The Impact of the Home Musical Environment on Infants' Language Development

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Abstract

There is strong evidence that musical engagement influences children's language development but little research has been carried out on the relationship between the home musical environment and language development in infancy. The current study assessed musical exposure at home (including parental singing) and language development in 64 infants (8.5 - 18 months). Results showed that the home musical environment significantly predicted gesture development. For a subgroup of infants' below 12 months, both parental singing and overall home musical environment score significantly predicted word comprehension. These findings represent the first demonstration that an enriched musical environment in infancy can promote development of communication skills.

Keywords: home musical environment, parental singing, language development, infancy

1. Introduction

In recent years, abundant research has associated musical training with positive language-related outcomes in adults (Kraus & Chandrasekaran, 2010; Kraus et al., 2009) and a number of randomized controlled trials in school-aged children have suggested causal links between formal musical training and at least some aspects of language processing (e.g. Barac et al., 2011; François et al., 2013; Moreno et al., 2008; 2011). Furthermore, Zhao and Kuhl (2016) recently revealed that infant music classes enhanced neural processing in aspects of both music and speech perception. For infants and toddlers, however, music is predominantly experienced in the home environment e.g. song and musical play in the form of dancing and/or interacting with musical instruments. Infants appear to show spontaneous inclination and enjoyment towards music and are equipped to process sound early on, as evidenced by their remarkable auditory discrimination abilities (Cirelli et al., 2016; He & Trainor, 2009; Plantinga & Trainor; Trainor & Adams, 2000). Furthermore, evidence of a perceptual shift from universal to native sounds in language during infancy (e.g. Langus et al., 2016; Werker & Tees, 2005) but also in music across early childhood (Corigall & Trainor, 2013; Jentschke, Friederici, & Koelsch, 2014) suggests that exposure to these everyday sounds has the potential to shape auditory perception and that shared learning mechanisms may underlie the two domains (see Brandt, Slevc, & Brevian, 2012 for a review). Infant-directed (ID) singing is arguably the most typical musical behavior that infants are exposed to in the home. ID-singing possesses several characteristics that distinguish it from adult-directed (AD) communication including higher pitch, slower tempo, repetition of shorter sequences and sustained pauses (Falk & Kello, 2017; Trainor et al., 1997; Trehub et al., 1997). Emotional arousal can be effectively regulated through ID singing (Shenfield, Trehub, & Nakata, 2003) and preference for ID singing over speech can be seen in infants between 6 and 10 months (Nakata & Trehub, 2004; Tsang & Falk, 2017). By 8 months infants learn lyrics and melody more easily when paired together than when presented alone (Thiessen & Saffran, 2009). Finally, studies have indicated that ID singing facilitates aspects of phonetic perception and word learning in both infants (Lebedava & Kuhl, 2010; Thiessen & Saffran, 2009) and adults (Schön et al., 2008). Crucially, neonatal brain responses to sung but not spoken streams of syllables have been shown to predict expressive vocabulary at 18 months (François et al., 2017).

While ID singing provides an attractive means of musical interaction, there are many additional ways and reasons to musically engage with one's child. Indeed, by quantifying children's musical exposure in the home using all-day recordings, Mendoza and Fausey (2019) have shown that a large amount of everyday musical experience (either recorded or live) is available to infants during the first year of life. Informal musical activities may also involve musical play using household items such as percussive instruments, listening to music, synchronizing or dancing to the beat of the music or any type of musical activity that does not require instruction (Cirelli et al., 2016; Huotilainen & Tervaniemi, 2018).

Only four studies so far (Politimou et al., 2019; Putkinen et al., 2013; Schaal et al., 2020; Williams et al., 2015) have directly assessed the effect of informal home musical experience on language development. They reported enhanced language and music-related auditory processing (Putkinen et al., 2013), improved vocabulary (Schaal et al., 2020; Williams et al., 2015) and higher grammar scores in young pre-schoolers as a function of informal musical experience at home (Politimou et al., 2019). These findings are a promising indication of the importance of *informal* musical environment for early years (see also Putkinen et al., 2015) but research around the music/language relationship at an even earlier stage – during infancy – is still lacking. The infancy stage may be particularly opportune for assessing this association. Compared with later stages of development, infants spend a greater amount of time at home relative to preschoolers (OECD, 2019) and parent-led musical activities may be particularly rich at this time, particularly because communicative and physical abilities are relatively limited.

