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Across demographics and recent history, most parents sing to their infants and toddlers daily

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Music is universally prevalent in human society and is a salient component of the lives of young families. Here, we studied the frequency of singing and playing recorded music in the home using surveys of parents with infants ($N = 945$). We found that most parents sing to their infant on a daily basis and the frequency of infant-directed singing is unrelated to parents' income or ethnicity. Two reliable individual differences emerged, however: (i) fathers sing less than mothers and (ii) as infants grow older, parents sing less. Moreover, the latter effect of child age was specific to singing and was not reflected in reports of the frequency of playing recorded music. Last, we meta-analysed reports of the frequency of infant-directed singing and found little change in its frequency over the past 30 years, despite substantial changes in the technological environment in the home. These findings, consistent with theories of the psychological functions of music, in general, and infant-directed singing, in particular, demonstrate the everyday nature of music in infancy.

This article is part of the theme issue 'Voice modulation: from origin and mechanism to social impact (Part I)'.

1. Introduction

Parent–infant interactions are routinely musical. Worldwide, parents often sing songs to their children that have specific, stable and culturally recognizable features [1–6]. From an early stage, infants perceive musical structure in this auditory input: they attend keenly to songs and move and vocalize in response to them [1,7–10], likely as a result of both musical predispositions and associative learning. For example, fetuses perceive, learn and remember music inside the womb during the last portion of pregnancy [1], newborns synchronize their movement to the rhythm of the mother's voice [11–13] and match their vocalizations to tonal qualities of the mother's voice [14].

Parents and infants engage in musical activities for diverse reasons, but two social functions of music may be especially prominent. First, music creates a shared cultural experience for the parent and child, as melodies produced live and experienced at home by known social partners can carry social meaning for infants [15,16]. In a similar fashion to the social meaning transmitted by language and dialect [17,18] or food preferences [19], parental singing provides a credible signal of social identity and social relatedness. Infants are sensitive to this signal: infants may use the melodies sung by others to identify new members of their social world [15,20,21].

Second, singing may also signal parental investment [21,22], transmitting reliable information concerning a parent's proximity, activity and attention. On this idea, it is in infants' interest to elicit infant-directed songs and in parents' interest to provide them. Indeed, music causes regulatory effects on

both infants and parents: infants are reliably calmed by familiar [23] and unfamiliar songs [24] and attend longer to singing than to speech before becoming fussy [25]. Infants also have a preference towards specific styles and forms of music, responding better to unaccompanied [26] and live singing [27] in the form of lullabies [28]. And parental singing is thought to be therapeutic for parents themselves, apparently relating to mood and emotion, with measurable effects on parent arousal [29].

What, then, might we expect when measuring musical parenting at home? Previous studies suggest that parents frequently engage in musical activity in the home throughout early childhood [30–36] and infancy [37–39]. For example, Mendoza & Fausey [40] captured daylong audio recordings from 35 6- to 12-month-olds and found that 100% of infants heard both live and recorded music. Such frequent exposure to music in both clinical and non-clinical settings could have profound impacts on infant and parent well-being, given relations between music and health [41,42], especially in infancy (e.g. [1–3]).

While precise measurement of real-world infant and parent behaviour is thought to require direct observation (see, e.g. [43]), such measures of the home musical environment are costly and, given their logistical complexity, typically have only been used in small samples. By contrast, parent surveys concerning the use of music with infants are feasible at a large scale, as in prior work using nationally representative phone surveys [38,39].

Studying parents at scale is essential to ensure the generalizability of findings to populations of interest, but also because the behaviours in question may in fact vary as a function of family characteristics that may not be captured in small samples of convenience with parents. Indeed, diminished resources found in families with lower socioeconomic status are negatively correlated with parenting practices, such as book-reading [44]. The evidence for such effects in music so far is mixed: Custodero *et al*. [38] found that more educated parents tended to sing and play music with their children more than those with less education, but found no relation between parents' musical behaviours and income or ethnicity.

Further, there are a variety of other effects of interest, raising questions that studies of broad samples of families can address. These include the nature of sex differences in parent musical interaction with children and the changes in the home musical environment that occur as children grow older. Women sing more than men in diverse contexts [45], and mothers have previously been found to sing more frequently and show more interest in singing than do fathers, but the reasons and sources of these differences merit further study [37,38,45,46]. As infants develop into toddlers their social worlds expand substantially, to include peers and extended family and community members, and their social cognition and language abilities increase (e.g. [47]). In line with their growing maturity, one might therefore expect parents to reduce the frequency of their singing as children become less reliant on parents as sources of attention and stimulation [22].

