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SHORT REPORT

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Shared musical knowledge in 11-month-old infants

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Abstract

Five-month-old infants selectively attend to novel people who sing melodies originally learned from a parent, but not melodies learned from a musical toy or from an unfamiliar singing adult, suggesting that music conveys social information to infant listeners. Here, we test this interpretation further in older infants with a more direct measure of social preferences. We randomly assigned 64 11-month-old infants to 1–2 weeks' exposure to one of two novel play songs that a parent either sang or produced by activating a recording inside a toy. Infants then viewed videos of two new people, each singing one song. When the people, now silent, each presented the infant with an object, infants in both conditions preferentially chose the object endorsed by the singer of the familiar song. Nevertheless, infants' visual attention to that object was predicted by the degree of song exposure only for infants who learned from the singing of a parent. Eleven-month-olds thus garner social information from songs, whether learned from singing people or from social play with musical toys, but parental singing has distinctive effects on infants' responses to new singers. Both findings support the hypothesis that infants endow music with social meaning. These findings raise questions concerning the types of music and behavioral contexts that elicit infants' social responses to those who share music with them, and they support suggestions concerning the psychological functions of music both in contemporary environments and in the environments in which humans evolved.

RESEARCH HIGHLIGHTS

- Eleven-month-old infants preferentially reach for objects endorsed by a person who previously sang a song known to the infant.
- Infants exhibit this preference regardless of whether they learned the song from a parent or a musical toy, in contrast to 5-month-old infants (see Mehr et al., 2016).
- Infants' visual attention to the object endorsed by the singer of the familiar song is predictable from their degree of exposure in the home to that song – but only when the original source of the song was a parent (not a musical toy).

1 | INTRODUCTION

Infants are avid music listeners. They discriminate consonant from dissonant intervals and detect musical beats at only a few days of age (Perani et al., 2009; Winkler, Háden, Ladinig, Sziller, & Honing, 2009); they tolerate repetitive, unfamiliar melodies longer than infant-directed speech (Corbeil, Trehub, & Peretz, 2016); they remember melodies heard in the womb after they are born (Granier-Deferre, Bassereau, Ribeiro, Jacquet, & DeCasper, 2011); and they discriminate highly similar songs on the basis of their melodies alone, long after last hearing them (Mehr, Song, & Spelke, 2016). These are a few highlights of a rich literature on infants' music cognition (review: Patel, 2008), but one basic question has received relatively little attention: Why do infants care about the music they hear?

One possibility is that infants garner social information from music, as they do from language and accent (Kinzler, Dupoux, & Spelke, 2007, 2012), from direct social overtures (Csibra & Gergely, 2009; Schachner & Hannon, 2011), and from food choices (Liberman, Woodward, Sullivan, & Kinzler, 2016). Recently, we reported that 5-month-old infants selectively attended to the singers of familiar songs when they had originally learned those songs from a parent (Mehr et al., 2016);

that attentional preference was found during a silent test, after singing was completed, and can thus be interpreted as a preference for the singer, rather than for the song itself. In contrast, infants displayed no such preference if they learned the same song from a recording embedded in a toy or from an initially unfamiliar adult, who sang to them both live and by interactive video. Infants attended to the song under these conditions and remembered it after long delays, but they did not prefer new singers who performed it.

These findings raise the possibility that a psychological function of music lies in the social domain. On this hypothesis, songs are more than pleasurable noise: Because they are produced by and learned from other people, primarily in social contexts, songs may convey social information about their singers, as two people who know the same song are more likely to be socially connected than those who do not. This social signal is potentially useful to infants, who could benefit from attending to and eliciting care from those people who are most likely to provide it.