A number of self-report tools have been used in the past for the assessment of the musical home environment, such as the HOMES-Home Musical Environment Scale (Brand, 1985) and the CMBI - Children's Musical Behaviour Inventory (Valerio et al., 2012). Other studies have used ad-hoc questionnaires and/or parental interviews to explore how parents use music at home with children younger than 6 years. However, these questionnaires typically addressed specific aspects such as frequency of musical interactions while neglecting others, such as breadth of musical exposure or parental beliefs regarding music and development. In contrast, a recently developed instrument - the Music@Home parent-report questionnaire (Politimou et al., 2018) draws on the responses of 1060 parents and encompasses a range of parent and child musical behaviours for infants and preschoolers. Unlike other measurements used in previous studies, this parent-report questionnaire does not only assess the frequency of musical interactions but is also able to address a number of dimensions that constitute the home musical environment, such as parent initiation of singing and music-making, the child's active engagement and parental beliefs about music. Finally, the Music@Home demonstrates good psychometric properties, such as internal consistency, test-retest reliability and convergent and divergent validity, and was validated not only for use with preschoolers but also with infants (Politimou et al., 2018).

Taking advantage of this novel tool, we set out to examine associations between informal musical environment and language/communication development in infancy. Of all the subscales of the Music@Home, parental singing is arguably the one with the most obvious associations to language development based on previous research. Nevertheless, prior literature also demonstrates a positive influence of other aspects of musical experience e.g., joint music-making on language development (e.g., Putkinen et al., 2013). Furthermore, subscales such as parental beliefs about music and child's active engagement are presumably reflective of activities that are going on within the home and will have reciprocal influences. For instance, an infant displaying active engagement may motivate a parent to provide more opportunities for musical interaction, thus bootstrapping their nascent musical inclination. We measured word comprehension and gestural communication skills, via the UK-Communicative Development Inventory (UK-CDI, "Words & Gestures" form - Alcock, Meints & Rowland, 2020). We specifically hypothesised that the *Parental Singing Initiation* subscale of Music@Home, as well as the overall Music@Home score would be significant predictors of word comprehension and gestural communication skills, as measured in infants between 8.5 and 18 months old, an age group where communicative skills develop rapidly and can be evaluated through parental reports.

2. Methods

2.1. Participants

Participants were recruited from Children Centres in East Hertfordshire (UK), after several in-person visits to baby and toddler playgroups. To be eligible for participation, infants were required to be between 8.5 and 18 months old and for English to be the only language spoken at home. While 103 infants were recruited, 39 infants were subsequently excluded due to incomplete surveys. Infants in the final sample (N = 64, 37 female, 27 male) were between 8.5 and 18 months of age (mean age 11.9 months, SD = 2.90). One infant who had just reached 19 months was retained in the sample since his inclusion was deemed unlikely to skew results.

2.2. Materials

Participants completed a demographic section giving information about parental education level and socio-economic class (based on the National Statistics Socio economic Classification or NS-SEC; Rose, Pevalin, & O'Reilly, 2005). The 73.5% of the parents who completed the survey had at least a bachelor or another degree/diploma of equivalent level.

Parents' Education Level

		Frequency	Percent
2	First School Qualification	5	7.8
3	Second Qualification (A levels)	7	10.9
4	Certificates of higher education	2	3.1
5	Diplomas of higher education (e.g.HNDs, HNCs etc)	3	4.7
6	Bachelor Degree	19	29.7
7	Post-Graduate Education	24	37.5
8	Doctorates	4	6.3
	Total	64	100.0

Parents' self-coded Classification according to National Statistics Socio-economic Classification

	NS-SEC class	Frequency	Percent
1	Managerial and professional occupations	48	75.0
2	Intermediate occupations	4	6.3
3	Small employers and own account workers	7	10.9
4	Lower supervisory and technical occupations	2	3.1
5	Semi-routine and routine occupations	2	3.1
6	Unemployed	1	1.6
Total		64	100.0

With respect to siblings, 44 (68.8%) infants were the only children in the family, while 20 (31.3 %) had one or more siblings. Finally, the parent completing the survey was predominantly the mother (n= 61), while only in a few cases it was the father (n = 3).