Last, the past few decades have seen technology become increasingly prevalent in infants' daily lives, with constantly accessible devices that can produce music. Whether and how such changes have affected the home musical environment is not yet known. Parents have reported some reliance on commercially available products such as CDs and DVDs for music in the home [35], and a recent study showed that the COVID-19 pandemic was associated with significant growth in the streaming of children's music in the USA [48]. Despite changes in lifestyles due to modernization, mothers still use vocal music with their infants, however, and singing may remain the primary musical activity of mother–infant dyads [30]. Longitudinal analysis of parent surveys can help to determine the extent to which the home musical environment has changed along with infants' and toddlers' technological environment.

Here, we study the frequency of parents' musical behaviours for infants and toddlers by pooling data from three new surveys of North American parents. We use the pooled data to (i) report the frequency of parents' singing and playing recorded music to their children in recent years; (ii) explore the relationship between musical parenting, child characteristics and parent demographics; and by comparing our data to results from similar, previous studies, (iii) examine changes in the frequency of maternal singing over the past few decades.

2. Methods

(a) Source data

We analysed survey data collected between 2013 and 2021, from three cohorts. In Cohort A, parents of 3- to 11-month-old infants in the Boston (USA) area completed a version of the Parent Arts Questionnaire (developed in [49]) using pen and paper or on a desktop computer, as a part of their participation in experiments conducted in 2013–2015 (other data from this study were published in [15] or [16]). In Cohort B, parents of 3- to 10-month-old infants, also in the Boston area, completed a survey concerning musical behaviours in the home, as part of their participation in experiments conducted in 2018–2020 (other data from these experiments are published in [24]; or are not yet published). In Cohort C, parents of 8- to 31-month-old infants living in the USA were recruited online in 2020–2021 (via https://prolific.co, a service for online participant recruitment), as part of an experiment on language development.

(b) Participants

Most analyses in this paper study all parents across the three cohorts together, in a 'pooled sample', which included 945 parents of infants aged 1.3–31 months ($M = 15.2$, s.d. = 7.8). All available demographics from the pooled sample are in table 1 and more detailed demographic information for each cohort is in electronic supplementary material, tables S1–S3 (note that these are presented separately because some demographic questions were not asked in all three cohorts).

(c) Measures

We studied two measures concerning the frequency of parental singing and playing recorded music, both of which were collected in all three cohorts. The wording and response options for these items differed across the cohorts, so we re-coded all parental responses into two categories: *less than daily* or *daily or more* (table 2). Re-coding was determined before analysing any data so that decisions concerning which scale points fell into each category could not influence any results reported here. When we used a finer-grained binning strategy, where we separated '4 or more times a day' from the 'daily or more' category, the results replicated internally; readers may use the open data at https://osf.io/ydf92 to test other, alternative binning strategies.

(d) Archival data on maternal singing

To ask how the home musical environment has changed over time, we obtained summary data from three prior studies

Table 1. Demographics of the pooled sample. Demographic information was collected as part of a series of items that varied across the cohorts; the full pooled $N = 945$ and all demographics that were available for the pooled sample are presented here. The data contained a 'Race' variable, which we used as a proxy for parent ethnicity. Missing data are due to some participants choosing not to respond to some demographic questions. Additional demographic information for each of the three cohorts is available in electronic supplementary material, table S1.

characteristic	percentage	*N*
parent sex		
male	27.8%	263
female	71.0%	671
unknown		11
child sex		
male	54.5%	515
female	45.4%	429
unknown		1
ethnicity		
African or African-American	6.6%	62
Asian or Asian-American	5.5%	52
European or White-American	76.1%	719
other	5.7%	54
unknown		58
Hispanic		
no	86.3%	816
yes	6.7%	63
unknown		66
	mean (s.d.)	*N*
parent age in years	32.8 (4.9)	882
unknown		63
child age in months	15.2 (7.8)	944
unknown		1

[37–39], with data collected between 1994 and 2001. These surveys were administered in the USA or Canada and included parents with children under the age of 3 and each asked parents how frequently they sang to them, in a fashion similar to the items in Cohorts A–C. The details are in table 3; note that two of these studies used nationally representative surveys in the USA.