Here, we explore this hypothesis through a new experiment that differs from our earlier studies in four ways. First, we use a more direct measure of infants' social preferences, based on research investigating infants' social preferences between native- and foreign-language speakers (Kinzler et al., 2012). After hearing two unfamiliar people sing different songs, one of which was learned from a parent who sang or activated a toy for the infant, infants were presented with two new objects of different types and each person, now silent, endorsed a different object for the infant, whose looking at and reaching for the objects was measured. If infants prefer the person who sang the song they had learned, they should reach more for the object endorsed by that person. Second, we present infants with play songs rather than the lullabies used in our past research, to test for the generality of the preference effect. Third, we use songs that differed from one another in melody, lyrics, and rhythms, unlike the original study, which presented songs with different melodies but identical lyrics and rhythms. This change addresses an alternative explanation of our original result: infants may have perceived the singer of the novel song as a less competent singer of the original song, and then exhibited a preference for the more competent individual.

Finally, we test 11-month-old infants, in contrast to the 5-month-old infants tested previously, as older infants may attribute social meaning to songs under a greater range of conditions. As infants approach their first birthday, they begin to incorporate objects into their social interactions (reviews: Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998; Tomasello, 2008). They share their social partners' attention to objects (Brooks & Meltzoff, 2005; Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004) and they treat gift-giving, imitation of object-directed actions, and helping others to attain objects as socially meaningful acts (Agnetta & Rochat, 2004; Hamlin, Ullman, Tenenbaum, Goodman, & Baker, 2013). Older infants therefore may show social preferences for new singers of songs even when the parent presented the song by activating a toy rather than by singing.

Thus, we randomly assigned infants to learn one of two obscure play songs, either from a parent or from a recording embedded in a stuffed animal (as in Experiments 1 and 2 of Mehr et al., 2016). After 1–2 weeks of exposure, infants returned to the lab, where they viewed videos of novel people, each of whom sang one of the two songs and then presented one of two objects to the infant (after Kinzler et al., 2012). We reasoned that infants would interpret the behavior of the two adults either as invitations to share attention to an object (see, e.g., Tomasello, 2008) or as attempts to convey information about an object (Csibra & Gergely, 2009). In either case, we predicted that the infants who learned the song from a singing parent would demonstrate a social preference for the singer of a familiar song by attending to and reaching for the object endorsed by that person. For infants in the parent-activated toy condition, predictions were less clear. When a parent activates the musical toy, infants may interpret the music as being offered or endorsed by the parent. Because the parent is not the direct source of the music, however, the social significance of the music may be attenuated, relative to the parent singing condition. Thus, 11-month-old infants may or may not show a social preference for the novel singer of the familiar song in the toy condition.

2 | METHOD

2.1 | Participants

All testing took place at the Laboratory for Developmental Studies at Harvard University. We recruited 79 full-term infants and their parents from the greater Boston area. Incentives were $10 in travel reimbursements for parents and toys or other small rewards for infants. Data from 15 infants were excluded because they were fussy during testing ($n = 4$) or failed to reach for an object on any test trials ($n = 11$). These exclusion criteria were determined before the experiment began. Thus, analyses included 64 infants (29 females; mean age = 11.2 months, $SD = 0.25$, range: 10.8–12.0), a sample size chosen before the experiment began to match our previous work. Parents accompanying their infants to the lab were predominantly female (52 female); when a male parent was present, we asked that he participate in the study as the primary parent, as in our previous work.

2.2 | Musical exposure

Families were randomly assigned to present a new song under one of two exposure conditions ($n = 32$ each) lasting 1–2 weeks (*Med*. = 10 days, IQR [7.5, 11]). In the parent singing condition, parents were taught one of the two songs during an initial visit to the laboratory, without music notation and with the aid of a keyboard (see Experiment 1 in Mehr et al., 2016), and they were given a recording of the song to take home for refresher training.[1] In the musical toy condition, parents were given a stuffed animal (a green alligator), adapted to play a recording of one of the two songs when squeezed (see Experiment 2 in Mehr et al., 2016). The recorded singers were two research assistants (gender matched to the participating parent) who sang in an infant-directed manner; neither vocalist was heard in subsequent testing (described below). Parents were asked to present the toy to their infants but not to sing the song. Compliance with this

instruction was high: at most, parents reported singing the song once or twice. In both conditions, they were told to present the song as much or as little as they liked. All families returned to the lab for a second visit.

