Infancy

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INFANCY THE OFFICIAL JOURNAL OF THE INTERNATIONAL CONGRESS OF INFANT STUDIES

RESEARCH ARTICLE OPEN ACCESS

Parental Social and Musical Characteristics, the Home Music Environment, and Child Language Development in Infancy

Ashley S. Boyne[1,2] | Camila Alviar[1] | Miriam Lense[1,2,3]

[1]Department of Otolaryngology - Head and Neck Surgery, Vanderbilt University Medical Center, Nashville, Tennessee, USA | [2]Psychology and Human Development, Vanderbilt University, Nashville, Tennessee, USA | [3]Vanderbilt Kennedy Center, Vanderbilt University Medical Center, Nashville, Tennessee, USA

Correspondence: Camila Alviar (maria.c.alviar-guzman@vumc.org) | Miriam Lense (miriam.lense@vumc.org)

Received: 10 May 2024 | **Revised:** 14 November 2024 | **Accepted:** 5 February 2025

Funding: This research was supported in part by the National Institute for Deafness and Communication Disorders, Grant/Award Number: R21DC016710; National Institute of Mental Health/National Center for Complementary and Integrative Health, Grant/Award Number: R61/R33MH123029; National Endowment for the Arts, Grant/Award Number: NEA 1906827-38-22; VUMC Faculty Research Scholars; Academy of Country Music Lifting Lives Foundation; and the VUMC Department of Otolaryngology. The use of REDCap was made possible by the Vanderbilt CTSA Grant from the National Center for Advancing Translational Science/National Institute of Health, Grant/Award Number: UL1 TR000445.

Keywords: infant-directed singing | language development | music at home | music training | parents | social motivation

ABSTRACT

Parents use music, especially singing, to interact with their young children, supporting parent-child bonding and social communication. Little is known about the parental attributes that support musical interactions with their infants. In this exploratory study, we analyzed self-report data from 43 caregiver/infant dyads at up to four time points (9, 12, 15, and 18 months) to assess parent social motivation and musical training as predictors of the home music environment overall, parental singing, and parental beliefs in the benefits of music. We also investigated the home music environment as a predictor of language development longitudinally. Parent social motivation was a stronger predictor of the home music environment than musical training. Parents' social motivation was positively related to parental singing, beliefs, and overall music environment, while musical training was only related to their beliefs. Furthermore, parent singing and overall home music, but not parental beliefs, were associated with infants' vocabulary comprehension, production, and gestures. Results highlight that music engagement in early childhood is fundamentally a social experience and emphasize the importance of parents' active participation (vs. only their beliefs) in musical experiences with their infant. The social nature of music experiences in infancy may contribute to relationships between the home music environment and child language development.

1 | Introduction

Across cultures and throughout the lifespan, music engagement is a social activity (Savage et al. 2021). Beginning early in life, parents and caregivers use music to interact with their young children as a way to communicate, entertain, and regulate arousal (Lense et al. 2022; Nguyen et al. 2023; Politimou et al. 2019; Putkinen, Saarikivi, and Tervaniemi 2013; Trehub, Ghazban, and Corbeil 2015). Infant-directed singing—lullabies in particular—plays an important role in daily caregiving routines across many cultures (Mehr et al. 2019). Most of the research on the role and use of music in infancy, such as the

Ashley S. Boyne and Camila Alviar should be considered joint first authors.

literature reviewed below, has primarily examined Western samples (the focus of the present study). In Western cultures, parents' daily music engagement with their children includes activities such as singing play songs and lullabies, interactive games like Pat-a-Cake, dancing, and listening to music (Cirelli et al. 2016; Wallace and Harwood 2018; Williams et al. 2015; Yan et al. 2021). The early childhood home musical environment involves parents' thoughts and behaviors around musical experiences, as well as children's own active musical participation (Politimou et al. 2019). In Western cultures, shared home musical activities support parent-child bonding and attachment (Steinberg, Liu, and Lense 2021), with parents' infant-directed singing highlighted as a common and meaningful behavior that regulates arousal and attention of parents and infants (Cirelli, Jurewicz, and Trehub 2020; Papadimitriou et al. 2021; Politimou et al. 2019; Trehub, Ghazban, and Corbeil 2015).

Yet, there is a lack of research in these populations into factors associated with parents' creation of a musical home environment during their children's earliest years, including their engagement in informal parent-child music activities like singing to their infant. As well, shared musical engagement, and particularly parents' singing to their infant, is increasingly highlighted as a potent form of social communication, supporting children's social engagement (Lense et al. 2022). Social interaction provides a critical context for child language learning and development (Bosseler et al. 2024; Endevelt-Shapira et al. 2024). Limited evidence suggests music/singing to infants is associated with child language comprehension and gestures (Franco et al. 2022; Papadimitriou et al. 2021). However, few studies have explored the longitudinal relationship between the home music environment broadly, and singing specifically, with language development in infants. The current exploratory study aims to investigate both (a) parental attributes that contribute to the home music environment; and (b) the relationship between the home music environment and child language development—including language production, comprehension, and gestures—during the first years of life.

1.1 | What Makes a Musical Parent?

Despite the central role of parents in cultivating the infants' home music environment, little research has considered parental factors and individual differences that shape this environment in industrialized, Western cultures. Many parents believe that music engagement has positive effects on children's development, including influencing their skills in non-musical domains (Mehr 2014; Politimou et al. 2019). However, it is important to separately consider parental beliefs versus parent behaviors in the context of the home music environment as the benefits of music are likely reaped from actual shared activity participation.

A potential contributing factor in the home music environment may be parents' formal musical training, since it is correlated with stronger parental beliefs in the importance of music (Kathios et al. 2023; Politimou et al. 2018), and musically-trained parents might be more dedicated to and comfortable engaging in music activities with their children. Previous musical experiences in mothers (including formal training and playing in an ensemble) have been positively associated with some parent-infant music activities such as music listening (Ilari 2005). However, parents' singing to their infants, the most common shared home music activity, is considered a behavior that is, intuitive to parents and does not require vocal training (Papousek 1996). Studies regarding parent musical training and use of singing to their infants generally report null or very small relationships (Ilari 2005; Politimou et al. 2018).

