

Associations between extracurricular arts activities, school-based arts engagement, and subsequent externalising behaviours: Findings from the Early Childhood Longitudinal Study

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Abstract

Introduction: Externalising behaviours during adolescence are associated with numerous long-term negative outcomes, although the majority of research is intervention-based as opposed to focused on risk reduction. Arts engagement has been associated with numerous beneficial factors linked to externalising behaviours, yet direct evidence linking them in longitudinal studies is lacking.

Methods: Data from the Early Childhood Longitudinal Study were used, with baseline taken at 5th grade (aged 10-11 years) and outcomes measured at 8th grade (13-14 years). Ordinary least squares regression was used to examine individual-level associations between extracurricular and school-based arts engagement (number arts classes and adequacy of arts facilities) with externalising behaviours measured using the Strengths and Difficulties Questionnaire. Poisson regression was used to examine associations between school-level arts classes and facilities with an administrator-reported index of externalising behaviours in the school. All models were adjusted for sociodemographic factors. Individual-level analyses were clustered by school.

Results: At the individual level, engaging in a greater number of extracurricular arts activities in 5th grade was associated with fewer externalising behaviours in 8th grade, although there was no association for school-based arts engagement. There were no school-level associations between arts classes or adequate arts facilities and externalising behaviours.

Conclusions: Our results suggest extracurricular arts activities may be beneficial in reducing the risk for externalising behaviours, but the relationship is seen at an individual-level of engagement rather than based on school-level provision or facilities. Ensuring extracurricular access to the arts should be considered as a cost-effective way of preventing externalising behaviours while simultaneously promoting healthy emotional, coping, and social behaviours.

Keywords: Longitudinal data, childhood, arts, school, externalising behaviours

Implications and Contribution summary statement.

Findings indicated that participating in a higher number of extracurricular arts activities was associated with reduced risk of externalising behaviours. However, no associations between school-based arts activities and externalising behaviours were found. This suggests that extracurricular access to the arts could help to reduce externalising behaviours while also promoting healthy psychological and social behaviours.

Introduction

Externalising behaviours such as conduct problems and hyperactivity/inattention are common during adolescence. Adolescents aged 13-18 have a 4% lifetime prevalence of Attention Deficit Hyperactivity Disorder (ADHD), and 6% lifetime prevalence of conduct disorder¹. Externalising behaviours are associated with a number of long-term negative outcomes at the individual level including leaving school without qualifications², more severe symptoms of depression and anxiety in middle age³, lower rates of workforce participation in adulthood⁴, adult criminality³, substance use disorders², and increased mortality rates⁵. In addition to the individual-level impacts of externalising behaviours, these behaviours may also influence others within the school environment. Those experiencing peer victimisation in adolescence also experience poor health, social, and economic outcomes in adulthood⁶. While schools are intended to be a safe-space for students, nationally representative data in the US indicate that nearly 1 in 5 high school students have been bullied on school property, 8% have been in a physical fight, and 7% threatened or injured with a weapon, while 9% stayed home from school because they had not felt safe in the past year⁷.

The vast majority of the literature on predictors of externalising behaviours has focused on risk factors. Pre-natal influences (e.g. maternal smoking), negative family environment, and genetics have all been found to increase the risk of externalising behaviors⁸. Aspects of the school environment such as class size, socioeconomic area⁹, and negative teacher-child relationships¹⁰ may also contribute to the initiation or exacerbation of externalising behaviours. A number of personal characteristics underly externalising behaviours including deficits in reward function⁸, negative self-esteem¹¹, poor coping skills¹², impulsivity¹³, and emotion dysregulation¹⁴. Although there are a number of risk reduction factors such as social competence¹⁵, resilience¹ and adaptive emotional regulation strategies^{17,18} associated with externalising behaviours, less research has focused on these areas. One group of activities known to be associated with each of these protective factors is arts engagement¹⁹.

Engagement with the arts¹⁹. Arts engagement is known to be associated with a number of beneficial outcomes including increased social interaction and cohesion, provision of supportive coping skills, improved emotion regulation, and decreased mental distress¹⁹. Many of these beneficial outcomes are similar to the problems experienced by those with externalising disorders. Previous evidence suggests that art therapy (whereby arts activities are delivered by a trained therapist) can be used as an effective intervention for externalising behaviors²⁰. However, there is a lack of resources to provide therapy interventions to all those who could benefit from them²¹. Further, individuals who could benefit from these services are only identified if the problem behaviours are reported²¹. Due to these shortcomings, it is relevant to examine whether broader arts engagement could reduce the risk of externalising behaviours occurring in the first instance²¹. There is some evidence to suggest creativity and artistic ability are helpful in reducing the risk of externalising behaviors²²⁻²⁵, but the literature is limited. Therefore, more work is needed to identify whether arts engagement could be a positive strategy in preventing or reducing externalising behaviours during adolescence.

