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Is the Past a Different Culture? Tracking Changes in Prosodic Features of Child-Directed Broadcasting Across Six Decades

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Abstract

While research has explored cross-cultural variation in child-directed speech (CDS), little is known about if and how it may have changed over time. We explore whether CDS has undergone historical change by analyzing prosodic features in child-directed (CD) broadcasts from a German children's bedtime program (1959–present) and comparing them to adult-directed (AD) weather forecasts from the same period. The program originated in East Germany and continued after German reunification in 1990, potentially reflecting a socio-cultural shift toward more child-centric attitudes characteristic of Western liberal democracies. Pitch variation in CD broadcasts, although higher than in AD broadcasts, remained stable over time. In contrast, articulation rates showed no register difference pre-1990; only after 1990 did CD broadcasts exhibit the slower articulation rates typical of CDS. This suggests that some features of CDS may be subject to cultural evolution over historical time, which can be accelerated by major historical events.

Keywords: child-directed speech; child-directed broadcasting; pitch variation; articulation rate; cultural evolution; historical psychology

Introduction

Recent large-scale cross-cultural studies and meta-analyses of CDS have identified features that appear to be widespread and may therefore be considered universal (Hilton et al., 2022; Cox et al., 2023), particularly in terms of CDS prosody. Compared to adult-directed speech (ADS), CDS is often characterized by higher pitch, increased pitch variation and slower articulation rate. Most studies comparing CDS to ADS have been conducted within the last 30 years (Kempe et al., 2024b) thereby providing all but a snapshot of this aspect of human behavior during a specific historical period. Yet human behavior is inevitably shaped by past cultural evolution (Muthukrishna et al., 2021). Even in industrialized societies, child-rearing practices and attitudes towards children likely have undergone changes across generations. To better understand which aspects of CDS are universal and which are shaped by cultural-evolutionary processes, we must complement studies of its extant regional and cross-cultural variation with investigations into its potential historical change.

The study of historical variation in human behavior is inherently challenging due to the scarcity of behavioral data from previous millennia, centuries or even decades. This issue is particularly acute in the study of historical CDS, as examining its acoustic characteristics requires audio-recordings. The systematic collection of audio-recordings of naturalistic caregiver-child interactions only began in earnest in the late 1980s / early 1990s with the creation of the CHILDES database (MacWhinney, 2014; Kempe et al., 2024a), thereby limiting the potential study of historical changes in CDS to at most three decades. To extend the study of historical CDS further into the past, we analyze CD broadcasting as a potential, albeit imperfect, solution to the problem of scarcity of historical CDS data.

CD broadcasting has recently emerged as a viable complement to the study of naturalistic CDS. Broadcasters are trained to exhibit culturally acceptable emotional display rules in their communication (Swerts & Krahmer, 2010). If naturalistic CDS relies on a culturally accepted, conventionalized template (Kempe et al., 2024b), it is reasonable to assume that CD broadcasting will reflect this template, at least to some extent. Although the speaking style of broadcasters exhibits distinct prosodic features across languages, such as higher pitch, repeated rise-and-fall intonation contours, and faster articulation rates compared to non-broadcast speech (Rodero & Cores-Sarría, 2023), CD broadcasting has still been shown to exhibit greater expressivity (Swerts & Krahmer, 2010) and some of the characteristic prosodic features of CDS compared to AD broadcasting. Specifically, a within-speaker comparison of Mandarin CD and AD broadcast production showed higher

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mean pitch and larger pitch variation in CD broadcasts (Zhang & Gu, 2023). Thus, analyzing CD broadcasts as a proxy for CDS predating the availability of naturalistic CDS recordings provides a unique opportunity to study historical changes in CDS across multiple generations[1].