Given music engagement is a social experience, another potential contributing factor to the home music environment may be parents' social motivation. Parents are highly expressive when singing to their children and parents' singing can even be considered a natural social performance (Lense et al. 2022). Parents identify singing and making music with their young children as a social bonding activity (Steinberg, Shivers, et al. 2021) and believe that musical activities impact their children's social and emotional development (Pitt and Hargreaves 2017). However, parents' social motivation has not been considered in prior studies of the early home music environment. Personality factors have been identified with regard to adults' involvement in other types of music engagement that are not child-directed. Adults' involvement in formal musical activities has been linked to personality traits like extraversion, conscientiousness, and openness-to-experience (Carlson et al. 2016; Corrigall, Schellenberg, and Misura 2013; Rose, Jones Bartoli, and Heaton 2019; Ruth et al. 2023). However, as noted, these studies are not related to parent-child activities.

1.2 | Music and Early Language Development

Music in general, and singing in particular, is thought to be beneficial for child language development in infants through various mechanisms. From early on in the lifespan, humans are able to process musical auditory stimuli (Putkinen, Saarikivi, and Tervaniemi 2013), discriminate and entrain to auditory rhythms (Cirelli et al. 2016; Demany, McKenzie, and Vurpillot 1977; Winkler et al. 2009), and exhibit neural tracking to the amplitude envelope of maternal singing (Nguyen et al. 2023). These early sensitivities may facilitate later language development such as through enhanced auditory processing of linguistic information in rhythmic inputs (Langus, Mehler, and Nespor 2017; Putkinen, Saarikivi, and Tervaniemi 2013). Indeed, infants' neural processing of infant-directed songs is associated with their later expressive vocabulary skills (François et al. 2017; Nguyen et al. 2023). Infants also attend longer to caregiver's singing than speaking (Alviar et al. 2023; Trehub, Ghazban, and Corbeil 2015), and particularly attend to the mouth area of singers, which might support language development by providing audiovisual speech cues (Alviar et al. 2023). Additionally, the clear, repetitive, and regular rhythmicity of musical activities promotes infants' spontaneous movements, which are associated with infant motor and gesture development (Franco et al. 2022; Ilari 2015; Punamäki et al. 2024; Zentner and Eerola 2010). Gestures indicate early word comprehension and expressive communication, and as such lay

a foundation for further language growth (Franco et al. 2022; Gerry, Unrau, and Trainor 2012; Papadimitriou et al. 2021). More broadly, child language development occurs within a social interactive context (Bosseler et al. 2024) and musical interactions like singing to infants are highly social and provide rich social communicative cues (e.g., Lense et al. 2022). Thus, a musical home environment may provide a forum consistent with multiple language learning processes, including ones specific to or potentiated during musical interactions such as singing.

A few studies have considered music training or shared music activities (e.g., preschool music class programs) in early life in relationship with language development. During the preschool years, musical training and shared music activities are associated with a variety of language skills including verbal memory, vocabulary, phonological and phonemic awareness and processing (Hutchins 2018; Politimou et al. 2019; Vidal, Lousada, and Vigário 2020; Williams et al. 2015; Yang et al. 2014). Studies investigating home music activities and language skills in infancy have only examined language development cross-sectionally or at a single follow-up time point, and mainly focus on a single language domain. In these survey studies, parental singing to their infant was associated with infant vocabulary comprehension while the overall home music environment was associated with infants' gesture production (Franco et al. 2022). There is a lack of longitudinal research that examines the association between parent-child music engagement and infant language development, and in the context of several language domains at the same time, including language production. Looking at the relationship between music and language development in a longitudinal sample can better control for individual differences in developmental levels and skills, and shed light into the association between music and the trajectory of language development as much as the outcomes.

1.3 | Aims of the Current Study

In this exploratory study, we first aimed to explore the relationships between parent social motivation and musical training with the home music environment during infancy. We considered the overall home music environment and then focused on comparing parents' self-reported active musical behaviors toward their child (parent singing) with parental beliefs in the benefits of music. Secondly, we aimed to investigate how the home music environment relates to multiple domains of child language development across a longitudinal sample.

2 | Methods

2.1 | Participants

Participants in the present study were part of a larger study on music engagement, child social development, and child language development conducted in the Southeastern U.S.A. We present a secondary data analysis of a convenience sample of 43 unique parent/infant dyads (41 mothers, 2 fathers) whose data were collected longitudinally at 9 ($n_{M@H} = 24$, $n_{CDI} = 42$, $M_{age} = 9.38$, $SD_{age} = 0.88$), 12 ($n_{M@H} = 31$, $n_{CDI} = 43$, $M_{age} = 12.29$, $SD_{age} = 0.74$), 15 (no M@H at this time point, $n_{CDI} = 43$, $M_{age} = 15.19$, $SD_{age} = 0.53$), and 18 months of age ($n_{M@H} = 39$, $n_{CDI} = 42$, $M_{age} = 18.54$, $SD_{age} = 0.82$). Participants were included in this study if parents provided completed surveys on the Music@Home-Infant questionnaire for at least one time point. 74.4% of participants had available Music@Home data for at least two time points. Sample size was determined based on this available data from the larger study. Demographic information on the sample is provided in Table 1. All parents reported English as the primary language spoken at home, and three families reported their child learning an additional language (Spanish = 1, Portuguese = 1, Thai = 1). Participants were recruited from pediatrician offices, listservs, community centers, and local daycares. The present study was conducted according to guidelines laid down in the Declaration of Helsinki and in compliance with the ethical standards of the American Psychological Association. All procedures involving human subjects in this study were approved by the Vanderbilt University Institutional Review Board and all parents/caregivers gave written informed consent for their participation before any data collection.

TABLE 1 | Demographic information.