It is also relevant to explore whether engaging in the arts either as part of school curriculum or as an extracurricular activity has a bearing on any relationship with externalising behaviours. The current US education legislation, 2015 Obama era 'Every Student Succeeds Act' (ESSA), has reduced the previous strict federal oversight of education and increased local flexibility in use of funds²⁶. Consequently, the introduction of ESSA has provided more flexibility into the curriculum: arts and music may be included as part of a 'well-rounded education' in schools²⁷. But whether the arts are included varies substantially from school to school as well as by state and district²⁶. Therefore, some students have extensive arts available as a part of their curriculum, while others may have none²⁷. This inclusion of the arts within the curriculum is important as research has shown that when arts engagement is included as part of the curriculum, engagement patterns are equal demographically and socioeconomically amongst children²⁸. However, when children engage in the arts as part of extracurricular activities, arts engagement is socially and geographically patterned and linked with structural opportunities and barriers, with those from lower socioeconomic backgrounds less likely to engage with the arts²⁸. Whilst this research has come from outside the US, concerns about unequal access to extracurricular arts activities has been

voiced in the US too³⁰. Schools therefore have an important role in providing universal access to the arts. But whether there are differential associations between engagement as part of school curriculum or as an extracurricular activity and externalising behaviours is important to explore further.

Therefore, the current study uses a large nationally representative cohort of children progressing from kindergarten through to 8th grade in the US (the Early Childhood and Longitudinal Programme [ECLS]) to explore whether extracurricular and school-based arts engagement are associated with externalising behaviours in adolescence. We examined individual-level associations between extracurricular art activities and school-based arts availability with parent reported externalising behaviours, as well as school-level associations between adequacy of arts facilities and administrator-reports of externalising behaviours. We hypothesised that increased arts engagement in 5th grade would be associated with reduced likelihood of externalising behaviours in 8th grade at both individual and school level.

Methods

Participants

Participants were drawn from the Early Childhood and Longitudinal Programme (ECLS)³¹, a nationally representative study of children, their parents, teachers, and school administrators from kindergarten (1998-1999) through the end of middle school (8th grade; 2007) in the United States. Data were collected on the children's cognitive, social, emotional, and physical development as well as the home environment, home educational activities, school environment, classroom environment, classroom curriculum, and teacher qualifications³¹.

For the individual-level analyses, we restricted our sample to participants with non-missing data on outcome variables in 8th grade. A total of 8,610 parents participated in the 8th grade wave and, of these, 8,586 had non-missing data on our outcome measures (see Supplementary Tables S1 for details on pattern of missingness in study variables).

The sample for school-level analyses was restricted to schools with non-missing outcome variables in 8th grade. A total of 537 schools were included in the 8th grade wave, and of these, 296 had non-missing data on our outcome measures (see Supplementary Table S2 for pattern of missingness in study variables).

Outcome variables

At the individual level, externalising behaviours were measured by parental report of the Strengths and Difficulties Questionnaire (SDQ)³² when children were in 8th grade. The SDQ is a 25-item questionnaire measuring prosocial behaviour and psychopathology in children and young people between the ages of 3-17. It includes five subscales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour). Response options are 'not true', 'somewhat true', and 'certainly true'. We used the summed scores of the conduct problems and hyperactivity/inattention subscales to create a continuous score (0-20), with higher value indicating a higher number of externalising behaviors³².

School-level outcomes were collected in 8th grade from school administrator-reports of externalising behaviours. Administrators were asked to report the frequency of 6 externalising behaviours [class cutting, physical confrontations, theft, vandalism, bullying, and classroom disorder] occurring in the school, with responses of 'daily', 'once a week', 'once a month', 'occasionally', or 'never'. Responses were collapsed into 'once a month or more' vs 'less than monthly' and summed to make an externalising behaviours index (range 0-6).

Predictor variables

For individual-level analyses, the extracurricular arts activities variable was derived from parental reports of their children's extracurricular arts activities in 5th grade. Parents were asked: 'In the past year, has your child participated in [dance lessons, music lessons, art classes or lessons, organised performing art programmes]?', and were required to check either yes or no for each of the four activities.

Responses were then summed to create a continuous score (0-4) of the number of extracurricular arts activities the child had engaged in during the past year.

Two school-based arts engagement variables were examined in both the individual-level and school-level analyses.

