

Melodic versus intonational coding of communicative functions: A comparison of tonal contours in infant-directed song and speech

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ABSTRACT—*Global intonational contours of infant-directed speech are said to serve effective communicative functions. For example, steep rising contours are thought to arouse an infant while smoothly falling contours are thought to be soothing. Several researchers (e.g., Cordes, 2005; Papoušek, 1996; Unyk, Trehub, Trainor, & Schellenberg, 1992) proposed that the melodic contours in nursery songs should follow the same communicative principles as in speech. In this study, melodic and intonational contours in play contexts were compared in three languages in order to determine 1) whether infant-directed speech and song are similar in the composition of their typical contours, and 2) whether there are differences across languages. Evidence from soothing contexts is also taken into account. The material was collected from 43 German-, French- and Russian-speaking parents singing or speaking to their 2- to 12-month-old infants. Tonal contour types in each register were assessed adopting protocols based on Cordes (2005). The results confirm the similarity between infant-directed speech and song in play contexts, but some differences occur in soothing contexts. Language-specific patterns are discussed, and it is put forward that it would be valuable to intensify research into the language-specific basis of infant-directed communication.*

KEYWORDS—*Infant-directed speech, song, contour forms, communicative function*

in Cruttenden, 1994; Trehub, 2003). In their first year of life, infants clearly prefer to listen to infant-directed speech (or “motherese”) and song than to adult-directed speech and song (Cooper, Abraham, Berman, & Staska, 1997; Fernald, 1984; Fernald & Kuhl, 1987; Nakata & Trehub, 2004; Trainor, 1996; Trehub & Trainor, 1998). Infants’ preference for infant-directed speech is thought to be mostly due to the tonal structure of the signal (Fernald & Kuhl, 1987): adults use a wider frequency range, a higher speech register and salient tonal contours when addressing children (Fernald & Simon, 1984; Fernald et al., 1989; Gavrilova, 2001; Stern, Spieker, & MacKain, 1982). Infant-directed songs are also sung at a higher pitch level (Trainor & Zacharias, 1998), in a smiling tone and with more jitter and shimmer in the voice (Trainor, 1996; Trainor, Clark, Huntley, & Adams, 1997), which might be due to a higher emotional involvement of the singer (Trehub & Trainor, 1998).

Fernald (1989), Papoušek (1996), and Papoušek, Papoušek, and Symmes (1991) showed that there is a narrow inventory of tonal contour types in infant-directed speech used by parents to fulfill distinct communicative functions. Rising contours encourage a turn or elicit attention (especially at the age of 2 and 3 months, see

In the presence of an infant, adults often unconsciously change their way of talking and singing. They slow down in tempo, use a higher overall pitch level, show more pitch variability, make more pauses and repeat their utterances (overview

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Henning, Striano, and Lieven, 2005), bell-shaped contours close a turn or signal approval, steeply falling contours with abrupt onsets are used for warnings, disapproval and prohibitions whereas smoothly falling contours soothe and comfort the infant (see Figure 1).

These functions were initially taken to be cross-linguistic universals (Grieser & Kuhl, 1988; Papoušek et al., 1991), though further research showed some variations in tonal features and in the frequency of contour types across language and cultural context, sex and age of the infant (Kitamura & Burnham, 2003; Kitamura, Thanavishuth, Burnham, & Luksaneeyanawin, 2001; Lam & Kitamura, 2006; Rabain-Jamin & Sabeau-Jouannet, 1997). In the first year of life, infants attend particularly to the global shape of tonal/melodic contours in speech and song (Fernald & Kuhl, 1987; Trehub, Bull, & Thorpe, 1984). Thus, tonal contours with communicative functions might help infants to establish a first semantic-pragmatic relation between phonetic form and global referential meaning.

Parents also use different songs and singing styles for different purposes. Two basic categories seem to be lullabies and play songs. Unyk, Trehub, Trainor, and Schellenberg (1992) examined these categories more closely: They found that lullabies were more likely to be identified by adults if they contained many falling contours and few contour changes. It was the musicologist Inge

Cordes (1998, 2005) who first proposed a classification method for songs based on the assumption that the melodic contours in song might mirror the contour types of infant-directed speech. In her study, she analyzed 83 children's songs from all over the world and established four song categories with regard to the occurrence of melodic contours. In a perception test, German adults rated the songs as to their communicative functions and confirmed the previously established categories. Songs of the first category "Schwingtyp", (narrow translation: oscillating songs) whose melodic contours smoothly oscillate up and down were rated as very calming and tender. Songs of the category "encomium" have a wide pitch range, bell-shaped and smoothly falling contours. These were rated slightly calming and pleasant to listen to. "Play songs" contain many contours with interval jumps in any direction. These songs were rated cheerful and stimulating. Finally there is a song category labelled "admonishing" by Cordes (2005) that is characterized by diversity of contour types and the occurrence of many steeply falling contours, which was rated stimulating, exciting and even menacing by adult listeners.

The proposal of Cordes (2005) is innovative because it results in a classification model taking into account structural and perceptual properties of songs. Yet one weak point is that it relies exclusively on melodic properties. Rock, Trainor, and Addison (1999) found other performance properties – such as voice quality and rhythmic performance – can solely distinguish between a lullaby and play song singing style.