Characteristic	Participants ($N = 43$), No. (%)
Child gender	
Male	22 (51.2)
Female	21 (48.8)
Maternal highest education level	
High school diploma or GED	1 (2.3)
Associate's degree	3 (7.0)
Bachelor's degree	14 (32.6)
Master's degree	16 (37.2)
Professional degree	9 (20.9)
Parent no. of years of formal music training	
0	11 (25.6)
1–4	8 (18.6)
5–8	10 (23.3)
9–12	8 (18.6)
13–16	3 (7.0)
> 16	3 (7.0)
Parent race	
White	40 (93.0)
Asian	1 (2.3)
More than one race	2 (4.7)
Parent ethnicity	
Hispanic/Latino	1 (2.3)
Not Hispanic/Latino	41 (95.4)
No response	1 (2.3)

2.2 | Measures

2.2.1 | Music@Home Questionnaire

The Music@Home-Infant questionnaire (M@H; Politimou et al. 2018) includes 18 items that measure the self-reported family home music environment for children up to the age of two. It consists of four subscales: parental beliefs (PB; e.g., "I believe music has an impact on my child's intelligence"), parent singing (PS; e.g., "I sing to/with my child several [e.g., 5–10] times a day"), child active engagement (CAE; e.g., "I have noticed my child moving in time with the beat of the music"), and parent-child music-making (PCMM; e.g., "Making music with my child [including toy instruments] is a regular part of playtime at home"). Responses indicate a level of agreement with each of the 18 statements on a scale of 1–7, where 1 represents "completely disagree" and 7 represents "completely agree." The highest possible score for the M@H Total scale is 126, where the higher the score, the more music engagement in the family home environment. The M@H questionnaire has very good test-retest reliability, internal reliability, convergent validity, and divergent validity (Politimou et al. 2018).[1]

For the present study, we first looked at the M@H Total score for a global look at the home music environment. We then conducted follow-up analyses centered specifically on the two parent-focused scales, PS and PB, to consider the roles of active parent singing behavior (PS) versus their beliefs (PB) about the importance of music for child development. We did not focus on PCMM or CAE as they involve active child behaviors and, for this study, we were interested in studying predictors of *parental* musical behaviors.

The M@H measure was collected at 9, 12, and 18 months of age. Not all participants had data at all three time points as the M@H measure was not yet available at the beginning of data collection for the present study. 76.7% of participants had M@H data at 9 and/or 12 months, and 90.7% had M@H data at 18 months providing good coverage over our developmental period of interest.

2.2.2 | Social Competence Questionnaire

The Social Competence Questionnaire (ComQ; Sarason et al. 1985) includes 10 items that measure an individual's self-report of their degree of social interest and motivation in various social situations. Individuals are to imagine themselves in each situation and respond to each statement indicating how well it describes them on a scale of 0–3, where 0 is "not at all like me" and 3 is "a great deal like me." Examples of items include: "Enjoy social gatherings just to be with people" and "Start a conversation with someone I don't know well, but would like to get to know better." The highest possible score is 30, where the higher the score, the higher the social motivation. This measure is highly related to other measures of social motivation and strongly inversely related to social anxiety (Sung et al. 2005).

2.2.3 | Music Questionnaire for Adults

Parents' reported the age at which they began and the age at which they ended (current age if ongoing) formal music training using the Music Questionnaire for Adults (MQA; Lense, Shivers, and Dykens 2013). The total number of years of formal music training was calculated by subtracting the start age of musical training from the end age. These questions asked about "any formal music training" experiences without referencing any specific instrument, and were designed to capture total years of training across instruments (if participants had formal training in multiple instruments; overlapping periods involving different instruments did not double count [i.e., 3 concurrent years of training on piano and flute, were counted as 3 years of training]). We did not specify the definition of formal music training for participants, allowing them instead to report any experiences that were formal and meaningful enough to them to count as formal training (As would be expected, total years of training calculated from responses to "any formal music training" correlated highly with total years calculated from responses to separate questions about "individual private lessons" for a participant's primary instrument [$r = 0.699$, $p < 0.001$]). Seventy-four percent of the parents in our sample had some previous formal musical training, with an average training duration of 6.47 years (SD = 7.01) (see Table 1).

2.2.4 | MacArthur-Bates Communicative Development Inventories: Words and Gestures

The MacArthur-Bates Communicative Development Inventories: Word and Gestures form (CDI; Fenson et al. 2006) is a standardized parent-report of a child's understanding and production of early vocabulary words, as well as a child's use of communicative and symbolic gestures. Responses present vocabulary words from different categories (such as animals, food, toys, and action words) in a checklist format and parents indicate which words their child understands and/or says. For gestures, a checklist is presented and parents indicate which gestures and play actions their child produces. For each scale, the raw number of items endorsed by the caregiver is obtained. The possible ranges (raw counts) for each scale are: 0–396 for Words Understood and Words Produced, and 0–63 for Gestures.

2.3 | Procedure

At study entry, caregivers reported on their demographics, their social motivation using the ComQ, and their formal musical training background using MQA. Caregivers reported on the parent-child home music environment using the M@H at up to three time points (9, 12, and 18 months of age) and on their children's words and gestures using the CDI at all four time points (9, 12, 15, and 18 months of age). Note that as this was part of a larger study, the language and music surveys included in this study were not completed consecutively at any time point as they were always interspersed with other measures.

2.4 | Data Analysis Plan

We conducted two sets of analyses to answer our research questions. The first set of analyses assessed the association between both parent musical training and parent social motivation with the home music environment while controlling for child age (previously reported to relate to parent singing/music playing (Custodero, Rebello Britto, and Brooks-Gunn 2003; Yan et al. 2021)) and maternal education (inconsistent relationships with parent singing/musical behaviors (Custodero, Rebello Britto, and Brooks-Gunn 2003; Yan et al. 2021)). For these analyses, we specified three different mixed-effects models predicting the M@H Total score, PB score, and PS score, respectively. ComQ score and years of musical training were included as fixed effects. Random intercepts and linear random slopes for age per participant were also specified to account for individual differences in families' engagement in musical activities. We *Z*-scored all dependent variables, as well as the ComQ score and the years of formal musical training across the sample. We also fitted a second-order orthogonal polynomial to child age to obtain uncorrelated linear and quadratic components of change over time to account for linear and non-linear developmental trajectories (see Mirman 2014). However, as per model comparison, only the linear component of age was necessary in this set of models to account for the developmental trajectories observed for music engagement.

The second set of analyses evaluated the relationships between the home music environment and child language production, comprehension, and gesture development, respectively. We were interested in evaluating the association of the music environment with language development overall, as well as with the longitudinal trajectories of language acquisition. Therefore, we modeled the trajectories of language development using growth curve models that accounted for age-related language growth and included both the M@H score for a given scale, and its interaction with child age as fixed effects. We also controlled for maternal education, and child sex in the models as these variables have been related to language development (Huttenlocher et al. 1991; Magnuson et al. 2009; though see Bergelson et al. 2023 for null effects of these variables on child language production in a large, diverse, cross-cultural sample). For each domain of language development (i.e., production, comprehension, and gesture), we specified separate growth curve models to assess the relationship with the music environment as a whole, as well as with each of the two scales of interest, specifically (i.e., PS and PB). We summarized the Music@Home variables per child averaging across time points, and then *Z*-scored those means across the sample to facilitate the interpretation of the results.