Given previously reported sex differences in the frequency of parental singing [37], which we also report below, and a lack of available data distinguishing between mothers and fathers, we only analysed data from mothers. Further, because data distinguishing the frequency of singing from the frequency of playing recorded music were also not available from these studies, we only studied maternal *singing*.

3. Results

(a) Most parents sing or play recorded music to infants daily

A majority of parents in the pooled sample reported singing daily (Prop. = 0.69, 95% CI [0.66, 0.72]) and playing recorded music daily (Prop. = 0.63, 95% CI [0.59, 0.66]) to their infants (figure 1). This pattern was replicated in each of the three cohorts (figure 1*b*). Further, there was a small, but consistent difference, within-subjects, across musical modalities: parents were more likely to sing daily than they were to play recorded music daily, on average (*z*-test of proportions: Pearson's χ^2 (1, $N = 927$) = 8.06, $p = 0.0045$, 95% CI [0.02, 0.11]).

(b) Parent sex and child age, but not family demographics, are predictive of parental music

Next, we analysed which demographic variables were predictive of the frequency of musical behaviours. We first analysed three groups of bivariate descriptive statistics of interest: (i) parent and child sex; (ii) child age; and (iii) family income and ethnicity. Based on these first-order results, we then proceeded with a series of logistic regressions, to more precisely estimate the associations between demographic variables and the odds of daily parental singing or playing recorded music. Unless otherwise specified, all analyses used the full pooled sample ($N = 945$).

(i) Parent and child sex

Consistent with prior reports that mothers sing more than fathers [37], we found that mothers sang daily (proportion: Prop. = 0.72, 95% CI [0.69, 0.76]) at a significantly higher rate than did fathers (Prop. = 0.59., 95% CI [0.53, 0.66]; χ^2 (1, $N = 924$) = 14.48, $p < 0.001$, 95% CI [0.06, 0.20]). Mothers also played recorded music daily (Prop. = 0.64, 95% CI [0.61, 0.68]) at a slightly higher rate than fathers (Prop. = 0.58, 95% CI [0.51, 0.62]), though this difference barely reached statistical significance (χ^2(1, $N = 920$) = 3.75, $p = 0.053$, 95% CI [−0.002, 0.14]).

We found no comparable effects, however, for child sex. Whereas parents differ by sex in the amount of singing and recorded music they engage in with their infants, parents of both sexes use music comparably with male (singing: Prop. = 0.68, 95% CI [0.64, 0.72]; recorded music: Prop. = 0.60, 95% CI [0.56, 0.64]) and female infants (singing: Prop. = 0.70, 95% CI [0.65, 0.74]; recorded music: Prop. = 0.66, 95% CI [0.61, 0.70]; comparison for singing: χ^2(1, $N = 930$) = 0.13, $p = 0.72$, 95% CI [−0.049, 0.075]; comparison for recorded music: χ^2 (1, $N = 926$) = 2.79, $p = 0.095$, 95% CI [−0.0089, 0.12]).

(ii) Child age

Previous work has suggested the possibility of age effects in parents' musical activities, such as that infants grow older, parents may produce less music for them [22]; these effects have been difficult to test, however, without large samples of parents with a broad range of child ages. The pooled sample solves this problem (table 1). We found strong evidence for an age effect: parents who reported singing daily to infants had significantly younger infants (age: $M = 14.3$ months, s.d. = 7.74, 95% CI [13.7, 14.9]) than parents who reported singing less than daily ($M = 17.6$, s.d. = 7.42, 95% CI [16.7, 18.5]; independent-samples *t*-test: $t = 6.19$, d.f. = 574.16, $p < 0.001$, $d = 0.43$). We found no such effect for recorded music (daily or more: $M = 15.4$ months, s.d. = 7.85, 95% CI [14.8, 16.0], less than daily: $M = 15.3$ months, s.d. = 7.68, 95% CI [14.5, 16.1]; $t = -0.24$, d.f. = 741.03, $p = 0.81$).

