The Impact of Music on Childhood and Adolescent Achievement*

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Objective. The study examines the association between music involvement and academic achievement in both childhood and adolescence using three measures of music participation: in school, outside of school, and parental involvement in the form of concert attendance. *Methods.* We review prior work pertaining to music's impact on achievement and then draw from two nationally representative data sources (ECLS-K and NELS:88). Our analyses apply logistic and OLS regression techniques to assess patterns of music involvement and possible effects on math and reading performance for both elementary and high school students. *Results.* Music involvement varies quite systematically by class, and gender status, and such involvement holds implications for both math and reading achievement, and for young children and adolescents. Notably, associations with achievement persist in our modeling even when prior achievement levels are accounted for. Although music does mediate some student background effects, this mediation is only minimal. *Conclusions.* Music participation, both inside and outside of school, is associated with measures of academic achievement among children and adolescents. Future work should further delineate the relevant processes of music involvement, as well as how background inequalities and music involvement intersect in relation to educational performance.

Music involvement has been publicly linked to student achievement—a presumed connection made all the more obvious in debates over cuts to high school elementary and high school music programs. Youth music participation is associated with higher matriculation rates (Aschaffenburg and Maas, 1997), higher rates of acceptance into medical schools (Thomas, 1994), lower rates of current and lifetime alcohol, tobacco, or drug abuse (Texas Commission on Drug and Alcohol Abuse, 1999), and lower rates of disruptive classroom behaviors (National Center for Educational Statistics, 1997). Despite these associations, there is much room for elaboration on the

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music-achievement relation owing to the extant literature's inability to define and empirically capture what music participation means. This is not to suggest, however, that the topic has not garnered the attention, both directly and indirectly, of educational theorists, psychologists, and sociologists. It certainly has and for quite some time.

The connection between music and cognitive benefits (especially in math skills) is generally traced to the ancient Greek, Pythagoras, who in the fifth century BCE suggested that mathematical relationships were integral to physical properties, including music. Pythagoras envisioned a living cosmos comprised of ratios and he and his students devoted themselves to articulating these relationships. Music and math were one and the same to the Pythagoreans. Pont (2004) argues that the correlation of math to the physical, commonly credited to Pythagoras, existed prior to the Greeks. Indeed, recent excavations of clay tablets in and around Mesopotamia and Egypt, created sometime around 2000 BCE, show tunings (standardized mathematical ratios of stringed instruments).

Such claimed associations between math, music, and cognition have persisted across time and cultures. Possible associations with children's development made their way into the system of U.S. public education quite early on when Horace Mann, a founding thinker of public education, pushed for music inclusion in the core curriculum. The general consensus, which persists today, is that music is an important dimension of academic development. According to a Gallup Poll conducted and reported by the American Music Conference (2003): "Ninety-five percent of Americans believe that music is a key component in a child's well-rounded education . . . more than three quarters of those surveyed feel schools should mandate music education."

Does music matter? In this article we build on prior theorizing and empirical work pertaining to music's potential impact on student academic development and then analyze how various forms of music involvement shape reading and mathematics achievement. We begin with an overview of theorizing and empirical work pertaining to how and why music may be meaningful and then turn specifically to the question of academic achievement. Our analyses, which draw from both the National Educational Longitudinal Survey (NELS:88) and the Early Childhood Longitudinal Survey (ECLS-K), allow us to address the achievement question directly and assess the reliability of patterns uncovered for small children as well as for adolescents. Given the breadth of research on stratifying processes as they are played out at educational (Alexander, Entwisle, and Thompson, 1987; Lucas, 1999, 2001; Roscigno and Ainsworth-Darnell, 1999) and familial levels (Lareau, 2002; Downey, 1995a, 1995b; DiMaggio and Ostrower, 1990), we also consider the degree of race, class, and gender disparities in music involvement. Significant group-level inequalities in music involvement would indeed be problematic to the extent that music holds implications for achievement.

How and Why Music May Matter

Research from psychology as well as sociology has attempted to explain the importance of music for intellectual development by focusing on a variety of cognitive and social-developmental outcomes. Studies of the structured neuronal model of the cortex (Shaw and Brothers, 1989; Leng and Shaw, 1991) encouraged social scientists to discover that certain music positively affects the spatial-temporal scores of listeners during exams—something often referred to as the "Mozart effect" (Rauscher, Shaw, and Ky, 1993). Specifically, college students who listen to Mozart prior to taking a pencil-and-paper test of abstract spatial reasoning perform better than their counterparts who do not listen to Mozart. As an elaboration, others have suggested that variations in genre preference alter the effect (Steele, 2001). Although certainly intriguing, no study to date has provided definitive modeling that considers tonal complexity, musical genre preference, and sociocultural responses, though studies do point to arousal and mood as mediating the music effect on cognition (Thompson, Schellenberg, and Husain, 2001). Listening to music stimulates cognition (Rauscher, 1998) and music training bolsters this effect in both mathematics (Bilhartz, Bruhn, and Olson, 2000; Brothers, Shaw, and Wright, 1996; Costa-Giomi et al., 1999; Graziano, Peterson, and Shaw, 1999; Gromko and Poorman, 1998; Rauscher et al., 1997) and language (Douglas and Willatts, 1994; Ho, Cheung, and Chan, 2003).