First, the arts classes variable was derived from questions asked of each child's teacher (reading or mathematics teachers were assigned to complete the academic questions for each student): 'How often and how much time do children in your class work on lessons or projects in the following areas [music, musical instruments, art, or art materials]?' and 'How often do children in your class use computers for [music composition, art]?' Response choices were 'never', 'less than once a week', '1-2 times a week', '3-4 times a week', and 'daily'. Each response was dichotomised to indicate 'less than once a week or never' vs '1-2 times a week or more' and summed to create the total number of arts classes offered at least weekly (0-5). There were slight differences in the consistency of teacher responses within schools to these questions, therefore we randomly selected one teacher from each school (either a reading or mathematics/science teacher) and used their responses in the analysis.

Second, adequacy of arts facilities was derived from school administrator responses to 'How adequate is each of the following school facilities [art room, music room, auditorium]?', with response choices of 'do not have', 'never adequate', 'often not adequate', 'sometimes not adequate', and 'always adequate'. Responses were collapsed into 'do not have or inadequate' vs 'adequate' and summed to create a score of the number of arts facilities that were adequate (0-3).

Covariates

We included a range of sociodemographic factors and other covariates. These categorisations were largely defined by the original survey and recategorizations were only conducted when necessary due to small sample sizes.

The individual-level covariates were: (1) gender (male vs female), (2) first-language (English vs Non-English) (3) ethnicity (White [Non-Hispanic] vs Black or African American [Non-Hispanic] vs Hispanic [specified and unspecified] vs other ethnicity [including Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaska Native, More than one race [Non-Hispanic]), (4) parental education indicating highest attainment of either parent (up to high school vs high school/vocational vs some college vs undergraduate vs postgraduate), (5) location (city vs suburb/large town vs small town/rural), (6) family structure (married vs unmarried [separated/divorced/widowed] vs never married), (7) household income in the past year (quartiles), (8) family use of food stamps in past year (yes vs no), (9) student eligibility for reduced or free school meals (yes vs no),

The school-level covariates were: (1) type of school (private vs public), (2) percentage of students from ethnic minority groups (<10% vs 10-25% vs 25-50% vs 50-75% vs >75%), (3) overcrowding at the school (yes vs no), (4) school location (city vs large town vs rural), (5) location (city vs suburb/large town vs small town/rural), and (6) school area safety in 5th grade (a summed score of the number of issues reported as a problem by the school administrator in the school area: racial tensions, unkempt area [garbage, litter, or broken glass in the streets, sidewalks, or yards], substance use [selling, using, or excessive drinking in public], gangs, heavy traffic, violent crime [e.g., drive-by shootings], vacant houses/buildings, and crime in the neighbourhood).

Statistical analysis

Regression models were used to examine associations between extracurricular arts activities and school-based arts engagement in 5th grade with externalising behaviours in 8th grade. Ordinary least squares regression was used for the individual-level data. Individual-level analyses were weighted according to age, ethnicity, education, and state in the US population to account for unequal sampling and were clustered by school. Poisson regression was used to examine school-level data. All models were initially run unadjusted and then rerun adjusting for covariates. Multiple imputation by chained equations (MICE) was conducted to address missing data in predictors, resulting in 50 imputed datasets)

resulting in a final individual-level sample of 8,586 and school level-sample of 296. All analyses were performed using Stata 16³³.

