Music-Based Mentoring and Academic Improvement in High-Poverty Elementary Schools

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Abstract

Recent research links disparities in children's language-related brain function to poverty and its correlates. Such disparities are hypothesized to underlie achievement gaps between students from low-income families and more advantaged peers. Interventions that improve language-related brain function in low-income students exist, but evaluations of their implementation within high-poverty elementary

schools do not. This comparison-group study evaluates whether implementation within high-poverty elementary schools of Harmony Project music-based mentoring, previously shown in randomized controlled research to improve language-related brain function and literacy in low-income students, might be associated with academic improvement for participants compared with non-participating peers. Standardized academic achievement scores were evaluated retrospectively for 2nd graders who opted into or out of Harmony Project (HP) at baseline (n_{HP} = 218; n_{non-HP} = 862) for weekly music-based mentoring over 2 years. Adjusting for baseline scores, HP participation was associated with higher standardized scores for math (+17 points; ß = .06, p = .02) and English language arts (+26 points; ß = .08, p = .002). Importantly, students with the lowest prior achievement scores showed the greatest gains for both math (+33 points; ß =.13, p =.02) and English language arts (+39 points; ß =.14, p =.02). Implementation within high-poverty elementary schools of a program previously found to improve language-related brain function in low-income students was associated with significant academic improvement for participants, particularly those with the lowest prior levels of achievement. Findings support the hypothesis that disparities in children's language-related brain function linked to poverty and its correlates may underlie achievement gaps.

Key Words: *achievement gap, after-school, cognitive development, mentoring, music training*

Introduction

An achievement gap between low-socioeconomic status (low-SES) students and their more advantaged peers has persisted for almost 50 years (Hanushek et al., 2019; Hoff, 2013; Horowitz & Samuels, 2017). Such longstanding disparities in academic achievement function as significant determinants of a student's opportunities throughout life, leading to inequities in health status (Evans & Kantrowitz, 2002) and in economic and political participation (Evans & Kantrowitz, 2002). SES is linked to brain structure (Johnson et al., 2016; Leijser et al., 2018), brain development (Johnson et al., 2016; Leijser et al., 2018), and brain function (Lawson et al., 2017) in otherwise healthy children. Language development (Fernald et al., 2013) and executive function (Lawson et al., 2017) vary by SES. Low-SES is also linked to maturational lag in neurological development (Leijser et al., 2018) that may interfere with early reading and numeracy in the elementary grades when such skills typically develop and form the basis for subsequent learning. Low-SES children often experience greater exposure to noise (Chang & Merzenich, 2003), to fewer words (Fernald et al., 2013; Hart & Risley, 1995), and to less language complexity than their higher SES peers (Bradley & Corwyn, 2002; Fernald et al., 2013; Hart & Risley, 1995). Together, these can contribute to delayed auditory neural development (Chang & Merzenich, 2003; Zhu et al., 2014). Successful language development requires the ability to accurately distinguish speech syllables and create strong sound–meaning connections (Benasich et al., 2014; Kraus & White-Schwoch, 2017; Skoe et al., 2013; Strait et al., 2015; Tallal & Gaab, 2006; White-Schwoch et al., 2015; Zhu et al., 2014). Music training strengthens the building blocks of auditory processing (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Kraus & White-Schwoch, 2017; Sala & Gobet, 2017; Slater et al., 2014; Slater et

al., 2015; Strait et al., 2015; Tallal & Gaab, 2006; Tierney et al., 2015). Evidence suggests that low-SES children may be particularly advantaged by music instruction combined with mentoring, which may help develop confidence and build more resilient, successful children (Deci & Ryan, 2012; Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Masten & Coatsworth, 1998; Slater et al., 2014; Slater et al., 2015; Stone et al., 1998), as early environments of low-SES children may lack emotional support (Evans & Kantrowitz, 2002) or cognitive enrichment necessary for optimal academic progress (Bradley & Corwyn, 2002; Chang & Merzenich, 2003; Evans & Kantrowitz, 2002; Fernald et al., 2013; Hart & Risley, 1995; Johnson et al., 2016; Lawson et al., 2017; Leijser et al., 2018).