Table 2. Measure and response options. Across the three cohorts, measures of the frequency of parental singing and playing recorded music differed slightly, as did their response options. The table depicts how these modest differences were resolved to create a single binary measure of the frequency of parental musical behaviour.

		original response options, pooled to	
cohort	item text	less than daily	daily or more
A	How often do you do the following activities?	never or almost never	daily
	I sing to my baby	monthly	2–3 times a day
	I play recorded music to my baby	weekly	4 or more times a day
		every 2–3 days	
B	Across all of [baby name]'s caregivers, how often do	less than monthly	2–3 times a day
	the following activities occur?	weekly	4–8 times a day
	sing	once every day or two	9 or more times a day
	play recorded music		
C	How often do you sing to your child?	once every 3 days or less	2–3 times a day
	How often do you play recorded music with lyrics to your child?	once every day or two	4–7 times a day
			8 or more times a day

Table 3. Details of prior studies included in longitudinal analysis.

						original response options, pooled to	
study	location	year	*N* mothers	age range	item text	less than daily	daily or more
Trehub *et al.* [37]	Canada	1994–1995	67	4–18 months	parents documented all instances of singing to infants in the following format: '*[Who] sang [what song] to their infant [when] and in [what situations]*' and provided general information on frequency of singing	occasionally or rarely	often or always
Custodero *et al.* [38]	USA	1995–1996	1320	0–36 months	… please tell me how many times, if any, you personally did this with your child in the past week	not at all	about once a day
					sing or play music for child	once or twice a week	more than once a day
						several times a week	
Custodero *et al.* [39]	USA	2000–2001	1613	4–6 months	How often do you get a chance to sing to [your child]?	never	everyday
						once a month or less	
						several times a month	
						once a week	
						about three times a week	

(iii) Demographics

Replicating prior work in older children [49], we found no relations between socioeconomic status or ethnicity and parents' musical behaviours. In the pooled sample, the frequency of daily parental singing was roughly comparable across ethnicities (range of proportions: 0.67–0.82), with no ethnic group having a majority of parents reporting *less than daily* singing or recorded music. Similarly, each of two measures of socioeconomic status was unrelated to either singing or playing recorded music (N.B., these analyses