For this second set of analyses into children's language development, we compared models with only a linear component of age versus both the linear and the quadratic components to account for the typical curvature of the language trajectories at this age. Below, we only present the results for the best-fitting models according to their AIC scores. For language production, the linear component was sufficient, while for comprehension and gesture, including both the linear and quadratic led to the best fit. Child sex was effect-coded to obtain overall effects for all other predictors. Lastly, the language distributions for production and comprehension were, as is expected for the developmental period under study, very positively skewed. So, we added 1 to all production and comprehension scores (as the logarithm of 0 is undefined) and log-transformed them to correct the heteroscedasticity of the residuals. Gesture scores and their corresponding residuals had better distributions, so we used the raw scores as the dependent variable in the gesture models. All models included a random intercept and a linear random slope for age per participant to account for individual differences in language skills and developmental rate.

Data was analyzed using RStudio (R Core Team 2022), and the lme4 (Bates et al. 2015) and lmerTest (Kuznetsova, Brockhoff, and Christensen 2017) packages were used to run the models and calculate their significance levels. The EMAtools package (Kleiman 2022) was used to calculate *d*-scores.

3 | Results

3.1 | Parent Social Motivation, Formal Musical Training, and the Home Music Environment

We first assessed the roles of parent social motivation and parent musical training in predicting the home music environment, controlling for demographic variables. Parent social motivation (ComQ) significantly predicted the overall home music environment (M@H Total) ($\beta = 0.39$, $p < 0.05$, $d = 0.81$, 95% CI [0.10, 0.68]), as well as the PB scores ($\beta = 0.32$, $p < 0.05$, $d = 0.77$, 95% CI [0.06, 0.59]) and PS scores ($\beta = 0.36$, $p < 0.05$, $d = 0.71$, 95% CI [0.05, 0.67]). More socially motivated parents self-reported having homes that were more musical overall. And specifically, more socially motivated parents self-reported stronger beliefs in the benefits of music (Figure 1a) and increased singing to their children (Figure 1c).

In contrast, parent musical training only significantly predicted PB ($\beta = 0.26$, $p < 0.05$, $d = 0.72$, 95% CI [0.03, 0.49]). Higher levels of parental formal musical training, correlated with higher self-reported beliefs in the benefits of music (Figure 1b). However, parent musical training did not significantly predict parents' self-reported active engagement in singing to their children (Figure 1d), nor did it predict the broader home music environment.

Both the M@H Total score and the PS score were stable across development and showed no moderation of effects by age or maternal education. PB scores, however, were significantly predicted by child age ($\beta = -2.11$, $p < 0.05$, $d = -0.86$, 95% CI [−3.83, −0.38]), and by the interaction between ComQ and child age ($\beta = 1.87$, $p < 0.05$, $d = 0.84$, 95% CI [0.11, 3.51]). As depicted in Figure 1a, while for younger infants, parents self-reported high beliefs in the importance of music for their child's development regardless of their social motivation, for older children moving into the toddler stage, these beliefs only persisted for parents with high social motivation. The older the child, the more socially motivated the parent had to be in order to still report strong beliefs in the benefits of music. Given that the M@H measure was not equally available at all time points and ComQ was only measured at baseline, these results should

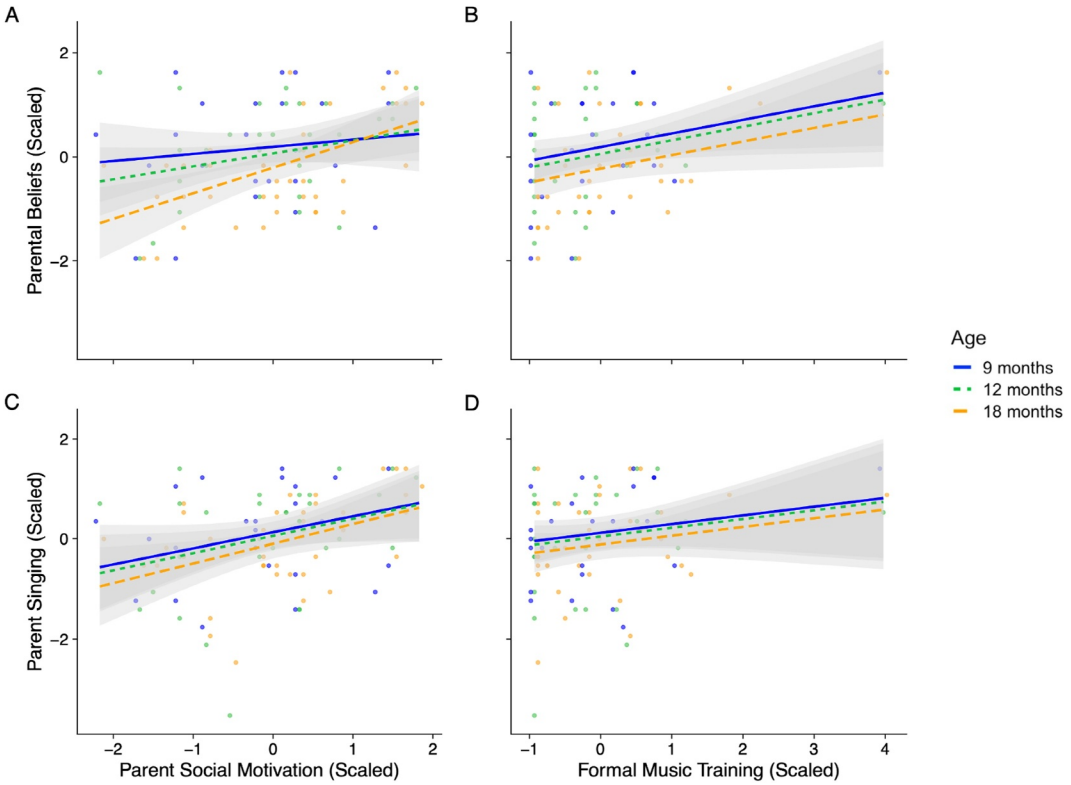

FIGURE 1 | Parent social motivation predicts parental beliefs and parent singing. Model predictions for parental beliefs and parent singing scores as a function of parent social motivation (panels A and C on the left, respectively) and parent formal music training (panels B and D on the right, respectively). Raw data points, and predictions for the different time points are shown with different colors and line types. Note age was a continuous variable in the models, but is presented as different groups in the figure for ease of visualization. The shaded regions reflect 95% CI around the model predictions.

be interpreted with caution (For the full results of each model see Supporting Information S1: Table S1).

