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MUSIC PROTOTYPES IN DEVELOPMENTAL PERSPECTIVE

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We explore the utility of the notion of natural prototypes in the domain of music. Natural prototypes have a biologically given focus or core rather than one computed from past experience. This core functions as a perceptual or cognitive frame of reference for the processing of incoming stimuli. We outline cross-cultural and developmental strategies for identifying natural prototypes. Empirical research with adults reveals that the lullaby may constitute a perceptually distinct, pan-cultural category consisting of exemplars varying in degree of prototypicality. Research with infants indicates that some melodies may be naturally good or well formed, as reflected in their enhanced processing relative to other melodies.

In the present paper, we explore the utility of the notion of natural prototypes in the domain of music. Following Rosch (1975), we use the term prototype or prototypical to refer to good or highly representative instances of a category. Such instances are considered to represent the essence or core around which other instances of a category are organized. Although it may be desirable to identify the best exemplars of any category, it will often be difficult or impossible to do so. Further, we distinguish natural prototypes from those that are arbitrary (Rosch, 1973, 1975). Natural prototypes arise from perceptually salient objects, events, or features or from intrinsically well-formed instances. By contrast, arbitrary prototypes emerge from some process of averaging category instances. There is no implication of structural or functional differences between natural and arbitrary prototypes. Rather, the differences relate primarily to the means by which exemplars achieve prototypical status. The distinction is between a biologically given focus or core, on the one hand, and a focus computed largely from past experience, on the other. These foci, whether natural or arbitrary, function as cognitive frames of reference.

If Rosch’s (1975) notion of arbitrary prototypes is translated for application to the music domain, it might approach Jones’ (1981) idea of expectancies or analog representations derived from objective regularities in music patterns. Where these views differ, however, is that Rosch’s (1975) prototype is not simply a theoretical or conceptual average; it exists as a best example of the category in question (e.g., bird: robin; red: reddest red). For Jones (1981, 1982), however, the prototype is an abstraction, a composite of invariants rather than an exact average of the invariants in actual music. It is an ideal or perfect realization of the rules or regularities of a music culture and, as such, it may never be heard at all. It functions, nevertheless, as a perceptual frame of reference as we listen to actual melodies. Any such melody is likely to deviate from the ideal to a greater or lesser degree.

Trehub and Unyk
Jones' (1981, 1982) ideal prototypes are not totally unrelated to Rosch's (1975) natural prototypes that originate in well-formedness, except that biological factors play a more explicit role in the latter case. Recently, however, Jones (1990) has elaborated her conception, bringing it closer to Rosch's (1975) natural prototypes. Some invariants or constancies are now considered more salient than others. Presumably, this would facilitate their incorporation into the ideal prototype. In fact, the formation of such internalized ideals on the basis of experience may be "jump-started by inherent, biologically-determined biases regarding structural form" (Jones, 1990, p. 193).

If prototypical forms exist in music, what are their implications for the perception of music and the acquisition of music knowledge? Where categories can be defined, prototypic instances would be maximally distinct from nonmembers of the category and maximally similar to category members, like the natural and arbitrary prototypes in nonmusic domains. Where categories are less clear or undefined, good form would confer comparable processing advantages. Prototypical patterns, whether natural or arbitrary, would be encoded in greater detail, remembered more readily, and perhaps preferred compared to nonprototypical patterns. In the case of natural prototypes, enhanced processing would be exhibited by listeners who have limited experience with the categories in question. Moreover, on tasks that require learning to associate some response with a pattern, such learning should be more rapid for prototypical than for nonprototypical patterns. Also, cross-cultural similarities should be evident in the perception of natural prototypical instances. This does not mean that natural prototypical patterns from one culture would necessarily play an important role in other cultures. What is implied, however, is that unfamiliar prototypical patterns should be processed more efficiently than equally unfamiliar nonprototypical patterns.

Identifying Natural Prototypes: Research Strategies

How can one determine whether inherent well-formedness or biologically-determined biases play a role in music perception and cognition? When adults exhibit attentional biases, preferences, or better retention for some music forms over others, it is always possible to attribute these effects to experience. Even if the adult listeners have not had formal training in music, they would have assimilated a great deal of tacit knowledge simply from passive exposure to the music of their culture (e.g., Cuddy, Cohen, & Mewhort, 1981; Krumhansl, 1990).

