META-ANALYTIC EVIDENCE FOR YEAR-ROUND EDUCATION'S EFFECT ON SCIENCE AND SOCIAL STUDIES ACHIEVEMENT

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In this meta-analysis, I have reviewed published and unpublished research on single-track, year-round education's effect on science and social studies achievement, 2001–2016. Of 30 studies that met inclusion criteria and had data from which an effect size estimate could be calculated, 7 reported science outcomes (18 effect size estimates) or social studies outcomes (9 effect size estimates). All estimates were from Grades 3–8 in the United States. The mean magnitude of the effects (using Cohen's *d*) were +0.11* in science and $+0.13^{+}$ in social studies, showing an average gain of about 1 month of learning in each subject area. The estimates for mean achievement are large enough to be policy relevant, align with recent meta-analytic estimates for reading and math effects from year-round education, and are also approximately the same magnitude as measured decreases in achievement caused by summer learning loss.

SUMMER LEARNING LOSS AND YEAR-ROUND EDUCATION

Students forget material during the long summer break, and their academic competency decreases measurably between each spring and the next fall (Cooper, Valentine, Charlton, & Melson, 2003; Vale et al., 2013; Von Drehle, 2010). A synthesis of research found that students decline by about one month of learning during summer, with slightly larger declines in math ($\sigma = .16$) than in reading ($\sigma = .11$), likely because students are more likely to read than to practice math in summer (Cooper, Nye, Charlton, Lindsay, & Greathouse, 1996). The decrease is as much as three times as large for low-income students, and the accumulation of this annual deficit is a large contributor to the income-based achievement gap (Alexander, Entwisle, & Olson, 2007; Burkam, Ready, Lee, & LoGerfo, 2004; Entwisle, Alexander, & Olson, 2001; Von Drehle, 2010). Income-

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based differences in summer learning are consistent with other research showing that wealthier students are more likely to participate in academic summer activities, such as taking lessons or visiting libraries, whereas low-income students have less interaction with parents and watch more television (Gershenson, 2013).

One policy option for decreasing summer learning loss is year-round education (YRE). YRE means redistributing the standard number of instructional days more evenly throughout the year; adding more vacation time to fall, winter, and spring, but shortening summer break. The logic of YRE is that this distribution, with fewer *consecutive* weeks for students to forget material, will diminish the degree of learning loss during the summer. In turn, students will need less review in the fall, which will allow teachers to cover more material in each full year. YRE is an affordable reform option (Brekke, 1997; Butchart, 2013). One state-level study found that between-sessions supplementary instruction increased costs by only 3% of normal operating expenses (Tittermary et al., 2012).

Single-Track YRE

Although sometimes considered a single treatment, there are two distinct forms of YRE. Single-track YRE and multitrack YRE differ in purpose, operation, and effect. A single-track calendar is typically introduced as an academic reform, and all students are either in class or on vacation on a single schedule. In contrast, multitrack YRE is a financial reform that allows a school to expand its capacity without new construction costs. Some percentage of students (usually 20% or 25%) are on break at all times, while the rest are in school. Multitrack YRE has previously been estimated to have little or no effect on student outcomes (Cooper et al., 2003; Kneese, 1996; Turk-Bicakci, 2005; White & Cantrell, 2001). Multitrack YRE also suffers from a variety of flaws that single-track does not; for example, teachers often share classrooms or use mobile carts (Dixon, 2011), tracks are often racially segregated as a result of the combination of different programming by track and parental sign-up decisions that differ by parental resources (Mitchell & Mitchell, 2005), and siblings can be assigned to different tracks (Glines, 1997; Shields & Oberg, 1999), often being pulled out of school for the other's vacation.[1] Because of these differences, I examined only single-track YRE.

Paucity of Research on Science/SS Learning Loss

Research estimating summer learning loss, or evaluating programs to diminish it, usually focuses on reading and math outcomes. Estimates of summer learning loss tend to be computed for reading, math, or both, but not for other subjects (e.g., McEachin & Atteberry, 2017; Quinn, Cooc, McIntyre, & Gomez, 2016; Vale et al., 2013). Summer interventions most often focus on reading or literacy outcomes (e.g., Kim, 2006; Kim & Quinn, 2013). Even the three meta-analyses of YRE itself have calculated outcomes either merged across subjects or for math and reading separately (Cooper et al., 2003; Fitzpatrick & Burns, 2017b; Kneese, 1996). Given that recent evidence shows that the effect of YRE does differ between math and reading, it is worthwhile to separately examine the effect of single-track YRE on science achievement and social studies achievement.