3.2 | The Home Music Environment and Child Language Development

We next examined how the home music environment predicted children's language development from 9 to 18 months of age and controlled for demographic variables. M@H Total significantly predicted higher overall scores for words produced ($B = 0.16$, $p < 0.01$, $d = 0.98$, 95% CI [0.06, 0.26]), words understood ($B = 0.12$, $p < 0.01$, $d = 0.91$, 95% CI [0.04, 0.21]), and gestures produced ($B = 2.87$, $p < 0.01$, $d = 0.98$, 95% CI [1.18, 4.57]). PS also significantly predicted higher overall scores for words produced ($B = 0.15$, $p < 0.01$, $d = 0.88$, 95% CI [0.04, 0.24]), words understood ($B = 0.11$, $p < 0.05$, $d = 0.82$, 95% CI [0.03, 0.20]), and gestures produced ($B = 2.47$, $p < 0.05$, $d = 0.86$, 95% CI [0.71, 4.23]), as well. In contrast, PB did not show a significant effect on children's overall vocabulary production or comprehension, or gesture production (ps > 0.72; ds < 0.12), nor their growth (ps > 0.43; ds range = −0.24–0.14; See Figure 2, panels b, d, and f). Taken together these results suggest that consistently and actively engaging with infants in informal musical activities at home, and specifically engaging infants with singing, correlates with overall language and gesture development in early childhood, as per parent report (see Figure 2, panels a, c, and e).

As expected, age was a significant predictor of language growth in all models (ds range = 5.05–7.95, ps < 0.001). The interactions between M@H scales and age, however, did not reach significance in the current sample for any of the language domains investigated (Words Produced—M@H total: $B = 0.60$, $p = 0.15$, $d = 0.48$, 95% CI [−0.20, 1.40]; Words Produced—PS: $B = 0.67$, $p = 0.11$, $d = 0.52$, 95% CI [−0.14, 1.47]; Words Produced—PB: $B = -0.34$, $p = 0.43$, $d = -0.25$, 95% CI [−1.17, 0.49]; Words Understood—M@H: $B = 0.05$, $p = 0.90$, $d = 0.04$, 95% CI [−0.63, 0.72]; Words Understood—PS: $B = -0.26$, $p = 0.46$, $d = -0.23$, 95% CI [−0.93, 0.41]; Words Understood—PB: $B = 0.16$, $p = 0.66$, $d = 0.14$, 95% CI [−0.52, 0.83]; Gestures—M@H: $B = 9.67$, $p = 0.15$, $d = 0.48$, 95% CI [−3.13, 22.46]; Gestures—PS: $B = 8.41$, $p = 0.21$, $d = 0.39$, 95% CI [−4.57, 21.37]; Gestures—PB: $B = -2.87$, $p = 0.68$, $d = -0.13$, 95% CI [−16.19, 10.41]). If the early home music environment relates to the growth rate of the language development trajectories, we were not powered to detect it in this study. Child sex and maternal education were not significant predictors in any of the models either (ps > 0.28). For the full results of each model see Supporting Information S1: Table S2.

As noted previously, our focus here was on the PS and PB scales to look at parent-focused scales of the M@H; however, given prior studies of children's rhythmic/musical behaviors and language development (e.g., Ní Choisdealbha et al. 2023; Nguyen et al. 2023; Politimou et al. 2019), we provide results for the CAE and PCMM scales predicting child language and gesture development in Supporting Information S1 for the