In a meta-analysis of experimental studies on the relationship between spatial performance and music listening, Hetland (2000), from Harvard's Project Zero, highlights significant limitations within existing studies. These include a reliance on quite small samples (ranging from 12 to 179 individuals). Moreover, only one of the 20 studies reviewed was in a peer-reviewed journal and that particular study was an analysis of music majors in college, published more than a half-century ago. The remainder, which were never published and include seven doctoral dissertations (Vaughn and Winner, 2000), tend to focus singularly on low-SES or mid-SES individuals, thus constraining comparison, and few controls are included (Winner and Cooper, 2000a, 2000b). This is particularly important if the goal is to systematically assess if benefits of music involvement exist and how. Without doing so, the relation between music and intellectual development may be a spurious one.

In another meta-analysis of experimental studies on the relationship between spatial performance and music making, spanning the years between 1950 and 1999 ($N = 188$), Hetland (2000) examined 14 comparable studies. Although none were published in peer-reviewed journals, they do demonstrate a strong bivariate relationship between learning to play an instrument and spatial-temporal ability (median $r = 0.34$; 25th quartile $r = 0.25$; 75th quartile $r = 0.42$; $p < 0.001$, two-tailed test). Findings were equivocal, however, as to the relationship between learning to play an

instrument and reading and mathematics achievement (Hetland and Winner, 2001). Indeed, there exists a relatively obvious social class bias in the methods used to measure these bivariate relations, as poor students have limited resources that may hinder music participation from the outset. Moreover, children from more well-to-do families, while perhaps more inclined to participate in music generally, are also advantaged in other ways meaningful to achievement (Bourdieu and Passeron, 1977; Downey, 1995a; Lareau, 2000, 2002; Teachman, 1987; DiMaggio, 1982). Without assessing social class variations, or controlling for other educational resources at children's disposal, conclusions regarding the impact of music participation are tentative at best.

In an effort to remedy some of these limitations—particularly those pertaining to small sample sizes and potential social class variations—Catterall, Chapleau, and Iwanaga (1999:9–13) examine the influence of music participation on student math achievement using the National Educational Longitudinal Study (NELS:88). Comparing low-SES students who exhibit high math proficiency in 12th grade, 33 percent are involved with instrumental music in the 10th grade, compared to 15 percent who are not involved. Yet, no inference of causality can be made as the positioning of students in the higher ranks could be due to other confounding factors. For example, the definition of music participation used by Catterall, Chapleau, and Iwanaga is the 10th-grade measure of participation in orchestra/band. If music participation positively affects cognition and some students who participate in the school band also participate in music outside of school, then they are advantaged. If students take music outside of school but do not participate in band, they are less advantaged, but more advantaged compared to students with no music participation. The music measure needs to be more precise but, given data limitations, it is not possible to control for the duration and quality of music participation. However, controlling for prior achievement would allow for a more precise comparison.

Broader analyses of extra-curricular involvement, such as that undertaken by Broh (2002), have added to our understanding of music's potential correlation to achievement beyond possible direct cognitive effects, supporting the theory of cultural capital. Using the NELS:88 data, Broh studied an array of within-school extra-curricular activities (i.e., sports, cheerleading, drama, student council, yearbook, vocational clubs, and music) and found several associations between participation and achievement (grades and math and language scores). She shows this is due to garnering of social and cultural capital. Specifically, students who participate have more academically-oriented peer groups, talk more with parents and teachers, and their parents are more likely to talk with friends' parents. These benefits are more purely social in nature and may be important in countering lower self-esteem and locus of control. Students with early music instruction are more likely involved with other extra-curricular activities (Orsmond and Miller, 1999). Moreover, music participation at school has been shown to bolster

not only individual benefits such as friendships with like-minded individuals and modeling commitment through rehearsals, but school music productions are perceived as making a valuable contribution to social life through a widespread awareness of the show by nonparticipants (Pitts, 2007).

Importantly, serious music involvement often occurs outside of the school context—a fact seldom considered in prior work. As should be obvious from the discussion above, consideration of music's impact necessitates (1) controls for potentially confounding factors; (2) a more longitudinal and rigorous design that moves beyond bivariate relations and allows the researcher to capture temporal ordering; (3) consideration of variations in involvement by social class, race, and gender, for instance; and (4) a focus on the ways group disparities in music involvement might be contributing to the academic inequalities established in much prior research. Below, we specify several reasons why music participation may be meaningful for student academic achievement, how familial resources may play a role, and why disparities in music involvement and, thus, achievement, may exist across subgroups.

Music, Achievement, and the Potential for Inequality

Prior research has tested the cognitive effects of music participation with mixed results, although this literature has not tested the cultural impact of music as a mediating effect on achievement. Prior educational research has shown quite clearly a strong relationship between family background and student achievement, owing in part to institutional processes that advantage those of higher status. The investments families are or are not able to make are quite central in these regards. When children are provided with basic skills from the outset, but also continued investment in household educational items and cultural capital, they enter the educational system and sorting process with clear-cut advantages (Astone and McLanahan, 1991; Alexander, Entwisle, and Thompson, 1987; Lareau, 2000; Kohn, 1959; Roscigno and Ainsworth-Darnell, 1999).