In this article, I examine whether the contour-based approach to communicative functions of Cordes (2005) holds in a direct comparison of tonal contours in infant-directed song and speech. I therefore hypothesize that the use of contour types in both registers should be similar in similar contexts if infant-directed singing equals speech with respect to contour-based communicative functions. Tonal contours in sung and spoken utterances in natural play and soothing contexts will be compared. In play contexts, it is expected that contours should predominate that have an arousing effect or increase attention. In infant-directed

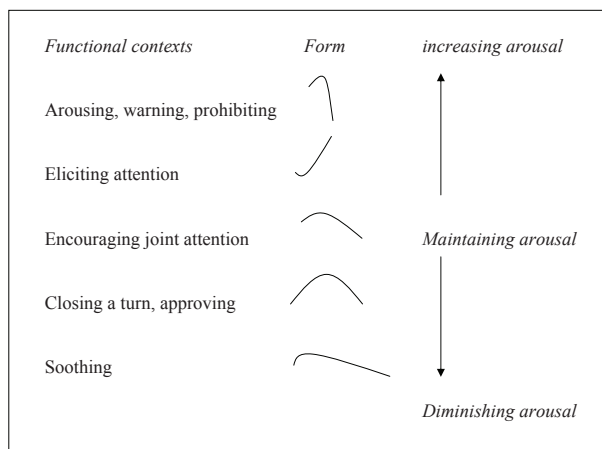


Figure 1. Contour form and function in infant-directed speech according to Papoušek (1996).

speech, Papoušek (1996) relates these functions to linear, steeply rising and u-shaped contours or contours with steep slopes in general. This matches the findings of Cordes (2005) who found many contours with interval jumps labelled as playful songs in her material. She also attributes a playful character to songs with many linear, steeply falling and abruptly ending bell-shaped contours. In soothing contexts, the intent of parents is to calm down their infant, that is, to decrease arousal level and create a cozy and warm atmosphere. Hence, it is quite the opposite of the communicative function of play contexts. In soothing contexts, flat contours with a small pitch range are expected as well as many descending linear and bell-shaped contours which are also employed for praise and approval (Cordes, 2005; Papoušek, 1996). A typical song form in this context is the lullaby which Cordes (2005) rates to be originally a “Schwingtyp” with many sinusoidal smoothly oscillating contours. In order to get a better idea of other performance features playing a role in the distinction of contexts and registers, a tempo measure is included in the analysis. Furthermore, whether length of utterance is related to the specific form of the tonal contour will be investigated.

A second purpose of the investigation is to determine whether there are language-specific aspects to the use of tonal contours in infant-directed song and speech. Therefore, field recordings from German, French and Russian speaking parents are considered. These languages were chosen primarily because they were available in the corpus. They are three languages representing the Indo-European family (one germanic, one roman, one slavic language). Nevertheless, we find important differences in the prosodic structure of these languages: concerning intonation structure, French has phrase-based pitch-accent distribution whereas German and Russian have pitch-accents linked to stress positions in a phrase (Féry, 1993; Odé, 2005; Welby, 2006). Furthermore, French has a prevalence of rising pitch accents (Vaissière & Michaud, 2006). These different prosodic patterns might lead to language-specific contour-forms if prosodic structure is reflected in infant-directed song and speech.

METHOD AND MATERIAL

Participants

Participants were recruited for a broader fieldwork study on infant-directed singing (Falk, 2009). These were 15 French, 13 German and 15 Russian speaking parents with infants who ranged in age from 2 to 12 months. Parent-infant dyads were recorded with a DAT-Recorder (Sony TCD-D100) and a microphone (Sony ECM-MS 907) at home while interacting naturally. The experimenter was present during recording and controlled the technical aspects of the recording (changing/pausing the DAT-tapes, adjusting the microphone). One recording session lasted between 45 minutes and 4 hours depending on the individual parent-child dyad. Parents were not instructed to sing specific songs, but rather were asked to interact, play, speak and sing as they did in their everyday life. On each session a protocol of the situation and recorded material was written by the experimenter that contained information on the context and situation in which the song/speech was uttered. Infants all showed normal hearing capacities. None of the parents was a professional singer or instrumentalist, but all of them liked singing and tended to sing quite often with their children.

Material

From the recordings, parents’ sung and spoken utterances in play and soothing contexts were extracted. The identification of contexts in the corpus was done on the basis of the protocol of each recording session. A play context was defined as a situation where the parent playfully performed rhythmical body movements with the infant, for example rocking the infant on his/her knees, pushing his legs or arms up and down, clapping his hands, dancing with him on his/her arms, massaging his body, assisting him in walking or crawling and so forth. A soothing context was defined as a situation where the infant was put to sleep, prepared to go to bed or comforted when crying or unsettled.

Utterances were itemized as phrases. A spoken (intonational) phrase is a syntactically and semantically meaningful sequence of sounds ending in a

lengthened syllable followed by an optional pause. Interjections like German “gell”, French “hein” or Russian “da” which frequently occur in infant-directed speech were not taken into account. A sung (musical) phrase was understood (as in the study of Cordes 2005) as a sequence of tones ending in a prominent tone of the scale (tonic, dominant) and ending in a lengthened tone followed by an optional pause. Repetitions of stanzas or refrains with the same text were not taken into account as far as the contours were clearly identical. This was done in order to avoid a bias of song length/refrain presence in the frequency analysis as long songs with many repetitions or refrains would have clearly dominated the analyzed material. Song variants were roughly transcribed in notation while checking the analysis of the intonation contour in parallel with the intonation analysis function of the program “Praat” (Boersma, 2001) for a subset of the material to guarantee the validity of the transcription. A song variant is a sung utterance that either could be assigned by text and melodic/rhythmic similarity to a specific (traditional, modern) song whose authorship or origin are known or one that is a made-up song which – in its structure and text – is unique to the parent who invented it. Major pauses were used to determine the end of a song.