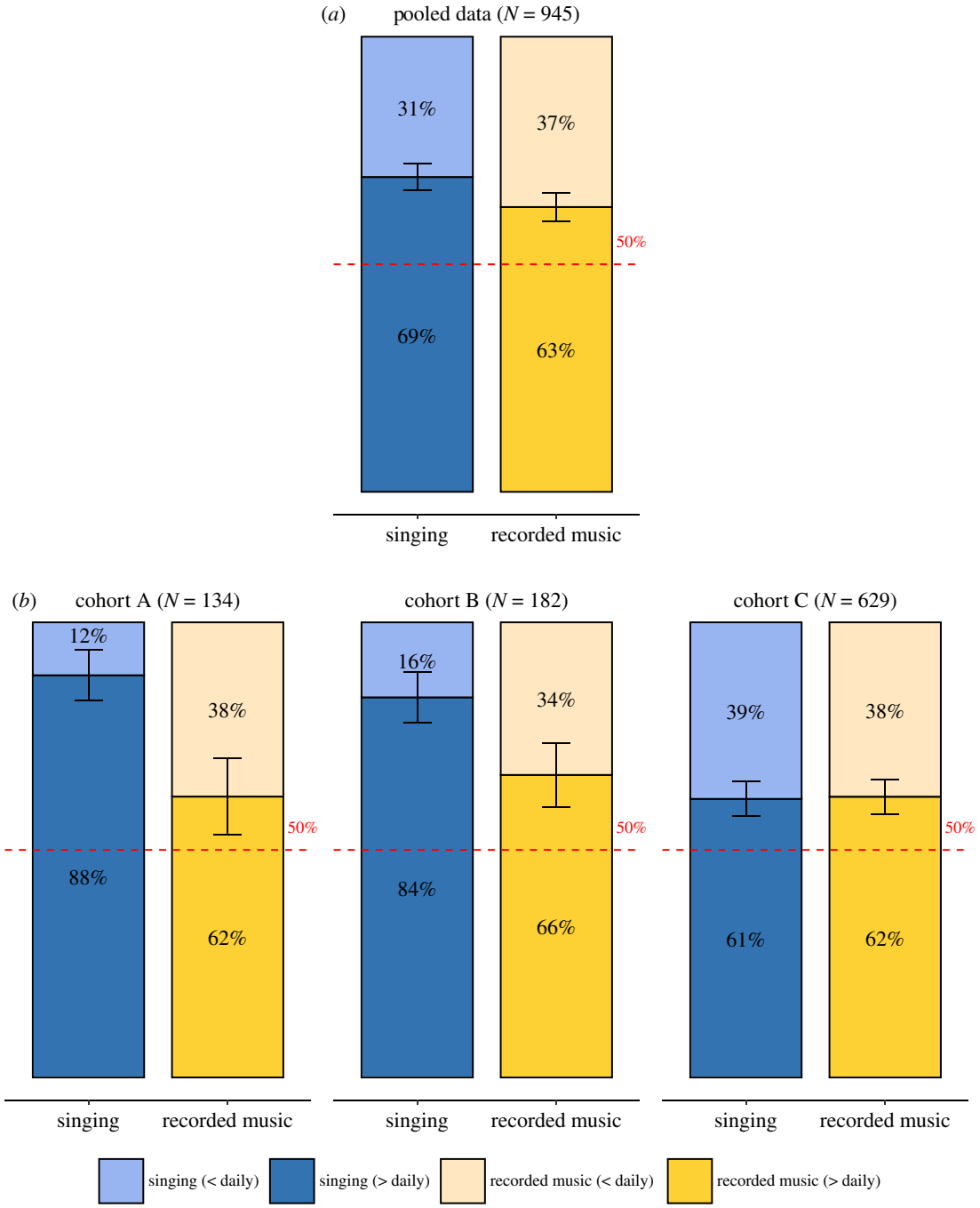

Figure 1. Frequency of parental singing and recorded music. Across the pooled sample (*a*) and each of the three cohorts (*b*), a majority of parents reported singing and playing recorded music on a daily basis and singing more frequently than playing recorded music. (Online version in colour.)

only included data from Cohorts A and C, with $N = 760$). Neither parent income (Wilcoxon rank-sum tests, singing: $z = -1.84$, $p = 0.065$; recorded music: $z = -0.32$, $p = 0.75$) nor parent education (i.e. whether or not the parent had a college degree or further education; singing: $z = -0.24$, $p = 0.81$; recorded music: $z = -1.64$, $p = 0.10$) were related to daily musical activities with infants.

Based on these first-order results, we continued by modelling the positive effects found above in a single model, so as to estimate the unique variance associated with each demographic characteristic. This approach also provides a degree of control for *overall* interest in parental musical behaviour, as it enables tests of the *relative* relations between singing, playing recorded music and demographic characteristics of interest.

We ran a logistic regression predicting the effects of parent sex and child age on musical activity, so as to test whether their relations with parental singing held when adjusting for their relations with playing recorded music (table 4). The overall model was significant ($\chi^2(5, N = 923) = 61.09$, $p < 0.001$) and showed a significant effect of child age on the frequency of singing (figure 2*a*; general linear hypothesis test: $\chi^2(1, N = 923) = 16.45$, $p < 0.001$), but not the frequency of playing recorded music (OR = 1.01, 95% CI [0.98, 1.03], $z = 0.61$, $p = 0.54$). The relation between parental musical behaviour and parent sex only held overall (figure 2*b*; OR = 1.60, 95% CI [1.05, 2.43], $z = 2.19$, $p = 0.03$), with no significant difference of the effect across musical activities (OR = 1.17, 95% CI [0.70, 1.95], $z = 0.60$, $p = 0.55$). This implies that the first-order sex differences in parent singing are not specific to singing, *per se*; mothers apparently participate in more musical activities in general with their infants than do fathers.