Harmony Project (http://www.harmony-project.org), founded in 2001, is a multi-year music-based mentoring program that promotes positive development of children from low-income families. Harmony Project is based on self-determination theory (Deci & Ryan, 2012) that posits that children's social, emotional, and cognitive development and well-being are contingent on having their underlying needs met. As implemented within Long Beach Unified School District (LBUSD), HP also reflects factors linked to pro-social impact in arts programs (Stone et al., 1998), as well as public health principles that suggest that effective interventions that engage children at critical points in a child's life-cycle—in this case in early elementary school—can have positive and lasting benefits for cognitive and social development and improve resiliency, academic success, and overall well-being (Evans & Kantrowitz, 2002; Masten & Coatsworth, 1998; Sala & Gobet, 2017; Tierney et al., 2015). Further, LBUSD HP reflects an effective application of general systems theory and social science research linking positive parental involvement to improved resiliency and academic success in children, as young people are affected by surrounding systems and the way those systems interact (Masten & Coatsworth, 1998; Pianta & Walsh, 2014). LBUSD HP also employs each of the *sequenced*, *active*, *focused*, and *explicit* (SAFE) elements that Durlak and colleagues identified in after-school programs associated with positive academic or behavioral outcomes (2010). Within HP, low-SES students receive music-based mentoring after school at least 4 hours per week, from early childhood through Grade 12 (Harmony Project, n.d.) . This well-established, national, award-winning program has been successfully replicated across multiple states (Harmony Project, 2020).

The city of Long Beach, California adopted HP in 2014 as a "Safe Schools Initiative" within the city's violence prevention plan through the advocacy of the city's then chief of police, Jim McDonnell. McDonnell believed that children who learn to make music together over multiple years might be less likely to harm one another later in life (J. McDonnell, personal communication, November 2014). HP launched in Long Beach in 2015/16 as an after-school

program in high-poverty Long Beach elementary schools located in neighborhoods selected by Chief McDonnell for their elevated level of violent crime—and in which the vast majority of students were qualified for federal meal subsidy due to low family income, and nearly half were English Language Learners.

HP adoption within LBUSD was informed by a prior randomized controlled trial (RCT) that found that brain functions linked to language development and literacy improved significantly in low-SES elementary school-age students who participated in HP, but did not improve in controls (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Slater et al., 2015; Slater et al., 2014). Slater and colleagues (2015) found significant improvement in "hearing in noise" among low-SES HP students who participated in the RCT, but no such improvements were seen in controls. Prior research showed that indicators of brain function involving "hearing in noise" reliably predicted future reading ability in preschool-age children (White-Schwoch et al., 2015). Kraus and colleagues also found that 2 years of HP participation improved neuroplasticity and language development in low-SES 6- to 9-year-olds but found no such improvement among children in control groups (Kraus, Hornickel, et al., 2014).

This study seeks to determine whether a program of after-school music-based mentoring (HP), previously found to improve brain functions linked to language development and literacy in low-SES students (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Slater et al., 2014: Slater et al, 2015; Slater et al., 2014), might be linked to improved academic achievement for low-SES elementary-age students when the *same program* is implemented within multiple high-poverty elementary schools by a large urban school district.

Method

This retrospective comparison-group implementation study includes HP and non-HP elementary school participants. LBUSD HP staff delivered music-based mentoring to students 4 hours per week after school hours on five LBUSD elementary school campuses in low-income Long Beach neighborhoods between 2015 and 2019. Measures of interest include student assessment ratings, standardized assessment scores and program monitoring data to assess student engagement. HP attendance data were collected by LBUSD HP staff and provided to LBUSD Office of Research and School Improvement (ORSI). Student demographic data, general school attendance, assessment ratings, and standardized assessment scores for HP and non-HP students were collected by ORSI as a routine school-based function.

The retrospective, de-identified student data analyzed for this study were provided directly to third-party data analysts at the University of Vermont College of Medicine by Drs. Christopher Lund and Jodi G. Fender, and their staff at the Long Beach Unified School District Office of Research and School Improvement. These data were provided in a manner that ensured the security and privacy of the data were maintained at all times.

Participants

Study participants included 1080 second-grade students across five LBUSD schools. Students in second grade were recruited into HP at five participating elementary schools on an opt-in basis from 2015/16 to 2017/18, and every student who wanted to enroll in HP was permitted to do so. Of this sample, 218 (20.2%) enrolled in the free HP at the beginning of second grade between 2016 and 2018. Within the HP group, 16.3% enrolled in 2016, 36.8% enrolled in 2017, and 46.9% enrolled in 2018. The remaining 79.8% of the sample did not enroll in HP (i.e., the non-HP group).