Cross-cultural comparisons provide one means of circumventing the problem of experience in the search for prototypes and natural processing biases. This approach has been pursued to great advantage in the study of color categorization (Heider, 1972), shape categorization (Rosch, 1973), and emotion recognition (Ekman, 1972; Krauss, Curran, & Ferlezger, 1983). For example, Heider (1972) explored the possibility that saturated colors, by virtue of their perceptual salience, would function as prototypes for individuals whose language had no names for hues. On a task that required associating words with hues and applying these to various category instances, the Dani of New Guinea per-
formed more rapidly and more accurately for prototypical than for nonprototypical instances. Similarly, the Dani acquired form concepts more readily for good geometric forms (e.g., circle, square) than for distortions of such forms, despite the absence of relevant lexical items in their language (Rosch, 1973). The latter finding indicates that good form can function as a prototype or cognitive anchor. Furthermore, there is considerable cross-cultural agreement on the recognition of basic emotions from the prosody of speech (Krauss et al., 1983), music glides (Clynès & Nettheim, 1982), and facial expressions (Ekman, 1972).

Complementing the cross-cultural approach to research on prototypes is the developmental approach. The notion here is that perceptual salience and good form should enhance perception, attention, and memory for children at least as much as they do for adults. Thus Heider (1971) demonstrated that 3- and 4-year-olds selected focal over nonfocal colors in response to nonspecific requests to choose a color. However, it is very difficult to distinguish natural from arbitrary prototypes in a population with a sizeable vocabulary of arbitrary labels and even a modest productive repertoire, which includes some songs. More fertile testing ground for hypotheses about natural prototypes or biologically-determined biases can be found in infancy, where cultural baggage is minimal. There is no necessity for an absolutely blank slate or complete absence of experience. Rather, biases that are evident in infancy must be readily acquired, at the very least, and likely involve processing predispositions (Trehub & Trainor, in press) or innate learning preferences (Marler, 1990).

Recent Prototype Research with Infants

Recent studies of infant categorization reveal that categories are formed around prototypical examples (for a review, see Quinn & Eimas, 1986). After systematic exposure to instances of faces (Strauss, 1979; Sherman, 1985) or geometric shapes (Bomba & Siqueland, 1983; Younger & Gottlieb, 1988), infants respond to the average or most typical example of the category as if it were familiar, even when this example was not among stimuli previously presented. This implies that infants abstract a central tendency from the examples presented, using this as a standard for evaluating new instances.

There is evidence, moreover, that infants process good patterns more efficiently than poor patterns. For example, Younger and Gottlieb (1988) used Garner's (1974) information-theoretic principles to construct good and poor visual patterns consisting of arrays of dots. The good patterns could be considered simple in the sense that they were symmetrical and informationally redundant whereas the poor patterns were asymmetrical. Adult ratings provided independent confirmation of the classification of these patterns as good or poor. After familiarization with exemplars from one category, infants were presented with a previously seen exemplar from the familiar category paired with an exemplar from an unfamiliar (contrasting) category. Infants 3, 5, and 7 months of age distinguished the novel from the familiar category (as reflected in differential visual fixation) in the case of the good patterns. However, only the 7-month-olds were able to distinguish the novel from the familiar category when
the patterns were poor. These findings imply that *good form* facilitates infants’ encoding and comparison of two-dimensional visual patterns.

Infants have also exhibited enhanced processing of *good* biologically relevant patterns such as faces. Despite the fact that 2-month-old infants would have experienced a limited number of faces in their brief life, they looked longer at slides of attractive faces (as rated by adults) than at paired unattractive faces (Langlois, Roggman, Casey, Ritter, Rieser-Danner, & Jenkins, 1987), implying a rudimentary preference for the former. Moreover, 6-month-olds showed similar attentional preferences for attractive infant faces and for attractive adult faces, whether black or white (Langlois, Ritter, Roggman, & Vaughn, 1991). One might imagine that an attractive face is unique in some sense and that its salience arises from special features or qualities. Recent research indicates quite the contrary, that faces composed by mathematically averaging over many individual faces are rated as highly attractive (Langlois & Roggman, 1990). Indeed, Langlois et al. (1991) outline the potential biological advantages arising from a preference for average (i.e., attractive) faces. It is likely, then, that the various notions that lie at the heart of natural and arbitrary prototypes such as central tendency, perceptual salience, and *good form* overlap a great deal.