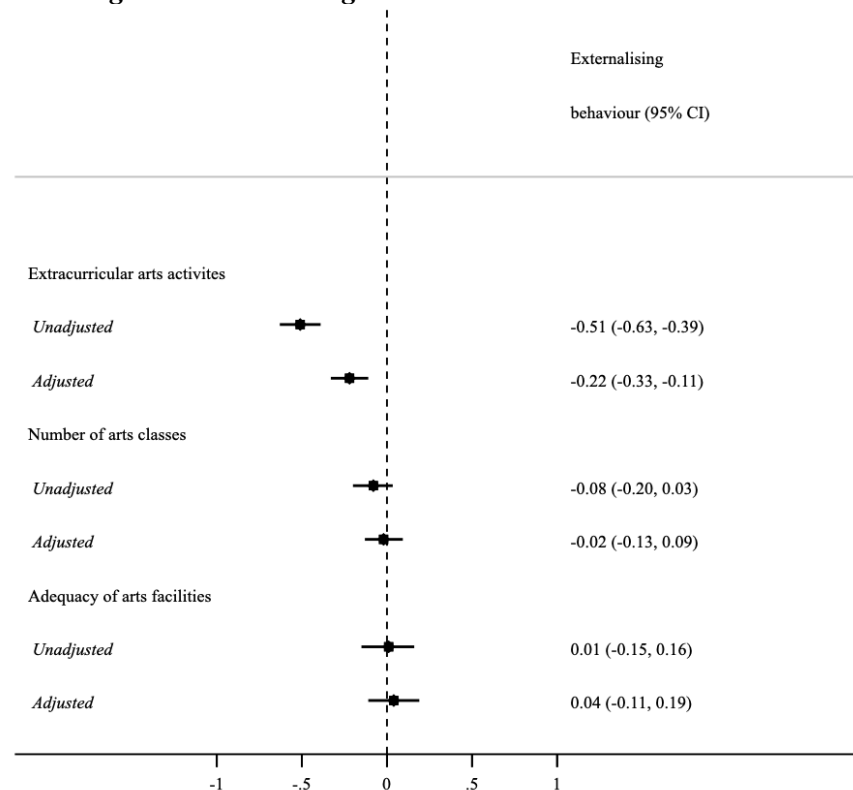
Results

Individual-level associations of 5th grade extracurricular arts activities and school-based arts engagement with 8th grade externalising behaviours

Of the 8,586 parents in the individual-level sample, their children had a mean age of 10.2 years (standard deviation [SD]=0.50) in 5th grade, and 13.3 years (SD= 0.5) in 8th grade. Just over half (53.0%) reported that students had not participated in any extracurricular arts activities in the past year in 5th grade, while 27.0% participated in 1 activity, 14.4% in 2 activities, 5.4% in 3 activities, and 1.0% in 4 activities. Schools offered a mean of 1.8 (SD=0.03) arts-based classes at least weekly (range 0-6) and had an average of 1.7 (SD=0.02) adequate arts facilities (range 0-3). Parents reported a mean of 3.7 (SD=0.6) externalising behaviours when children were in the 8th grade (see Supplementary Table S1 for more information).

In the unadjusted model, participation in a greater number of extracurricular arts activities in 5th grade was associated with decreased individual-level externalising behaviours in 8th grade (regression coefficient [coef.]=-0.51: 95% Confidence Interval [CI]=-0.63 to -0.39; Figure 1). This association was attenuated but remained significant in the adjusted model (coef. =-0.22: 95% CI=-0.33 to -0.10). Variables associated with the largest reductions in externalising behaviours were those related to socioeconomic status, particularly higher parental education, ethnicity (Hispanic), family receipt of food stamps and qualifying for free school meals. There were no associations in either the unadjusted or adjusted models of arts classes or adequacy of arts facilities in 5th grade with individual-level externalising behaviours in 8th grade (Full results available in Supplementary Table S3).

Figure 1. Individual-level associations of extracurricular and school-based arts engagement in 5th grade with externalising behaviours in 8th grade



Note: Extracurricular arts activities is a continuous score (0-4) of the number of extracurricular arts activities child had engaged in over the past 12 months. Number of arts classes variable is a continuous score of the number of arts classes offered 1-2 weekly or more (0-5). Adequacy of arts facilities is a continuous score (0-3). Outcome variable is continuous score (0-20) of SDQ externalising behaviours. AS= Asian, NH/OPI= Native Hawaiian or Other Pacific Islander, AI/AN= American Indian or Alaska Native. Dashes indicate reference category.

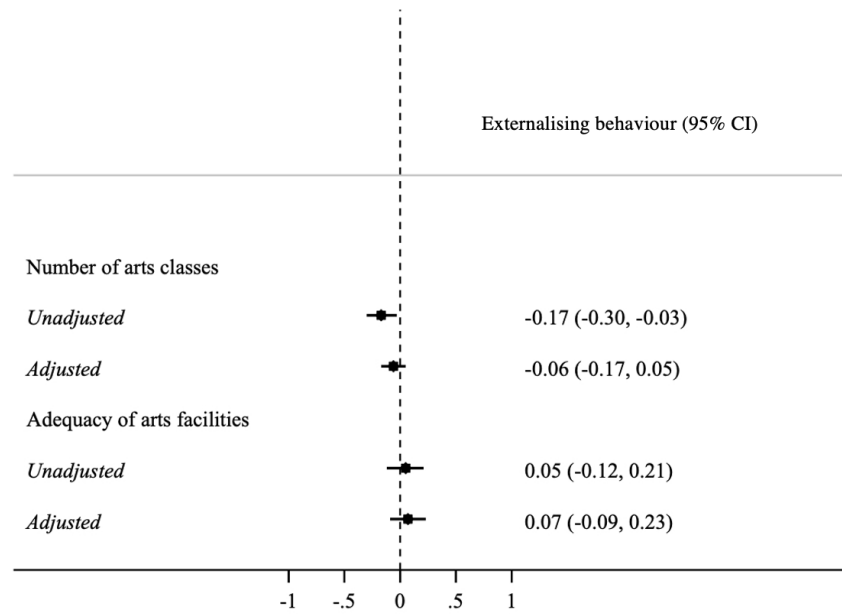
School-level associations of 5th grade school-based arts engagement with 8th grade externalising behaviours

Of the 296 schools included in the sample, teachers reported a mean of 2.16 (SD=0.8) arts classes per week (range 0-6) and 1.7 (SD=0.6) adequate arts facilities (range 0-3), while school administrators reported a mean of 0.9 (SD= 0.7) of externalising behaviours, (range 0-6) (see Supplementary Table 2 for more information).