Procedure

Parents attended mandatory initial orientations and signed a contract committing to their child's participation in HP. Students were offered their choice of string instruments (violin, viola, cello). Tuition-free lessons and rehearsals included one 1-hour after-school class per week on the selected instrument and one 3-hour ensemble rehearsal on Saturday mornings, starting in second grade, during which students worked with professional and near-peer mentors in large groups, small groups and one-on-one. Mentors included music-specialist teachers, professional musicians and accomplished high school and college student musicians. Parents attended frequent student performances. Students were loaned instruments to take home with them for daily practice. HP staff created a supportive family-like atmosphere, monitored student attendance and progress, maintained communication with parents and engaged in regularly scheduled professional development trainings. Program costs were covered by district-level funds (local, state, and federal Title I) available to most U.S. public schools.

To conduct data analysis for this study, LBUSD ORSI staff provided third-party data analysts at the University of Vermont with retrospective de-identified student data for both HP and non-HP students in the respective grade levels involved in all participating schools. Student data were provided in a manner that ensured that the privacy of individual students was secure at all times.

Measures

Achievement Ratings

Achievement Ratings in math, reading, writing, and speaking were collected at the end of the school year prior to HP enrollment, 1 year post enrollment, and 2 years post enrollment. Ratings were provided by and reflect the professional adjudication of classroom teachers and ranged from 1 to 4 (1 = *not met*, 2 = *nearly met*, 3 = *met*, 4 = *exceeded*). Teachers were not blinded to whether students participated in HP.

Standardized Assessments

Year-end assessments developed by Smarter Balanced Assessment Consortium (SBAC) were administered to all LBUSD students in Grades 3 through 8, as well as Grade 11. SBAC assessments align with Common Core state standards in math and English language arts/literacy (ELA) and assess progress toward career and college readiness (Smarter Balanced, n.d.). SBAC standard scores are continuous, ranging from approximately 2000 to 3000. California uses descriptive categories of not met, nearly met, met, and exceeded to label ranges of scores (see Table 1).

Students begin completing SBAC testing in third grade. Because our sample enrolled in HP in second grade, we were not able to assess SBAC scores at the end of the 1st year. Therefore, SBAC analyses were restricted to the subsample with 2-year follow-up data (e.g., enrolled fall 2016, SBAC scores from spring 2018).

General School Attendance

Baseline school attendance (prior to HP) differed slightly. Prior to HP, school attendance was 97.1% for students who subsequently enrolled in HP and 95.7% for students who did not enroll in HP. At the end of the 2-year period, general school attendance remained relatively unchanged for the two groups (97.0% for HP students and 95.4% for non-HP students). Importantly, HP school attendance declined slightly and did not increase disproportionately to non-HP school attendance over the 2-year period.

HP Attendance

HP student attendance was collected by LBUSD HP staff at each meeting and provided to LBUSD ORSI. In the 1-year sample, attendance ranged from 21% to 100% (*M* = 84.75%, *SD* = 15.32%), with 70.1% of students attending at least 80% of sessions. Retention measures showed that 66.9% of students who enrolled in a 1st year of HP also enrolled the following year. HP attrition almost exclusively involved families moving out of the district due to gentrification

of low-income Long Beach neighborhoods (R. P. Ashley, LBUSD Deputy Superintendent, personal communication, March 2019). In the 2-year sample, attendance ranged from 50.5% to 100% (M = 85.35%, SD = 12.35%), with 67.1% of students attending at least 80% of sessions.

Covariates

Gender, race and ethnicity, and school were provided by students and parents to LBUSD HP staff via HP enrollment forms and provided by HP staff to LBUSD ORSI. Free and reduced-price lunch (FRL) status, English language learner (ELL) status, and English fluency status were coded dichotomously (yes/no) and were collected by LBUSD ORSI the year before HP enrollment.

Statistical Analyses

Analyses of 1- and 2-year samples were completed using SPSS Version 26.

Achievement Ratings

Ordinal regression was used to identify independent variables that predicted achievement ratings (AR) 1 and 2 years after HP enrollment. The primary predictor was HP enrollment (yes/no) and covariates included gender, race and ethnicity, school, pre-enrollment FRL status, ELL status, and English fluency status. The influence of students' AR score in the same subject from the previous year was accounted for by entering the baseline AR score as another covariate. After obtaining regression coefficients, odds ratios were calculated, which represented the likelihood of HP students obtaining the highest AR (4) in comparison to non-HP students. It was hypothesized that HP enrollment would predict higher AR scores 1 and 2 years after enrollment.

SBAC Scores

Math scores ranged from 2227 to 2659, and English Language Arts (ELA) scores ranged from 2272 to 2663.