Grieser and Kuhl (1989) and Kuhl (1991) explored auditory prototypes in infancy and the implications of such prototypes. They had adults rate the typicality of vowel sounds and then evaluated adults’ and 6-month-old infants’ differentiation of prototypical and nonprototypical instances from other instances *within* the category. Both adults and infants exhibited greater generalization from prototypical than from nonprototypical vowels, confirming Rosch’s (1978) view that prototypical or good instances reflect “the redundancy structure of the category as a whole” (p. 37). Further work with English- and Swedish-learning infants (Kuhl, 1991) indicates that early listening experience plays a role in vowel category organization. This does not rule out the possibility of “jump-starting” by biologically-determined biases (Jones, 1990). Indeed, there are numerous indications that the selection of phonemes in various languages has been guided by their relative ease of processing (Stevens & Keyser, 1989). It would be of interest, then, to determine whether adults and children could learn a task (e.g., recognition, discrimination, labeling) more readily with prototypical than with nonprototypical exemplars of Swedish or other foreign vowel categories. If this were the case, it would provide evidence for innate learning preferences (Marler, 1990) or innately-guided learning (Gould & Marler, 1987; Jusczyk & Bertoncini, 1988), which are associated with very rapid acquisition, and evidence against gradual, experientially-driven learning of vowel prototypes. It would also increase the likelihood of finding other natural auditory prototypes.

**Cross-Cultural Identification of Lullabies**

Identifying prototypes in music is a challenge indeed. Unlike objects and events in the natural world, the categories in music are not intuitively obvious. To the extent that categories are identifiable, however, they tend to be complex and culture-specific (e.g., music style). Discussions of prototype formation in
music (Jones, 1981, 1982, 1990) have implicated mechanisms for abstracting invariants such as rhythm or tempo from multiple exemplars. Nevertheless, the possibility that some music prototypes have biological foundations (Jones, 1990) raises the possibility of similarities across cultures and of rudimentary processing biases in early life.

In view of the known and presumed links between music and emotion (Brown, 1981; Hevner, 1936; Langer, 1957), and the biological roots of emotion expression and recognition (Frick, 1985; Scherer, 1981), the search for natural music prototypes does not seem altogether foolhardy. Moreover, cross-cultural similarities in the prosody of speech directed to infants (Fernald, 1989; Fernald & Simon, 1984; Grieser & Kuhl, 1988; Trehub, Trainor, & Unyk, in press) and the attentional and affective impact of such speech on infant listeners (Cooper & Aslin, 1990; Fernald, 1985; Papoušek, Bornstein, Nuzzo, Papoušek, & Symmes, 1990; Werker & McLeod, 1989) provide special encouragement for the study of music forms that are linked to caregiving. Especially interesting in this regard is the fact that many infant-directed speech adjustments involve the addition of music-like features such as higher pitch, smooth pitch contours, regular rhythms, stretched-out vowels, and greater dynamic variations (Fernald, 1989; Papoušek, Papoušek, & Bornstein, 1985).

One music genre, the lullaby, has obvious parallels to infant-directed speech (see Trehub et al., in press). Lullabies are intimate communications between caregiver and infant that are intended to soothe the listener and induce sleep. Given the common function of lullabies across cultures and the well-defined audience, it is possible that the lullaby genre is recognizable across cultures, as is the case for infant-directed speech and adult-directed emotional expressions. It might also be possible to identify a pan-cultural category of lullabies consisting of good exemplars surrounded by progressively poorer instances.

To this end, we collected recordings of 30 foreign lullabies from 28 different cultures around the world together with comparison songs (primarily adult-directed) matched in tempo, culture, and singing style. A composite tape of pairs of 20-second excerpts from lullabies and nonlullaby comparisons (none sung in English) was presented to North American adults (all native speakers of English or highly fluent in English), who were required to judge which song in each pair was a lullaby (Trehub, Unyk, & Trainor, in press).