In the unadjusted model, schools offering a greater number of weekly arts classes in 5th grade had fewer externalising behaviours in 8th grade (coef. =-0.17: 95% CI=-0.30 to -0.03; Figure 2). However, this association was attenuated after adjusting for sociodemographic factors. Public schools (coef. =0.89: 95% CI=0.55 to 1.24) and schools with at least half or more proportion of ethnic minority students (50-75% coef.=0.81: 95% CI= 0.20 to 1.43; >75% coef.=0.84: 95% CI=0.34 to 1.33) had more externalising behaviours.

There were no associations in either the unadjusted or adjusted models between adequacy of arts facilities in 5th grade with externalising behaviours in 8th grade (Figure 2; full results available in Supplementary Table 4). However, as with provision of arts classes, both public schools and schools with a larger proportion of ethnic minority students had more externalising behaviours.

Figure 2. School-level associations of arts classes and adequate arts facilities in 5th grade with externalising behaviours in 8th grade



Note: . Number of arts classes variable is a continuous score of the number of arts classes offered 1-2 weekly or more (0-5). Adequacy of arts facilities is a continuous score (0-3). Outcome variable is a continuous index of the number of externalising behaviours (0-7) in the school. Dashes indicate reference category.

Discussion

This study examined whether extracurricular arts activities and school-based arts engagement in 5th grade were associated with reduced risk of externalising behaviours in 8th grade in a sample of US children and schools. In the individual-level analyses, we found that extracurricular arts activities in 5th grade (e.g., dance, music, or arts lessons or performing arts programs) were associated with decreased externalising behaviours reported by parents in 8th grade. We did not, however, find evidence of an association between school-based arts classes or adequacy of school arts facilities and later individual-level externalising behaviours. In our school-level analyses, more weekly arts classes were associated with decreased school administrator-reported externalising behaviours in 8th grade, although this association attenuated following adjustment for sociodemographic factors relating to the schools. There was no evidence of an association of adequacy of arts facilities with school-level externalising behaviours.

There has been little research into the use of arts as a risk-reduction strategy for externalising behaviours (as opposed to as an intervention). Our findings that extracurricular arts activities are associated with reduced externalising behaviours align with the little longitudinal evidence available in this area and further supports the theory that arts may be an effective risk reduction strategy^{22,23}. There are numerous well known benefits of arts engagement that may aid in the reduction of externalising behaviours, which can occur on the individual, group, and/or societal level³⁴. Improved emotion regulation and provision of supportive coping skills through art¹⁹ may help offset emotion dysregulation¹⁴ and negative behaviours such as aggression and impulsivity³. Skill development can lead to feelings of accomplishment subsequently improving in self-esteem and self-worth³⁵. Further, social interaction and cohesion in art activities may be beneficial in increasing social competence¹⁹ and reducing antisocial and disruptive behavior⁸.

However, it was somewhat unexpected that there was no evidence of an association between the school-based arts variables and externalising behaviours. Although previous longitudinal research in this area has also been conducted inside schools, it examined teacher rated creativity using free-writing, storytelling, handwork, painting, drawing, and drama²². This may suggest that it is the level of engagement a child has with the arts (i.e., actively creating or skill development) that may be driving the associations with externalising behaviours (as opposed to purely exposure). Similarly, in the current study, our school-based arts exposures measured numbers of arts available (i.e., classes offered, facilities available), which may not reduce the risk of externalising behaviours. Additionally, a number of arts interventions have also focused on creative expression. For example, a creative arts intervention was associated with reduced externalising behaviours in a sample of adolescents from refugee backgrounds²⁰, while music-making was beneficial in reducing externalising behaviours in a sample of adolescents involved in the criminal justice system³⁶. Interventions using drama²⁴ and visual arts²⁵ have been effective in the reduction of bullying in the classroom. Another longitudinal study found (parental rating of) arts abilities to be associated with decreased risk of externalising behaviours²³. These findings suggest that future studies should further examine these differences, investigating the role of *actively* engaging in the arts compared to having *opportunities* to engage in the arts as potential risk-reducing factors for preventing or reducing externalising behaviours.