Table 1. SBAC Score Ranges per Descriptive Category for Third Grade

	Not met	Nearly met	Met	Exceeded
ELA	2114 – 2366	2367 – 2431	2432 – 2489	2490 – 2623
Math	2189 – 2380	2381 – 2435	2436 – 2500	2501 – 2621

Math and ELA scores were entered as dependent variables in separate multiple linear regressions with the same independent variables used in the ordinal regression, again with HP enrollment as the predictor of interest. When assessing SBAC math scores, math AR scores from the prior year were entered as an independent variable to account for baseline math competency prior to the HP enrollment period. When assessing SBAC ELA scores, reading and writing AR scores were included to account for ELA competency prior to HP enrollment. It was expected that Harmony enrollment would be associated with higher Math and ELA scores 2 years after enrollment.

Follow-up Analyses

Additional linear regressions were conducted to assess the association of HP enrollment with standardized SBAC scores in a subgroup of students (HP and non-HP) with baseline AR scores of 1 or 2 (i.e., not meeting academic expectations at the end of the year prior to initial HP enrollment). The low performing sample included 20 HP students and 307 non-HP students (low math performers) and 18 HP students and 282 non-HP students (low reading performers).

Results

Sample Description

Demographic profiles of HP and non-HP students are presented in Table 2 for 1-year analyses. Compared to non-HP students, HP students were more likely to be female, less likely to be English language learners, and had higher AR scores in math, reading, writing, and speaking the year prior to HP enrollment. HP students were distributed across schools differently from non-HP students. Groups did not differ significantly with regard to race and ethnicity and there was a trend (0.07) toward lower levels of FRL status in the HP group. Table 3 presents a subsample ($n = 930$) of students with data available for 2 years post-HP enrollment (HP $n = 68$, non-HP $n = 862$). In this 2-year sample, HP students were more likely to be female, less likely to receive FRL, and had higher pre-enrollment math and reading AR scores than non-HP students. Groups did not differ in regard to race and ethnicity, English fluency, English language learner status, and AR scores for writing and speaking.

Table 2. Demographic and Academic Characteristics of Harmony and Non-Harmony Students for 1-Year Analyses

	Harmony	Non-Harmony	Comparison
N	218	862	
Female (%)	66.1	46.5	$\chi^2 (1) = 26.56, p < .001$
School (%)			$\chi^2 (4) = 12.67, p = .013$
403	16.1	9.0	
410	21.6	23.9	
424	18.8	15.2	
432	19.7	25.2	
448	23.9	26.7	
Race and ethnicity (%)			$\chi^2 (7) = 12.88, p = .075$
Asian	5.8	5.6	
African American	7.5	13.2	
Filipino	1.7	2.8	
Hispanic	76.7	73.1	
Native American	0.0	0.1	
Pacific Islander	0.0	1.5	
White	1.7	1.4	
Multi-racial	6.7	2.2	
English fluency (%)			$\chi^2 (3) = .28, p = .964$
English language learner	22.4	39.6	
English only	25.3	43.8	
FEP [a]	0.4	1.2	
GEP [b]	1.2	2.0	
Missing	50.6	13.4	
ELL (%)	25.2	45.7	$\chi^2 (1) = 30.04, p < .001$
FRL (%)	73.3	80.6	$\chi^2 (1) = 3.33, p = .068$
Achievement ratings	*M* (*SD*)	*M* (*SD*)	
Math	2.98 (.86)	2.67 (.94)	$t(356) = 4.53, p < .001$
Reading	3.06 (.79)	2.80 (.89)	$t(366) = 4.17, p < .001$
Writing	2.78 (.80)	2.59 (.88)	$t(358) = 2.89, p = .004$
Speaking	3.03 (.74)	2.80 (.84)	$t(370) = 4.03, p < .001$

Note. Analyses compared data obtained in the spring prior to enrollment period with data obtained 1 year after enrollment period.

[a] FEP = Redesignated fluent English proficient. [b] GEP = Initial fluent English proficient.

Table 3. Demographic and Academic Characteristics of Harmony and Non-Harmony Students for 2-Year Analyses

