Dancing to Metallica and Dora: Case Study of a 19-Month-Old

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Rhythmic movement to music, whether deliberate (e.g., dancing) or inadvertent (e.g., foot-tapping), is ubiquitous. Although parents commonly report that infants move rhythmically to music, especially to familiar music in familiar environments, there has been little systematic study of this behavior. As a preliminary exploration of infants’ movement to music in their home environment, we studied V, an infant who began moving rhythmically to music at 6 months of age. Our primary goal was to generate testable hypotheses about movement to music in infancy. Across nine sessions, beginning when V was almost 19 months of age and ending 8 weeks later, she was video-recorded by her mother during the presentation of 60-s excerpts from two familiar and two unfamiliar songs presented at three tempos—the original song tempo as well as faster and slower versions. V exhibited a number of repeated dance movements such as head-bobbing, arm-pumping, torso twists, and bouncing. She danced most to Metallica’s *Now that We’re Dead*, a recording that her father played daily in V’s presence, often dancing with her while it played. Its high pulse clarity, in conjunction with familiarity, may have increased V’s propensity to dance, as reflected in lesser dancing to familiar music with low pulse clarity and to unfamiliar music with high pulse clarity. V moved faster to faster music but only for unfamiliar music, perhaps because arousal drove her movement to familiar music. Her movement to music was positively correlated with smiling, highlighting the pleasurable nature of the experience. Rhythmic movement to music may have enhanced her pleasure, and the joy of listening may have promoted her movement. On the basis of behavior observed in this case study, we propose a scaled-up study to obtain definitive evidence about the effects of song familiarity and specific musical features on infant rhythmic movement, the developmental trajectory of dance skills, and the typical range of variation in such skills.

Keywords: music, infancy, rhythm, movement, dance, development

INTRODUCTION

Active musical engagement, whether by attentive listening, singing, or rhythmic movement, is pervasive across the lifespan and across cultures (Savage et al., 2015; Trehub et al., 2019). These activities play a critical role in mood regulation (Laukka, 2007), social bonding (Cirelli et al., 2014; Tarr et al., 2014), personal identity (North and Hargreaves, 1999), and other aspects of well-being (Groarke and Hogan, 2016). The seeds of such musical engagement are planted in infancy when the primary caregiver serves as musical partner and mentor (Cirelli and Trehub, 2018; Trehub and Gudmundsdottir, 2019). Caregivers around the world sing to infants in a warm and distinctive manner...
Methods

Participant

V is part of a bilingual (French/English) household in a small city in Northern Ontario, where she lives with her mother, father, and 7-year-old brother. She was 18 months, 27 days of age on the first recording session and 20 months, 18 days on the final session. According to maternal report, she began moving regularly to music at 6 months of age. V had not participated in music programs in the community, but her parents and brother exposed her to music by singing and dancing with her and playing musical recordings. No member of her family had formal music training, but her father is a self-taught amateur guitarist. Written informed consent was obtained from the mother for the publication of this case report and the inclusion of identifiable information including images, age, and gender.

Stimuli

The stimuli featured four songs, two familiar and two unfamiliar. When asked to report V’s “favorite songs”, her parents identified Dora the Explorer Theme Song (119 beats per minute [bpm]) (Sitron and Strauss, 2010), heard regularly from 6 months (once weekly at study onset, more frequently in earlier months), and Metallica’s Now That We’re Dead (128 bpm) (Hetfield and Ulrich, 2017), heard regularly from 12 months (once daily at study onset), resulting in greater cumulative exposure to Dora but more consistent recent exposure to Metallica. The
Dora theme was typically played from YouTube, but V was visibly excited by the music and relatively disinterested in the visuals. Exposure to Now that We’re Dead (Metallica), her father’s favorite song, was from an audio-recording, but father and daughter often danced together to the song, with father bobbing his head to the music. An unfamiliar song chosen to match Dora was Hey It’s Franklin, the theme song from Franklin the Turtle, another animated children’s TV show (Cockburn, 2000). An unfamiliar song chosen to match Metallica was the Backstreet Boys’ Everybody (Pop and Martin, 1997), a song for adults that has been used previously to investigate cross-species dancing (Patel et al., 2009). We used Audacity 2.1.0, to create versions of each song at 100 bpm (designated slow) and 140 bpm (designated fast), maintaining original pitch levels. We equated maximum amplitude across clips, which were comparable in subjective loudness. For intermediate tempo, familiar songs were maintained at original bpm, and unfamiliar songs were set to 120 bpm. The usual tempo range for dance music is 94–176 bpm, with 120–150 being most common (van Noorden and Moelants, 1999). Pulse clarity (i.e., strength of rhythmic periodicities) and mean fundamental frequency (F0) were calculated at the intermediate tempo using MIRtoolbox 1.7 running on Matlab 2016a. Metallica and Backstreet had high pulse clarity (0.79; 0.67) and low mean F0 (120 Hz; 203 Hz), respectively. Dora and Franklin had low pulse clarity (0.49; 0.31) and high or low F0 (304 Hz; 225 Hz), respectively. The 12 recordings (4 songs X 3 tempos) were trimmed to 60 s, with 1-s fade-out. The first minute of each recording was always used to optimize familiarity for Metallica and Dora. Except for Metallica, which was instrumental\(^1\), the other songs contained vocals and instrumentals. Excerpts of these clips at each tempo can be accessed in the supplementary section (see Supplementary Audios 1–4). Individual audio files for each test session had six song clips (trials) separated by 10-s silence. The song clips were ordered across sessions so that each session included two clips at each of the three tempos, and each of the 4 songs as heard at least once but not more than twice. Across all 8 sessions, the 12 clips (4 songs at 3 tempos) were presented 4 times each\(^2\). A ninth session replaced trials lost because of V’s fussiness (four trials) or camera malfunction (one trial).