2.3 | Assessment of song exposure

Between the two lab visits, we contacted parents each evening with a survey (completion rate: 87%), asking 'About how many times did your baby hear the song today?' We multiplied each parent's mean responses by the duration of their participation in the study, yielding an estimate of the amount of song exposure that was not skewed by missing data or variation in study length.

2.4 | Musical content

In both musical exposure conditions, infants were randomly assigned to learn one of two obscure children's songs (Feierabend, 1986). We wrote new lyrics for both songs, aimed to make them attractive to infants (Figure 1A).

2.5 | Social preference test

During a 15-min test, infants viewed videos of two novel people who, over four familiarization trials, each sang the two verses of one of the two songs (Figure 1B). A silent test followed, in which both people appeared side by side (Figure 1C), lifted different objects in synchrony with one another, looked toward their object while smiling, looked at the infant, nodded, moved the object back and forth, and pointed downward. Immediately beneath the screen were physical replicas of the two objects, giving the illusion that the people in the videos were pointing at and endorsing them. The video froze during the pointing, and the infant's high chair, which was fitted with wheels and a track, was then pushed forward so that the infant could reach for the objects.

This process was repeated four times, yielding 16 familiarization and four test trials. The position and identity of the singer, along with the order of song presentation, was fully counterbalanced. The objects on trials 1 and 3 were a small stuffed lion and bear; on trials 2 and 4 they were realistic models of an apple and a pear. The location of these objects (and hence, their pairings with the two singers) was swapped across trials, such that on trials 3 and 4, both objects had been previously endorsed by both singers. Thus, primary analyses focus on the first two trials, in which each object was endorsed by only one singer (see Results).

Infant behavior was monitored by a hidden high-definition camera at 30 frames per second. Four coders viewed all footage independently of one another and blind to which song was familiar to the infant, to how the infant had learned that song, and to which singer sang which song (i.e., with footage muted). They coded gaze to each person and each object and touching of each object, in two passes per infant using Datavyu (2014), split across coders such that all data were independently coded twice. Inter-coder reliability, computed as the percent agreement on a frame-by-frame basis and weighted by infant, was 97.6%.

3 | RESULTS

Because infants were randomly assigned to learn one of the two songs, and because there were no differences in reaching or gaze