Four questionnaires were completed. The Music@Home-Infant (Politimou et al., 2018) was used for the assessment of the home musical environment. This is an 18-item questionnaire, scored on a 7-point agreement disagreement scale and comprises four subscales:

Parental Beliefs, Child's Active Engagement with Music, Parent Initiation of Singing and *Parent Initiation of Music-making*. Scores for the *Parent Initiation of Singing* can range from 5 to 35. The questionnaire also yields an Overall Music@Home score that can range from 18 to 126. The *Reading* and *Parental Involvement in Developmental Advance* subscales of the Stim-Q Cognitive Home Environment (Dreyer, Mendelsohn & Tamis-LeMonda, 2018) were used for the assessment of the home learning environment and cognitive stimulation. Also included in the survey was a measure of the parents' musical sophistication utilising two subscales from the Gold-MSI, a self-report questionnaire used to assess a multi-faceted involvement with music aside from musical expertise (Müllensiefen et al., 2014). The Musical Training subscale was included to assess parents' level of musical expertise and the Active Engagement with Music subscale assessed parents' personal connection with music. Finally, the UK-Communicative Development Inventory (UK-CDI) was used to assess infant language. This is a standardised parent report tool that provides separate scores relating to the comprehension, production and gestural communication of infants between 8 to 18 months old (Alcock, Meints & Rowland, 2020).

2.3. Procedure

[Ethics statement]. Permission to recruit at several targeted premises was granted through contacting playgroup managers. Parents were approached individually during informal play sessions by researchers, who told them about the goals of the study. Parents who were interested to participate read the information sheet and gave informed consent. Immediately following this, parents were asked to complete a set of questionnaires that included general and demographic information, the Music@Home Infant version, the StimQ questionnaire and the *Musical Training* and *Active Engagement* subscales from the Gold- MSI. Completing these questionnaires took approximately 10 minutes in total. The final questionnaire, the UK

Communicative Development Inventory: Words and Gestures (UK- CDI) is a lengthier questionnaire, taking at least 30 minutes to complete. Some parents were able to complete this questionnaire alongside the previously mentioned measures, while others either took this questionnaire away to complete at home or scheduled a time to complete it over the phone on a future occasion. Importantly, parents who did not complete the UK-CDI at the time, were required to complete it within one week, to ensure that data across all 4 questionnaires could be considered to relate to the same time-frame. Participating parents received a £10 gift voucher as compensation for their time. Afterwards, scores for each questionnaire were calculated and raw data were aggregated for the statistical analyses.

2.4. Statistical Analyses

Data was analysed using SPSS version 23.0 and R software environment (R core Team, 2012). Inspection of UK-CDI scores (comprehension, production, gestural communication) revealed that most infants in the sample were non-verbal, owing to their age, thus analyses examining the relationship between musical home environment with UK-CDI focused only on comprehension and gestural communication.

Before performing the analysis, the data were checked for collinearity. None of the predictors used in the same regression model were correlated (Stim-Q Reading / Age / Music@Home: Parental Singing Initiation /or Music@Home Overall Score). Data were entered into separate exploratory multiple linear regression models, first examining the influence of two Music@Home variables on *UK-CDI Comprehension;* the second examining the influence of these same two variables on *UK- CDI Gestural Production.* In both cases, two models were computed, the first used *Parental Singing Initiation* as main predictor of interest; the second used *Music@Home: Overall Score* as main predictor. In all models, *Infant Age* and

Home Reading Environment scores were also entered into the models, allowing us to assess the influence of the Music@Home predictors over and above these variables.

For each one of these models, the drop1() function in R was used for backward elimination: gradually eliminating variables with no significant contribution to the model. The final models reported here are those which are the most parsimonious and explanatory after progressively removing the different predictors. Regression assumptions were met for all models.

