and reading effects graphically through a scatter plot of math effect sizes on reading effect sizes (studies' bubbles are weighted to reflect the inverse of the variance of the math effect size). Effect sizes are highly correlated, with an unweighted Pearson's r of 0.93 (weighted $r=0.98$; Spearman's $\rho=0.94$).

<Insert Table 2 about Here>

<Insert Figure 1 about Here>

We also conduct within-study moderator analyses for student income status to test the sensitivity of our results from Table 1 to model specification. For the subset of math studies that reported effects separately by student income status, we found that low income students benefitted more from summer math programs than did higher income students attending the same programs, and this difference was statistically significant. This allows us to rule out the possibility that the moderator result from Table 1 was due to cross-study confounders, and replicates the within-study income moderation analysis for reading (the results of which we also include in Table 2 for reference). The overall pattern of results, then, suggests that low income students benefit more from academic summer programs than do higher income students, in both math and reading.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

In this study, we examined whether the moderating effect of student income status observed in a meta-analysis of summer reading programs replicated for math. We found evidence that the result does replicate for math, with stronger effects for low income students than for higher-income students. We also found that the effects of summer programs did not differ for math and reading outcomes; on the contrary, programs with both math and reading components demonstrated effect sizes that were highly correlated between content areas.

One hypothesis as to why our moderator result differed from Cooper et al.'s (2000) is that the summer counterfactual for the average higher income student may have changed from the period of Cooper's review (which included studies from 1966 to 1998) to the period of our review (1998 to 2011). Today, the achievement returns to family income are 20-50% larger than they were for children born in the 1970s, and this may be due to parents' increased levels of investment in their children's cognitive development (Reardon, 2011). If academic investment by wealthier parents is higher today than 40 years ago, the summer counterfactual for higher income students may also be quite different today compared to the past. Given that the effects of summer school depend in part on the amount of loss or gain experienced by nonparticipants, the summer school treatment/control contrast for higher income students may be weaker today than in the past.

Of course, there is always the possibility that the discrepant findings are due simply to chance, particularly when sample sizes (and in the case of random effects meta-analysis, number of studies) are small (Allison, 1999). The middle income subgroup in Cooper et al.'s (2000) moderator analysis consisted of effect sizes from only four studies, while our math analysis had only 3 middle-income samples. Furthermore, despite the overall discrepancy in results across reviews, similarities exist. One of the studies from Cooper et al.'s (2000) middle income subgroup reported separate effects for Title 1 students, migrant students, and middle class students; while effects were negative for Title 1 and middle class students, effects were positive for migrant students, who "probably represent students who suffer the greatest economic disadvantage" (Cooper et al., 2000, p. 63). In fact, other studies in Cooper et al.'s (2000) meta-analysis featuring children of migrant workers exhibited some of the largest effect sizes in the review. This is consistent with our result that low income students benefit more from summer programs than do higher income students.

The limitations of the current study call attention to areas in which more research is needed. To begin with, the number of studies on the effects of math summer school is low. We were able to find over three times as many studies of summer reading programs in our review window. The math studies that we did find often did not report enough information that would allow us to explore the impacts of theoretically important potential moderators. If, as prior research suggests, higher income students have a summer advantage in reading but not math, then there is not an easy explanation for why we observed the moderating effect of income for both math and reading outcomes. Unfortunately, few math studies reported the extent of summer learning loss in the control group, which prevented us from examining the role of summer loss in explaining the effect size patterns of our included studies. Additionally, none of the studies disaggregated the math results by sub-domain. Previous research suggests that students experience large losses in math computation over the summer while making gains in problem-solving (Cooper et al., 1996). The effects of math summer school may therefore differ by the math skills that are taught and/or assessed, and cross-study differences in this area may explain cross-study differences in effect sizes. Unfortunately, we are unable to test this hypothesis. We were also unable to probe the reasons behind the high correlation between math and reading effects due to generally limited descriptions of the actual instruction provided by the programs. While our investigation provides additional evidence that summer school is more effective, on average, for low income students compared to higher income students, it also raises questions that the current body of evidence cannot answer conclusively.

Appendices

Not included in page count.

Appendix A. References

References marked with an asterisk indicate studies included in the meta-analysis.

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Appendix B. Tables and Figures

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Table 1.