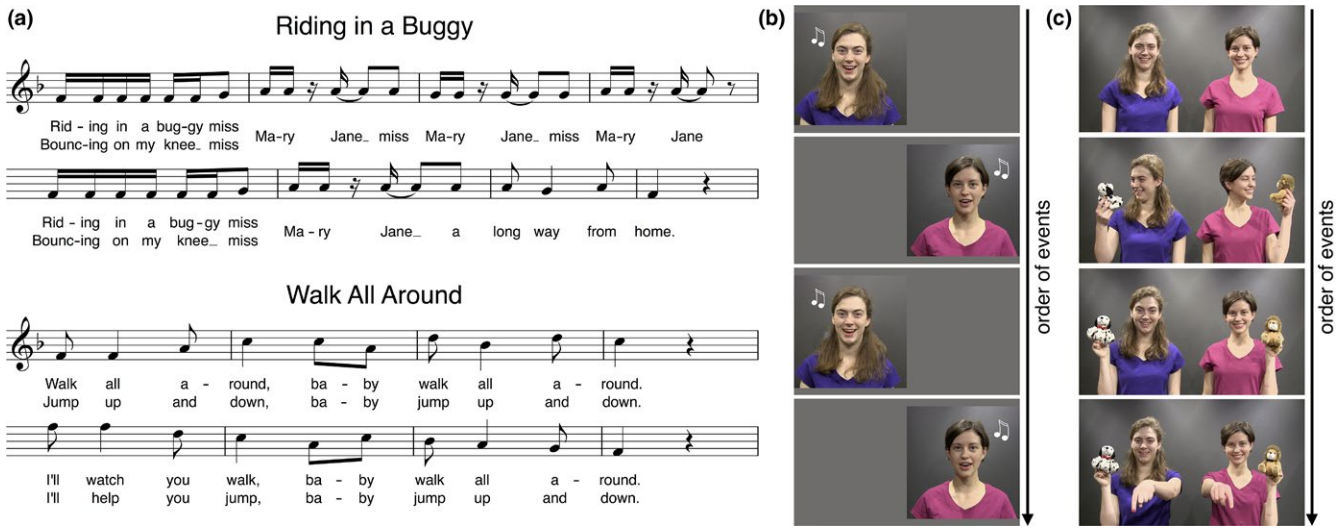

FIGURE 1 One of the two songs (A) was either sung by a parent or produced when a musical toy was activated during the exposure period. The testing procedure included four familiarization trials (B); each of two novel adults sang one of the two songs, one verse at a time, such that infants heard each adult sing both verses of her song. Then, each adult endorsed one of two objects (C) in the reaching test. In synchrony with one another, both adults smiled at the infant, presented and looked at a different object, showed it to the infant, and pointed down, toward a replica of that object that had been placed on a table before the familiarization trials. Infants then were moved forward so they could reach for either of the objects. The full sequence [i.e., (B) followed by (C)] was repeated two times, and then two further sequences were presented in which the pairings of people and objects were reversed

behavior across the two song conditions (*ps* > .4), we collapsed over the two songs and analyzed infants' responses to the person who sang the familiar song.

3.1 | Object choice

In the first two sets of familiarization trials, infants attended highly and comparably to both singers (across all eight trials, familiar song: *M* = 46.2 s, *SD* = 30.8 s; unfamiliar song: *M* = 45.2 s, *SD* = 28.2 s; *t*(63) = 0.66, *p* = .51). This pattern was comparable to 5-month-old infants' responses to the same style of familiarization trials in Mehr et al. (2016), as well as 10-month-old infants' responses to unfamiliar people who had previously spoken in a native vs. foreign language (Kinzler et al., 2012). In the main analyses, we computed for each infant a difference score between the number of target object reaches and the number of non-target object reaches on the first two trials. Given a priori, directional predictions, reported *p*-values are one-tailed except when analyses are specified as exploratory.

In both music exposure conditions, infants reached more for the target object than the non-target object (difference in number of reaches, parental song condition, Figure 2A: *Med*. = 0.5, *IQR* = [−0.5, 2], *z* = 1.73, *p* = .042; musical toy condition, Figure 2B: *Med*. = 0, *IQR* = [0, 1], *z* = 1.76, *p* = .039; Wilcoxon signed-rank tests here and below unless otherwise specified). These rates of reaching did not differ from one another (*z* = 0.58, *p* = .56; Wilcoxon-Mann-Whitney test) and a combined analysis of both conditions demonstrated that overall, infants reached more for the target object than the non-target object (Figure 2C, *Med*. = 0, *IQR* = [0, 2]; *z* = 2.41, *p* = .008).

Secondary analyses included the data from all four trials. During familiarization trials, infants across both music exposure conditions showed equal looking to the two singers as they sang the songs (across all 16 trials, familiar song: *M* = 81.5 s, *SD* = 41.4 s; unfamiliar song: *M* = 83.7 s, *SD* = 42.0 s; *t*(63) = 1.00, *p* = .32). Reaching results were comparable, though somewhat weaker: infants in the musical toy condition reached significantly more to the target object than the non-target object (difference in number of reaches: *Med*. = 1, *IQR* = [0, 2], *z* = 2.30, *p* = .011), while results in the in the parental song condition were not significant (*Med*. = 0, *IQR* = [−2, 2.5], *z* = 1.25, *p* = .11). These rates of reaching did not differ from one another (*z* = 0.39, *p* = .70; Wilcoxon-Mann-Whitney test). As in the main analysis, across both conditions infants reached more for the target object than the non-target object (*Med*. = 1, *IQR* = [−1, 2]; *z* = 2.29, *p* = .011).