3. Results

The Music@Home: Overall Score, the Music@Home: Parental Singing Initiation subscale (Figure 1 and Figure 2) and the UK-CDI Gestures scores were normally distributed. In order to preserve the relationship with the other variables, the Expectation Maximization imputation method was used to deal with the one missing value in the StimQ-Reading measurement. Once imputation was performed, the StimQ-Reading scores and the UK-CDI Comprehension scores displayed negatively skewed distributions [UK-CDI Comprehension (zSkewness = 4.22, $p<.001$) and StimQ-Reading (zSkewness = 5.85, $p < .001$)]. For that reason and in order to deal with two extreme values in the StimQ-Reading scores, raw data of these measurements were logarithmically transformed. The skewness of the distribution of the Age variable (measured in months) was not statistically significant. As expected, the distribution of the UK-CDI Production scores was highly significantly skewed (zSkewness = 12.85, $p < .001$), as was the NS-SEC variable (zSkewness = 6.60, $p < .001$). For means and standard deviations of all variables, see Table 1.

Table 1

Descriptive statistics of means, medians, standard deviations range, skewness and kurtosis for the predictor and outcome variables.

	Mean	Median	Std. Dev	Range	Skewness	Kurtosis
Music@Home: Overall Score	103.64	104.00	12.24	78-126	-.36	-.70
Parental Singing	28.97	29.50	4.55	16-35	-.69	.03
StimQ-Reading	13.81	14.00	3.63	0-19	-1.75	4.82
Age	11.88	11.50	2.90	8.5-19	.35	-.76
Comprehension	96.02	64.50	97.96	0-382	1.26	.90
Gesture Communication	25.84	23.50	15.79	0-59	.32	-.90
Production	19.25	2.00	49.68	0-276	3.84	15.47

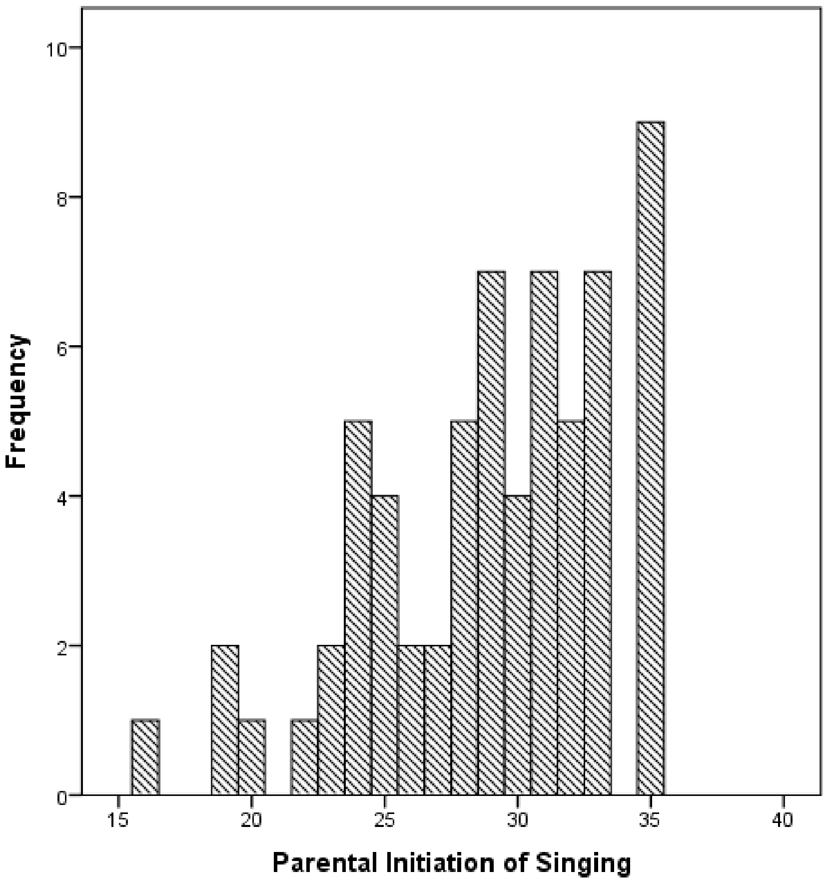

Figure 1.Histogram that shows the distribution of scores for the Parental Initiation of Singing Subscale.