	Harmony	Non-Harmony	Comparison
N	68	862	
Female (%)	61.8	46.5	$\chi^2 (1) = 5.87, p = .015$
School (%)			$\chi^2 (4) = 22.87, p < .001$
403	22.1	9.0	
410	17.6	23.9	
424	27.9	15.2	
432	14.7	25.2	
448	17.6	26.7	
Race and ethnicity (%)			$\chi^2 (7) = 9.37, p = .234$
Asian	7.4	5.6	
African American	10.3	13.2	
Filipino	2.9	2.8	
Hispanic	69.1	73.1	
Native American	0.0	0.1	
Pacific Islander	0.0	1.5	
White	2.9	1.4	
Multi-racial	7.4	2.2	
English fluency (%)			$\chi^2 (3) = .11, p = .991$
English language learner	45.6	45.7	
English only	50.0	50.6	
FEP [a]	1.5	1.4	
GEP [b]	2.9	2.3	
ELL (%)	45.6	45.7	$\chi^2 (1) = .00, p = .985$
FRL (%)	69.2	80.6	$\chi^2 (1) = 4.79, p = .029$
Achievement rating (M(SD))			
Math	2.97 (.80)	2.67 (.94)	$t(81) = 2.90, p = .005$
Reading	3.03 (.84)	2.80 (.89)	$t(847) = 2.04, p = .042$
Writing	2.79 (.81)	2.59 (.88)	$t(845) = 1.73, p = .084$
Speaking	2.95 (.77)	2.80 (.84)	$t(78) = 1.60, p = .114$

Note. Analyses compared data obtained in the spring prior to enrollment period with data obtained 2 years after enrollment period.

[a] FEP = Redesignated fluent English proficient. [b] GEP = Initial fluent English proficient.

Achievement Ratings

In the 1-year sample, HP enrollment was associated with significantly increased odds of receiving the highest AR score in subjects of math, reading, and writing, even when accounting for the AR score in a given subject the year prior to the HP enrollment period (Table 4). In the 2-year sample, HP enrollment was associated with significantly increased odds of receiving the highest AR score in subjects of writing and speaking, again while including prior year's AR score as a covariate (also in Table 4).

Table 4. Achievement Rating Outcomes of 1-Year and 2-Year Samples of Harmony and Non-Harmony Students.

	1-Year				2-Year			
	OR	95% CI	Highest AR (%)		OR	95% CI	Highest AR (%)	
			HP	Non-HP			HP	Non-HP
Math AR	2.05**	[1.33, 3.14]	56.2	38.6	1.26	[0.76, 2.11]	33.8	25.2
Reading AR	1.64*	[1.10, 2.44]	27.4	21.7	1.06	[0.65, 1.74]	26.5	16.6
Writing AR	1.79**	[1.20, 2.66]	9.7	8.3	1.80*	[1.08, 3.00]	13.2	10.0
Speaking AR	1.36	[0.92, 2.03]	25.3	19.9	2.56**	[1.50, 4.38]	36.8	15.3

Note. OR = odds ratio, CI = confidence interval, AR = achievement rating

* $p < .05$. ** $p < .01$

Standardized Assessments

Models were estimated to test the association between HP enrollment and standardized test scores two years later. For math standardized scores (Table 5), the regression model explained a significant proportion of the variance ($R^2 = .40$, $F(8, 805) = 66.54$, $p < .001$). HP enrollment was associated with significantly higher math standardized scores (17 points higher, on average) in the 2nd year following HP enrollment, even when accounting for math AR scores from the spring prior to the enrollment period (HP $M = 2.97$, $SD = .80$; non-HP $M = 2.67$, $SD = .94$). Pre-enrollment math AR score was the strongest predictor of math standardized scores, suggesting it is an adequate proxy of baseline ability in the absence of SBAC scores prior to enrollment. For ELA standardized scores (Table 6), the regression model explained a significant proportion of the variance ($R^2 = .46$, $F(9,806) = 75.05$, $p < .001$). HP enrollment was associated with higher ELA standardized scores (26 points higher, on average), even when accounting for pre-enrollment reading AR scores (HP $M = 3.03$, $SD = .84$; non-HP $M = 2.80$, $SD = .89$) and writing AR scores (HP $M = 2.79$, $SD = .81$; non-HP $M = 2.59$, $SD = .88$) compared with the scores of non-HP students. Pre-enrollment reading and writing AR scores were the strongest predictors of ELA standardized scores.

Table 5. Regression Coefficients of Model Predicting Math SBAC Scores 2 Years After Harmony Enrollment Period

Predictor	B	95% CI	SE	ß	t	p
Harmony	17.56	[2.33, 32.79]	7.76	0.06	2.26	.024
School	-0.01	[-0.27, 0.25]	0.13	-0.00	-0.09	.930
Gender	0.04	[-8.19, 8.27]	4.19	0.00	0.01	.993
Race/ethnicity	-0.43	[-3.92, 3.06]	1.78	-0.01	-0.24	.808
FRL	-15.55	[-25.92, -5.17]	5.28	-0.08	-2.94	.003
Fluency	8.71	[-4.43, 21.86]	6.70	0.07	1.30	.194
ELL	1.50	[-15.35, 18.34]	8.58	0.01	0.17	.862
Math AR	49.89	[45.43, 54.36]	2.27	0.61	21.94	< .001