There were 102 song variants analyzed in play contexts, the fieldwork material overall contained 690 sung (268 German, 214 French, 208 Russian) and 344 (113 German, 84 French, 147 Russian) spoken phrases. The greater proportion of sung phrases in this corpus can be explained by the fact that parents recorded in the study liked singing and tended to sing a lot in the aforementioned situations. Furthermore, spoken infant-directed speech is built on turn-taking which resulted in fewer spoken utterances in the same amount of time (awaiting the “answer” of the infant) compared to sung utterances that tended to be more monologue-like.

There were 42 song variants analyzed in soothing contexts. Overall they contained 296 sung (92 German, 142 French, 62 Russian) and 177 spoken (47 German, 77 French, 53 Russian) phrases. Soothing contexts were more rare than play contexts which resulted in a smaller sample. Parents of the same cultural community often sang identical songs;

additionally these songs had many stanzas and were sung over and over again. Since only one occurrence of the song and one stanza was included in the sample, the overall number of phrases is rather small. Nevertheless, it is assumed that the entire set of songs sung in these situations is limited compared to play contexts and that the sample would be sufficient to make some observations.

Analytical method

The analysis is largely along the lines of the work of Cordes (2005). Additionally, the categories of Papoušek (1996) and Katz, Cohn, and Moore (1996) were taken into account.

Tonal contour types were determined using the following parameters (for examples, see Figures 2, 3, 4):

1. Form: (a) linear: a contour with one tonal maximum and one minimum (b) bell-shaped: a contour with one tonal maximum and two minima (c) u-shaped: a contour with two tonal maxima and one minimum (d) sinusoidal: a contour with multiple local tonal maxima and minima

2. Direction: (a) ascending: the last tone of a phrase is on a higher pitch level than the first tone (b) descending: the last tone of a phrase is on a



Figure 2. Examples for contour classification (from the French song “Frère Jacques”). First bar: bell-shaped neutral contour, steep slope; Second bar: ascending linear contour, flat slope.



Figure 3. Examples for contour classification (from the French song “Frère Jacques”). First bar: descending bell-shaped contour, flat slope; Second bar: neutral u-shaped contour, steep slope.



Figure 4. Example for contour classification (from the French song “Les petits poissons”): descending sinusoidal contour, flat slope.

lower pitch level than the first tone (c) neutral: the last and first tone of a phrase are on the same pitch level

3. Slope: (a) flat: a contour whose adjacent pitch levels differ by no more than one or two semitones (b) steep: a contour whose adjacent pitch levels differ by more than two semitones. In ambiguous cases a contour was classified as flat when the ratio of the number of intervals with two semitones or less to the number of intervals with more than two semitones was at least 3:2.

The analysis of sung contours was based on the aforementioned transcripts. The contour types of infant-directed speech were determined acoustically using the phonetic program “Praat” (Boersma, 2001). Two samples of sinusoidal contours in the spoken and sung material are shown in Figures 5 and 6. As can be seen in these figures, the contour of sung phrases stays at the same tonal level over one or more syllables whereas in spoken contexts, the frequency level changes continually. Therefore, tonal maxima and minima of each contour type were determined differently: in spoken phrases, a tonal maximum/minimum was determined by analysing local pitch height in sonorous segments in a syllable (vowel+sonorous coda consonants) and by taking into account the following rises and falls that had to be continuous in their slope over the same or next syllable. In sung phrases a change of one semitone could already constitute a tonal maximum/minimum as long as the contour stayed at the same level over the preceding/following syllable(s). Thus, in general, spoken contours had larger differences

in frequency of tonal maxima and minima as compared to sung contours. In determining the contour types, contours often had to be checked aurally because of voice phenomena (e.g., creaky voice at the end of utterance), infant interference (babbling, crying) or pitch jumps in the pitch algorithm of Praat.

A two-dimensional Pearson χ^2 -test was performed to decide whether the distribution of the four contour forms (in percent) was dependent on speech register (singing vs. speaking) or not (null hypothesis). Independence of the variables would lead to the conclusion that the use of contour types in both registers is similar. Each language was tested separately to see language-specific effects. Finally, the contour forms were tested cross-linguistically in either the speaking or singing condition. The contour parameters “Direction” and “Slope” served as additional evidence, but were not evaluated statistically.

Additionally, a tempo measure was included in the analysis in order to show if contour and/or rhythm could account for differences in speech and song or across contexts. A representative subset of the spoken and sung material (160 to 200 phrases per language in play contexts (half of them sung, half of them spoken), 80 to 100 phrases in soothing contexts) was analyzed in order to determine the mean syllable duration in a sung or spoken phrase. The contexts were then compared using a *t*-test.

Finally, the length of utterances was measured by counting tonal events or syllables in sung and spoken phrases. It is widely assumed in the literature

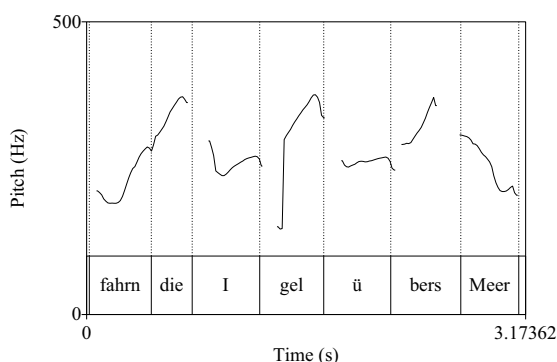


Figure 5. Sinusoidal contour in German infant-directed speech, play-context, rhyme. The tonal slope is continuously changing throughout the utterance, no distinct tonal levels are provided.