Though there is certainly discretion in educational investments (see Teachman, 1987), higher-SES and Caucasian parents have disparate resources available to invest relative to lower-status families (Roscigno, 1998). Sometimes, even within families, investments in cultural capital in particular can take on a gender-specific character (DiMaggio and Mohr, 1985; Buchmann, 2000). Music involvement may very well represent one such investment, impacted by prevailing stratification arrangements with implications for educational success.

Lareau (2002), in one of the most developed and recent treatments of time use, shows how the investments of working-class and middle-class parents and families fundamentally differ in meaningful educational ways. Specifically, higher-SES parents tend to look at their children as ''works in

progress'' and structure their children's time around furthering education outside of school. Music involvement and lessons may certainly be one such route. Lower-SES parents, in comparison, are less likely to structure their children's time outside school in educationally important ways, regardless of race. If music involvement indeed reflects an important route through which resource and time investments are disparately allocated, and music itself influences achievement levels, then the issue of music involvement has clear-cut implications for our understanding of educational stratification. Indeed, this would be consistent with arguments pertaining to structure and the exclusionary nature of cultural reproduction (e.g., Bourdieu and Passeron, 1977; Roscigno and Ainsworth-Darnell, 1999).

Our analyses, following the discussion above, address two central questions using a cultural capital framework. First, who participates in music both in and outside of school, and to what extent is such involvement stratified by social class, race/ethnic, and gender status? Second, and relative to the more central question discussed at the outset, do various forms of music involvement influence academic achievement, even after accounting for prior achievement, background statuses, and other educationally meaningful investments? Relatedly, to what extent might disparities in music involvement shape group-specific gaps in achievement that have been so well documented elsewhere?

Data and Measurement

We draw from two data sources collected by the Department of Education: the Early Childhood Longitudinal Study (ECLS-K) and the National Educational Longitudinal Study (NELS:88). ECLS-K was administered to approximately 20,000 U.S. kindergarten students in 1998–1999 from more than 1,000 schools, with follow-up waves in first, third, and fifth grade. We use the K–1st-grade data specifically, given the availability of music participation variables in these waves. NELS:88 followed a different group of students from eighth grade and beyond high school, with (high response rate) followups every two years. Its base year (1988) sample size is just under 25,000 adolescents from approximately 1,000 U.S. schools. We only draw on cases that include IRT (Lord, 1980) scores on math and reading. Given this and the sensitivity of longitudinal data to attrition, the samples are reduced in the latter waves, leaving a sample size of 4,376 in ECLS-K and a sample size of 7,781 in NELS:88. Both these data sources are nationally representative longitudinal studies utilizing multilevel stratified, clustered national probability samples. Proper weights are employed in our analyses, given subgroup over- and underrepresentations within each data set. These data are, in several regards, ideal, given relatively parallel indicators of achievement, music involvement, and student background over time.

Achievement

Comparable measures of standardized achievement in reading and mathematics are available in both data sets. Although standardized test scores are by no means perfect measures of cognition and cognitive complexity, they have proven to be relatively effective indicators of success in schooling. The standardized scores in the NELS:88, reported in Table 1, have a mean of 51 for both math and reading scores. For the ECLS-K, the reading mean is slightly higher at 57 and the mathematics score slightly lower at 44. We draw from later waves of NELS:88 (12th grade) and ECLS-K (first grade) for these dependent variables for reasons of temporal ordering. Family background, student status attributes, and controls for prior achievement are measured during the base year (kindergarten and eighth grade, respectively).

Music Involvement

We include three parallel dichotomous measures of music involvement from each data set. Data limitations preclude a calibrated measure of participation. This is, however, a minor limitation given the validity of the large data sets and the large, representative samples. Formal music participation exists in and outside school and this is captured in both the childhood and adolescent data. Since there is significant variability nationwide in the extent and degree to which music classes are available, we first include an indicator of weekly, in-school music class participation. One minor data limitation is that the data sets ask parallel music participation questions in the base year, but not consistently across subsequent waves. Therefore, the in-school music effect will be captured after participation occurred. To address this issue, we include an additional music participation question from the second wave (10th grade) of NELS:88 in our modeling of adolescent achievement. This measure of music participation captures, in half-year increments, the amount of in-school music coursework a student has taken between 8th and 10th grade. Unfortunately, the same measure was not included in the ECLS-K survey. Notably, whereas nearly all small children are involved in a music lesson at least once a week, this only holds true for approximately half the adolescents sampled. This makes intuitive sense. By the high school years, music involvement becomes voluntary in terms of students' curricular plan rather than a generic music class. Adolescents often have the option of taking band, orchestra, marching band, or, sometimes, chorus.