Table 6. Regression Coefficients of Model Predicting ELA SBAC Scores 2 Years After Harmony Enrollment Period

Predictor	B	95% CI	SE	ß	t	p
Harmony	26.13	[9.25, 43.00]	8.60	0.08	3.04	.002
School	0.62	[0.33, 0.91]	.15	0.11	4.16	.000
Gender	-10.36	[-19.54, -1.17]	4.68	-0.06	-2.21	.027
Race/Ethnicity	3.70	[-0.18, 7.59]	1.98	0.05	1.87	.061
FRL	-11.67	[-23.13, -0.29]	5.84	-0.05	-2.00	.046
Fluency	5.76	[-8.84, 20.35]	7.43	0.04	0.77	.439
ELL	-3.80	[-22.47, 14.87]	9.51	-0.02	-0.40	.690
Reading AR	44.32	[36.78, 51.86]	3.84	0.44	11.54	< .001
Writing AR	25.97	[18.36, 33.58]	3.88	0.25	6.70	< .001

Low Performing Students

Follow-up analyses were conducted in a sample of students who had received low ARs at baseline, the year prior to HP enrollment (low math performers: HP $n = 20$; non-HP $n = 307$; low reading performers: HP $n = 18$; non-HP $n = 282$). ARs were assigned by classroom teachers and low ARs were defined as scores of 1 or 2 that did not meet expectations (1 = *not met*, 2 = *nearly met*, 3 = *met*, 4 = *exceeded*). The overall regression models were significant for both math standardized scores ($R^2 = .17$, $F(8, 296) = 7.55$, $p < .001$) and ELA standardized scores ($R^2 = .15$, $F(9.265) = 5.30$, $p < .001$). For students with the lowest ARs prior to enrolling in HP, HP participation was associated with significantly higher Math standardized scores (33 points higher; ß = .13, $p = .02$) and with significantly higher ELA standardized scores (39 points

higher; β = .14, p = .02) than were seen in non-HP students with the lowest ARs at baseline. Amongst low math performers, no significant differences were seen at baseline between HP and non-HP students with respect to race, ethnicity, gender, English fluency, English language learner status, English-only status, or free and reduced lunch status (an indicator of low family income). Amongst low reading performers, no significant differences were seen at baseline between HP and non-HP students with respect to gender, English fluency, English language learner status, English-only status, or free and reduced-price lunch status. However, the low-performing reading groups did reflect significant racial and ethnic differences ($\chi2$ (7) = 32.85, p < .001): Low-performing readers in the HP group were more likely than those in the non-HP group to be Asian (HP = 16.7%, non-HP = 3.6%), White (HP = 5.6%, non-HP = 1.1%) or Multi-racial (HP = 16.7%, non-HP = 1.1%) and less likely to be African American (HP = 0.0%, non-HP = 11.9%), Filipino (HP = 0.0%, non-HP = 1.1%), Hispanic (HP = 61.1%, non-HP = 78.4%), Native American (HP = 0.0%, non-HP = 0.4%) or Pacific Islander (HP = 0.0%, non-HP = 2.5%). Further analysis of these differences was not possible due to the small sample sizes.

Discussion

In this retrospective comparison-group implementation study of Harmony Project music-based mentoring within high-poverty LBUSD elementary schools, using baseline educational records to account for levels of academic achievement prior to enrollment in HP, it was shown that after 1 year of HP engagement, participants displayed higher levels of math, reading, and writing achievement scores than non-HP students. After 2 years, participants displayed modestly higher levels of standardized test scores in reading and math, even when accounting for pre-HP achievement scores. Importantly, these associations were strongest for standardized test scores in reading and math of HP students who had the lowest achievement scores prior to program enrollment; such gains were not seen in low-achieving non-HP students.

After 1 year, HP students were somewhat more likely to achieve top scores in speaking than non-HP students (25.3% vs. 19.9%). After 2 years the percentage of students achieving top scores in speaking climbed for HP students but fell for non-HP students (36.8% vs. 15.3% p=.01). This observation is meaningful, as speaking ability is critical to student agency, resilience, and success (Deci & Ryan, 2012). HP students practiced expressing themselves after school (through music) at least 4 hours per week, which may have contributed to improvement seen in speaking for HP students versus the decline in speaking observed for non-HP students.