Consider the challenge that faced such listeners. Without informants from the various cultures, we had no way of determining the extent to which each lullaby was typical of lullabies in that culture. We were similarly ignorant of the contextual appropriateness of the performance. For example, was the singer actually lulling an infant or merely producing some rendition of a song that was generally sung to soothe infants? Moreover, in selecting adult songs with comparable tempo (i.e., very slow), we may have restricted our selection to atypical examples or to soothing songs in general. In short, we were likely presenting listeners with lullabies and adult songs that ranged from central to very peripheral instances of their respective categories. Despite the great diversity of singing styles and music systems represented in our collection, listeners categorized the lullabies with greater accuracy (about 66% correct) than would be

Trehub and Unyk

77
expected by chance (50% correct). Music training on the part of the listener and familiarity with the music system (Western vs. non-Western) had no influence on performance. Rather, listeners behaved as if they had some internal model or ideal—some culture-free notion of what a lullaby should sound like—which served as a reference for evaluating individual instances. The operation of this hypothesized internal model was reflected not simply in listeners’ above-chance performance but also in the consistency with which they correctly categorized some lullabies and incorrectly rejected others. For example, over 90% of listeners correctly categorized the Creek Indian, Pygmy (Congo), Irish, and Czechoslovakian lullabies. For whatever reason, features of these lullabies seemed to match prominent features of the model. On the other hand, listeners overwhelmingly miscategorized Samoan, Ukrainian, Ecuadorian, and Chadian lullabies, which presumably deviated from the conceptual ideal. The set of consistently identified lullabies can be considered to exhibit some of the properties of prototypical exemplars such as ease of processing and maximal distinctiveness from contrasting categories (i.e., nonlullabies). The consistently rejected lullabies, on the other hand, could be considered to be less prototypical or peripheral instances because of their minimal distinctiveness from nonmembers. Presumably, good or prototypical instances would provide a relatively stable frame of reference in the detection of contrasting categories.

In related research (Unyk, Trehub, Trainor, & Schellenberg, 1992), we presented listeners with the same foreign lullabies and comparison songs and asked them to choose the simpler of each pair. To the extent that some of the melodies were easier to encode than others, they might be perceived as simpler. In fact, listeners rated the lullabies as simpler than the comparison songs and they also rated consistently categorized lullabies as simpler than the consistently miscategorized lullabies.

It was possible that, in categorizing lullabies, listeners used cues in the text such as stereotyped syllables (e.g., la la) or onomatopoeia. When such cues from the lyrics were eliminated by electronically filtering the materials (e.g., frequencies above 500 Hz removed), listeners were still able to classify the lullabies, remaining highly accurate on the prototypical exemplars (Creek, Pygmy, Irish, Czech). When all vocal quality cues were removed by synthesis of the melody line (piano timbre), performance, although attenuated, was still correlated with that on the original version. This indicates that melodic form, like vocal quality, contributes to the definition of this vocal genre.

What melody features might influence adults’ judgments of lullaby? Soothing infant-directed speech is characterized by smooth, descending contours (Fernald, Taeschner, Dunn, Papoušek, de Boysson-Bardies, & Fukui, 1989; Papoušek et al., 1985). If such features have fundamental affective significance to caregivers with soothing intentions or to prelinguistic listeners, they might also prevail in soothing songs to infants. An analysis of melodic direction in the lullabies and comparison songs (Unyk et al., 1992) revealed that the most readily categorized lullabies embodied a smoother melody line (i.e., fewer contour changes) and more descending intervals than did the other songs.
This research would seem to indicate that lullabies constitute an identifiable, pan-cultural category consisting of exemplars with greater or lesser degrees of prototypicality. Smooth, descending contours and distinct vocal quality (as yet unspecified), whether in speech or song, likely express biologically-determined affective meaning that is accessible to prelinguistic listeners. Patterns that exemplify these features to a greater degree will be inherently more soothing than others and readily become the foci of categories of soothing songs such as lullabies.