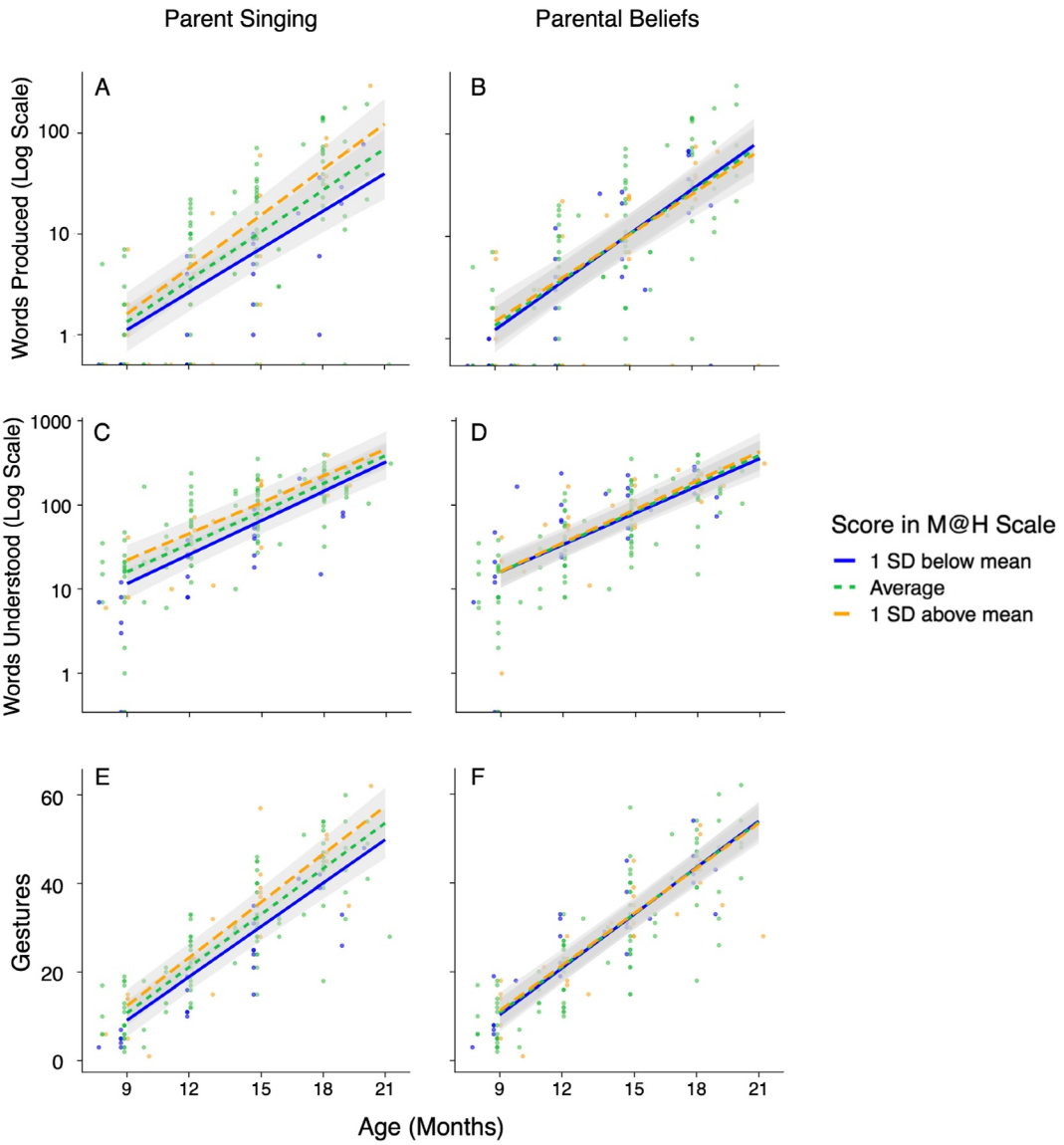

FIGURE 2 | Parent singing (not parental beliefs) predicts domains of child language development. Model predictions for language scores as a function of age (*x*-axis) and the parent singing and parental beliefs scores (average and 1 SD above and below presented with different colors and line types). The raw data points are shown color coded depending on the scores in the Music at Home scales, with different colors for participants with scores between −1 and 1 SD (green), participants above 1SD (orange), and participants below 1SD (blue). Note that the M@H scores are continuous variables in the models, but are discretized here for ease of visualization. The *y*-axis is plotted in log scale for the top and middle panels (A–D) but is linear for the bottom ones (E–F). The shaded areas represent 95% CI around the model predictions.

interested reader (see Supporting Information S1: Figure S1 and Table S3).

4 | Discussion

Music is a ubiquitous activity in the early home environment and parents engage in music with their young children for a variety of functions in industrialized, educated, Western societies (Steinberg, Liu, and Lense 2021). In the current study, we first examined individual parent characteristics that relate to the self-reported home music environment in the first years of their child's life in this population. We then investigated how specific aspects of the home music environment related to parent-reported children's language development. We discuss the findings for each of these aims and their implications below.

4.1 | Parent Social Motivation and the Home Music Environment

The first goal of the present study was to explore whether parent social motivation and musical training were related to early parent-child music engagement. In particular, we were interested in contrasting the strength of such relationship for parents' self-reported active singing to their child (i.e., a behavior) and parents' beliefs in the benefits of music. Parents' social motivation was more strongly and consistently related to the home

music environment than was musical training. Parent social motivation positively covaried with the home music environment overall, and specifically, with parent beliefs and parent singing. In contrast, parents' formal musical training was only related to parent beliefs and had no relationship with how much parents reported actually interacting musically with their children.

Prior research in Western cultures that has considered parent factors predicting the home music environment has been primarily focused on parents' own musical training. This research has mixed findings: parents with more musical training reported a more musical home environment for their infant using the Music@Home, although the correlations were generally small in magnitude (Politimou et al. 2018). Amongst the different Music@Home scales, musical training was most strongly associated with parental beliefs rather than active musical behaviors like singing to their infant (Politimou et al. 2018). Similarly, parent musical training was associated with parent-infant music listening but not parent singing to their infant in a separate study (Ilari 2005). Relatedly, a study with school-aged children highlighted that parents' beliefs about the developmental benefits of music promoted more interest in their children's musical behaviors but had no influence on the musical activities actually conducted in their households (Kreutz and Feldhaus 2020). The current study adds to prior evidence in suggesting that parent musical training does not relate to parents' reports of actual music engagement with their infants even though it does to parents' beliefs in the importance of music. This highlights the need for researchers to consider other parent-related characteristics to better understand individual differences associated with a musical home environment.

To our knowledge, parents' general social motivation has not previously been considered in the context of the home music environment. Parent social motivation was strongly associated with both parents' active singing to their child and their beliefs in the importance of music as measured via parent self-report. This may relate to the strong connection between music and social engagement (Savage et al. 2021) and the social performative nature of parents' infant-directed singing (Lense et al. 2022). Previous studies associate general musical engagement/interests in adults with higher extraversion and social motivation (Luck et al. 2010; Ruth et al. 2023; Wainer, Ingersoll, and Hopwood 2011). Even amongst musicians (professional or amateur), singers report higher degrees of extraversion than instrumentalists, which is thought to relate to the high social demands of vocal performance (Kuckelkorn, de Manzano, and Ullén 2021). The current study suggests these findings in non-child-directed contexts may extend to the fundamental social context of the parent-child relationship. While previous work has highlighted how musical interactions in infancy relate to parent-child social bonding and attachment (Steinberg, Liu, and Lense 2021) and to children's development of prosocial behavior (Williams et al. 2015), the current study uniquely adds parents' broader (non-infant-directed) social motivation as another factor to consider when investigating the social function of music in caregiving and early child development. Future work could consider if parent social motivation connects to their social reward experience of music (e.g., Mas-Herrero et al. 2013; Nummenmaa, Putkinen, and Sams 2021), which could contribute to a positive feedback loop that cultivates a more musical home environment.

Beyond the main relationship between parent social motivation and parent beliefs, there was also an interaction with child age such that parent social motivation was more strongly associated with parent beliefs for older infants (18 months) than for younger infants (9 months). Given the uneven distribution of the Music@Home across time points, we consider this finding to be preliminary (though we note that such an interaction with age was not also observed between parent social motivation and parent singing, which involved the same time points of data collection). Nevertheless, we speculate on potential interpretations. These results may be related to the socialization of parents with younger infants. During early infancy, there is more emphasis and social pressure on improving child development with music activities such as singing to one's baby and attending Mommy and Me music classes (Ilari 2005). Therefore, this may shape parents' beliefs during this time. As children get older and this social pressure decreases, parents who are less socially motivated may no longer report as strong of beliefs. Another potential explanation may be that as children get older, these emphasized music activities become even more social, involving more group activities. Therefore, parents who are less socially motivated may be less participatory in such experiences. These parents may then believe that music is no longer beneficial if they are not interested in participating in those experiences. Future research with larger samples will be needed to replicate and, if upheld, identify the reasons behind this interaction effect.