More pertinent, we believe, is the extent to which families invest in their children's music involvement outside the parameters of school. Following Lareau (2003), such involvement (which requires both resources and time) may constitute educationally directed use of leisure time, particularly for higher-SES parents. In this vein, we include measures of music lessons

TABLE 1

Description of Key Measures, Mean, and Standard Deviation

		ECLS-K		NELS	
		Mean	*SD*	Mean	*SD*
Mathematics Score	Standardized reading IRT score	44.55	8.70	50.81	10.04
Music in school		44.65	8.62	51.66	10.05
Music outside school		44.97	8.72	52.73	10.00
Parent attend concerts		44.72	8.72	51.77	9.98
Reading Score	Standardized mathematics IRT score	57.07	13.00	50.59	9.89
Music in school		57.01	12.98	51.44	9.87
Music outside school		57.46	13.41	52.33	9.77
Parent attend concerts		57.46	13.40	51.42	9.80
Music Involvement					
In school	Music in school, at least once a week	0.97	0.18	0.51	0.07
Outside school	Music outside of school = 1; no = 0	0.10	0.29	0.27	0.07
Parent attend concerts	Parent attends concerts = 1; no = 0	0.40	0.49	0.63	0.07
Amount of music coursework	Coursework between 8th and 10th grades? (0.5 yr; 1 yr; 1.5 yrs; 2 yrs)	—	—	0.89	1.47
Family Background and Status Attributes					
SES	Socioeconomic status composite	0.05	0.74	0.00	10.86
Two parents		0.81	0.39	0.69	0.46
Single parent	Coded yes = 1; no = 0	0.16	0.37	0.28	0.37
Neither parent	Coded yes = 1; no = 0	0.03	0.16	0.03	0.17
Number of siblings	Continuous variable	1.51	1.15	1.52	1.21
Female	Coded yes = 1; no = 0	0.51	0.50	0.50	0.50
Black	Coded yes = 1; no = 0	0.10	0.30	0.10	0.30
Hispanic	Coded yes = 1; no = 0	0.09	0.29	0.12	0.33
Asian	Coded yes = 1; no = 0	0.04	0.20	0.07	0.26
White	Coded yes = 1; no = 0	0.76	0.42	0.70	0.45
More than 50 books	Coded yes = 1; no = 0	0.72	0.45	0.71	0.30
Prior math achievement	Standardized base-year mathematics IRT score	29.07	8.51	51.83	10.22
Prior reading achievement	Standardized base-year reading IRT score	33.63	10.53	51.56	10.01

outside of school. Approximately 27 percent of adolescents and about 10 percent of small children were so engaged. We also include an indicator of parental musical involvement, in the form of attending concerts. This indicator likely captures not only household cultural capital in some generic

sense, but also the more general appreciation of music by parents and the likely introduction, appreciation, and use of music in the household.

Family Background, Status, and Controls

We also include baseline indicators of family background and race and gender status that much prior work has shown to be consistently influential for student achievement. These are nearly identical between the NELS:88 and ECLS-K samples and include, specifically, a composite of family socioeconomic status (SES), parental structure, race/ethnicity, gender, and if the family has more than 50 books in the home, a standard measure of cultural capital (DeGraaf, DeGraaf, and Kraaykamp, 2000). Our measure of 50 or more books was constrained by NELS:88, which coded the item dichotomously: Does your family have more than 50 books? We recoded the ECLS-K measure for comparison.

The SES composite was constructed by the Department of Education and includes income, parental level of education, and parental occupation. Family structure is measured discretely as living with two parents versus living with neither or only one, and we use the exact number of siblings present in the home. We include indicators of race/ethnicity, coded in dichotomous fashion, to assess potential effects of race on music involvement. There are too few Native Americans and Pacific Islanders in the sample; subsequently these cases were dropped. The referent in the following baseline models is a white male living in a two-parent family, either biological or blended.

Along with controls for household educational items such as books, we control throughout for baseline achievement levels at Time 1. Inclusion of such a control represents a serious effort to systematically isolate achievement change over time and the extent to which music involvement affects achievement during early childhood years and adolescent years, respectively. All cases with missing data are removed from the analyses.

Analytic Strategy and Results

The reliance on these two large nationally representative data sets allows for a comparison between cohorts in terms of music participation and academic outcomes. It also advances the literature by allowing a more comprehensive analysis of the education process and how it interrelates with parental investment (i.e., music participation). This is important given that prior work has not addressed the determinants of music participation across cohorts.

Analyses proceed in two steps. We begin by addressing the question of who participates in music, and whether there are variations by social class,

race, and gender status. For these models, we make use of logistic regression, and hold constant the number of books in the home as a control for other tangible educational investments. To the extent that class, race/ethnic, and gender differences exist, such differences may hold implications for differences in achievement.

The second portion of our analysis examines the extent to which music participation may be meaningful for achievement. We undertake separate analyses for math and reading, and present childhood and adolescent models side by side for comparative purposes. Equation (1) is the baseline model of achievement with indicators of family background, student race and gender status, the number of books in the home, and prior achievement. Equation (2) introduces the three indicators of music involvement in an effort to assess both the impact on achievement as well as the extent to which music participation may be mediating some of the class, race, and gender effects highlighted in the first equation. For adolescent models, we include in a third equation 8th–10th-grade music coursework.

Music Involvement and Student Background

Table 2 reports logistic regression estimates of music involvement for children and adolescents by the status attributes of students and their families, with a control for household educational resources in the form of number of books. The reader will first note that there appears to be no social class variation in within-school and external music involvement for children. Social class differences do, however, emerge for adolescents. Moreover, the effects of social class on parental music involvement are strong, statistically significant, and consistent for both small children and adolescents. Such effects are undoubtedly a function of variations in resource availability within families. In the case of music involvement occurring outside of school, resource advantages/disadvantages are also very likely compounded by differential structuring of children's leisure time (Lareau, 2003). In general, family structure does not impact music involvement, with the exception of single-parent households, which depresses taking music in eighth grade, while having siblings seems to dilute resources, at least for adolescents.