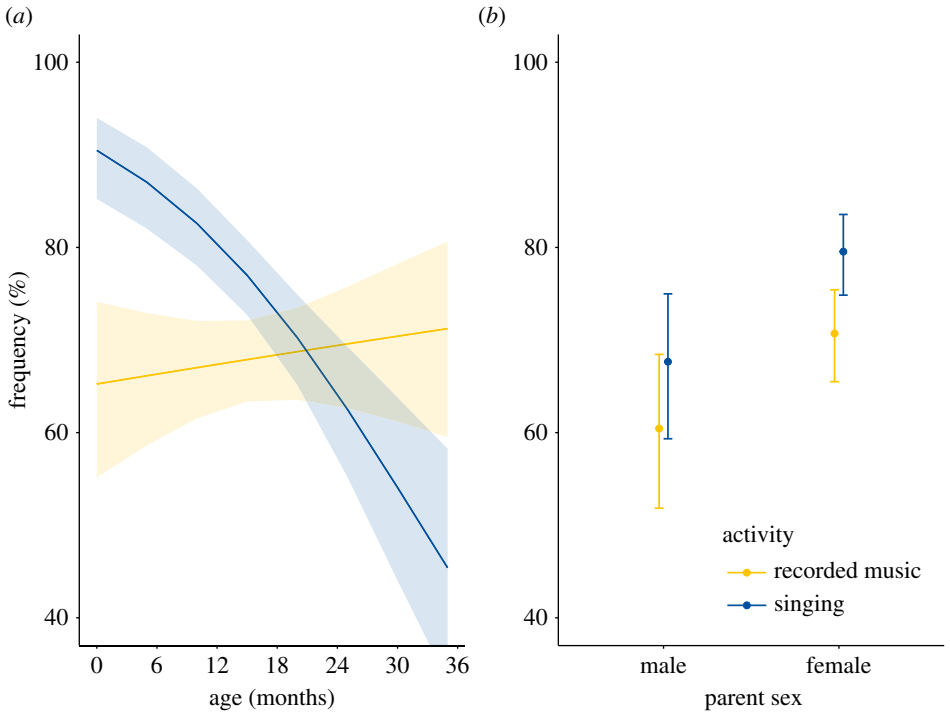

Figure 2. Relations between child age, parent sex and parental music behaviours. The figure depicts estimates of the likelihood that parents will sing or play recorded music daily, from the logistic regression, across (*a*) levels of child ages or (*b*) parent sex. The vertical lines represent 95% confidence intervals. (Online version in colour.)

Table 4. Estimated effects of child age and parent sex on daily musical activities. Results are from a multiple logistic regression, with recorded music as the reference group. Italicized rows are significant at the alpha level of 0.05.

	odds ratio	s.e.	*Z*	*p*	95% CI
intercept	1.35	0.28	1.06	0.29	[0.78, 2.35]
child age	1.01	0.01	0.61	0.54	[0.98, 1.03]
female parent	*1.60*	*0.21*	*2.19*	*0.03*	*[1.05, 2.43]*
musical activity: singing	*4.46*	*0.36*	*4.17*	*<0.001*	*[2.21, 9.02]*
female parent × singing	1.17	0.26	0.60	0.55	[0.70, 1.95]
child age × singing	*0.93*	*0.02*	*4.83*	*<0.001*	*[0.90, 0.96]*

(c) Frequency of maternal singing has not changed over the past 30 years

Last, we tested how the frequency of maternal singing has changed over the six timepoints' worth of summary data we were able to obtain (table 3). The summary data are visualized in figure 3. A simple linear regression of the proportion in each study (using the year midpoint of each study as the predictor) showed no significant change in the frequency of maternal singing across the six studies ($\beta = -1.87$, s.e. = 2.87, $t = -0.65$, $p = 0.55$).

4. Discussion

We found that most parents across three separate cohorts sang and played recorded music to their children daily, at rates comparable to those found in other surveys over the past 30 years [37–39], and consistent with research that directly observes in-home musical behaviour [40]. These effects were consistent across family ethnicities and different levels of socioeconomic status, confirming prior results in older children [32], and contrasting with *negative* relations between family income and other, non-musical parent–infant activities, such as book-reading [44]: the daily production of music for young children, found in most parents, is robust to demographic variability and more so than other parenting behaviours. The small but consistent differences between the frequency of parents' singing versus playing recorded music could be attributed to the differences in effects of live versus recorded music on infants. In a study of preterm infants, for example, listening to live or recorded lullabies elicited reduced heart rates, relative to a no-music control; but the live lullabies caused deeper sleep than recorded lullabies [27].

These findings support the longstanding view that music—and particularly live singing—plays a universal role in parent–child interaction [3,21,22,50,51].

Two characteristics were predictive of the frequency of parents' musical behaviours: parent sex and child age.