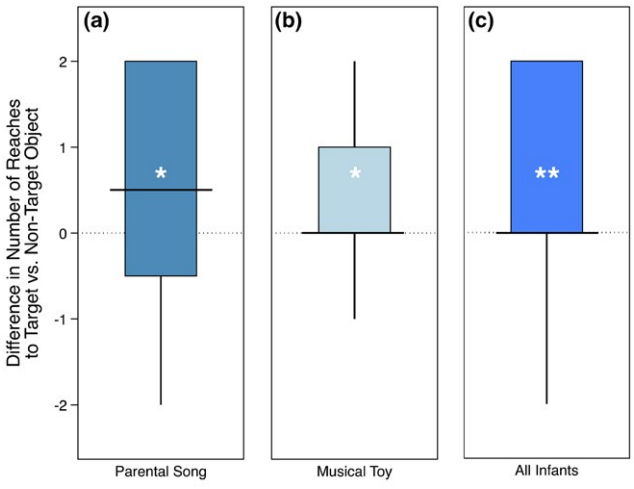

FIGURE 2 The box plots show the difference in number of reaches to the target object on trials 1 and 2, among (A) infants in the parental song condition, (B) infants in the musical toy condition, and (C) all infants. The dotted line indicates chance (0), the solid horizontal lines indicate the medians, the boxes indicate the interquartile ranges, and the vertical lines indicate the full ranges. Asterisks indicate significant differences from 0, via Wilcoxon signed-rank tests (**p* < .05; ***p* < .01, one-tailed)

Two exploratory analyses focused on the object choice data. First, we asked whether the main effects were attributable to infants' failure to attend to the non-target object. They were not: infants held both objects for comparable durations during the first two trials (target object: *M* = 10.7 s, *SD* = 10.1 s; non-target object: *M* = 8.64 s, *SD* = 8.29 s; *t*(63) = 1.46, *p* = .15) and across all trials (target object: *M* = 22.2 s, *SD* = 16.4 s; non-target object: *M* = 22.1 s, *SD* = 18.2 s; *t*(63) = 0.04, *p* = .97). They also looked at both objects for comparable durations during the first two reaching trials (target object: *M* = 14.1 s, *SD* = 6.77 s; non-target object: *M* = 13.3 s, *SD* = 6.13 s; *t*(63) = 0.87, *p* = .39) and across all reaching trials (target object: *M* = 26.6 s, *SD* = 8.57 s; non-target object: *M* = 27.6 s, *SD* = 11.8 s; *t*(63) = 0.60, *p* = .55). Unsurprisingly, the duration of gaze to an object and duration of holding that object were correlated in the first two trials (target object: *r* = .50, *p* < .001; non-target: *r* = .46, *p* < .001) and across all trials (target: *r* = .32, *p* = .01; non-target: *r* = .63, *p* < .001).

Second, we asked whether the strength of the main effect of reaching toward the target object differed on the basis of the type of objects presented (fruits or stuffed animals). On fruit trials (i.e., trials 2 and 4) infants reached significantly more frequently to the target object than to the non-target object (*Med*. = 0, *IQR* = [0, 1], *z* = 2.47, *p* = .014). No such difference was found on animal trials (i.e., trials 1 and 3; *Med*. = 0, *IQR* = [−1, 1], *z* = 1.35, *p* = .18). Rates of reaching to the target object did not differ across object types, however (*z* = 1.12, *p* = .26).

3.2 | Predictive effect of song exposure

Because parents were not given a quota for how often to present the song, the estimated degree of song exposure was variable across infants. The mean estimates did not differ across conditions (estimated number of song performances, parental song condition: *M* = 77.5, *SD* = 41.5; musical toy condition: *M* = 71.9, *SD* = 34.6; *t*(62) = 0.59, *p* = .56), nor was there any significant difference in the amount of variance on this variable across conditions (*F*(31, 31) = 0.69, *p* = .32, variance ratio test).