**Procedure**

Audio files for each session were provided via Google Drive. The mother was instructed to play the audio files for V at her convenience and to capture V’s responses with video-recordings. She was asked to refrain from moving to the music or singing during the recording sessions and to ensure that no other family members (brother or father, if present) did so. However, she was free to offer verbal encouragement (e.g., asking V to dance). In fact, she provided such encouragement only when V had not initiated dancing on a trial, doing so comparably on familiar (65%) and unfamiliar (65%) song trials. The music was presented (at \(\sim 60\) dB) by means of a personal tablet, and sessions were recorded by cell phone. After each session, the mother reported time of day, those present, and any notable circumstances, transmitting all recordings and information via Google Drive.

**Data Analysis**

An assistant coded the videos with ELAN software (https://tla.mpi.nl/tools/tla-tools/elan/, Lausberg and Sloetjes, 2009). She was trained extensively by the lead author, and had years of experience working with young children. The assistant used audio only to locate the start of each trial, subsequently coding the target behaviors with the audio turned off. For each trial, she

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\(^1\)The first minute of the original recording is instrumental.

\(^2\)An error resulted in having 3 Dora Fast trials and 5 Franklin Fast trials.
identified number of dance bursts, burst duration, and percentage of time smiling when V’s face was visible. Dance bursts were defined as time windows with two or more rhythmic movements within 2,000 ms. Independent coding of 27% of the trials yielded high interrater reliability for the three measures ($r = 0.97$, $r = 0.98$, $r = 0.82$, for number of dance bursts, burst duration, and smiling, respectively). V exhibited various dance patterns including head bobbing, arm pumps, swaying, torso twists, and bouncing (examples in Figure 1). For each dance burst, the coder indicated the time of peak movement position (lowest head position for head-bobbing, fully extended arm for arm pump). V’s requests for more music (“d’autre?”) were coded during the silent interval between songs.

RESULTS

Dance bursts occurred in all recording sessions and in 32 of 48 trials. For trials with dance bursts, bursts per trial ranged from 1 to 5 ($M = 2.22$, $SD = 1.21$). Although dance bursts occurred in 67% of the trials, overall dancing per trial was limited, from 1.3 s to 22.1 s ($M = 8.1 s$, $SD = 5.1 s$ for trials with at least 1 dance burst). Mean dancing per trial also varied across song selections. As can be seen in Figure 2A, V danced more to Metallica’s *Now That We’re Dead*, a familiar pop song (heavy metal genre) that had considerably greater pulse clarity than the other familiar songs and lower mean F0 than the other songs.

Dance time as a function of tempo is shown in Figure 2B. V’s propensity to dance most to Metallica was driven by the tempo-modified (fast and slow) conditions. Otherwise, tempo exerted no clear effects on dance time.

Table 1 shows the incidence of each recurring dance pattern (see Figure 1 and Supplementary Videos 1–3 for examples) for each song. Arm pumps were common during three of the four songs, and distinctive head-bobbing was especially notable during Metallica trials.