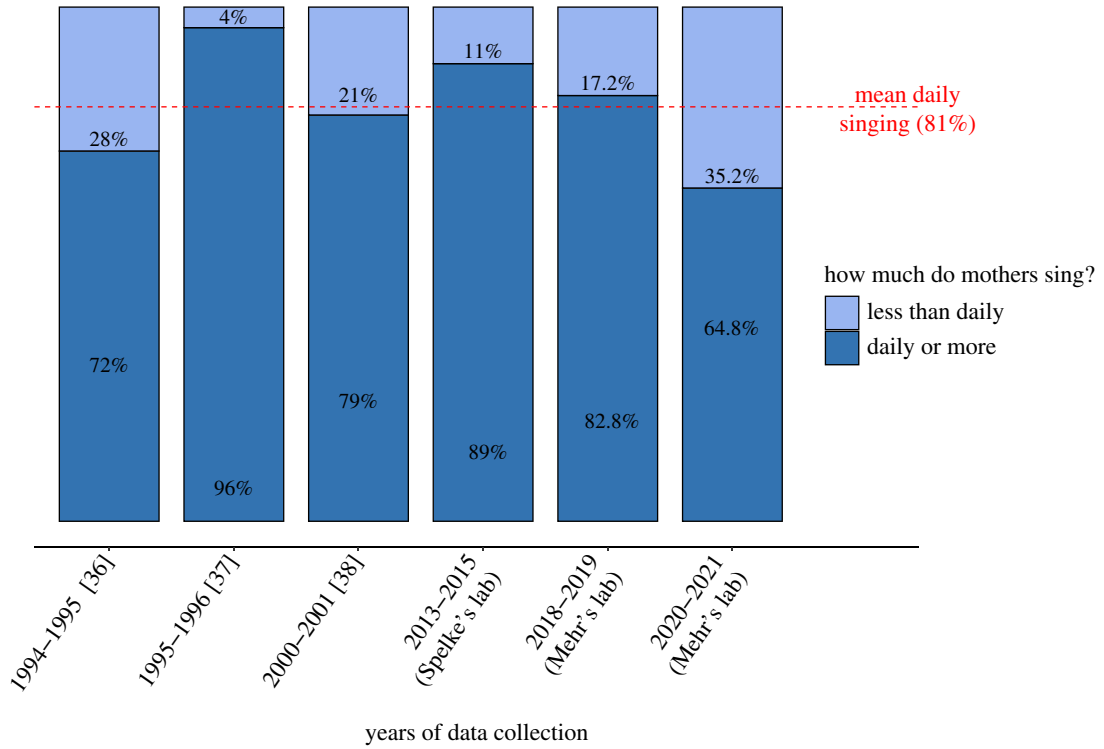

Figure 3. Frequency of maternal song over the past 30 years. Despite the many changes in the technological environment in the home between the 1990s and the present, mothers' reported singing frequency did not show any downward trend over the past 30 years. (Online version in colour.)

Consistent with prior work [37], mothers engaged more in musical activities than did fathers. This is further supported by broader research on family engagement, in which mothers are generally more involved in caregiving activities than fathers [44] across cultures. The non-significant interaction between parent sex and the type of musical activity (singing versus recorded music) reported in the logistic regression (see §3b) raises the possibility that there is no specific relation between parent sex and singing in particular; the sex differences reported here may reflect a general difference in interest in using music with infants and toddlers [45,46] or even an overall difference in the frequency of parenting behaviours, rather than any specific relation between parent sex and musical activities.

By contrast, parents reported singing less as infants transition into toddlerhood, but did not report playing less recorded music, suggesting a specific relation between child age and the rate of parents' use of infant-directed songs. This result, which corroborates prior findings that musical activities occurred more frequently with infants than with toddlers [38], may be explained in part by toddlers' developing linguistic abilities. Indeed, parents read books more often to toddler-age children than to infants [44], and the songs that parents produce for preschoolers tend to be more oriented towards imparting language-related information [52].

A further contributor to this pattern of decreased singing may involve infants' physical changes. As infants grow to be able to ingest solid food and sleep longer, there may be a reduced role for maternal singing in the management of feeding and sleep [53]. Finally, the growth of peer interactions may foster a change in the balance between live singing and recorded music for groups of young children, whose responses to music exceed their abilities to produce music together. Further research could test for all these effects.