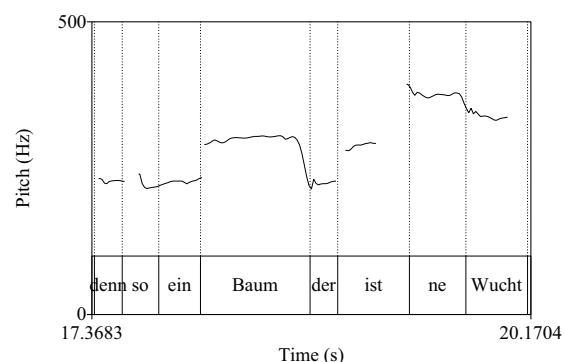


Figure 6. Sinusoidal contour in German infant-directed singing. Compared to figure 5, tonal targets remain stable for a certain time which constitutes distinct tonal levels.

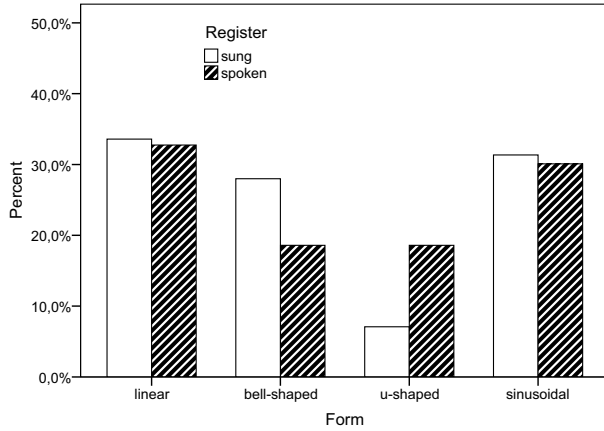


Figure 7. German contour form distribution (in percent) of sung and spoken utterances in play contexts.

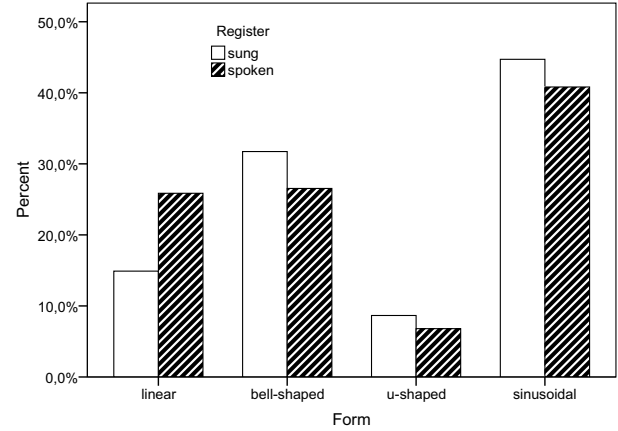


Figure 9. Russian contour form distribution (in percent) of sung and spoken utterances in play contexts.

that syllables are comparable to tonal events as these two units are often linked in a one-to-one fashion in popular music (e.g., Gelber, 1995; Noel & Vetterle, 2009; Patel, Iversen, & Rosenberg, 2006). The mean length was calculated for each contour form per register.

ANALYSIS 1: PLAY CONTEXTS

Results: Speech versus song

In play contexts, tonal characteristics of infant-directed speech and song were found to be very similar (see Figures 7 to 9). In French and German infant-directed speech and song, parents make use of the entire spectrum of contour types which

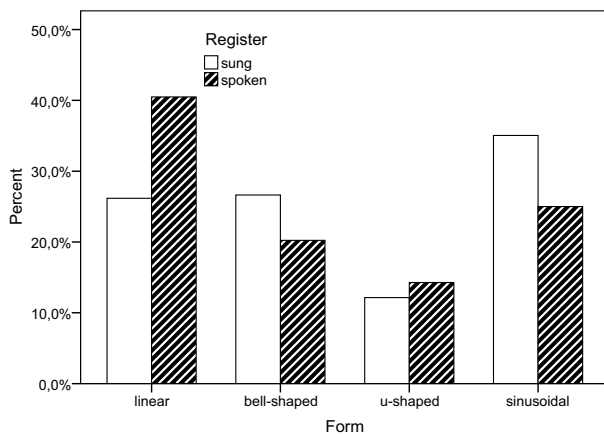


Figure 8. French contour form distribution (in percent) of sung and spoken utterances in play contexts.

gives the impression of a varied singing/speaking style (see Figures 7 and 8). The sung and spoken phrases of Russian parents were mostly sinusoidal in form, however, other contour types were frequently used as well (Figure 9). It is remarkable that u-shaped contours were found more rarely overall than the other contour forms. The contour slope in all languages was characterized by many interval jumps in both song and speech, the pitch range was middle to high. There were many ascending contours, but sinusoidal contours in French and Russian were mostly descending. French spoken linear contours were descending, whereas the reverse was true for sung linear contours. In none of the three languages did the χ^2 -test become significant. This implies that the null hypothesis cannot be rejected: speech register (singing vs. speaking) showed no effect on the distribution of contour forms in play contexts.