While research has shown that disparities in language-related brain function linked to poverty and its correlates may underlie the persistent achievement gap between low-SES children and

their more advantaged peers (Chang & Merzenich, 2003; Evans & Kantrowitz, 2002; Fernald et al., 2013; Johnson et al., 2016; Lawson et al., 2017; Leijser et al., 2018; Zhu et al., 2014), programs that enable low-SES students to improve their own language-related brain function (and academic achievement) have been developed (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Kraus & White-Schwoch, 2017; Slater et al., 2014, 2015), but have yet to be broadly implemented throughout the nation's underperforming schools. Implementing brain-changing interventions within high-poverty schools may help close the achievement gap by enabling low-SES students to overcome potential disparities in language-related brain function that could serve as barriers to learning. This hypothesis is supported by the findings of this study.

The findings of this study were consistent with prior research involving the National Educational Longitudinal Survey (NELS:88) that followed 25,000 students over 10 years in which Catterall and colleagues (1999) found that twice as many low-SES eighth graders with a high level of instrumental music participation scored at the highest levels in mathematics than low-SES eighth graders with no-music participation (21.2% vs. 10.7%). By 12th grade this NELS:88 gap favoring low-SES, high-music students had grown (33.0% vs. 15.5%). Accelerating gains in math achievement for low-SES, high-music students may reflect a positive "dose response" related to *duration of music training,* as the benefits of music training on brain function build over time (Benasich et al., 2014; Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Kraus & White-Schwoch, 2017; Sala & Gobet, 2017; Slater et al., 2015; Slater et al., 2014; Strait et al., 2015; Tallal & Gaab, 2006; Tierney et al., 2015).

These findings are also consistent with those of a meta-analysis of evaluations involving 68 after-school programs designed to promote personal and social benefits for students conducted by Durlak and colleagues (2010), in which positive behavioral or academic outcomes were seen *only* in after-school programs that were *sequenced* (used a step-by-step training approach), *active* (emphasized active forms of learning), *focused* (time was spent on specific skills training), and *explicit* (clear learning outcomes were identified), which the researchers referred to by the acronym SAFE. HP's multi-year program of music-based mentoring fits neatly within the SAFE framework for after-school programs developed by Durlak and colleagues (2010). However, fewer than half of the 68 after-school program evaluations Durlak and colleagues (2010) analyzed involved elementary school-age students, and inconsistent or absent demographic data limit the applicability of their findings to after-school programs for low-SES students who attend high-poverty elementary schools. Mentoring is included within HP to promote social and emotional development (Deci & Ryan, 2012; Masten & Coatsworth, 1998;

Stone et al., 1998), student resilience and well-being (Deci & Ryan, 2012; Masten & Coatsworth, 1998; Stone et al., 1998), pro-social behavior (Deci & Ryan, 2012; Masten & Coatsworth, 1998; Stone et al., 1998), and to utilize the intrinsic rewards of social connection and parental involvement (Deci & Ryan, 2012; Masten & Coatsworth, 1998; Stone et al., 1998) to engage students in HP over multiple years so as to maximize the program's developmental benefits.

A large federally funded evaluation of 21st Century Community Learning Center (21 CCLC) after-school programs specifically developed to help close the achievement gap for low-SES elementary-age students found *no improvement in reading or math achievement scores for participating students* (James-Burdumy et al., 2005). Meanwhile, rates of reading proficiency have remained below 40% for U.S. fourth graders (as well as for U.S. eighth and twelfth graders) for decades, and non-proficient readers primarily involve low-SES students (Hanushek et al., 2019; Hoff, 2013; Horowitz & Samuels, 2017).

The importance of *fourth grade reading proficiency* to an individual's future education, earnings and health was underscored when this metric (fourth-grade reading proficiency) was included as one of 23 leading health indicators within *Healthy People 2030*, health objectives for the nation developed for the U.S. Department of Health and Human Services by the Centers for Disease Control and Prevention (Healthy People 2030, n.d.). Within this context, the positive academic outcomes associated with HP within multiple high-poverty LBUSD elementary schools, *especially for students with the lowest prior levels of academic achievement*, show particular promise. HP music-based mentoring is a positive brain-changing program (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Slater et al., 2014, 2015) that can be broadly implemented within high-poverty schools, as the present study demonstrates. The success of HP within LBUSD prompted the district to extend HP to four additional campuses by the 2019/20 school year at the district's cost, which will provide data for future evaluations. HP represents a successful and potentially game-changing approach to improving academic achievement for students attending high-poverty elementary schools. LBUSD covers the cost of implementing HP within multiple high-poverty schools with existing district-level state and federal funds that may be available to other school districts in the country.