Here, we present an analysis of a corpus of CD broadcasts from the German children's bedtime program *Unser Sandmännchen* [Our Little Sandman], the longest-running animated TV series in history, which originated in 1959. The program follows a format where an opening and closing sequence featuring the popular animated *Sandmännchen* character frames a central segment. Many of these central segments feature an adult actor addressing either a child-like character or a child TV audience. For the current analysis, we selected broadcasts of segments containing monologues by actors either addressing the child TV audience directly or engaging in on-camera book reading. These CD broadcasts were compared to weather forecasts—a form of AD broadcasting with comparable continuity in terms of content. The comparison between CD and AD broadcasting does not just provide an ADS baseline but also allows us to control for potential historical changes in general broadcasting style.

The acceptance of childhood as a distinct developmental phase constitutes an attitudinal shift that in European societies emerged only after the Middle Ages (Aries, 1962). It seems to have triggered a trajectory of increasing child-centered attitudes (Allerton, 2020), which continues to this day, as reflected by recent legal and educational policy reforms in many Western countries, including Germany (Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, 2023). Spanning the last six decades, our broadcast corpus encompasses potential socio-cultural changes towards greater child-centeredness manifesting over the last two to three generations. We expect increasing child-centeredness over this period to be reflected in a trend towards amplification of CDS features compared to ADS as reflected in typical CDS features like higher pitch, greater pitch variation, and slower articulation rates. These prosodic features reflect the expression of positive affect toward children (Singh et al., 2002) as well as accommodation to their communicative needs via audience design (Tippenhauer et al., 2020). Even CDS speech directed to an imaginary child audience likely follows a learned template of the register that cements conventionalized notions of culturally sanctioned emotion expression and speech accommodation (Kempe et al., 2010; 2024b). The present study rests on the assumption that CD broadcasting will at least to some extent mirror any such historical trend in CDS.

Uniquely, our broadcast corpus does not just cover a period of over six decades but also includes a major historical event that led to a fundamental socio-cultural change—the fall of the Berlin Wall and subsequent German reunification in October 1990. Prior to German reunification *Unser Sandmännchen* was produced by East German state TV, reflecting the values and attitudes of an illiberal and non-democratic society. However, due to its popularity, after German reunification production was taken over by a newly created regional TV station which subsequently merged with a TV station in what was formerly located in West Berlin; this new station continues production of the program to this day, retaining the popular animated framing sequences while modifying and updating some, but not all, of the characters featured in the central segments. This means that our corpus tracks three decades of East German broadcasts up until 1989 and another three decades of broadcasts produced in reunified Germany. The continuation of a formerly East German children's program for a reunited German audience was undoubtedly influenced by West German socio-cultural attitudes and broadcasting practices. This offers the unique opportunity to explore if and how socio-cultural shifts associated with this major historical event are reflected in a shift in CD broadcasting style. The implementation of a liberal-democratic political system in East Germany after German reunification triggered a socio-cultural shift towards an emphasis on individual rights, including those of children, and away from an emphasis on collectivist upbringing that favoured directiveness towards children (Sorkhabi, 2012). We hypothesize that these socio-cultural shifts towards greater child-centeredness may have amplified prosodic features of CDS. To capture the potential effect of this historical inflection point, we use Regression Discontinuity Analysis to explore whether any observed changes in the prosody of CD broadcasting follow a continuous trajectory over time or exhibit a discontinuity around 1990.

The present study presents the first analysis of the CD monologues in this corpus, and tracks pitch variation and articulation rate – two prosodic features that are indicative of the distinct prosody of CDS.

Method

Data Acquisition

Pre-1990 broadcasts of *Unser Sandmännchen* were produced by East German state TV broadcaster *Deutscher Fernsehfunk* (Petzold, 2009)*;* archived broadcasts are held by the German broadcasting archive *Deutsches Rundfunk Archiv* (DRA). A parallel children's bedtime program called *Das Sandmännchen* was produced by West German TV station *Sender Freies Berlin;* its production ceased in 1989, and no archived broadcasts of this West German equivalent could be located. Upon request, the DRA generously granted us access to 261 archived recordings of the East German *Unser Sandmännchen*-broadcasts and 99 archived weather forecasts dating from 1959 to 1991. We also contacted regional TV-stations which aired *Unser Sandmännchen* post-1990 and were granted access to 47 *Unser Sandmännchen*-broadcasts from *Rundfunk Berlin-Brandenburg* (RBB) and 16 *Unser*

[1] We base our estimate of a generation length of ~25 years on findings and conventions from biology (Wang et al., 2023), as well as anthropology and sociology (Goody, 1983).