Table 1

Tempo differences measured as mean syllable duration (seconds) per utterance in soothing and play contexts in German, French, Russian

		German	French	Russian
soothing	sung	0.58	0.54	0.45
	spoken	0.24	0.24	0.30
play	sung	0.39	0.39	0.35
	spoken	0.36	0.28	0.26

The tempo analysis revealed significant differences (see Table 1) between speech and song in Russian (after exclusion of 6 outliers, $N = 195$, $t(192) = 5.81$, $p < .001$) with longer syllable durations in song than in speech. This was also the case in French (after exclusion of 7 outliers $N = 154$, $t(150) = 4.00$, $p < .001$). In German however, no significant difference in mean syllable duration was found.

Results: Cross-linguistic observations

When comparing the sung contour distributions across languages the χ^2 -test does not reach significance. However, pairwise testing of the languages reveals a significant difference between German and Russian ($p = .01$, $\chi^2 = 9.96$, $df = 4$) due to linear contour forms. Russian has only 15% linear contour forms in this sample whereas German songs have 34%. The Russian material stands out in infant-directed speech as well. The cross-linguistic χ^2 -test was significant ($p < .05$, $\chi^2 = 14.29$, $df = 6$). Pairwise tests show that the spoken contour distributions of Russian and French differ ($p < .05$, $\chi^2 = 10.52$, $df = 4$) as well as the distributions of Russian and German ($p < .05$, $\chi^2 = 9.27$, $df = 4$). U-shaped contours seem to be characteristic for German (18.5%) and French (14.3%) infant-directed speech in play contexts in contrast to Russian (6.8%).

Discussion

Results show that in play contexts, the contours of infant-directed spoken and sung utterances are very similar in form, slope and direction. As expected, these contours seem to be appropriate to enhance the arousal and attention level of the infant (Papoušek, 1996): steep slopes, ascending contours, variable contour forms and many u-shaped contours in French and German. Contrary to Cordes (2005), there was no predominance of descending linear contours in either sung or spoken utterances except for the French spoken material. In terms of tempo measured as the mean syllable duration, syllables are longer in sung than in spoken contexts at least in Russian and French. In these languages, although

the contour does not distinguish reliably between speech and song, tempo effectively does.

The cross-linguistic analysis revealed that Russian was slightly different from the other two languages in speech and song. The material had more sinusoidal contours in general and a different contour distribution in infant-directed speech. It is only a small difference, nevertheless, a language/culture-specific parametrization of contour use in infant-directed speech and song cannot be excluded. It will be necessary to consider another functional context to know if the contour-based approach allows one to distinguish between different communicative functions and to determine typical and/or language-specific context-related contour types. Therefore soothing contexts are considered in the next section.

ANALYSIS 2: SOOTHING CONTEXTS

Results: Speech versus song

In soothing contexts, the contour forms of infant-directed speech and song differ (see Figures 10 to 12). This is due to the distribution of linear and sinusoidal forms: sinusoidal forms appear very often in sung speech in all three languages and less often in spoken speech; descending linear contours are frequently found in German and French infant-directed speech whereas they are rare in the songs of this sample. In all three languages the t -test

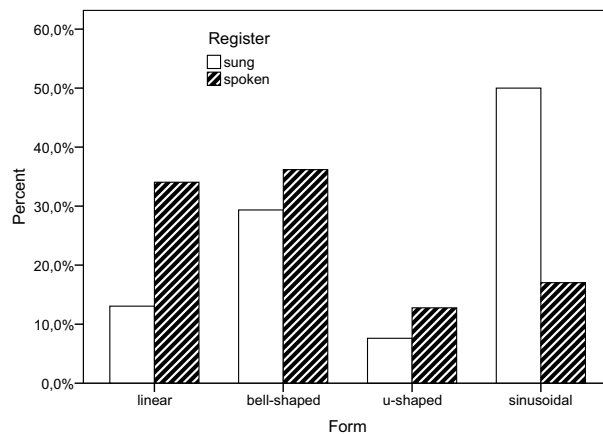


Figure 10. German contour form distribution (in percent) of sung and spoken utterances in soothing contexts.

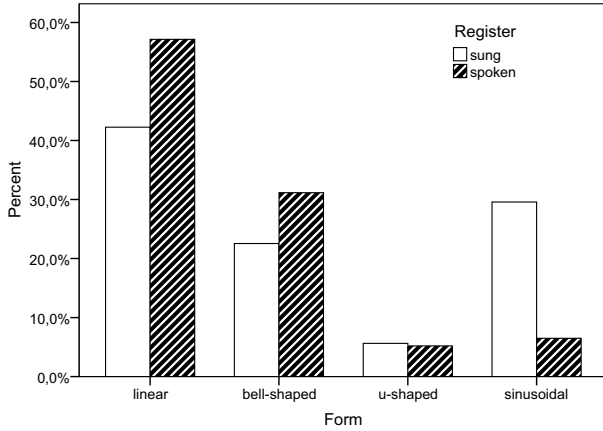


Figure 11. French contour form distribution (in percent) of sung and spoken utterances in soothing contexts.