A Pearson correlation between dance time and percentage of time smiling per trial, $r = 0.60$, $p < 0.001$ (Figure 3) highlighted the link between musical movement and positive affect. For each dance burst, we calculated interonset intervals (ms) between successive movement peaks. For each trial, mean interonset interval was converted to movement rate.
TABLE 1 | Number of trials in which V performed specific dance patterns.

| Song     | Head bobbing | Arm pumps | Swaying | Torso twists | Bouncing |
|----------|--------------|-----------|---------|--------------|----------|
| Dora     | 2            | 5         | 0       | 2            | 1        |
| Metallica| 11           | 4         | 0       | 1            | 3        |
| Backstreet| 3           | 5         | 0       | 3            | 3        |
| Franklin | 1            | 1         | 2       | 2            | 0        |

(bpm). Movement rate across tempo (Fast, Moderate, Slow) and song familiarity is displayed in Figure 2C. For familiar songs, movement tempo was rapid for all musical tempos. For unfamiliar songs, there is suggestive evidence of slower movement tempo for slower songs. Moreover, there is a suggestion of tempo convergence (coordination of movement with musical tempo) at the fastest song tempo regardless of familiarity.

During the 10-s silent intervals between songs, V asked for “more” (“d’autre?”) after 27 of 48 trials (56%), doing so more frequently (sometimes repeatedly) after hearing familiar songs (70%) than unfamiliar songs (44%) (see Figure 2D) and most frequently after hearing the Dora song.

DISCUSSION

The present case study explored the feasibility of studying infant dance or rhythmic movement to music in the home environment. We focused specifically on the influence of song familiarity and tempo on the incidence and tempo of movement as well as links between movement and pleasure. V danced in every recording session, supporting the home environment as a promising venue for eliciting movement to music. Overall, she danced 9% of the time, which is modest but somewhat higher than the 6% of rhythmic movement for 5- to 24-month-olds in a laboratory context (Zentner and Eerola, 2010). Note that the laboratory study excluded data from a third of infants who fusssed or attended excessively to the caregiver. Moreover, infants sat on their parents’ lap, reducing the likelihood of observing typical patterns of movement to music. As for 2- to 4-year-olds, 40% were unwilling to dance in the laboratory (Eerola et al., 2006).

V’s head-bobbing, arm pumping, and body twists were more dance-specific and motorically complex than the rhythmic limb movements observed in previous studies with infants (Zentner and Eerola, 2010; Fujii et al., 2014) but less complex than the rhythmic body movements observed with 2- to 4-year-olds (Eerola et al., 2006). Age-related changes in the complexity of V’s “dancing” can be seen in her limb movements at 8 months (Supplementary Video 4) before data collection began, body twists at 19 months (Supplementary Video 5), and hopping at 29 months (Supplementary Video 6) after data collection ended. V’s most common dance move was head-bobbing, especially for Metallica. Such motion has powerful effects on the vestibular system and on rhythm perception (Phillips-Silver and Trainor, 2008). Adult head-bobbing is often evoked by music with a strong bass line (Burger et al., 2013), as in the Metallica song. The contribution of bass sounds to the nature and frequency of young children’s movements can be explored in future investigations with a wider range of stimuli and a large sample of children across a broad age range. V’s head-bobbing to Metallica probably stemmed from dancing with her father, who modeled such head movements to that song.

V’s dance duration was greater for familiar music (12% of the time) than for unfamiliar music (6%), which was driven by her response to Metallica (16%). For example, V danced no more to the familiar and well-liked Dora theme than to the unfamiliar excerpts. Familiarity may influence rhythmic movement in infants but only in conjunction with other factors such as pulse clarity or beat salience, which is correlated with groove (Madison et al., 2011; Witek et al., 2014; Stupacher et al., 2016). Now that We’re Dead has high pulse clarity, in contrast to the low pulse clarity of Dora. On its own, high pulse clarity may be insufficient to enhance movement in infants, as evident in V’s modest dance duration to Everybody (Backstreet Boys), which was high in pulse clarity but unfamiliar. V’s experience with Now that We’re Dead as a “dance song” may be relevant. The relative contributions of familiarity and pitch clarity to movement could be explored in future research that involves independent manipulation of these factors.

Unexpectedly, V danced most to Metallica on trials with altered tempo (21%)—15.1 s with increased tempo, 10.2 s with decreased tempo, and 3.6 s with the original tempo. Presumably she had long-term memory for the original tempo, perhaps finding the altered versions amusing or exciting, as reflected in increased smiling during the altered versions. Just as younger infants perceive absurd versions of familiar events as humorous (Mireault et al., 2018), older infants may react with heightened excitement when their expectations of highly familiar music are violated. Musical tempo may be most memorable for music with
a highly salient bass line or pulse and least memorable for music with a less salient bass line and more salient melody line.