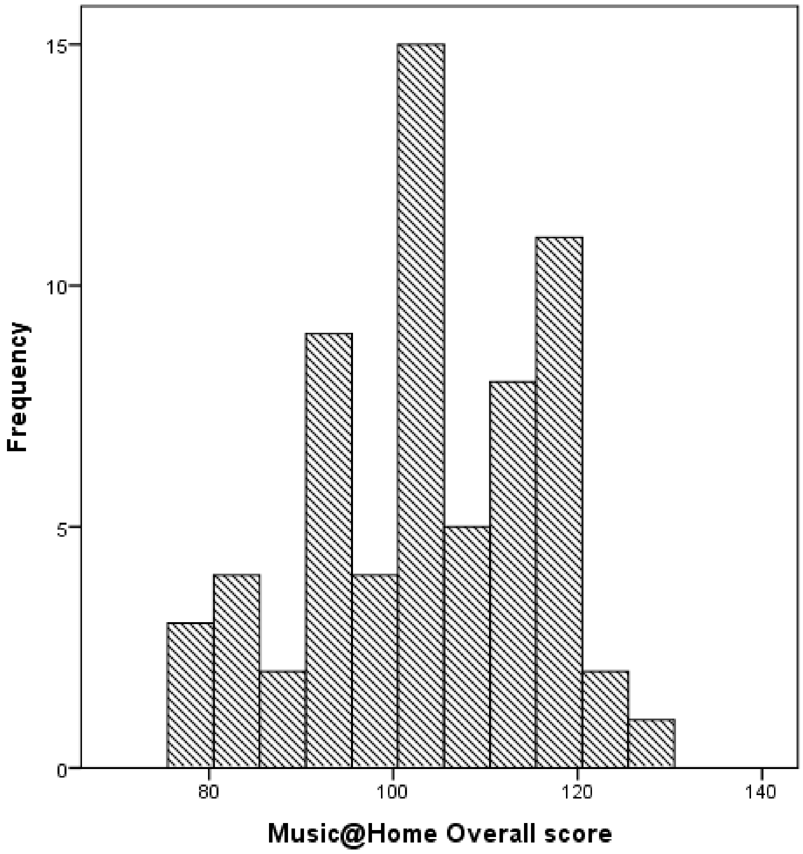

Figure 2. Histogram that shows the distribution of scores for the Music@Home Overall Score.

The correlations between the StimQ-Reading scores, Music@Home: Overall Score, Parental Singing Initiation score, Age and UK-CDI Comprehension and Gestures scores are reported in Table 2.

Table 2

Bivariate correlations between the StimQ-Reading, Music@Home:Overall Score, Music@Home: Parental Singing Initiation, Age, UK-CDI Comprehension and UK-CDI Gestures scores (N=64).

	StimQ-Reading	Music@Home	Parental Singing	Age	Comprehension	Gesture
StimQ-Reading	1	-.05	-.04	-.17	-.25*	-.17

Music@Home	1	.74**	.16	.26*	.29*
Age		-.11	1	.59**	.80**
Comprehension		.08		1	.73**
Gesture		-.06			1
Parental Singing		1			

* Correlation is significant at the 0.05 level.

** Correlation is significant at the 0.01 level.

3.1.Does *Music @ Home: Parental Singing Initiation* predict *UK-CDI?*

As shown in Table 3, *Music@Home: Parental Singing Initiation* was not a significant predictor of either *UK-CDI Comprehension* or *UK-CDI Gestures.* Age was the only significant predictor in both cases.

Table 3

Multiple Regression Results for predicting UK-CDI Comprehension score and UK-CDI Gestures score from Music@Home: Parental Singing Initiation, Age and StimQ-Reading Scores, using Backward Elimination Method (N=64).

Comprehension[a]

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.40	13.14	<.001
Age	.59	5.71	<.001			
Stim-Q	.15	1.46	.15			
Parental Singing	.14	1.41	.16			
Model 3				.35	33.75	<.001
Age	.59	5.81	<.001			

Gestures[b]

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.63	34.70	<.001

Age	.79	9.92	<.001			
Stim-Q	.41	.52	.61			
Parental Singing	.03	.33	.74			
Model 3				.63	106.42	<.001
Age	.80	10.32	<.001			

3.2. Does *Music @ Home: Overall Score* predict *UK-CDI?*

As shown in Table 4, *Music@Home: Overall Score* approached significance in predicting *UK-CDI Comprehension* while *Age* significantly predicted this. In contrast, both *Age* and *Music@Home: Overall Score* was a significant predictor of *UK-CDI Gesture.*