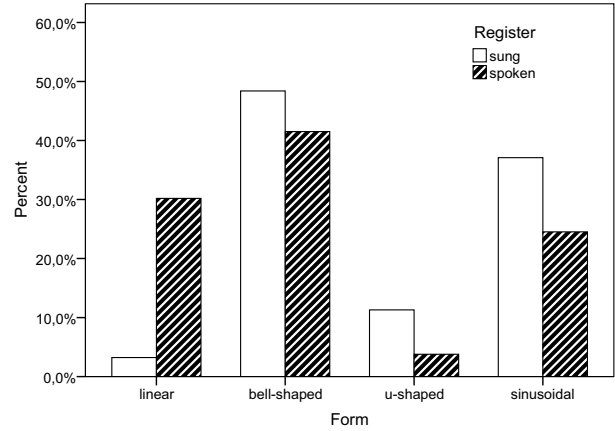


Figure 12. Russian contour form distribution (in percent) of sung and spoken utterances in soothing contexts.

becomes significant (German: $p < .001$, $\chi^2 = 27.76$, $df = 3$; French: $p < .001$, $\chi^2 = 18.41$, $df = 3$; Russian: $p < .001$, $\chi^2 = 28.66$, $df = 3$).

Apart from these differences, sung and spoken contours in soothing contexts have commonalities as well. In the German sample (Figure 10), there are many bell-shaped contour forms in both registers, the direction of the contours (except for sinusoidal contours) is mainly descending, the slope is predominantly flat; in songs, intervals seldom exceed a fourth. In French (Figure 11), the prevailing contour form is linear descending in speech and song, although sung contours proceed in a steep slope whereas spoken contours run smoothly. Bell-shaped and u-shaped contours show a similar distribution in speech and song: a one-dimensional χ^2 -test including the four contour forms in each register yields similar deviations from the expected values for these contour forms. Concerning the Russian material (Figure 12), the bell-shaped contour is the prevalent contour form in speech and song, although neither direction (ascending in song vs. neutral in speech) nor slope (steep in song, flat in speech) are similar.

Tempo differences (see Table 1) between speech and song were clearly visible in all three languages with sung syllables being much longer than spoken ones (German: after exclusion of one outlier $N = 75$, $t(73) = 12.25$, $p < .001$; French: after exclusion of one outlier, $N = 101$, $t(69) = 10.22$, $p < .001$; Russian: after exclusion of 2 outliers, $N = 99$, $t(97) = 6.34$, $p < .001$).

Results: Cross-linguistic observations

In infant-directed songs, the three languages are significantly different with respect to contour ($p < .001$, $\chi^2 = 60.82$, $df = 6$). Pairwise χ^2 -tests confirm the disparity, even though Russian and German have a lower χ^2 -value when compared to each other. Nevertheless the difference between linear and bell-shaped contour forms holds in these languages.

In infant-directed speech, the result is slightly different. Across languages, bell-shaped and/or descending linear contour forms prevail. The χ^2 -test is significant ($p < .001$, $\chi^2 = 28.62$, $df = 6$), but pairwise tests show that this is due to the French sample which differs from Russian and German, whereas the distribution of contour forms in these languages is similar (non-significant χ^2 -test).

Results: Play versus soothing contexts

Finally, contour distributions of both functional contexts were compared per language and register. Results of the χ^2 -test show that register and contour forms are dependent in infant-directed speech, thus the contexts can be distinguished via contour form distributions. German soothing contexts are characterized by a high amount of bell-shaped contours in contrast to play contexts. In French, the contexts can be distinguished by the presence (play contexts) or near absence (soothing contexts) of sinusoidal contours and the

frequent occurrence of u-shaped forms (in play contexts). In Russian, the high frequency of sinusoidal contours is typical for play contexts. Tempo however, distinguishes between play and soothing contexts in German and French (see Table 1). In German infant-directed speech, syllables in play contexts are significantly longer than in soothing contexts (after exclusion of 8 outliers $N = 137$, $t(133) = 4.9$, $p < .001$). In French, this is also the case (after exclusion of 8 outliers $N = 124$, $t(121) = 2.36$, $p < .05$). No significant difference was found in Russian.

The contour-based approach produces more controversial outcomes in the case of infant-directed songs. In the German and Russian sample, contexts can be clearly distinguished (German: $p < .005$, $\chi^2 = 13.50$, $df = 3$; Russian: $p < .01$, $\chi^2 = 12.09$, $df = 3$). German contour distributions differ especially in linear forms (indicate a play context) and sinusoidal forms (indicate a soothing context). In soothing contexts, the Russian sample was characterized by bell-shaped contours that are more frequent than in play contexts and the near absence of linear contours. For both languages, tempo differences also account for differences between contexts: In soothing contexts, parents use significantly lower tempo (longer syllables, see Table 1) than in play contexts. In German, the mean difference is 19 ms between syllables in both contexts ($N = 145$, $t(47) = 6.83$, $p < .001$), in Russian, this is 10 ms with $N = 145$ (after exclusion of 5 outliers, $t(143) = 5.54$, $p < .001$).

The French case is more difficult since the χ^2 -test does not reach significance either for the overall contour forms or with each contour type tested separately. This implies that in the French sample, soothing and play contexts cannot be reliably discriminated by contour forms. The distributions of contour forms are too similar. At least a tonal hint to contexts could be the contour direction which is mostly descending in soothing contexts and ascending in play contexts. Nevertheless, as in German and Russian, tempo distinguishes between the contexts. With 54 ms per syllable, parents sing significantly slower in soothing than in play contexts (39 ms) ($N = 131$ (1 outlier excluded), $t(129) = 4.58$, $p < .001$).