RESEARCH SYNTHESIS AND META-ANALYSIS METHODS

To understand the average effect of single-track YRE on academic achievement in research completed since 2000, I conducted a research synthesis of published and unpublished works. I searched seven variations of the term "year-round education" on 21 electronic databases (ERIC, ProQuest Dissertations & Theses, PsychArticles, etc.), using database-specific tools and keywords. For all results found, I assessed the title and abstract for whether to reject the study, or whether it might meet my inclusion criteria, in which case I then read the full text. For all works in the full-text sample, I used "snowball" sampling to identify other studies found in reference lists. I also searched for unpublished reports on more than 50 research, education, and corporate websites (Hammerstrøm, Wade, & Jørgensen, 2010). Aligned with recommended practice in meta-analysis, this combination of methods served to identify the bulk of studies on single-track YRE and academic achievement since 2000.[2]

In assessing whether search results might be appropriate for inclusion, I applied four criteria beyond the fact that they needed to be original research about YRE. First, studies could not be evaluations of extended instructional time (e.g., lengthened school day or additional instructional days). Second, studies had to include standardized achievement data. Third, studies were required to include a comparison group, though this could include a prior cohort of students at a school that switched its calendar. Fourth, studies had to be of K–12 schooling in the United States.

At all stages of information retrieval, document review, coding, calculation, and synthesis, I observed best practices recommended by the Campbell Collaboration (Kugley et al., 2017; The Methods Group of the Campbell Collaboration, 2016a, 2016b). This included multiple quality checks. A second coder reviewed 25% of the initial search results, achieving interrater reliability over 90%, and reviewed 25% of the full-text sample, with all differences at either stage discussed until consensus was achieved on the final sample. Additionally, I extracted the data for calculating effect sizes twice and calculated the effect sizes using two different tools, achieving reliability over .96 and correcting discrepancies before beginning analysis. From most studies, I extracted *N*, mean, and standard deviation data to calculate Cohen's *d*, the standardized mean difference (Borenstein, 2009).

Effect Size Calculation

A majority of studies included more than one effect size measure (e.g., data for multiple grades or for multiple years). A plurality of meta-analyses calculate a simple or weighted average of such multiple estimates in order to produce a single estimate for each study (Ahn, Ames, & Myers, 2012). This approach, though, does not account for statistical dependencies in the estimates. I also employed a technique, robust variance estimation meta-regression (RVE), which does correctly account for dependence (Hedges, Tipton, & Johnson, 2010a, 2010b). RVE has been successfully tested (Moeyaert et al., 2017; Scammacca, Roberts, & Stuebing, 2014) and is increasingly used to account for the dependence of multiple within-study estimates in meta-analyses in education (e.g., Conn, 2017; Dietrichson, Bøg, Filges, & Jørgensen, 2017; Gardella, Fisher, & Teurbe-Tolon, 2017). The RVE calculation of the effect size can be used with near-optimal results with only 10 studies (Hedges et al,. 2010a; Tanner-Smith & Tipton, 2014; Tipton, 2014). Since my final sample in science is just below this threshold, I calculated effect sizes estimated both by RVE and by inverse-variance weights.

RESULTS

Searching electronic databases yielded 346 results. Papers citing or cited by the studies downloaded for full-text review added another 153. Of the 494 unique results, 413 failed inclusion criteria based only on review of the abstract.[3] Of the 81 studies reviewed in full, 26 considered multitrack calendars or treated single- and multitrack calendars as equivalent, 25 failed another of the inclusion criteria, and 30 met criteria and provided sufficient data to calculate an effect size. As in other contexts, studies emphasized math and reading outcomes, with slightly under a quarter of the studies (7) reporting science achievement outcomes, and 5 reporting social studies achievement.

Table 1 shows the characteristics of the studies that reported science outcome data. The study-level effect sizes shown are based on inverse-variance weights used to combine estimates within the studies that reported outcomes for multiple grades or years. The studies varied among the middle grades (3–8) included and in the number of weeks to which schools shortened summer. Studies varied minimally based on geography, with all studies set exclusively in Texas and the southeast. With that caveat established with regard to generalizability, the descriptive results are suggestive of positive effects from YRE in both subjects: just one estimate is negative, a majority are over +0.1, and some are much larger.