An ANOVA was conducted to compare the model including both *Music@Home: Overall Score* and *Age* as predictors, versus a model where only *Age* was included. Results indicated that the models were significantly different [F(1,62)= 5.82, p<.05] indicating that the *Music@Home: Overall Score* significantly predicted *UK-CDI Gestures* over and above *Age.*

Table 4

Multiple Regression Results for predicting UK-CDI Comprehension score and UK-CDI Gestures score from Music@Home: Overall Score, Age and StimQ-Reading score, using Backward Elimination Method (N=64).

Comprehension[a]

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.40	13.71	<.001
Age	.54	5.33	<.001			
Stim-Q	.15	1.52	.13			
Music@Home	.18	1.75	.09			
Model 3				.35	33.75	<.001
Age	.59	5.81	<.001			

Gestures[b]

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.67	39.76	<.001
Age	.76	9.97	<.001			
Stim-Q	.04	.51	.61			
Music@Home	.18	2.39	.02			
Model 3				.66	60.25	<.001
Age	.77	10.25	<.001			
Music@Home	.18	2.41	.02			

To explore the data further, we next conducted an exploratory analysis to explore the relationships between Music@Home and language development for younger and older infants using median split age (median=11.5) to define the cut-off (n=32 per subgroup). We asked whether the previously analysed variables (Music@Home: Parental Singing Initiation and Music@Home: Overall Score) predict UK-CDI in both younger and older infants,

3.3. Does *Music @ Home: Parental Singing Initiation* predict *UK-CDI in both younger and older infants?*

As shown in Table 5, for younger infants (< 12 months), *Music@Home: Parental Singing Initiation* was a significant predictor of *UK-CDI Comprehension.* In contrast, only *Age* significantly predicted *UK-CDI Gestures.* For older infants (see Table 6), *Music@Home: Parental Singing Initiation* was not a significant predictor of either *UK-CDI Comprehension* or *UK-CDI Gestures.* These variables were only predicted by *Age*.

Table 5

Multiple Regression Results for predicting UK-CDI Comprehension score and UK-CDI Gestures score from Music@Home: Parental Singing Initiation, Age and StimQ-Reading score, using Backward Elimination Method, in Younger Infants (<12 months, N=32).

Comprehension

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.19	2.20	.11
Age	.12	.72	.48			
Stim-Q	.07	.42	.68			
Parental Singing	.40	2.32	.03			
Model 3				.17	6.29	.02
Parental Singing	.42	2.51	.02			

Gestures

	β	*t*	*p*	*R2*	*F*	*P*
Model 1				.15	1.68	.19
Age	.39	2.21	.04			
Stim-Q	.01	.06	.96			
Parental Singing	.05	.28	.78			
Model 3				.15	5.30	.03
Age	.39	2.30	.03			

Table 6

Multiple Regression Results for predicting UK- CDI Comprehension score and UK- CDI Gestures score from Music@Home: Parental Singing Initiation, Age and StimQ-Reading score, using Backward Elimination Method, in Older Infants.

Comprehension

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.22	2.68	.07
Age	.41	2.44	.02			
Stim-Q	.19	1.13	.27			
Parental Singing	-.10	-.60	.56			
Model 3				.18	6.42	.02

Age	.42	2.53	.02			

Gestures

	β	*t*	*p*	*R2*	*F*	*P*
Model 1				.51	9.51	<.001
Age	.70	5.26	<.001			
Stim-Q	.07	.54	.60			
Parental Singing	.02	.16	.88			
Model 3				.50	29.93	<.001
Age	.71	5.47	<.001			

3.4. Does *Music @ Home: Overall Score* predict *UK-CDI in both younger and older infants?*

As shown in Table 7, for younger infants, *Music@Home: Overall Score* was a significant predictor of *UK-CDI Comprehension.* In contrast, only *Age* significantly predicted *UK-CDI Gestures.* For older infants, *Music@Home: Overall Score* was not a significant predictor of either *UK-CDI Comprehension* or *UK-CDI Gestures.* These variables were again only predicted by *Age* (Table 7).