Discussion

In soothing contexts there is only partial congruency between the contour types of spoken and sung utterances. Additionally there are differences between the language samples. In the German sample, direction and slope of spoken and sung contours match, but contour forms do not. In French the characteristic contour form, (i.e., descending linear contours), is equal in song and speech, but slope is steep in sung contours whereas it is flat in spoken contours. The Russian data show a prevalence of bell-shaped contours of either song and speech but these contours run in interval jumps in songs and mostly flat in spoken utterances. Tempo differentiates in all languages between sung and spoken register as sung syllables tended to be 1.3 to 2 times longer than spoken ones.

These outcomes already show that there are differences between the three language samples. The French data are particularly remarkable. Firstly, the use of linear contour forms in French differs considerably in speech and song from German and Russian. There are also many interval jumps in French soothing songs which is rather rare in German and Russian songs. It will be discussed later (i.e., General discussion) whether these tonal differences could be related to the specific international structure of French. Secondly, in French songs, play and soothing contexts cannot be reliably distinguished by tonal contours. A closer look at the songs reveals that several French play songs and lullabies are nearly identical in their contour pattern, although there might be a different text. This concerns variants of the very popular play song "Bateau sur l'eau" that strongly resembles the equally popular lullaby "Dodo, l'enfant, do". In addition, the songs "Frère Jacques" and "Meunier, tu dors" were sung in both contexts with almost identical melodic contour, but tempo did obviously vary as parents sang consistently slower in soothing than in playful contexts. This suggests that French singers prefer unique contour templates for different communicative functions. Besides tempo, the context might be additionally differentiated by other aspects of rhythmic structure and voice

qualities as Rock et al. (1999) and Trehub, Unyk, and Trainor (1993) have shown. Nevertheless, we have to bear in mind that these results might be influenced by the small size of the sample. Another notable result of this study was that syllables were longer in sung utterances in soothing contexts but shorter in spoken utterances in soothing compared to play contexts.

Finally, the differences between sung and spoken utterances in soothing contexts were most visible in the use of linear and sinusoidal contour forms. As a sinusoidal contour form requires at least two tonal maxima and minima whereas a linear contour form had only one maximum and minimum, the difference could be related to the mere length of an utterance. This will be examined in the next section.

ANALYSIS 3: LENGTH OF UTTERANCES

Results

Table 2 displays overall results for contour forms across languages, Table 3 shows mean utterance length per language and context. As can be seen in Table 2, linear contours are shortest, whereas contours with more than one tonal maximum/minimum are longer with sinusoidal contours being the longest. This applies to both spoken and sung phrases in all languages and holds true for every language considered individually as well.

Table 2
Mean number of syllables and tones in spoken and sung contour forms across languages

	sung phrases (mean length in tones)	spoken phrases (mean length in syllables)
linear	4.58	4.99
bell-shaped	6.35	5.96
u-shaped	5.56	5.75
sinusoidal	7.48	7.91

Discussion

It seems plausible that the differences in sinusoidal and linear contours as found in soothing contexts stem basically from the fact that phrases in infant-directed singing are generally longer than in infant-directed speech. Three other factors might play a role in this regard. Firstly, it is syntactic complexity that could induce longer utterances. Infant-directed speech is often elliptical, especially in soothing contexts. Parents sometimes do not even use verbs, instead, they often repeat the child's name or terms of endearment to calm the infant. Thus, those utterances are shorter compared to full sentence structures or even verse lines (which are at the basis of many children's songs, see below). Secondly, infant age could be an influencing factor as well. As we know from long-term studies on motherese (e.g., Henning et al., 2005; Stern, Spieker, Barnett, & McKain, 1983) syntactic complexity of parental discourse increases with infant age in the first year of life, and so does length of utterance. Thus, age of infant could be the reason for different phrase lengths in speech or contour forms respectively. In this sample, however, this could be excluded, because in none of the language samples did a single age group have a clear preponderance in either context.

Thirdly, metrical structure could be important since metrical accents may influence the length and shape of contours. German and Russian might be especially concerned as their metrics (and their language rhythm in general) is foot-based (see e.g.,

Table 3
Mean utterance length in soothing and play contexts measured in syllables (in speech) and tones (in songs) per language

		German	French	Russian
soothing	sung	6.3	5.1	6.8
	spoken	5.7	5.4	6.5
play	sung	6.2	6.4	6.7
	spoken	5.8	5.7	6.9

Abercrombie, 1967; Bailey, 1995; Wagenknecht, 1999) which means that metrical accents occur every second or third syllable in a verse line. As accents are marked amongst others by a change in fundamental frequency in these languages, the frequent occurrence of sinusoidal contours in spoken utterances – especially in play contexts where parents used many rhymes and word-plays – may be explained by this language-specific prosodic feature. Such a strong intonational feature might influence the structure of songs as well. In this sample, song texts in both contexts were metrically bound in the majority of cases. As musical phrases tend to be consistent with verse lines in infant-directed singing (Falk, 2009), metrical accents may not only influence the tactus level as has been shown in the literature (Albertsen, 1997; Tatubaev, 1982), but also the melodic contour. Further studies should examine this relationship more closely.

GENERAL DISCUSSION

In this study, tonal contours in natural infant-directed speech and singing were compared cross-linguistically in two situations where parents had different communicative intents – in play and soothing contexts. The aim was to know whether 1) infant-directed speech and singing are similar in the composition of their contour types and 2) whether there would be language-specific differences in German, French and Russian.