The difference between parents' rates of producing live singing and recorded music, both overall and as a function of child age, may also be explained by the putative signalling functions of music [21]. Five-month-olds selectively attend to the singer of a familiar song when that song was originally produced by a parent, but not when it was originally produced by a recording [15]; but in contrast, 11-month-olds show a social preference (measured by object-reaching) for the singer of a familiar song *both* when it was originally produced by a parent or a recording [16]. An age-related difference in social responses to recorded versus live music may be reflected in parents' choices of musical behaviours.

Moreover, on the idea that parental songs signal parental investment [21,22,54,55], then infant-directed songs should be expected to be most effective in young infants and less so in toddlers (N.B., readers interested in the relevance of parental singing to evolutionary theories concerning music should see the target article and commentaries in [21]). The relative value of singing may decrease in comparison to other activities (e.g. talking, reading) as children become more engaged with peers and more reliant on other forms of parental investment. This prediction, outlined in [22, p. 678] is clearly supported here: we found that parents sing to toddlers less frequently than they sing to infants, with no corresponding change in the frequency with which parents played recorded music. Thus, the present findings support the idea that parents' use of music with infants credibly signals information concerning social affiliation, parental investment or both [21]. Notably, neither of these theories makes predictions concerning differences in the rate of infant-directed singing across child sex; indeed, we found no relation between child sex and parents' singing frequency.

We were surprised to find no evidence for changes in the frequency of mothers' singing over the past 30 years, given how much the home environment has been altered by the

ubiquitous presence of smartphones and other music-playing devices. While one might expect parents to increase their use of recorded music, given its increasing availability, and decrease their use of live singing correspondingly, we found no evidence for such a decrease: across variability in survey design, samples and locations, mothers reported singing to their infants daily. Measures of the frequency of singing that are more precise than a binary measure (daily or more versus less than daily) might detect such an effect. We also note that if anything, we *under*estimate the frequency of singing, as parents are fairly conservative in their responses to the surveys. For example, in one prior study [37], some mothers apparently disregarded humming, made-up songs and songs with altered words when reporting their singing frequency, despite these behaviours still constituting one form of singing or another (S. Trehub, April 2021, personal communication). This observed temporal stability may be caused by the universality of maternal singing widespread and cross-cultural norms for mothers to sing to their children [56].

In summary, our study used archival data to replicate prior descriptive work laying out the prevalence of parental singing to infants. It adds support to previously reported parent sex differences in musical parenting, reports a new effect of child age on parents' singing frequency, where parents sing less to older children, and shows the temporally consistent nature of parental singing across the past 30 years.

To develop a more comprehensive understanding of the home musical environment, future studies can and should go beyond parent self-reports, given their relatively coarse nature [43]. Exciting new applications of lengthy in-home recordings are already being applied to the study of parent–infant musical interaction [40]. Such methods, combined with or augmented by tools of ecological momentary assessment [57], could facilitate more fine-grained analyses of the characteristics associated with variability in parental musical behaviours at larger scales and with higher precision. For example, the *actual* frequencies of musical activities in the families we studied here may have been over- or underestimated, and the precise relations between different socioeconomic factors (and the interactions thereof) would require larger-scale data than we provide here.

Other priorities may include the relations between infants' temperament and parental musical activity, as fussier, difficult-to-soothe infants may be particularly receptive to live singing, leading to increases in parental singing frequency. And, given music's regulatory effects on both singers and listeners, future research would do well to determine how the state of the home music environment relates to parent and infant stress regulation. Such an inquiry would have important implications for parent–infant mental and physical well-being.

We look forward to the results of such work, which we expect will continue to demonstrate the many ubiquitous roles of music in the lives of parents, infants and toddlers.

Ethics. This research was approved by the Harvard University Committee on the Use of Human Subjects in Research.

Data accessibility. De-identified data analysed in this paper are available at https://osf.io/ydf92.

Authors' contributions. R.Y., J.d.V., P.d.V. and S.A.M. designed the research. S.A.M. and E.S.S. designed the survey in Cohort A and S.A.M. collected the data. S.A.M. designed the survey in Cohort B and supervised data collection. G.J. and S.A.M. designed the survey in Cohort C and G.J. collected the data. R.Y. conducted the analyses. R.Y. and S.A.M. wrote the paper and all authors approved it.

Competing interests. The authors declare no competing interests.

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