Racial differences in music participation are a bit more complex. On average, African Americans, Hispanics, and Asians exhibit lower music involvement than whites. Asian students are more likely to take music outside of school as adolescents and black parents with young children attend more concerts than do whites. Children of color are significantly less likely to participate in all three as adolescents. Although the effects are more robust for adolescents, findings largely suggest an overall white advantage in music involvement during early childhood and the high school years. Gender effects are negligible to nonexistent, with the exception of the

TABLE 2

Binary Logistic Regression Coefficients of SES, Family Structure, Race, Gender, and Cultural Capital on Music Involvement by Children (C) and Adolescents (A)

	Music Inside of School		Music Outside of School		Parental Music Involvement	
	C	A	C	A	C	A
SES	0.14	0.09***	0.09	0.34***	0.33***	0.34***
	(0.13)	(0.03)	(0.07)	(0.03)	(0.05)	(0.03)
Single parent	−0.08	−0.10*	0.26	−0.03	−0.10	−0.01
	(0.23)	(0.05)	(0.14)	(0.05)	(0.09)	(0.05)
Neither parent	−0.36	0.12	0.19	0.18	−0.04	0.10
	(0.42)	(0.14)	(0.32)	(0.16)	(0.20)	(0.14)
Number of siblings	−0.15	−0.04**	0.07	−0.12***	−0.00	−0.12***
	(0.08)	(0.01)	(0.04)	(0.01)	(0.03)	(0.01)
Black	−0.78**	−0.30***	−0.39*	−0.28**	0.28**	−0.16*
	(0.26)	(0.07)	(0.20)	(0.09)	(0.12)	(0.08)
Hispanic	−0.07	−0.81***	−0.11	−0.67***	0.06	−0.76***
	(0.30)	(0.07)	(0.18)	(0.09)	(0.11)	(0.07)
Asian	0.25	−0.29***	−0.55	0.22*	0.39	−0.51***
	(0.53)	(0.08)	(0.30)	(0.09)	(0.16)	(0.08)
Female	0.13	−0.03	0.07	−0.05	0.17**	−0.08
	(0.17)	(0.04)	(0.10)	(0.05)	(0.06)	(0.04)
More than 50 books	0.06	0.11	−0.21	0.04	0.42***	0.07**
	(0.20)	(0.07)	(0.12)	(0.09)	(0.08)	(0.07)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, two-tailed test.

parents of young girls, who disproportionately attend concerts with their daughters.

Clearly, attending concerts is, in part, a matter of economics, but it is also in keeping with Lareau's description of the middle-class production logic of child rearing and is therefore culturally proscribed. Although certainly driven by resource disparities, and family SES in particular, there is a discretionary dimension to educational investments—investments that may take multiple forms, from tangible resources to the structuring of leisure time in ways that may be educationally meaningful. By high school, however, some students earn an income and support their own interests, such as music lessons and playing in bands. The structuring of leisure time is not only determined by guardians but by students, suggesting culture weighs heavy in the decision to participate in music. Unfortunately, current data do not query both parental and student levels of music interest or preference, which would permit a direct measure of intergenerational cultural impact. Instead, the data provide proximate measures of cultural capital and direct measures of achievement.

The Association Between Music and Achievement

Music indeed appears to matter. Tables 3 and 4 report regression estimates of math and reading achievement for childhood and adolescent samples. The first equation, our baseline model, introduces measures of family SES and structure, race and gender, and controls for educational items and prior achievement (eighth grade for adolescents; kindergarten for children).

TABLE 3

OLS Regression Coefficients and SEs of SES, Family Structure, Race, Gender, Music Involvement, Cultural Capital, and Prior Achievement on Mathematic IRT Scores for Children (C) and Adolescents (A)

	Model 1		Model 2	
	C	A	C	A
SES	1.02***	5.24***	0.99***	5.05***
	(0.13)	(0.15)	(0.13)	(0.15)
Single parent	−0.33	−1.60***	−0.31	−1.46***
	(0.24)	(0.23)	(0.24)	(0.24)
Neither parent	−1.13**	−2.90***	−1.15*	−2.73***
	(0.51)	(0.75)	(0.50)	(0.83)
Number of siblings	−0.02	−0.25***	−0.02	−0.15*
	(0.08)	(0.07)	(0.08)	(0.07)
Black	−0.18	−2.06***	−0.21	−2.02***
	(0.31)	(0.37)	(0.31)	(0.39)
Hispanic	−0.88**	−0.55	−0.92**	−0.46
	(0.30)	(0.35)	(0.30)	(0.37)
Asian	−0.23	0.11	−0.27	0.15
	(0.65)	(0.43)	(0.65)	(0.44)
Female	−0.13	−1.00***	−0.16	−01.30***
	(0.17)	(0.21)	(0.17)	(0.22)
Music in school	—	—	1.82***	0.35
			(0.44)	(0.22)
Music outside school	—	—	−0.47	0.44
			(0.29)	(0.26)
Parents attend concerts	—	—	0.35*	−0.05
			(0.18)	(0.24)
Amount of music coursework	—	—	—	0.50***
				(0.07)
More than 50 books	0.89***	2.00***	0.83***	1.83***
	(0.19)	(0.36)	(0.21)	(0.38)
Prior achievement	0.73***	0.06***	0.73***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	22.94	48.49	21.19	48.64
	(0.40)	(0.73)	(0.57)	(0.76)
R^2	0.60	0.23	0.60	0.23

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$, two-tailed test.