To correct substantial right skew, we log-transformed the exposure variable, and tested whether it predicted infants' reaching for the target object. It did not: ordered logistic regressions predicting infants' difference scores for reaching to the target vs. non-target objects on trials 1 and 2, from the amount of song exposure, were not significant in the parent singing condition ($\chi^2(1) = 0.92$, *p* = .34), the musical toy

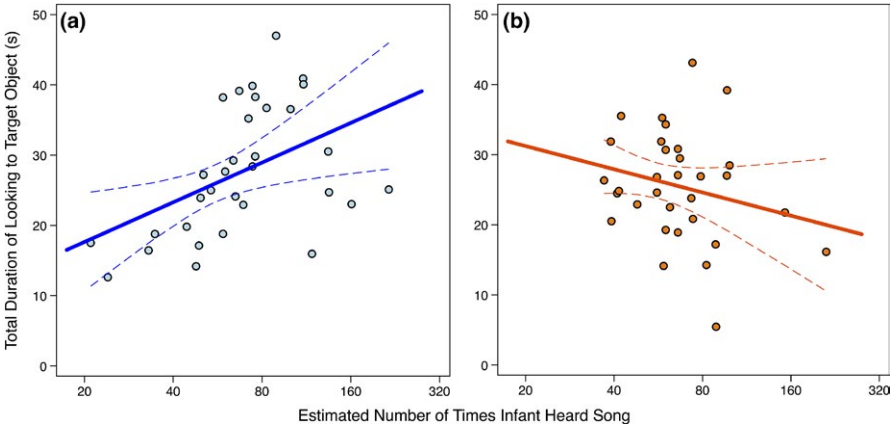

FIGURE 3 The scatterplots show infants' duration of looking toward the target object, in (A) the parental song condition and (B) the musical toy condition, along with the predictive effects of the amount of song exposure (solid lines) ± 2 standard errors (dashed lines) from a bootstrapped model with 40,000 replications. Note that the *x*-axes are on $\log_2$ scales.

condition ($\chi^2(1) = 0.04$, $p = .85$), or overall ($\chi^2(3) = 1.07$, $p = .30$). Song exposure therefore appears to be unrelated to reaching behavior at test.

However, the proportion of reaching to target objects is necessarily a low-variance measure, in contrast to the continuous selective attention measure used in previous work (Mehr et al., 2016). Thus, in exploratory analyses, we tested whether the amount of song exposure was predictive of the duration of gaze to the target object during the reaching trials: a measure more directly comparable to that used with 5-month-old infants. Because the looking measure was continuous and approximately normally distributed, we used bootstrapped multiple linear regression, verified by sensitivity analyses.

Across all four trials, song exposure predicted the duration of gaze to the target object in the parental song condition (Figure 3A; $\chi^2(1) = 6.22$, $p = .013$, $R^2 = .21$; Wald test), such that a doubling of the amount of song exposure corresponded with an estimated 0.88 *SD* increase in the duration of gaze to the target object in that condition. In contrast, song exposure did not predict gaze to the target object in the musical toy condition (Figure 3B; $\chi^2(1) = 2.18$, $p = .14$, $R^2 = .05$). Thus, we continued by modeling the two conditions together, to test their interaction. The overall model was significant ($\chi^2(3) = 8.50$, $p = .037$, $R^2 = .16$), as was the condition by song exposure interaction term ($z = 2.81$, $p = .005$). These results held when including as a covariate the duration of gaze to the non-target object ($\chi^2(4) = 9.60$, $p = .048$, $R^2 = .17$), the difference in infants' number of reaches to the target vs. non-target objects ($\chi^2(4) = 9.63$, $p = .047$, $R^2 = .18$), or both measures ($\chi^2(5) = 13.3$, $p = .021$, $R^2 = .22$). Tests of the interaction terms in each of these models survived a Bonferroni correction for six tests (i.e., adjusted alpha level of .0083); we corrected for six tests given the six exploratory models we ran here (i.e., each condition separately, both conditions together, and the three models with covariates). Crucially, these effects were driven by gaze during the portion of the trial *after* the actors pointed to the objects: the overall model of infants' gaze before the pointing occurred yielded no significant effects ($\chi^2(3) = 1.05$, $p = .79$, $R^2 = .01$), but it held for gaze after the actors' pointing ($\chi^2(3) = 8.95$, $p = .030$, $R^2 = .156$), with a significant condition by song exposure interaction ($z = 2.81$, $p = .005$).