Table 7

Multiple Regression Results for predicting UK- CDI Word Comprehension score and UK- CDI Gestures Score from Music@Home: Overall Score, Age and StimQ-Reading score, using Backward Elimination Method, in Younger Infants.

Comprehension

	β	*t*	*p*	R^2	*F*	*P*
Model 1				.21	2.52	.08
Age	.07	.40	.69			
Stim-Q	.05	.31	.76			
Music@Home	.44	2.51	.02			
Model 3				.18	6.42	.02

Music@Home	.46	2.80	.01			

Gestures

	β	*t*	*p*	*R2*	*F*	*P*
Model 1				.26	3.20	.04
Age	.34	2.02	.05			
Stim-Q	-.06	-.33	.76			
Music@Home	.33	1.98	.06			
Model 3				.15	5.30	.03
Age	.39	2.30	.03			

4. Discussion

The current study explored whether variation in early language development, as indexed via the CDI-UK, is related to variation in the home musical environment during infancy, indexed via the parental self-report measure, Music@Home (Politimou et al., 2018). Contrary to our initial hypothesis, linear regressions showed that, when the full sample of infants between 8.5 to 18 months was considered, scores on the *Parental Singing Initiation* subscale did not significantly predict either word comprehension or gestural communication. However, the overall Music@Home score significantly predicted gestural communication over and above age and variations in the general home learning environment as measured by STIM-Q. This result suggests that an enriched home musical environment has a direct implication for generating a gestural conversation, and is consistent with findings that suggest that active music classes support infants' communication and social development (Gerry, Unrau & Trainor, 2012) and enhances neural processing of relevant aspects of music and speech perception (Zhao & Kuhl, 2016). There is a growing body of literature that reports a neurological and developmental link between gestures, speech and language as well as a neural overlap in the case of speech and gesture instantiation which probably indicates a parallel development of gesture and language (Capone & McGregor, 2004; Iverson & Thelen, 1999). Communicating through gestural movements is an early indication of language understanding and demonstrates an infant's capacity to begin producing words. From this perspective, gestural communication predates future language development (e.g., Iverson & Goldin-Meadow, 2005; Özçaliskan & Goldin-Meadow, 2005).

Although the main analysis revealed an association between Music@Home and communicative development which was significant with respect to gesture and approaching significance with respect to comprehension, we were motivated to explore the data further, by examining these associations in a younger and older subgroup. When separated in this way, we show that for preverbal infants (8.5 - 11 months old), both Parental Singing Initiation score and Music@Home: Overall score were significant predictors of word comprehension. These results suggest that early engagement in musical activities as well as ID singing can influence language development in terms of comprehension during the first year of life (cf Franco et al., 2020). The fact that parental singing appears to be a significant predictor of young infants' word understanding could imply the presence of a strong link between singing processing and specific language processing skills that have been shown to develop before 12 months, such as the increased sensitivity to native phonetic contrasts (see Mauren & Weker, 2014 for a review; Falk et al., 2021; Kuhl et al., 2006), which may facilitate word segmentation and has been shown to predict later language development (Kuhl et al., 2005).

A relationship between Music@Home and language development was not, however, seen for the older infants (12 - 18 months). This is somewhat surprising and could be explained by the fact that, for infants 12 months and above, there is typically greater variability in terms of environmental input (linguistic, social, musical) since the vast majority of UK mothers have returned to work once their child is 12 months (Chanfreau et al., 2011). A large-scale project would be required to determine which specific activities are predominantly benefitting the component aspects of language at differential developmental stages but such knowledge would be highly useful for designing targeted interventions for specific language difficulties. Nevertheless, the main finding - that overall Music@Home score predicts aspects of communicative development in infants - provides a rationale for encouraging and supporting families to involve informal musical play within daily routines and activities within the first year of life and beyond. While music classes for infants have also been shown to be beneficial (e.g., Gerry, Unrau and Trainor, 2012), their availability and accessibility cannot always be assumed and the total duration of input is low compared with what can, potentially, be achieved in the home environment in daily life. Initiatives that can empower and equip caregivers across all demographic groups to prioritize high frequency musical play and interaction in everyday life offer an approach to scaffolding language development in a low/no cost, versatile and highly accessible way.

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