Effectiveness of YRE for Science and Social Studies

Table 2 presents the estimated mean difference in science and social studies achievement for students at year-round schools. Overall, the estimates are positive and not sensitive to method of calculation. The science effect is 0.11–0.12 from all calculations, and is statistically significant ($p = .017$ in RVE[4] analysis). The social studies effect ranges more, but the outlying estimate of only +0.08 is from the random effects approach to aggregation, and—particularly given the geographic homogeneity among the studies—the study-level effects are unlikely to meet the representativeness assumptions of random effects modeling. The

TABLE 1
Characteristics of Studies in Final Sample

Study Author and Year	*Science E.S.*	*Social Studies E.S.*	*State*	*Weeks of Summer*	*Grade Level*	*Identification Strategy*
Coopersmith (2011)	+.075	+.203	TX	4–6[a]	6–8	School-level pairing within TEA campus comparison group, matched on ethnicity, economic status, LEP, and mobility
D'Alois (2005)[a]	+.127	+.031	VA	4	3, 5	Cohort comparison; 1 year before and 1 year after conversion
Ferguson (2001)[a]	+.139		VA		5	Cohort comparison; 1 year before and 1 year after conversion
Marks (2006)	+.132	+.085	TN	8	6	Cohort comparison; 1 year before change versus first 2 years YRE
Moore (2002); Moore and Verstegen (2004)	+.047	+.355	VA	~6	3–4	School-within-a-school with parent opt-in
Sexton (2003)	–.282	+.118	VA		8	School-within-a-school
Wilmore-Dafonte (2013)	+.119		TX	Mixed	5	2:1 match from TEA campus comparison group using matched on ethnicity, economic status, LEP, and mobility

Note: [a]The Ferguson (2001) estimate and one of the three estimates from D'Alois (2001) are from a dichotomous outcome variable (% proficient); figures were transformed into Cohen's *d* for comparability (see Polanin & Snilstveit, 2016).

TABLE 2
Estimates of Average Science and Social Studies Effect Sizes

Synthesis Approach	*Robust Variance Estimation*	*Fixed-Effects Estimate of Within-Study Weighted Avg.*	*Random-Effects Estimate of Within-Study Weighted Avg.*	*Simple Weighted Average of All Estimates*
Science effect size	+.113* (τ^2 0.000, ω^2 0.0075)	+.112	+.116	+.112
Science 95% confidence interval	[.051, .176]	[.091, .133]	[.102, .130]	n/a
Social studies effect size	$+.129^{+}$ (τ^2 0.0009, ω^2 0.0064)	+.158	+.077	+.158
SS 95% confidence interval	[–.027, .286]	[.116, .200]	[.010, .145]	n/a

Note: Based on the number of estimates included, random effects are probably inappropriate, but are included for thoroughness. +$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

other estimates cover a narrower band, of 0.13–0.16 (borderline significant, $p = .075$ in RVE analysis).

DISCUSSION

In interpreting the science effect of 0.11 and a marginally larger (but less precisely estimated) social studies effect, one should recall that summer learning loss is estimated to be .11 in reading and .16 in math. Comparable estimates of summer learning loss in science and social studies are not available. However, the magnitude of the science and social studies outcomes indicates that a single-track year-round calendar can counter most of summer learning loss and thereby add about a month of learning to each subject. These estimates are similar to those for reading ($\sigma = .17$) and math ($\sigma = .16$), both statistically significant at $p = .05$, calculated for middle grades from the same 30-study final sample (Fitzpatrick & Burns, 2017b). Given the relatively low cost of calendar conversions, the findings of a consistent modest positive effect support administrators' adoption of single-track YRE to improve student achievement in all subjects.

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NOTES

1. Other disadvantages of multitrack YRE include that administrators are needed on all days (Mutchler, 1993), there is no period when the building is empty for facilities work and even some routine maintenance (Mussatti, 1981; White, 1993), and teachers on differing tracks have barriers to communication and unity (Severson, 1997, Shields, 1996). For a review of problems with multitrack YRE, see Sparks (2002).
2. Details of literature retrieval protocols available in Fitzpatrick and Burns (2017a, 2017b).
3. For full flow diagram information, aligned with best-practices reporting standards (Moher, Liberati, Tetzlaff, & Altman, 2009), see Fitzpatrick and Burns (2017b), which includes full details of the systematic review protocols.
4. Meta-regression calculation of the coefficient only, using the small sample correction and hierarchical weights.

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