4.2 | Language Development and the Home Music Environment

The second goal of the present study was to determine how the parent-reported home music environment relates to the trajectories of parent-reported child language development in our longitudinal sample. We found that the overall home music environment and specifically, parent singing, positively correlated with child language development across 9–18 months of age when considering multiple domains of language: vocabulary comprehension, vocabulary production, and gesture production. While we did not find significant interaction effects of the home music environment/parent singing with child age on child language growth, the interaction effect sizes were medium for vocabulary production and gestures. Our ability to detect interaction effects in the current study may have been limited by low power due to the sample size and variability. Future work can follow up on these potential interactions with larger and more variable samples, and perhaps consider an even longer developmental time period (e.g., 24 months rather than 18 months), to investigate if home music environments may also covary with faster language growth over time. Regardless, the current findings, including M@H being significantly associated with child vocabulary production, extend prior studies of parent singing and child language development, which examined cross-sectional or single follow-up time points for child language comprehension and gestures (Franco et al. 2022; Papadimitriou et al. 2021).

In contrast, we found no association between (parent-reported) parent beliefs and child language development. These findings highlight the importance of distinguishing between parents' beliefs about music versus parents' actual music behaviors with their child (which may also apply to parenting in general; Holden et al. 2022). It requires more than parents' belief in music for music to impact their child's development; parents must actively take steps to create this musical environment. Enriching musical engagement with infants is likely more about the positive and interactive social experience rather than highly skilled musical experiences (noting that parent formal musical training, as a proxy for parent musical "skill," was associated with parents' beliefs but not their self-reported singing). Musical interactions provide a positive, highly social, and, in the case of singing, linguistically rich experience. It is through these types of social interactive contexts that children learn and advance their communicative skills. The connection between parents' self-reported active singing behaviors with their infant and infant language and gesture development also highlights the embedded nature of infant learning, where children's skills are developed by interacting with their everyday environments (Tamis-LeMonda and Masek 2023). For example, many songs and nursery rhymes that parents sing to their young children include specific song-associated gestures and movements and use a combination of repetition and novelty to provide and structure linguistic information (Labendzki, Goupil, and Wass 2023).

While the current study results are correlational, we can consider the mechanisms by which musical interactions such as singing may engage processes important for infant language learning. Musical interactions may be effective language learning contexts in part due to infants' increased attention to caregiver singing (vs. speech), particularly for multimodal audiovisual singing (Trehub, Ghazban, and Corbeil 2015). During infant-directed singing, singers modulate their facial expressions and infants modulate their social attention to support dyadic social communication (Lense et al. 2022). Infants also increase their looking toward the caregiver's mouth during infant-directed singing, which may facilitate language development through potentiated multimodal cues (e.g., to rhythm, audiovisual synchrony, etc.; Alviar et al. 2023). Indeed, infants' neural tracking when engaged by multimodal singing is associated with their later vocabulary skills (Nguyen et al. 2023). Interactive musical activities including singing may support the development of auditory processing in young children, including detection of temporal and melodic changes important for both music and speech processing (Langus, Mehler, and Nespor 2017; Putkinen, Saarikivi, and Tervaniemi 2013; Putkinen, Tervaniemi, and Huotilainen 2019; Zhao and Kuhl 2016). These findings highlight the importance of educating and supporting parents to actively engage in social musical interactions with their infants.

4.3 | Limitations

While the present study provides novel insight into the relationships among parent characteristics, the home music environment, and child language, the results should be examined considering some limitations. First, while all the measures used are well-validated and widely used measures of their respective constructs, the results rely on self-reported data which may be under- or over-reported. Comparisons of caregivers' self-reported singing against the time they actually spend singing on daylong audio recordings reveal low rates of actual singing despite high rates of self-reported singing (Costa-Giomi and Benetti 2017; Costa-Giomi and Sun 2016). This is an important consideration when interpreting the results. However, this discrepancy is perhaps unsurprising and may be less alarming than it appears. Music making and singing with infants is a behavior that typically occurs in short and bursty episodes (Mendoza and Fausey 2022), and so recordings, even when daylong, might be at risk of underestimating the occurrence of the behavior. For bursty behaviors, self-report measurements might actually capture general behavioral patterns better than direct measurement over only a few days. For instance, Ecological Momentary Assessments (EMA) completed 1–3 times a day over 6 weeks find singing is a very common daily activity for families of infants, though still variable in its frequency between families (Cho et al. 2024). The Music@Home questionnaire aims to measure this variability in the behavioral patterns of families' music engagement over longer timescales (asking for frequency of behaviors over days, weeks, and routines). So, although an imperfect and possibly overestimated measure, the M@H should likely still reflect the natural variability in the frequency with which different families regularly engage in music. Future empirical investigations comparing responses to the M@H with EMAs will be necessary to further inform this issue.

Second, the M@H data was not available for every participant at every time point, due in part to the instrument not yet being publicly available when data collection began. Therefore, the reported age effects are only preliminary (though note we still had good coverage across earlier [9–12 months] and later [18 months] time points). Third, the sample is limited concerning size and demographic diversity of participants. This importantly limits the generalizability of our findings. The majority of mothers in our sample were white and college educated, so our findings only directly generalize to this population. While we controlled for maternal education in our analyses and, consistent with prior studies (e.g., Bergelson et al. 2023; Mehr 2014; Yan et al. 2021), did not find it to be related to either home musical environment or child language, the limited variability of this characteristic in our sample limits our conclusions about this. We were unable to examine other potential demographic variables, but prior studies have not reported differences in frequency of maternal singing related to ethnicity (Mehr 2014; Yan et al. 2021), and have highlighted the ubiquity of this behavior across the population. Replication of this study with a larger and more diverse sample would strengthen the current results.