TABLE 4

OLS Regression Coefficients and SEs of SES, Family Structure, Race, Gender, Music Involvement, Cultural Capital, and Prior Achievement on Reading IRT Scores for Children (C) and Adolescents (A)

	Model 1		Model 2	
	C	A	C	A
SES	1.56***	4.20***	1.56***	4.19***
	(0.20)	(0.15)	(0.20)	(0.16)
Single parent	−0.76*	−0.54*	−0.73*	−0.68**
	(0.36)	(0.24)	(0.38)	(0.25)
Neither parent	−2.48**	−2.75***	−2.48**	−2.38**
	(0.78)	(0.78)	(0.78)	(0.86)
Number of siblings	−0.31**	−0.19**	−0.33**	−0.14*
	(0.12)	(0.07)	(0.12)	(0.07)
Black	−1.33**	−1.34***	−1.32**	−1.37***
	(0.47)	(0.38)	(0.47)	(0.40)
Hispanic	−0.39	−0.18	−0.43	0.17
	(0.48)	(0.36)	(0.48)	(0.38)
Asian	1.97*	−0.30	1.87	−0.25
	(0.95)	(0.44)	(0.95)	(0.45)
Female	1.02***	2.38***	1.01***	2.30***
	(0.24)	(0.21)	(0.26)	(0.22)
Music in school	—	—	2.12**	0.70**
			(0.68)	(0.23)
Music outside school	—	—	−0.44	0.62**
			(0.44)	(0.27)
Parents attend concerts	—	—	0.10	−0.02
			(0.27)	(0.24)
Amount of music coursework	—	—	—	0.44***
				(0.08)
More than 50 books	1.20***	2.12***	1.16***	1.75***
	(0.32)	(0.37)	(0.33)	(0.39)
Prior achievement	0.86**	0.04***	0.86***	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	27.23	46.61	51.01	46.80
	(0.57)	(0.75)	(0.89)	(0.78)
R^2	0.57	0.16	0.58	0.16

*$p<0.05$; **$p<0.01$; ***$p<0.001$, two-tailed test.

All background indicators act as one would expect, and in statistically significant ways, for both reading and math. Notable is the strong effect of SES even with controls from prior achievement. It is clearly the case that SES, and the advantages/disadvantages it affords, is not purely influential by shaping baseline achievement levels; rather, its impact persists into the schooling years.

African-American students remain disadvantaged in terms of both math and reading achievement in these models, while the disadvantage for Hispanic students only exists for childhood math. Asian adolescents do not differ significantly from white adolescents with prior achievement included in the models. Among younger Asian children, however, we find an advantage in reading. Females generally exhibit lower math achievement than do their male counterparts, but significantly higher reading achievement. As expected, household educational items have a positive effect for both age groups and for both achievement outcomes.

Equation (2) introduces our indicators of music involvement. For reading achievement, music involvement within school positively predicts achievement for both adolescent and small children. It may be the case that there is generally greater variation in reading ability among small children, and that active involvement of children in music contributes in some way to the garnering of early reading skills. Music participation outside of school is positively associated with reading achievement for adolescents. This effect remains even when in-school music is controlled. However, parental music involvement is not significantly associated with reading achievement. Even more notable is that these effects emerge even when other household educational items and especially prior achievement are accounted for. Math performance is associated with music participation in school and parental attendance at concerts for young children, and a robust effect unfolds when music participation has occurred recently in adolescents.

The results thus far suggest unique and robust associations between achievement and music—effects that are not strictly tied to very early cognitive development but that, rather, take place during the early and later schooling years. All three forms of music involvement matter for adolescents and this holds true for reading and less so math achievement. For small children, the clear benefit of music involvement on math achievement is found in school and parental music participation, but not in outside of school participation. For reading, music in school translates into higher overall reading achievement. Again, we would stress that younger children are nearly universally placed in music classes whereas adolescents choose to participate and few families choose music lessons outside of school for young children.

Does music involvement add to our understanding of academic achievement? The answer is both yes and no. On the one hand, music clearly matters for achievement in statistically meaningful ways as denoted in the findings just presented. The reader will note, however, that the overall variance explained changes little across equations as music indicators are added. This suggests to us that music is meaningful not as a predictor of achievement in and of itself, but rather as a mediator, to some degree, of family background and student status, thus supporting arguments and theorizing pertaining to cultural capital. Music, for example, might influence disposition or habits of mind. Our earlier modeling in Table 2 established the

ways music involvement varies systematically as a function of social class, race/ethnicity, and, to a lesser extent, gender. Those patterns, combined with changes in coefficient magnitudes for SES, race/ethnicity, and gender across equations of Tables 3 and 4, strongly support this possibility, as do supplemental analyses that, due to space constrains, are not reported in the tables. Comparing the coefficients for SES across Equations (1) and (2), without the interaction terms, we see a decline of approximately 3 percent for math, less so for reading. Similar, albeit small, declines can be seen for measures of race/ethnicity and gender.