Sandmännchen-broadcasts alongside 22 weather forecasts from *Norddeutscher Rundfunk* (NDR). A further 6 *Unser Sandmännchen*-video-recordings and 73 video-recorded weather forecasts were obtained from YouTube, resulting in a total of 330 CD broadcasts and 194 AD broadcasts dating from 1959 to 2023.

Child-directed broadcasts. For the current analysis, we selected all 134 monologue segments from a total of 330 *Unser Sandmännchen*-broadcasts. These were monologues where actors addressed an imaginary child audience or read a children's book. We excluded 17 CD monologues where the actors read scripts consisting of children's verses and poetry because rhyming speech resulted in a rhythmical speech rate that is not fully comparable to natural speech. Of the remaining segments, 44 had a music track accompanying the speech, which, according to information provided by the DRA and the other TV-stations was added after voice recording thereby not affecting speaking style. We used the software package *Audiostrip* (https://audiostrip.co.uk) to isolate the voice track from the music for further analyses. A further 14 CD monologues were excluded because speech was accompanied by various noises which proved difficult to strip from the soundtrack. This selection procedure resulted in a total of 103 CD monologue segments, which were narrated by 35 different actors (11 of them female): 18 actors contributed 1 segment each, 9 actors contributed 2 segments each, and the remaining actors contributed between 5 and 14 segments each. The average segment duration was M = 225.1 sec (SD = 64.5 sec), ranging from 116.7 to 424.6 sec.

Adult-directed broadcasts. Of the 194 weather forecasts 2 were excluded due to poor audio quality. The remaining 192 forecasts included in the analysis were presented by 90 (30 female) different broadcasters: 61 broadcasters contributed 1 segment each, 18 broadcasters contributed 2 segments each, and the remaining broadcasters contributed between 3 and 20 segments each. The average segment duration was M = 46.3 sec (SD = 36.2 sec), ranging from 3.8 to 201.4 sec.

Data Processing

The two prosodic features of interest were pitch variation and articulation rate. Pitch variation, measured as the standard deviation of fundamental frequency (F_0), is considered a more reliable measure of pitch fluctuations than pitch range. The latter is only based on two values – minimum and maximum F_0, which are more sensitive to artifacts and outliers (Cox et al., 2023), while the former captures the average variation across the entire time window and thus is less sensitive to these issues. Articulation rate is computed by dividing the number of syllables by phonation time, excluding pauses, accounting for the fact that, especially in a CD broadcasting context, pauses often arise from non-speech related actions such as drawing, pointing, demonstrating objects or turning pages during book reading.

To extract pitch variation, we first added a high-pass filter to further reduce any remaining background noise. We then extracted the pitch contours using the *Parselmouth* library in Python (Jadoul et al., 2018), which were smoothed to remove any spurious jumps in sequential pitch data.

To extract articulation rate, we used an algorithm written for PRAAT (Boersma & Weenink, 2018) by De Jong and Wempe (2009) to identify voiced intensity peaks as proxies for vowel onsets that identify individual syllables. Articulation rate was computed as the number of syllables divided by phonation time. This algorithm also returned the length of the entire segment in seconds, which was included into the statistical models to control for potential variation in pitch contour and articulation rate that may be due to differences in the overall duration of the speech segments.

Analyses

To model change in prosodic features of CD broadcasting over time while also accounting for a potential discontinuity in the trend linked to German reunification in 1990, we used Regression Discontinuity Analysis. Temporal change was modelled by including the year of broadcast (scaled and centered) as a fixed effect. The discontinuity potentially introduced by the inflection point of German unification was modelled by including the fixed effect of the pre- vs. post-1990 period, coded as a deviation-coded binary variable (1959-1989 vs. 1990-2023). In addition, we included deviation-coded effects of register (CD vs. AD broadcasts) and speaker gender (male vs. female). The latter factor was included because of findings that male caregivers exhibit differences to female caregivers in the prosodic characteristics of CDS (e.g. Broesch & Bryant, 2017; Kondaurova et al., 2023).