Limitations

Despite the pressing need for an effective approach to improving reading proficiency for U.S. fourth graders, this study has clear limitations, and findings should be interpreted with caution. Students *chose* to enroll in HP. Student and family characteristics that led them to select HP

may also lead to greater student and family resilience and thereby benefit academic progress. Whereas supervised after-school programming (10+ hours per week of physical activity, academic support, enrichment activities, and snacks) was available to non-HP students at each participating school, resources did not permit evaluation of the impact of HP participation relative to other after-school programming. Importantly, we were able to account for academic achievement prior to enrollment in HP, which may be a proxy for family educational investment, but in-depth information about families was not available. Achievement ratings were provided by classroom teachers and were collected at the end of the school year prior to HP enrollment, 1 year post HP enrollment and 2 years post HP enrollment. As classroom teachers were not blinded to whether or not students participated in HP, achievement ratings for 1 year and 2 years post HP enrollment were subject to potential teacher bias. Students' standardized test scores, however, were not subject to teacher bias. Since standardized test scores for HP students who had the lowest achievement ratings in reading and math *prior* to enrolling in HP showed the greatest gains compared with standardized test scores of low-performing non-HP students, teacher bias is not implicated in findings for these groups of students. Therefore, it is hypothesized that program participation, rather than other variables, may have played a role in improving reading and math achievement for HP students with the lowest reading and math achievement ratings prior to enrolling in HP by improving participating students' language-related brain functions linked to literacy, an outcome associated with engagement over time in music-based mentoring (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Slater et al., 2014, 2015). Whereas HP participation within high-poverty LBUSD elementary schools was associated with academic improvement, causation cannot be inferred due to the above limitations.

The study data do not allow us to test which aspects of music training or mentoring were most beneficial for academic outcomes. Participation may be beneficial because of increased attention and support from program leaders, mentors and parents, the discipline and sense of mastery that come from learning a new skill, peer support, or a specific benefit of music training itself, such as the positive impact of music training on language-related brain function. This study provides a promising approach for additional research that includes participant randomization, child and family assessments prior to enrolling, qualitative assessments of music teaching, and careful follow-up with a range of measures to clarify the mechanisms contributing to positive outcomes. Finally, this study looked only at academic progress, but development of non-cognitive skills, including social-emotional learning, has been strongly linked to participation in music training and mentoring (Heckman et al., 2006; Kraus & White-Schwoch, 2017; Sala & Gobet, 2017).

Implications for Future Research

Despite its limitations, this study builds an important implementation pathway for high-poverty schools amid growing evidence linking low-SES and its correlates to disparities in children's language-related brain development and function (Evans & Kantrowitz, 2002; Fernald et al., 2013; Johnson et al., 2016; Lawson et al., 2017; Leijser et al., 2018). This preliminary pathway may yet become a superhighway by inspiring additional research into the link between disparities in language-related brain function and academic achievement within school-age children, the distribution of such disparities relative to SES and the development of additional effective interventions that schools can implement to help level the cognitive playing field, and enable most, if not all, U.S. children to become proficient readers.

This study joins growing evidence linking music training to positive academic outcomes and skills that contribute to improved memory and phonological processing (Kraus, Hornickel, et al., 2014; Kraus, Slater, et al., 2014a, 2014b; Kraus & White-Schwoch, 2017; Slater et al., 2014, 2015). Focus should now become *who* is most likely to benefit from music training and *when*. This study supports a benefit for combining music instruction with mentoring for low-SES children throughout the first years of formal schooling.

Harmony Project music-based mentoring, as implemented by Long Beach Unified School District, provides a template that other school systems can follow to improve student achievement within high-poverty schools. It will be important to assess whether similar benefits are observed in other schools and for children at different ages. Such advantages, if replicated, would offer an effective strategy for addressing the underlying neurological foundation for gaps in achievement involving children from low-SES families that appear early (Evans & Kantrowitz, 2002; Fernald et al., 2013), persist long term (Bradley & Corwyn, 2002; Chang & Merzenich, 2003; Evans & Kantrowitz, 2002; Fernald et al., 2013; Johnson et al., 2016; Lawson et al., 2017; Leijser et al., 2017), and serve as determinants of inequity in health status (Evans & Kantrowitz, 2002) and in future economic (Evans & Kantrowitz, 2002) and political participation (Evans & Kantrowitz, 2002). Involvement in programs like Harmony may have additional advantages not easily captured by standardized achievement scores including the improved resilience, well-being, and pro-social behavior that HP seeks to develop via long-term engagement, skill mastery, and social support. Coupling such social and emotional benefits with improved academic functioning presents the best opportunity for lasting change and life success.

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