It is also of note that we did not find school-level associations between either number of arts classes or adequacy of facilities. However, for the former, associations were present until we adjusted for socioeconomic factors affecting the schools: public schools, for example, had fewer opportunities for arts engagement and more externalising behaviours. This suggests that simply offering more arts opportunities in schools or improving facilities would be insufficient as a strategy to decrease externalising behaviours. Several studies have examined how altering the school's physical environment (i.e., lighting, air quality, heating) may affect the student experience, however the results are mixed and largely focus on academic outcomes rather than behavioural³⁷. Therefore, strategies to improve the student experience and behaviour should consider supporting extracurricular activities moving forward, given the associations between these and behavioural outcomes. However, it is also possible that measurement error may have obscured potential associations. The school-level data did not include a

validated scale of externalising behaviours, so we created an index from a list of behavioural outcomes. Therefore, we were unable to directly compare individual and school-level results. Additionally, due to small sample sizes, we could not investigate the effect of art class frequency beyond less than weekly and weekly or more often. The way in which school administrators reported externalising behaviours meant that we collapsed ambiguous responses ('neither agree or disagree') into the disagree response category, indicating that this externalising problem did not occur in the school, which could have introduced bias into our analyses. Teacher reports of arts frequency also varied depending on which class the student was assigned to and therefore resulted in inconsistent reporting within a single school. Future cohort studies should include an independent individual (such as the school administrator) who is able to verify reports within schools. Finally, while the ECLS weights meant that the individual-level data included in this study was nationally representative, the school-level data was not. There may therefore have been selection bias in the schools included in this study. Our school-level findings should thus be replicated in a nationally representative sample of schools in the US. However, selection into the study was first recruited by geographic region followed by school type and within each category schools were sorted to ensure sample representation over other characteristics³⁰.

There are a number of strengths to the current study. ECLS is a large nationally representative cohort study with rich data, meaning we were able to adjust for a range of sociodemographic covariates³¹. We included reports from parents, teachers, and administrators and therefore reduced the likelihood of reporting bias by collecting similar information across several sources. We used a validated measure of externalising behaviours in the individual-level analyses (the SDQ). However, there are also a number of limitations to consider. The SDQ was parent-reported which may be subject to reporting bias, as parents may be more likely to report externalising behaviours compared to self-report SDQ assessments³⁸. Similarly, the wording of questions on individual-level extracurricular activities made it unclear whether these activities occurred independent of school or within the school setting (e.g., after hours school club). Therefore, it is difficult to fully disentangle school associated activities with those occurring outside school. Similarly, we were limited by the demographic categories available in the ECLS dataset. For example, only male and female genders and language spoken at home grouped into only English and non-English were available. Future cohort studies should endeavour to collect more well-rounded demographic data to ensure all individuals are equally and accurately represented. Finally, it is critical to note that neurological differences are often at the root of the behaviours known as externalising behaviours, and that they may in some way be protective against the detrimental health consequences of early life adversity and neurological differences³⁹. We did not have such variables available to include in our analyses, but future research is needed to consider these differences as when they are overlooked, problematic behaviours and their consequences can escalate and create a cycle of perpetuation. Additionally, when behaviours related to neurodivergence are linked to school discipline and criminality, variables such as structural determinism, racism, and social disenfranchisement must be considered^{40,41}. So although we took care to include a rich panel of demographic and socioeconomic confounders in our analyses, we may have omitted important further confounders due to their non-availability in the dataset. Finally, we have followed current conventions for describing externalising behaviours. But we recognise that it may be useful to use less 'problematic' and 'deficit' heavy language when referring to differences in neurodivergence^{42,43}.

Our results suggest that extracurricular arts activities (e.g., dance, music, or arts lessons or performing arts programs) are effective in reducing the risk for externalising behaviours. However, the findings also caution against simply increasing facilities in schools to try and tackle behavioural issues. Instead, it appears that more targeted provision of extracurricular classes, in particular aiming to reach those who are less likely to engage outside of school time, is important. Future research is recommended to extend the findings reported here. For example, it would be revealing to examine associations between more subjective engagement variables (i.e., creativity) or across different age groups and externalising behaviours. Further, cultural engagement (e.g. going to museums, galleries, art exhibitions, concerts, and theatre) is also known to have similar beneficial outcomes to arts engagement¹⁹, and therefore future studies may wish to examine the associations of extracurricular and school-based cultural engagement with externalising disorders. Overall, the benefits of arts engagement are well established, and many of these benefits parallel the mechanisms underlying externalising behaviours. Art has previously been

used as an intervention; however, our evidence suggests it may also be an efficient tool in reducing the risk of externalising behaviours in the first instance through more general extracurricular activity provision. Therefore, extracurricular arts activities should be considered as a cost-effective way of reducing the risk of externalising behaviours while simultaneously promoting healthy emotional, coping, and social behaviours.