We are currently evaluating other predictions that arise from the prototype framework. Adults are providing independent lullaby-goodness ratings of each lullaby (divorced from the previous comparison context). Our prediction is that lullabies that were most readily distinguished from other songs should receive the highest ratings, being the best examples of the genre. A second prediction that follows from prototype research is that lullabies with high ratings should be more similar to other lullabies (i.e., reflecting the redundancy structure of the category) than are lullabies with low ratings.

Ultimately, the final word on lullaby-goodness must come from the intended audience, notably infants. This difficult test awaits future research. Naturally, adult-like judgments are precluded but some appropriate alternative such as effectiveness in soothing (e.g., number of seconds to sleep onset) or preferential listening (e.g., Fernald, 1985; Krumhansl & Juszczyk, 1990) may be feasible.

Naturally Good Melodies

Research on music perception has focused primarily on processing that is culture-specific. A notable exception is provided by Narmour (1990), who proposes pan-stylistic or universal processes based on the Gestalt principles of similarity, proximity, and common direction. Patterns that conform to these principles are likely to influence the formation of prototypes. After all, it seems reasonable to expect that music styles build on basic properties and processing predispositions of the auditory system.

Patterns that adults find easy to remember and differentiate from other patterns are often said to exhibit good form. For example, Western listeners’ recognition of melodies is facilitated if these melodies conform to principles of Western music theory (Cuddy, Cohen, & Mewhort, 1981). Moreover, listeners find it easier to detect changes to such conforming melodies than to nonconforming melodies (Cuddy, Cohen, & Miller, 1979).

Does enhanced processing for patterns exemplifying good form or for those conforming to Western music principles reflect familiarity with the relevant music conventions or is there some contribution of inherent processing predispositions? The study of infants offers possibilities for differentiating these influences. Infants are naïve listeners in the sense of having limited exposure to culture-specific music systems and styles. Patterns that they find easy to process could be considered inherently or naturally good (see Trehub & Trainor, in press), arising from attentional predispositions or innate learning preferences (Marler, 1990).

Trehub and Unyk 79
Recent research in our laboratory illustrates the potential of this approach for uncovering such features. The operant head turn procedure (Eilers, Wilson, & Moore, 1977; Kuhl, 1985) makes it possible to determine whether infants as young as 6 months of age can detect changes to a target auditory stimulus. A repeating melody, usually consisting of a sequence of pure tones, is presented over a loudspeaker to one side of the infant (see Trehub, Bull, & Thorpe, 1984). Initially, the infant is attracted to the speaker because of the novel melody but soon loses interest as the melody continues to repeat. At this point, the infant attends primarily to the experimenter who is manipulating puppets directly in front of the infant. At randomly determined time intervals, we replace one instance of the repeating melody with a new or altered melody. If the change is noticeable and salient, the infant tends to turn to the locus of this novel event (i.e., toward the loudspeaker). To help maintain this behavior, we reward correct responses (i.e., turns to a change) with the presentation of animated toys near the speaker. To ensure that turns to the speaker are responses to the sound change rather than attempts to check on the availability of toys, we tabulate the occurrence of head turns on an equivalent number of trials on which no change is presented. The adults present (parent and experimenter) wear headphones so that they cannot distinguish change from no-change trials and inadvertently provide cues to the infant. If infants turn significantly more on change than on no-change trials, this indicates that the change in question is not only discriminable but also salient. This procedure has enabled us to document that infants can discriminate changes in melodic contour (Trehub et al., 1984; Trehub, Thorpe, & Morrongiello, 1985; Trehub, Thorpe, & Morrongiello, 1987), timbre (Trehub, Endman, & Thorpe, 1990), and rhythmic patterning (Thorpe & Trehub, 1989; figure 1).

Figure 1. Examples of repeating stimuli in transposition with the major-triad melody as standard and the augmented-triad melody as change (upper panel) and the reverse (lower panel). Each example shows three successive standard melodies, with their frequencies and note names, followed by a change and subsequent return to the standard melody. Only one change is shown but comparable changes occurred during presentations in different keys. Stimuli from Cohen et al. (1987).
Trehub & Thorpe, 1989). We have also determined that they perceive the similarity or equivalence of discriminably different patterns with common pitch contour (Trehub et al., 1987), timbre (Trehub et al., 1990), or rhythm (Trehub & Thorpe, 1989).