In sum, while reaching to the target object did not differ across song exposure conditions, gazing to the target object varied as a function of the amount of song exposure in the parental song condition, but not in the musical toy condition.

4 | DISCUSSION

Infants preferentially reached to objects endorsed by a new person who sang a familiar song. Because this act is more explicitly interpretable as a social preference than the visual preferences observed in younger infants, infants' selective reaching replicates and extends previous findings concerning infants' social preferences for the singers of familiar songs (Mehr et al., 2016). In contrast to those findings, however, we observed preferential reaching to the target object regardless of whether the infant learned the song from a parent who sang or who activated a musical toy for them. Exploratory analyses nevertheless suggested differences in infant social preferences across these two song exposure conditions: infants' looking at the target object varied with song exposure only if that exposure came from a singing parent.

Why did infants show a social preference for the singer of the familiar song in the toy condition, whereas the 5-month-old infants in our previous research did not? The previous negative finding is not likely attributable either to sampling error or to low sensitivity of the looking time measure, because the original experiments were well powered (power of .84), and experiments using the same measure have reliably detected social preferences in smaller samples of young infants across multiple domains (e.g., Farroni, Csibra, Simion, & Johnson, 2002; Kinzler et al., 2007; Schachner & Hannon, 2011). The negative finding also is not due to younger infants' failure to attend to or remember toy-produced recorded songs: 5-month-old infants remembered the song produced by the toy many months later (Mehr et al., 2016).

Two remaining differences between the past and present experiments may account for their differing findings in the conditions with toy-produced songs. First, the style of music differed across the two experiments: our previous work used slow, soothing lullabies, whereas the current studies used faster, upbeat play songs. Infants may have been more socially engaged by the play songs than by lullabies, and also more predisposed to associate play songs than lullabies with toys.

It is difficult to evaluate this explanation because data on the relative effects of lullabies vs. play songs are scarce. Second, decades of research have shown that infants' understanding of social interaction skyrockets around 1 year of life, especially in the context of interacting with social partners about objects (reviews: Carpenter et al., 1998; Tomasello, 2008). Thus, older but not younger infants may construe the musical toy as part of their social play with a parent, and a novel person singing the same song may inherit social meaning from this parent-infant social experience.

Both possibilities remain open, and further experiments may distinguish between them. In particular, it would be worthwhile to repeat the present experiments with younger and older infants while varying the types of music that infants hear. If the original finding is robust to changes in music type, it would lend support to the idea that 11-month-old infants are more apt than 5-month-old infants to garner social information from their interactions with parents in the context of recorded music. Further experiments also could unpack the particular social aspects of live song that drive infants' social preferences. Live singing includes a variety of rich behaviors that recorded song does not, including reciprocal gaze, smiling, and contingent interaction. It is not yet known whether the lack of such behaviors in current or previous musical toy conditions, or their reduced presence in the previous interactive video condition, could account for infants' social preferences (see Mehr et al., 2016, for further discussion).

Although we obtained positive and equal effects on the object choice test in the parent singing and musical toy conditions, exploratory analyses revealed that infants who had received more exposure to parental song (but not to toy-produced song) gazed longer, on average, at the object endorsed by the singer of the familiar song than those whose parents sang less frequently. This positive association in the parental song condition and its absence in the musical toy condition is similar to effects obtained in the selective attention test used with 5-month-old infants. In contrast to our previous findings, however, the effects did not reflect a preference for one object or the other, as infants looked to the two objects for comparable durations.