Results showed that contour types in singing and speaking were most similar in play contexts. No significant differences in the distribution of contour forms were found. A variety of contour types that are presumably arousing is typical for this context across languages. Contour slope was steep and many ascending contours were found. In soothing contexts the situation was less clear. On the one hand, contour slope and direction matched well in German; the predominant contour forms were the same in French and Russian. On the other hand, χ^2 -tests supported a significant difference in the use of contour form distribution in infant-directed speech and song. This finding is inconsistent with the view of Unyk et al. (1992) that contour types in

songs and speech in soothing contexts should be most similar. However, differences were mainly due to the use of linear and sinusoidal contour forms. In the samples used in the present study, contour form seemed to be influenced by utterance length where linear contours were shortest and sinusoidal contours were longest in terms of syllables or tones in speech and song respectively. For example, the Russian sample showed the highest mean value in length of utterance (see Table 3) and it had the smallest amount of linear contours across the language samples. The French soothing data comprised the shortest utterances and the highest amount of linear contour forms in this context. This observation is an important finding: it suggests that contour forms could also be related to other language-intrinsic factors like syntactic complexity or prosodic structure, an idea that has not been investigated so far. In this data, infant-directed speech in soothing contexts was often elliptical while songs had mostly rhymes and poems as a textual basis. The sung phrases being syntactically more complex also contained a higher portion of sinusoidal contours. But why should syntactic structure influence tonal contours at all? German, French and Russian speakers make use of fundamental frequency to mark sentence, phrasal and word accents. This behavior results in language-specific intonational patterns. Syntactically more complex utterances give more opportunities for accentuation, especially in metrical regulated texts. Thus, the metrical and rhythmic structure of an utterance might induce changes in its tonal contour. While this is a well-known fact in spoken speech, it is less clear in sung speech. If and how the melody of songs depends on linguistic prosody is not well understood. Only recently, some studies have taken interest in this question (see e.g., Dombrowski, Holzrichter, Münz, Nowak, & Poschmann, 2007; Falk, 2008a; Ho, 2006). Finally, when looking at the tempo of utterances measured in mean syllable duration per phrase, it can be seen that sung utterances have slower tempo than spoken utterances in both soothing and playful contexts.

Cross-linguistic comparisons also revealed language-specific differences in the use of contours

in infant-directed speech and song. In spoken utterances in play contexts, the Russian contour distribution differed from French and German especially in u-shaped contours. As mentioned above, the Russian sample had remarkably few linear contours and many sinusoidal contours in general. In soothing contexts, French was set apart from the other two languages in both speech and song because of the high frequency of linear contour forms. There might be two explanations for that: the first one is language prosody. French has a phrase-based accent and intonation system where the primary accent is usually set on the last non-reduced syllable of the phonological phrase (e.g., Lacheret-Dujour & Beaugendre, 1999). Thus, if only one intonational phrase is articulated and no secondary accents intervene, a linear contour form is likely for a French utterance. The metrical system might not interfere because it is rather built up on syllabic timing than on stress timing as it is the case for German and Russian (Gibbon, 1998; Svetozarova, 1998). In these languages every content word can have a pitch accent depending on the informational structure of the sentence. Consequently, more than one pitch accent can occur in one intonation phrase. In exaggerated infant-directed speech, especially in metrical bound utterances, this could often result in an up-and-down sinusoidal contour (Falk, 2008b) as we have found it in play contexts in this data. It seems worthwhile to examine the connections of accent placement and melodic form more closely in further studies.

The second explanation for differences in this sample could be the cultural background. In terms of the classification system of Cordes (2005), French soothing songs could be classified as a special case of the “Schwingtyp” category. In the Russian and German data, the contour distribution in soothing contexts was dominated by bell-shaped and sinusoidal contours which best matched the “encolium” category of Cordes (2005). Altogether, these songs included many contour forms that presumably have a calming effect or communicate affect (Cordes, 1998; Papoušek, 1996). Thus, language specificities could also be due to cultural preferences. Especially in soothing contexts, parents rely

on a rather small inventory of songs with sometimes long historical tradition (Boock, 2001; Holaubeck-Lawatsch, 1985). In German for example the very popular lullaby “Schlaf, Kindlein, schlaf” is traced back to the 14th century and maybe farther (Erk & Böhme, 1893/1894). Lullabies are often handed down from generation to generation over centuries. Consequently, a canon of culture-specific melodic templates for different song types could have developed which could be used in new productions as well. This explanation could also account for the differences in slope in sung and spoken soothing utterances in the French and Russian data.

Finally, this study shows that the contour-based approach of Cordes (2005) can be fruitfully applied in the analysis of infant-directed speech and song. Nevertheless, results indicate that metrical/rhythmic structure has to be taken into account in some way. Firstly, French songs in play and soothing contexts could not be reliably distinguished by a mere contour-based approach. This was partly ascribed to the fact that French parents in this sample sang several tonal doublets with same melody but different functional purposes. However, the assessment of tempo showed that soothing songs contained much longer syllables than playful songs. Thus, rhythmic features help to distinguish between the two contexts. Secondly, as it was discussed in the above sections, it is likely that rhythmic and metrical accents influence melodic contour.

The major result of this study is the finding that melodic and intonational coding of communicative functions is similar in infant-directed speech and song in many ways. Nevertheless, results yield a differentiated view of the contour-based approach. As has been discussed, language-specific and also cultural aspects could interfere with contour forms which makes it hard to claim universal or even biological functions for tonal contours in speech and music (Cordes, 2005; Papoušek, 1996). Therefore, it would be fruitful for future research on motherese and infant-directed singing to expand knowledge on the language- and culture-specific basis of both production and perception of infant-directed communication.

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AUTHOR NOTES

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