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Supplementary Material

Supplementary Table S1. Descriptive statistics for predictor variables in the individual-level analyses

Externalising behaviours (0-20) N= 8,586			
	Eligible (%)	Missing (%)	Imputed (%)
Extracurricular arts activities (0 Activities)	47.8		52.6
1 Activity	27.5		26.6
2 Activities	14.8	2.9	14.5
3 Activities	5.9		5.4
4 Activities	1.1		0.9
Number art classes (0)	16.5		21.8
1	13.4		15.8
2	29.6		34.6
3	14.2	14.6	15.0
4	10.1		11.0
5	1.2		1.3
6	0.4		0.5
Adequate arts facilities (0)	15.0		16.4
1	16.4	11.2	17.8
2	40.8		45.4
3	16.6		20.4
Gender (Male)	50.6		52.1
Female	49.4	0.0	47.9
First language (English)	83.7		87.0
Non-English	12.7	3.6	13.0
Ethnicity (White)	63.6		57.2
Black or African American	7.4	0.1	17.1
Hispanic	16.6		18.5
Other ethnicity [incl. AS, NH/OPI, AI/AN]	12.3		7.2
Parent education (Up to high school)	7.9		10.9
High school/vocational	26.9		30.6
Some college	25.7	3.0	27.1
Undergrad	20.0		18.0
Postgraduate and above	16.6		13.4
Location (City)	35.9		36.3
Suburb/ large town	38.1	0.7	42.2
Small town/ rural	25.3		21.5
Family structure (Married)	74.0		69.5
Unmarried	15.8	2.9	19.6
Never married	7.2		10.9
Income (Quartile 1)	22.4		32.3
Quartile 2	37.1	9.2	39.6
Quartile 3	14.5		13.0
Quartile 4	16.8		15.1
Food stamps (No)	86.9		85.1
Yes	9.9	3.2	14.9
Free/reduced school meals (No)	67.1		60.4
Yes	29.8	3.1	39.6

Supplementary Table S2: Descriptive statistics for predictor variables in the school-level analyses

Externalising behaviours index (0-6) N=296			
	Eligible (%)	Missing (%)	Imputed (%)
Number art classes (0)	13.2		15.4
1	11.8		13.8
2	26.7		30.4
3	19.3	13.2	22.0
4	14.5		16.8
5	1.0		1.1
6	0.3		0.4
Adequate art facilities (0)	15.2		16.3
1	17.6	7.8	19.0
2	39.5		43.1
3	19.9		21.5
Type (Private)	57.8		57.8
Public	42.2	0.0	42.2
Percent minority ethnic students (<10%)	37.2		37.3
10-25%	17.6		17.7
25-50%	14.2	0.3	14.2
50-75%	8.1		8.1
>75%	22.6		22.7
Overcrowded (No)	66.2		70.3
Yes	27.7	6.1	29.7
Location (City)	40.2		43.6
Suburb/ large town	32.4	8.8	37.9
Small town/ rural	18.6		18.6
School area safety (0)	25.0		33.0
1	24.0		33.2
2	8.8		11.8
3	4.4		5.8
4	2.4	26.4	3.3
5	2.0		3.1
6	3.0		4.3
7	1.7		2.4
8	2.4		3.1

Supplementary Table S3. Individual-level associations of extracurricular and school-based arts engagement in 5th grade with externalising behaviours in 8th grade