The Regression Discontinuity Models included the fixed effects of year (scaled and centered), pre/post-1990 discontinuity, register, and speaker gender, along with all possible higher-order interactions. Session duration (scaled and centered) was included as a control variable. The models also included random intercepts of speaker and of year to account for individual and temporal variability. Specifically, including random year-specific intercepts for average values accounts for the uneven distribution of broadcasts across years. All regression analyses were implemented using the R-package *glmmTMB* (Brooks et al., 2017) in *R version 4.4.1* (2024-06-14). We used a Gamma distribution with log link function for pitch variation, owing to its skewed distribution, and a Gaussian distribution with identity link function for the articulation rates, which have normally distributed errors. Subsequent analyses relying on estimated marginal means and pairwise tests used the *emmeans* R-package (Lenth, 2024). Data and code are available at https://osf.io/59wsb/.

Results

For pitch variation, the model revealed a significant effect of speaker gender, $\beta = 0.53$, $z = 6.13$, $p < .001$, with female speakers showing significantly greater mean pitch variation measured as F_0 SD (mean estimated pitch variation = 49.9 Hz, SE = 3.64 Hz) compared to male speakers (mean estimated pitch variation = 29.1Hz, SE = 1.19 Hz). The model also

revealed a significant main effect of Register, β = -0.53, z = -5.13, p < .001, with CD broadcasting (mean estimated pitch variation = 49.5 Hz, SE = 3.91 Hz) showing greater pitch variation than AD broadcasting (mean estimated pitch variation = 29.7 Hz, SE = 1.44 Hz). There was also an interaction between Register and Year, β = 0.13, z = 1.98, p = .048, indicating an upward trend in pitch variation over time in AD broadcasting (mean multiplicative change = 1.11, 95% CI [1.03, 1.19]), but no clear trend in CDS (mean multiplicative change = 0.97, 95% CI [0.87, 1.08], see Figure 1.

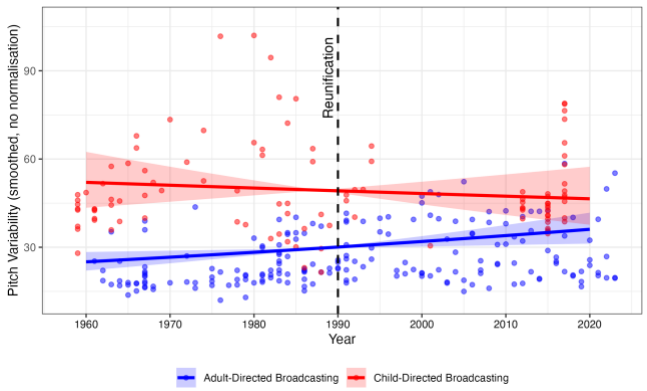


Figure 1: Change in pitch variation over time. Lines indicate model-estimated marginal slopes; ribbons indicate model-estimated 95% CIs.

For articulation rate, the model revealed a significant interaction between year and pre-/post-1990 discontinuity, β = -0.30, z = -2.06, p = .04, with a trend towards slower articulation rates pre-1990, β = -0.278, 95% CI [-0.462, -0.095], followed by a flat trend with no significant slope post-1990, β = 0.023, 95% CI [-0.2, 0.246], (see Figure 2).