4.4 | Future Directions and Implications

The results of the present study raise many questions for future research. While we focused here on parent characteristics, future research may explore how child-related variables (e.g., temperament, children's musical skills) correlate with early

parent-child musical engagement and moderate its relationship with language development. Analyses presented in Supporting Information S1 point to individual differences in infants' early rhythmic skills and musical engagement as two of such variables that are related to child language development (see Supporting Information S1 for more in-depth discussion). As well, our findings are limited to infants in the first 18 months of life. Future research may investigate parent factors of social motivation and music training and the home musical environment over longer time periods. As children get older, daily shared parent-child activities, including music, substantially decrease (Kreutz and Feldhaus 2020). This may in part be related to parents believing their children receive enough music engagement in preschool settings (de Vries 2009; Williams et al. 2015). One study found that parents who reported being sung to when they were young were more likely to also sing to their preschoolers, while parents' own musical skills (assessed via a standardized assessment), were unrelated to their musical engagement with their preschoolers (Mehr 2014). This may suggest informal parent-child musical interactions into the preschool period continue to primarily reflect shared social engagement experiences.

Another question raised by the current study that tempers the current findings, is whether these results reflect a direct connection between the home music environment and child language or whether instead this relationship is (in part) mediated by the effects of musical interaction on other variables. For example, parental singing leads to an immediate increased sense of closeness to one's infant (Fancourt and Perkins 2018), which might in turn prolong and promote additional parent-child musical interactions, but also other types of non-musical interactions (such as conversations, book-reading, and non-musical play) that support language development. In a recent study, dyads randomized to a parent-infant music class (vs. a non-music play program) exhibited increased conversational turns during free play following 6-month of music class experience (Smith et al. 2024). Conversational turns, a marker of contingent vocal responsiveness during social interactions, are a predictor of child language development (Ferjan Ramírez, Lytle, and Kuhl 2020; Smith et al. 2024). It is also possible that the observed relationships in the current study result instead from parents with more musical households simply being parents who talk to their children more and/or provide higher quality linguistic input to their child. However, the quantities of speech and music a parent provides to their infant at home were not correlated in a recent study using daylong audio recordings (Hippe et al. 2024). As well, Music@Home scores during infancy were only very weakly correlated ($rs \leq 0.2$) with measures of parent-child engagement (combining quantity and quality) in non-musical activities such as reading or developmental play, and parent singing was not correlated at all with these other forms of engagement (Politimou et al. 2018; Papadimitriou et al. 2021). Still, the association between the home music environment and child language development may be about the quality of language interactions as opposed to the quantity (see Liu et al. 2024 regarding quality [but not quantity] of linguistic input around reading and musical environment during preschool years). At this time, therefore, it is unknown if there is a true independent effect of the home music environment/singing on child language or if music engagement/singing is simply a reflection of a high-quality, socially responsive, language-promoting environment and has no "value-added" role. In one study, after controlling for shared book reading, shared parent-child music activities were no longer significantly associated with improved child vocabulary (though they continued to be associated with children's attention and prosocial skills) (Williams et al. 2015). However, these results used a single item report of the musical home environment and were in children aged two to 5 years, when book reading is a more relevant and developmentally appropriate activity. At the early age of the present study's participants, parent singing is much more likely than reading and is more developmentally appropriate (Yan et al. 2021) (and as noted above, music/singing and quantity of language input are not clearly related with each other in infancy (Hippe et al. 2024; Politimou et al. 2018)). Future research needs to longitudinally compare music activities to non-music activities in infants and consider the broader language environment of the infant to identify if and how musical experiences may differentially or synergistically relate to or affect language development.

The results of the present study may also have implications for infants with elevated likelihood for developmental and/or learning disabilities (Hutchins 2018; Thompson 2012; Vaiouli and Andreou 2018; Yang et al. 2014) and for low-income families, where children are more likely to fall behind academically (Kraus et al. 2014; Slater et al. 2014). Previous studies have shown that free community music classes are associated with auditory enrichment and reading scores in school-aged children (Kraus et al. 2014). The current study suggests informal parent-child music engagement correlates with language development beginning in infancy. Perhaps promoting infant-directed singing through parent-infant music classes or other music-based experiences (Fancourt and Perkins 2019) might be an accessible way to support underserved populations (Teggelove, Thompson, and Tamplin 2019).

5 | Conclusions

The current study highlights the fundamentally social nature of the home music environment during infancy and the importance of considering parent factors in this environment. Parents with higher social motivation (but not parents with more musical training) reported a more musical home environment, particularly through their engagement in singing to their child. The highly social nature of music experiences in infancy may also help explain, in part, why the home music environment is positively related to child language development. Our correlational results suggest parental music and singing may serve as a socially meaningful, attention-grabbing, and developmentally appropriate scaffold for language development in the first years of life (Vaiouli and Andreou 2018).

Author Contributions

Ashley S. Boyne: formal analysis, visualization, writing–original draft, review and editing. **Camila Alviar:** data curation, conceptualization, formal analysis, methodology, writing–original draft, review and editing, visualization. **Miriam Lense:** funding acquisition, conceptualization, supervision, writing–review and editing.

Acknowledgments

We thank Meredith Watson, Valerie Muñoz, Talia Liu, and Olivia Boorom for data collection assistance. This research was supported in part by the National Institute for Deafness and Communication Disorders, Grant/Award Number: R21DC016710; National Institute of Mental Health/National Center for Complementary and Integrative Health, Grant/Award Number: R61/R33MH123029; National Endowment for the Arts, Grant/Award Number: NEA 1906827-38-22; VUMC Faculty Research Scholars; Academy of Country Music Lifting Lives Foundation; and the VUMC Department of Otolaryngology. The use of REDCap was made possible by the Vanderbilt CTSA Grant from the National Center for Advancing Translational Science/National Institute of Health, Grant/Award Number: UL1 TR000445. The NIH and NEA do not guarantee the accuracy or completeness of the information included in this report and are not responsible for any consequence of its use.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The code and datasets that support these findings can be found in this OSF repository: https://osf.io/2u4d3/?view_only=None; doi: 10.17605/OSF.IO/2U4D3.

Endnotes

[1] Note that PS and PCMM scales were termed Parent Initiation of Singing and Parent Initiation of Music-Making in the original publication of the M@H scale (Politimou et al. 2018); however, we have removed the term "initiation" from the scale names because the text of the items themselves does not stipulate that the parent is initiating the activity; as well, the PCMM items all require active involvement by the child (Fram, Liu, and Lense 2024; N. Politimou, 2023, personal communication, September 13, 2023).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.