Meta-analytic Effects for Math Programs and Moderator Analysis: Student Income Status

Analysis	<i>k</i>	<i>d</i>	95% CI		<i>Q_w</i>	<i>I² within</i>	<i>Q_{between}</i> (<i>p</i> -value)
			Low estimate	High estimate			
<i>Income Moderator</i>							2.802
Math (All studies)	12	0.080	0.023	0.137	26.22 **	58.00%	(0.094)
Math (low income)	8	0.110	0.039	0.183	18.52 **	62.20%	
Math (mixed income)	3	-0.017	-0.237	0.203	5.14~	61.10%	

Note: k=number of studies. Models are random effects models. One math study in the overall results did not report information on student income status and is therefore excluded from income status moderator analysis

Table 2.

Within-study Comparisons of Low-income Vs. Middle-income Students (Math and Reading) and Math Vs. Reading Effects

Comparison	Fixed Effect Model			
Low-income v. middle-income students, math		Low-income	Mixed-income	Difference: Low-income - Mixed-income
	<i>d</i>	0.107	-0.053	0.16
	95% CI	-0.016 to 0.230	-0.148 to 0.042	0.004 to 0.317
	k	3	3	3
	Q	3.1	1.35	0.51
	I ²	35.50%	0.00%	0.00%
Low-income v. middle-income students, reading		Low-income	Mixed-income	Difference: Low-income - Mixed-income
	<i>d</i>	0.139	-0.14	0.25
	95% CI	0.057 to 0.220	-0.188 to -0.099	0.15 to 0.35
	k	7	7	7
	Q	6.197	26.875	11.688
	I ²	3.18	77.675	48.67%
Math v. reading		Reading	Math	Difference: Reading - Math
	<i>d</i>	0.02	0.051	-0.024
	95% CI	-0.006 to 0.047	0.028 to 0.074	-0.059 to 0.011
	k	9	9	9
	Q	15.37~	20.18*	0.83
	I ²	48.00%	60.40%	0.00%

Note: k=number of studies.

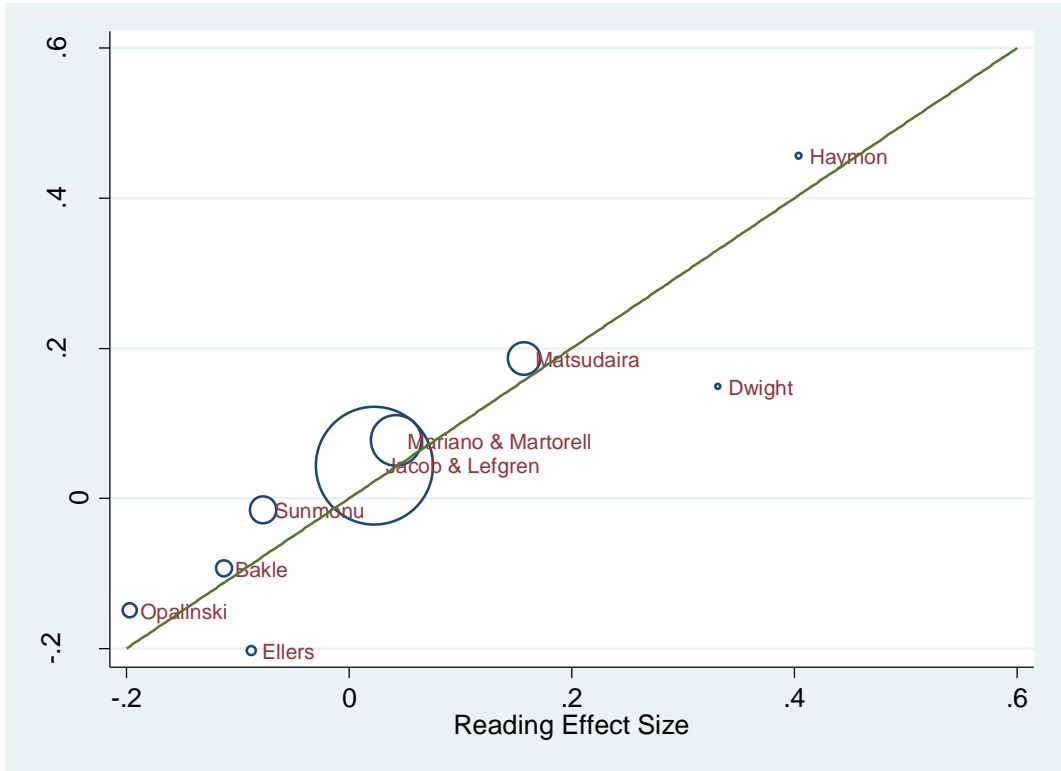


Figure 1. Scatter plot of math effect sizes on reading effect sizes for studies with both outcomes, $y=x$ line in overlay. Bubble sizes are weighted by the inverse of the variance of the math effect size.