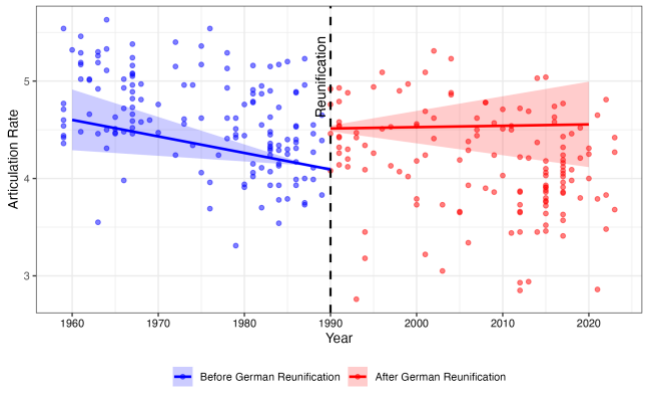


Figure 2: Change in articulation rate over time before and after German reunification. Lines indicate model-estimated marginal slopes; ribbons indicate model-estimated 95% CIs.

Crucially, the articulation rate model also revealed a significant interaction between the pre/post-1990 discontinuity and register, β = -1.28, z = 3.53, p < .001 (see Figure 3). Before 1990, there was no significant difference in the means of articulation rates between AD broadcasting (estimated mean = 4.18 syllables/sec, SE = 0.163) and CD broadcasting (estimated mean = 4.44 syllables/sec, SE = 0.174); t(275) = -1.03, p = .305. However, after 1990, CD broadcasting (estimated mean = 3.53syll/sec, SE = 0.274) showed significantly lower articulation rates compared to AD broadcasting (estimated mean = 4.51, SE = 0.100); t(275) = 3.29, p = .001, with a difference of 0.97 syllables/sec (SE = 0.296).

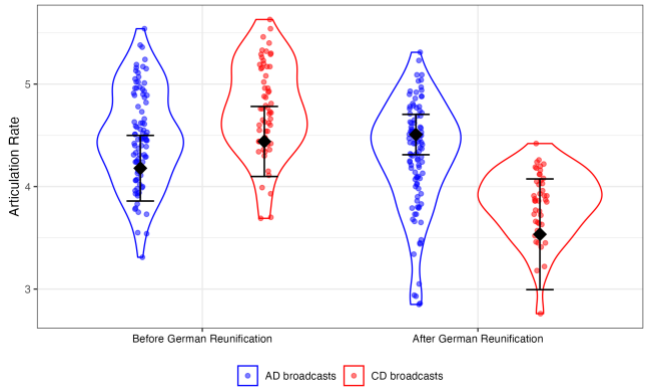


Figure 3: Articulation rates in CD compared to AD broadcasts before and after German reunification. Black diamonds indicate model-estimated marginal means; lines indicate model-based standard errors.

Discussion

Our analysis of German CD broadcasts spanning six decades revealed that, in line with expectations about differences between CD and AD communication (Cox et al., 2023), pitch variation was greater in CD broadcasting, despite suggestions that due to cultural stereotypes pitch excursions may typically be discouraged in German broadcasting (Mennen et al., 2012). Together with the findings by Zhang & Gu (2023), who also found evidence for greater pitch variation in CD broadcasting, this lends support to the idea that CDS features are evident in CD broadcasting, which therefore serves as a suitable proxy for studying historical trends in CDS.

However, compared with AD broadcasts from the same period, the slower articulation rate typical of CDS emerged only after 1990. In this respect, German post-1990 CD broadcasts align with cross-linguistic evidence, obtained mainly over the past three decades, which shows slower articulation rates in CDS compared to ADS (Cox et al., 2023). Crucially, no difference between CD and AD articulation rate was found in the pre-1990 East German broadcasts; if anything, the trend pointed in the opposite direction. This observed historical trend is in line with the hypothesis that a lower degree of child-centeredness and a higher emphasis on directives in collectivist parenting may have attenuated some prosodic features of CDS pre-1990 and that German reunification precipitated a shift in child-centeredness that is reflected in a drop in articulation rates in CDS. At the same

time, there was no effect of a discontinuity around German reunification on pitch variation.