	Extracurricular arts activities			Externalising behaviours				Adequacy of arts facilities				
	Coef.	95% CI		P	Coef.	95% CI		P	Coef.	95% CI		P
Unadjusted	-0.51	-0.63	-0.39	<0.001	-0.08	-0.20	0.034	0.165	0.01	-0.15	0.16	0.926
Adjusted	-0.22	-0.33	-0.11	<0.001	-0.02	-0.13	0.093	0.741	0.04	-0.11	0.19	0.608
Gender (Male)	--				--				--			
Female	-1.02	-1.27	-0.78	<0.001	-1.13	-1.37	-0.89	<0.001	-1.13	-1.37	-0.89	<0.001
First language (English)	--				--				--			
Non-English	-0.54	-0.96	-0.13	0.01	-0.58	-0.99	-0.17	0.005	-0.58	-0.99	-0.17	0.005
Ethnicity (White)	--				--				--			
Black or African American	-0.3	-0.8	0.2	0.235	-0.35	-0.85	0.14	0.162	-0.35	-0.85	0.14	0.164
Hispanic	-0.64	-1.05	-0.23	0.002	-0.63	-1.04	-0.21	0.003	-0.62	-1.03	-0.2	0.004
Other ethnicity [incl. AS, NH/OPI, AI/AN]	-0.54	-1.02	-0.07	0.024	-0.56	-1.03	-0.08	0.021	-0.54	-1.03	-0.06	0.029
Parent education (Up to high school)	--				--				--			
High school/vocational	-0.36	-0.88	0.16	0.17	-0.4	-0.92	0.12	0.131	-0.41	-0.92	0.11	0.126
Some college	-0.63	-1.19	-0.08	0.025	-0.69	-1.25	-0.14	0.015	-0.7	-1.26	-0.15	0.013
Undergrad	-0.96	-1.55	-0.37	0.001	-1.05	-1.64	-0.46	0.001	-1.07	-1.65	-0.48	<0.001
Postgraduate and above	-0.92	-1.56	-0.28	0.005	-1.07	-1.71	-0.43	0.001	-1.08	-1.72	-0.44	0.001
Location (City)	--				--				--			
Suburb/ large town	-0.05	-0.34	0.23	0.71	-0.06	-0.34	0.23	0.700	-0.06	-0.35	0.23	0.689
Small town/ rural	-0.09	-0.43	0.25	0.613	-0.08	-0.42	0.26	0.646	-0.08	-0.42	0.27	0.664
Family structure (Married)	--				--				--			
Unmarried	0.56	0.17	0.95	0.005	0.58	0.19	0.97	0.004	0.58	0.19	0.97	0.004
Never married	-0.07	-0.55	0.42	0.790	-0.04	-0.52	0.45	0.886	-0.04	-0.52	0.45	0.887
Household income (Quartile 1)	--				--				--			
Quartile 2	-0.31	-0.70	0.09	0.129	-0.31	-0.71	0.08	0.123	-0.31	-0.71	0.08	0.120
Quartile 3	0.06	-0.45	0.58	0.807	0.05	-0.48	0.57	0.859	0.04	-0.48	0.57	0.869
Quartile 4	-0.38	-0.89	0.14	0.150	-0.42	-0.93	0.10	0.113	-0.42	-0.93	0.10	0.111
Food stamps (No)	--				--				--			
Yes	0.57	0.13	1.01	0.012	0.58	0.13	1.02	0.011	0.57	0.13	1.02	0.011
Free/reduced school meals (No)	--				--				--			
Yes	0.63	0.23	1.03	0.002	0.64	0.23	1.04	0.002	0.64	0.24	1.05	0.002

Note: Extracurricular arts activities is a continuous score (0-4) of the number of extracurricular arts activities child had engaged in over the past 12 months. Number of arts classes variable is a continuous score of the number of arts classes offered 1-2 weekly or more (0-5). Adequacy of arts facilities is a continuous score (0-3). Outcome variable is continuous score (0-20) of SDQ externalising behaviours. AS= Asian, NH/OPI= Native Hawaiian or Other Pacific Islander, AI/AN= American Indian or Alaska Native. Dashes indicate reference category.

Supplementary Table S4. School-level associations of arts classes and adequate arts facilities in 5th grade with externalising behaviours in 8th grade

	Externalising behaviours index							
	Number arts classes				Adequacy of arts facilities			
	Coef.	95% CI		P	Coef.	95% CI		P
Unadjusted	-0.17	-0.30	-0.03	0.017	0.05	-0.12	0.21	0.562
Adjusted	-0.06	-0.17	0.05	0.289	0.07	-0.09	0.23	0.383
Type (Private)	--				--			
Public	0.89	0.55	1.24	<0.001	0.92	0.58	1.25	<0.001
Percent ethnic minority (<10%)	--				--			
10-25%	0.55	0.09	1.01	0.019	0.56	0.10	1.01	0.016
25-50%	0.52	-0.02	1.07	0.060	0.54	-0.01	1.09	0.054
50-75%	0.81	0.20	1.43	0.010	0.83	0.19	1.46	0.011
>75%	0.84	0.34	1.33	0.001	0.86	0.36	1.36	0.001
School is overcrowded (No)	--				--			
Yes	-0.07	-0.39	0.25	0.669	-0.07	-0.38	0.25	0.689
Location (City)	--				--			
Suburb/ large town	0.06	-0.33	0.44	0.774	0.04	-0.34	0.43	0.828
Small town/ rural	0.39	-0.03	0.81	0.065	0.41	-0.01	0.84	0.058
School area safety (No problem)	--				--			
Problem	0.06	-0.03	0.15	0.174	0.07	-0.03	0.16	0.160

Note: . Number of arts classes variable is a continuous score of the number of arts classes offered 1-2 weekly or more (0-5). Adequacy of arts facilities is a continuous score (0-3). Outcome variable is a continuous index of the number of externalising behaviours (0-7) in the school. Dashes indicate reference category