Conclusion

Prior research has attempted to measure the impact of music involvement on student achievement. Limitations in research designs, however, have left many questions unanswered. In this article, we have attempted to overcome some prior limitations by examining three dimensions of music involvement and variations by student status, by controlling for prior achievement, thus isolating potential effects, and by comparing such effects across unique samples of small children and adolescents. Only a randomized design experimental study can capture causality; yet our analyses demonstrate in a relatively rigorous fashion a robust relationship between music participation and achievement—a relationship that emerges particularly when music participation is conceptualized and measured broadly. Most children are probably involved in classical music and we do not have measures of countercultural or pop music nor do we know how many students are in bands outside school. We would expect to see more robust findings if participation could be more precisely calibrated.

Notably, we found evidence of social class variation in within-school music involvement in adolescents but not in early childhood. The effects of class on parental music involvement were strong and consistent for both samples. We believe that this pattern is at least partially a function of resource inequalities, which, if anything, only exacerbate social class differences in how children's leisure time is structured (Lareau, 2003). As a mediator of educational outcomes, music involvement holds significance for both math and reading achievement. Music participation generally increases achievement levels, although gains are not distributed equally among all students. A white student advantage exists in music involvement during early childhood and the high school years. As noted above, there is certainly a social class bias in these processes.

Admittedly, our data and analyses are limited in their ability to measure and capture the quality and duration of children's and adolescents' participation. Although our study captured the influence of music involvement and different types of involvement in a manner unique to the literature, future data-collection efforts and analyses should consider quality and du-

ration. Moreover, to gauge the relevant microinteractional processes that are involved would arguably require more in-depth, perhaps case-specific, analyses of what music participation means for families and social groups of varying statuses. Music involvement is a form of cultural capital that seems to provide cognitive and social tools that help students successfully navigate the educational terrain. Clearly, more work on this topic is warranted. Our analyses are but an important starting point.

REFERENCES

Alexander, Karl L., Dorris R. Entwisle, and Maxine S. Thompson. 1987. "School Performance, Status Relations, and the Structure of Sentiment: Bringing the Teacher Back In." *American Sociological Review* 52:665–82.

American Music Conference. 2003. *Press Releases*. Carlsbad, CA: American Music Conference.

Aschaffenburg, Karen, and Ineke Maas. 1997. "Cultural and Educational Careers: The Dynamics of Social Reproduction." *American Sociological Review* 62:573–87.

Astone, Nan Marie, and Sara S. McLanahan. 1991. "Family Structure, Parental Practices and High School Completion." *American Sociological Review* 56:309–20.

Bilhartz, Terry D., Rick A. Bruhn, and Judith Olson. 2000. "The Effect of Early Music Training on Child Cognitive Development." *Journal of Applied Developmental Psychology* 20:615–36.

Bourdieu, Pierre, and Jean-Claude Passeron. 1977. *Reproduction in Education, Society, and Culture*. Beverly Hills, CA: Sage.

Broh, Beckett A. 2002. "Linking Extracurricular Programming to Academic Achievement: Who Benefits and Why?" *Sociology of Education* 75:69–95.

Brothers, Leslie, Gordon Shaw, and Eric Wright. 1996. "Durations of Extended Mental Rehearsals are Remarkably Reproducible in Higher Level Human Performances." *Neurological Research* 15:413–16.

Buchmann, Claudia. 2000. "Family Structure, Parental Perceptions and Child Labor in Kenya: What Factors Determine Who is Enrolled in School?" *Social Forces* 78:1349–78.

Catterall, James, Richard Chapleau, and John Iwanaga. 1999. "Involvement in the Arts and Human Development: General Involvement and Intensive Involvement in Music and Theater Arts." In *Champions of Change: The Impact of the Arts on Learning*. Washington, DC: Arts Education Partnership.

Costa-Giomi, Eugenia, Harry E. Price, Frances H. Rauscher, Joan Schmidt, Martha Shackford, Wendy L. Sims, and Ella Wilcox. 1999. "Straight Talk About Music and Research." *Teaching Music* 7(3):29–34.

DeGraaf, Nan D., Paul M. DeGraaf, and Gebert Kraaykamp. 2000. "Parental Cultural Capital and Educational Attainment in the Netherlands: A Refinement of the Cultural Capital Perspective." *Sociology of Education* 73:92–111.

DiMaggio, Paul. 1982. "Cultural Capital and School Success: The Impact of Status Culture Participation on the Grades of U.S. High School Students." *American Sociological Review* 47:189–201.

DiMaggio, Paul, and John Mohr. 1985. "Cultural Capital, Education Attainment, and Marital Selection." *American Journal of Sociology* 90:1231–61.

DiMaggio, Paul, and Francie Ostrower. 1990. "Participation in the Arts by Black and White Americans." *Social Forces* 68:753–78.

Douglas, Shelia, and Peter Willatts. 1994. "The Relationship Between Musical Ability and Literacy Skills." *Journal of Research in Reading* 17:99–107.

Downey, Douglas B. 1995a. "When Bigger is Not Better: Family Size, Parental Resources, and Children's Educational Performance." *American Sociological Review* 60:746–61.

———. 1995b. "Understanding Academic Achievement Among Children in Stephouseholds: The Role of Parental Resources, Sex of Stepparent, and Sex of Child." *Social Forces* 73:875–94.