With respect to tempo flexibility, V’s tempo of movement was faster for the familiar songs than for the unfamiliar songs (see Figure 2C), perhaps because of heightened arousal. For the familiar songs, moreover, V danced fastest for the original tempo and slowest for the fastest tempo, precluding orderly relations between dance tempo and musical tempo. For the unfamiliar music, there was tentative evidence of tempo flexibility in the sense of faster dancing to faster music. Infants may accord greater attention to timing details in the context of unfamiliar songs that elicit moderate arousal levels. Although 5- to 24-month-olds move modestly faster to faster music than to slower music (Zentner and Eerola, 2010), preschool children show little evidence of doing so (Eerola et al., 2006).

Further study of the effects of age, song familiarity, and social context (dancing alone or with parent) on tempo flexibility is warranted.

Developmental changes in coordinated movement to music have been linked to changes in spontaneous tempo (characteristic rate of rhythmic movement without sound) and preferred tempo (optimal tempo for perception and coordinated movement) (McAuley et al., 2006). V’s movement timing was closest to the target tempo for the fastest songs (140 bpm), both familiar and unfamiliar (Figure 2C). Spontaneous motor tempo changes from ~200 bpm at 4 years of age to 90 bpm in elderly adults, and synchronization is most accurate when the target tempo matches the preferred tempo (McAuley et al., 2006). The developmental timetable may be influenced by age-related changes in internal timing mechanisms (Vanneste et al., 2001; McAuley et al., 2006) and biomechanical factors involving limb length and weight (Goodman et al., 2000). Future research with infants should encompass a wider range of tempos, including the preferred tempo of 4-year-olds (200 bpm), and spontaneous motor tempo should be documented.

V’s dance duration per trial was positively related to smiling (Figure 3), highlighting the links between dance and pleasure. In previous research, smiling was related to ratings of movement coordination to music in 5- to 24-month-olds (Zentner and Eerola, 2010). Does movement to music generate pleasure, or do pleasurable responses to music motivate movement? Both may well be the case. Adults’ motivation to move to music has been linked to pleasure and to perceived musical groove (Janata et al., 2012; Witek et al., 2014). Musical features such as syncopation have independent effects on pleasure and desire to move (Witek et al., 2014). Moreover, musical movement heightens pleasure through increased arousal (Tarr et al., 2015).

Although Metallica prompted V to dance more and to dance distinctively, Dora prompted the most requests for more music. Aside from its familiarity, the high pitch and prominent vocals may have contributed to its appeal. Infants’ preference for high pitch in speech (Fernald, 1992) and song (Trainor and Zacharias, 1998) is well-documented.

Obviously, a case study of a normally developing child warrants cautious interpretation and cannot speak to issues of individual differences or to development in general. Nevertheless, V’s responses reveal dance behavior that is possible but not necessarily typical for 19- or 20-month-olds. A study of supine 3- and 4-month-olds revealed less movement in the context of music than in silence, but 2 of the 30 infants moved more to the music and also exhibited some coordination to the musical beat (Fujii et al., 2014). That study underlines the importance of considering individual behavior patterns even in group studies. With respect to the present study, a scaled-up version with large sample size could provide definitive evidence about the effects of song familiarity and various musical features on infant movement. When familiarity and pulse clarity are manipulated independently, we would expect familiar music to prompt more dancing than unfamiliar music and music with high pulse clarity to prompt more dancing than music with low pulse clarity. In light of the current findings, we would also expect young children to demonstrate greater tempo flexibility when moving to unfamiliar compared to familiar music. An expanded age range (e.g., 1–4 years of age) could provide information about the developmental trajectory of dance skills (e.g., characteristic movements, tempo flexibility, synchrony), the typical range of variation, and the effects of dance experience and musical exposure. Systematic testing in the home environment with specified, parent-administered protocols would provide multiple benefits such as a comfortable and familiar context for participating children, convenience for parents, access to non-local as well as local participants, and a wealth of information about the early development of dancing.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the University of Toronto Research Ethics Board with written informed consent from the participant’s legal guardian.

AUTHOR CONTRIBUTIONS

Both LC and ST contributed to study design, data analysis, and manuscript preparation.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01073/full#supplementary-material

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