This difference may be attributable to differences in the timing of the measures. Preferential reaching for a toy is a function of the person who recommends the toy, the infant's existing preference for one type of toy over another, and the infant's previous experience with those toys. This measure is most directly comparable to our previous results, where infants' gaze represented a forced choice between the two actors' faces: a preference for one person over the other. Gaze toward a toy that a potential new social partner endorses may differ in meaning: if infants interpreted the actor's pointing as an invitation to share attention toward an object, the degree of their attention to that object might reflect their immediate social engagement with the actor, as opposed to a preference for that actor. The degree of this engagement was moderated by infants' degree of familiarity with the actor's song – but only when that song had been previously presented by a parent.

We suggest two interpretations of this finding. First, it may reflect differences in the speed with which infants habituate to live vs. recorded singing over time. Whereas a recording played repeatedly over 1–2 weeks becomes more and more predictable, repetition in live singing may maintain or increase interest, as the musical features of live song can be intentionally varied in response to the listener's interests and expectations. Indeed, musical repetition and redundancy have been proposed to be human universals (Brown, 1991). Thus, parents who sang more to their infants may have enjoyed the song more, enhancing its social value for infants.

Second, one of us has hypothesized that infant-directed song functions as parental investment in the form of attention (Mehr & Krasnow, in press). Live singing on the part of a parent requires continuous investment of effort and attention throughout the song's duration, whereas toy-produced singing in the present experiment required only a single press of a button at the song's onset. By this hypothesis, therefore, the strength of infants' social preferences for new people who sing the same songs as their parents do might vary as a function of the effort the parent exerted in producing the song. If a new person demonstrates shared musical knowledge with a parent who has been providing reliable and frequent parental investment in the form of song, that new person is likely to provide future investment to the infant. These interpretations are speculative, however, and further research is needed to ascertain the sources of the music exposure effect.

Two further questions are raised but not answered by our findings. The first concerns a deflationary account of the present results. Might infants prefer a person associated with any familiar behavior, as in mere-exposure effects in adults (e.g., Zajonc, 2001)? We cannot yet rule out this account, but three points weigh against it. First, in the present experiments, while infants reached to the target objects at comparable rates across the parental song and musical toy conditions, their patterns of visual attention to the target objects differed across conditions as a function of the degree of their exposure. Second, in our previous work, infants who learned a song from a friendly but otherwise unfamiliar singer via Skype demonstrated no visual preference for a new actor who sang that song, despite having learned it well enough to distinguish it from a second song with the same words and rhythms, but a different melody, some 8 months later (Mehr et al., 2016). Third, in a previous study using the same reaching methods used here, White infants reached for objects endorsed by White or Black adults at comparable rates, despite having far more familiarity with White adults than with Black adults (Kinzler & Spelke, 2011). Each of these findings suggests that raw familiarity does not fully account for infants' social preferences. Future experiments might more tightly control the song exposure conditions while directly manipulating the degree of that song's social meaning to the infant; for instance, infants might learn a song from a research assistant who visits the home regularly, but is otherwise unknown to the infant.

The second question concerns the uniqueness of the social effects of music. Is music 'special', or might infants have shown comparable social preferences for new adults who shared infants' knowledge in other, non-musical domains? In these experiments we did not test the strength of music's ability to convey social information relative to other domains that are known to have similar effects, such as language (Kinzler et al., 2007) or food choice (Liberman et al., 2016). Infants' observations of behavior in these and other domains may well interact to produce varied responses to new social partners.

But our claim is more general. In our view, music is one of a class of behaviors that reliably inform infants' preferences for new social partners, because songs are learned from other people and are often sung in social contexts. Not all behaviors are expected to fall into this class: instrumental actions (e.g., breaking a rock), self-directed actions (e.g., scratching one's head), and unlearned actions (e.g., yawning), for example, should not. The present findings, taken together with our previous work (Mehr et al., 2016), support this view.

AUTHOR CONTRIBUTIONS

S.A.M. and E.S.S. designed the research. S.A.M. collected and analyzed the data. S.A.M. and E.S.S. wrote the manuscript.

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NOTE

[1] Because the songs in this study were considerably easier for parents to learn than those we used in previous work, the music lesson was brief, most parents reported not using the refresher recording, and most parents reproduced the song with accuracy at or near ceiling during a subsequent visit to the lab.

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