Graziano, Amy, Matthew Peterson, and Gordon L. Shaw. 1999. "Enhanced Learning of Proportional Math Through Music Training and Spatial-Temporal Training." *Neurological Research* 21:139–52.

Gromko, J., and A. Poorman. 1998. "The Effect of Music Training on Preschoolers' Spatial-Temporal Task Performance." *Journal of Music Education* 46:173–81.

Hetland, Lois. 2000. "Listening to Music Enhances Spatial-Temporal Reasoning: Evidence for the 'Mozart Effect'." *Journal of Aesthetic Education* 34:105–48.

Hetland, Lois, and Ellen Winner. 2001. "The Arts and Academic Achievement: What the Evidence Shows." *Arts Education Policy Review* 102:3–6.

Ho, Yim-Chi, Mei-Chun Cheung, and Agnes S. Chan. 2003. "Music Training Improves Verbal But Not Visual Memory: Cross-Sectional and Longitudinal Explorations in Children." *Neuropsychology* 17(3):439–50.

Kohn, Melvin. 1959. "Social Class and the Exercise of Parental Authority." *American Sociological Review* 24:352–66.

Lareau, Annette. 2000. *Home Advantage: Social Class and Parental Intervention in Elementary Education*. New York: Rowman & Littlefield Publishing.

———. 2002. "Class, Race, and Contemporary American Childrearing Practices." *American Sociological Review* 67:747–76.

———. 2003. *Unequal Childhoods: Class, Race, and Family Life*. Berkeley, CA: University of California Press.

Leng, Xiaodan, and Gordon L. Shaw. 1991. "Toward a Neural Theory of Higher Brain Function Using Music as a Window." *Concepts in Neuroscience* 2(2):229–58.

Lord, Frederic M. 1980. *Applications of Item Response Theory to Practical Testing Problems*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Lucas, Samuel. 1999. *Tracking Inequality: Stratification and Mobility in American High Schools*. New York: Teachers College Press.

———. 2001. "Race, Class, and Tournament Track Mobility." *Sociology of Education* 74:139–56.

National Center for Educational Statistics. 1997. *National Assessment of Educational Progress (NAEP) Report Card*. Washington, DC: National Center for Educational Statistics.

Orsmond, Gael I., and Leon K. Miller. 1999. "Cognitive, Musical and Environmental Correlates of Early Music Instruction." *Psychology of Music* 27(1):18–37.

Pitts, Stephanie E. 2007. "Anything Goes: A Case Study of Extra-Curricular Musical Participation in an English Secondary School." *Music Education Research* 9(1):145–65.

Pont, Graham. 2004. "Philosophy and Science of Music in Ancient Greece: The Predecessors of Pythagoras and Their Contribution." *Nexus Network Journal* 6.

Rauscher, Frances. 1998. "Improved Maze Learning Through Early Music Exposure in Rats." *Neurological Research* 20:427–32.

Rauscher, Frances, Gordon L. Shaw, and Katherine Ky. 1993. "Music and Spatial Task Performance." *Nature* 365:611.

Rauscher, Frances, Gordon Shaw, L. J. Levine, E. L. Wright, W. R. Dennis, and R. Newcomb. 1997. "Music Training Causes Long-Term Enhancement of Preschool Children's Spatial-Temporal Reasoning." *Neurological Research* 19:2–8.

Roscigno, Vincent J. 1998. "Race and the Reproduction of Educational Disadvantage." *Social Forces* 76:1033–60.

Roscigno, Vincent J., and James Ainsworth-Darnell. 1999. "Race, Cultural Capital, and Educational Resources: Persistent Inequalities and Achievement Returns." *Sociology of Education* 72:158–78.

Shaw, Gordon, and Leslie Brothers. 1989. "The Role of Accurate Timing in Human Performance and the Code for Higher Cortical Function." Pp. 285–91 in R. Cotterill, ed., *Models of Brain Function*. New York: Cambridge University Press.

Steele, Kenneth. 2001. "The 'Mozart Effect': An Example of the Scientific Method in Operation." *Psychology Teacher Network* 11:2–5.

Teachman, Jay D. 1987. "Family Background, Educational Resources, and Educational Attainment." *American Sociological Review* 52:548–57.

Texas Commission on Drug and Alcohol Abuse. 1999. "Reported by First Act." *Houston Chronicle* January 11.

Thomas, Lewis. 1994. "The Case for Music in the Schools." *Phi Delta Kappan* February.

Thompson, William F., E. Glenn Schellenberg, and Gabriela Husain. 2001. "Arousal, Mood, and the Mozart Effect." *Psychological Science* 12(3):248–51.

Vaughn, Kathryn, and Ellen Winner. 2000. "SAT Scores of Students Who Study the Arts: What We Can and Cannot Conclude About the Association." *Journal of Aesthetic Education* 34:77–90.

Winner, Ellen, and Monica Cooper. 2000a. "The Arts in Education: Evaluating the Evidence for a Causal Link." *Journal of Aesthetic Education* 34:3–10.

———. 2000b. "Mute Those Claims: No Evidence (Yet) for a Causal Link Between Arts Study and Academic Achievement." *Journal of Aesthetic Education* 34:11–76.