How can this procedure be used to identify good patterns? Since a good pattern will be encoded in greater detail than a poor pattern, the former provides a better frame of reference for comparisons with other patterns. Specifically, changes to good patterns should be easier to detect than changes to poor ones. To preclude the use of absolute pitch cues in such a melody discrimination task, each repetition of the melody in question and each changed melody are presented in different keys than the immediately preceding and immediately following melody. Moreover, the use of sinusoidal tones as the components of such patterns eliminates common harmonics as a potential basis for pattern goodness.

In searching for candidate melodies that are naturally good, it is reasonable to begin with those that are good for adult listeners. A subset of such culturally good melodies may be naturally good, as evidenced by enhanced processing on the part of infant listeners. In one study (Cohen, Thorpe, & Trehub, 1987), we compared infants’ ability to detect a semitone change to a melody based on the major triad (transposed to related keys) and to another melody based on the augmented triad (also transposed to related keys) (see Figure 1). For the major-triad melody, the semitone change was upward from the third note; for the augmented triad melody, it was downward from the third note. Thus when the major-triad melody served as the background (standard), the augmented-triad melody was the comparison. Similarly, when the augmented-triad melody was background, the major-triad melody was comparison. The surprising finding was that infants responded to the semitone change only in the context of the major-triad melody. The superiority of the major-triad melody over the augmented was confirmed for adult and infant listeners in a subsequent study with upward and downward changes to both melodies (Trainor, 1991). In another investigation (Trehub, Thorpe, & Trainor, 1990), there were three different standard melodies, one based on the major triad, another with notes from the chromatic scale but not any major scale, and a third with some intervals smaller than a semitone. All three standard melodies had a similar pitch range and rise-fall contour. In line with the previous findings, infants successfully responded to the semitone change only in the context of the major-triad melody.

There are indications that infants’ sensitivity to pitch relations may go beyond relations that are evident within a brief melody or phrase. When infants listen to repeating patterns that are presented in transposition, the nature of the key relations influences their encoding and retention of melodies. Specifically, infants’ and adults’ ability to detect semitone changes in major-triad melodies was enhanced for transpositions to related compared to unrelated keys (Trainor, 1991).

These studies imply that some aspects inherent in the major triad are naturally good, originating in universal constraints on auditory pattern processing. We would predict, then, that infants from very different music environments...
(e.g., cultures with no access to Western music) would also show differential processing of good and poor Western patterns. We are not suggesting that Western major scale structure is inherently superior to basic scale structures found in other cultures or that the major triad should appear in all cultures. Rather, the major triad is likely one of many possible instances of good form. Correspondingly, we would predict processing biases on the part of Western infants for foreign melodies that conform to important foreign conventions or rules.

Lynch, Eilers, Oller, and Urbano (1990) evaluated Western adults and 6-month-old infants on their detection of mistunings (i.e., subtle within-contour changes) to melodies based on the Western major or the Javanese pélog scale.

![Standard Melody](image)

**Figure 2.** The standard melody, the within-key change, and the out-of-key change. These were always repeated in transposition.

Musically-untrained adults performed better on the major than on the pélog melody, which is consistent with an experiential interpretation. If infants' demonstrated ability to detect interval changes in conventional Western melodies (Cohen et al., 1987; Trehub et al., 1990) was attributable to experience, then they should have been able to detect mistunings in the context of the Western but not the Javanese melody. In fact, infants detected both changes and did so equally well. Because incidental exposure to Western music in the first 6 months of life was insufficient to generate superior processing of Western over Javanese melodies, it is unlikely to be responsible for the superior processing of major-triad over augmented-triad melodies.

Other research in our laboratory with 8-month-old infants indicates that the processing biases observed previously cannot be due to adult-like knowledge

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of major scale structure. Infants were exposed to transposed repetitions of a conventionally structured 10-note melody (e.g., C^4 E^4 G^4 F^4 D^4 G^3 C^4 E^4 D^4 C^4) (Trainor & Trehub, in press). On the basis of our previous research, we could assume that this would constitute a naturally good melody or one exemplifying good features. Of special interest in this investigation was whether infants would find some changes to this good melody to be more salient or noticeable than others. One change involved substituting Ab^3 for G^3 in the sixth note of the C-major version and a comparable semitone change in other keys (see Figure 2). Although the change in pitch distance was small (one semitone), its music consequences were substantial because the new note was always outside of the relevant key. Another change involved substituting B^3 for G^3 in the C-major version (see Figure 2) and analogous changes in other keys. This represents a large change in pitch distance (four semitones) but a subtle music change, one that was consistent with the implied harmony of the melody. Musically-untrained adults readily detected the former change (small pitch change, large music change) but not the latter (large pitch change, small music change), indicating their tacit knowledge of major scale structure and, perhaps, their processing of melodies in terms of implied harmony. Infants, on the other hand, performed equivalently on both changes, outperforming adults in some circumstances involving the within-key change.

A number of implications follow from this study. First, infants have incomplete knowledge of major scale structure in the sense that out-of-key changes are not differentiated from in-key changes. Second, adults’ informal exposure to music must lead to acquired schemas that underlie such differentiation. Third, if exposure to music in early infancy does not promote the differentiation of in-key from out-of-key changes, it is unlikely to be principally responsible for our earlier findings of enhanced processing for major-triad over augmented-triad melodies (Cohen et al., 1987) or for superior processing of conventionally structured melodies over those that embody distortions of conventional form (Trehub et al., 1990).

What, then, could underlie infants’ enhanced processing for certain melodies and for near-key relations between melodies? In terms of the present framework, we would argue that some notion analogous to good form or natural prototypicality is implicated. Perhaps it is significant that the perfect fifth interval figured prominently in all of the good Western melodies (e.g., Cohen et al., 1987; Trehub et al., 1990) and in the transpositions to near keys (Trainor, 1991). In the key-distance study (Trainor, 1991), successive repetitions were transposed to the nearest key (upward or downward), so that they were a perfect fifth apart from the preceding and succeeding melody. It is possible, then, that the perfect fifth interval, which approximates a 2:3 frequency ratio, is inherently salient. Jones (1990) and others (e.g., Burns & Ward, 1982) have commented on the potential importance of small integer ratios in auditory pattern processing. Such ratios are also prevalent in vocal music across cultures, where singers can sing in parallel thirds, fifths, and octaves, thinking they are singing in unison (Kolinski, 1967).
Concluding Comments on Natural Prototypes in Music

Our research on lullabies from different cultures indicates that adults can go beyond dissimilarities in music system and language to extract a common core, as yet undefined, in lullabies. There are suggestions, however tentative, that the lullaby exists as a perceptual category consisting of exemplars varying in degree of prototypicality. Further research is necessary to delineate the nature of the central and peripheral instances within the category.

One can speculate on the factors that make some lullabies better examples of the genre than others. Because we used recorded materials gathered by other investigators over an extended time period, we had very limited access to information about the actual context of singing. Thus some lullaby examples may have been sung in appropriate contexts (i.e., with a sleepy baby) and others not (e.g., an adult simply obliging a persistent ethnomusicologist). Prototypicality in lullabies may be a joint function of melodic structure, on the one hand, and dynamic qualities of performance on the other. We would predict that, all other things being equal, lullabies sung in appropriate contexts would be rated as more lullaby-like than those sung in less appropriate contexts. Fortunately, this prediction is amenable to empirical evaluation. When good contextually-appropriate lullabies have been identified, the next step will be to isolate the features that contribute to lullabyness. Of interest, as well, is whether such lullabies will exemplify the features of good melodies in general.

Our research on music perception in infancy identified some good melodies and some potentially good or inherently salient features of melodies. Our findings are consistent with the notion that perceptual biases “jump-start” the acquisition of culture-specific music knowledge (Jones, 1990). Our findings are also in line with Terhardt’s (1987) contention that composers intuitively capitalize on universal auditory principles as they create their music. Perhaps mothers use similar intuitions in their generation of universally soothing vocal rhythms as they rock or jiggle their infants to sleep.

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**Author Notes**

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