What might account for the observation that a socio-cultural inflection point is reflected in a change in CD articulation rate but not in CD pitch variation? We suggest that articulation rate may be more susceptible to attitudinal effects than pitch-related variables, as it is more likely influenced by processes linked to speech accommodation and audience design rather than by spontaneous emotion expression. This conjecture is supported by meta-analytical findings which showed an increase in CDS articulation rate, but not in CDS pitch variation, with child age (Cox et al., 2022). Changes in CDS features that correlate with child age reflect speech accommodation and audience design – by speaking more slowly caregivers are adapting their speech to children's cognitive and speech processing limitations, and these limitations are greater in younger children. Our findings suggest that attitudinal changes associated with increased child-centeredness may have encourages such a speech adaptation for children. This, in turn, may have shaped the conventionalized CDS template that informed CD broadcasting. Conversely, pitch exaggerations that underpin greater pitch variation in CDS may predominantly be manifestations of positive affect expression towards children (Nitschke et al., 2004), which is likely under less strategic control. The lack of changes in CDS pitch variation with children's age (Cox et al., 2023) indicates that this prosodic feature may be less susceptible to audience design and is not deployed to accommodate the limited language proficiency of younger children.

Below we briefly discuss two other findings not directly related to the main question of interest: For pitch variation, we also observed a significant 2-way interaction between year and register. This interaction was carried by an increase in pitch variation in AD broadcasting over time. Even though exploring changes in broadcast speech over time was not the focus of this study, we suggest that this may reflect a pivot to infotainment formats, potentially to do with the arrival of commercial broadcast competitors leading to substantial changes in the German media landscape (Pfetsch, 1996).

We also observed greater pitch variation in female compared to male broadcasters, in line with observation from laboratory studies on gender differences in some languages (Pépiot, 2014) but not others (Biemans, 1998). Cross-cultural research suggests that sex and gender differences in pitch variation depend on culture-specific gender stereotypes in vocal expressivity. However, as we do not have data on such stereotypes in the German context, it would be unwarranted to speculate further about the observed gender difference, especially since there was no interaction between speaker gender and speech register, which was the main variable of interest.

Limitations. The biggest limitation of our study is that it assumes that CD broadcast speech reflects naturalistic CDS. This assumption rests on the notion that CDS is to an extent an acquired register where speakers rely on culture-specific conventionalized templates (Kempe et al., 2024b), and that such templates shape broadcasting standards (Swerts & Krahmer, 2010). While initial explorations of CD broadcasting (Zhang & Gu, 2023; 2024) demonstrate similarities to naturalistic CDS, future research needs to investigate further the extent of these similarities to determine suitability of CD broadcasts for tracking historical changes in CDS. We therefore see this study as a first exploration of historical changes in CDS and its cultural evolution outside the laboratory. Hopefully it will encourage further attempts to source and analyze historical CDS data.

Another limitation of this study is the relative sparsity of data points of CD broadcasts: So far, we have analyzed 103 CD monologue segments covering a period of 64 years. The next step is to expand this corpus by including the 196 dialogue segments. Still, the observed discontinuity in CD articulation rate is an encouraging finding suggesting that even relatively sparse historical data spanning only several decades yet covering major historical events can reveal how socio-cultural shifts may have shaped CDS.

Finally, our findings so far are based on just two prosodic features – pitch variation and articulation rate. Two other available and commonly studied prosodic features, mean pitch and pitch range, were not included in the analysis for the following reasons: Mean pitch was excluded because our between-broadcaster comparison prevented a control of individual speaker pitch. Pitch range was excluded because the nature of the available audio-recordings made it difficult to extract minimum and maximum pitches through automated processing with sufficient certainty that these data points would not return spurious pitch values. Still, we thought it acceptable to confine this initial analysis of the corpus to just two prosodic features to determine whether it is at all feasible to track historical changes in CDS, before committing ourselves to more fine-grained acoustic analyses. Future analyses of this corpus will include phonetic and phonological features such as vowel duration, voice onset time and vowel space.

These limitations notwithstanding, our study is the first to reveal historical changes in CDS thereby enriching the study of extant cross-cultural variation in CDS with an understanding of its cultural evolution. It highlights the importance of considering the possibility that even in industrialized societies, which to date have supplied the bulk of evidence for CDS as a distinct register (but see recent cross-cultural evidence from pre-industrial small-scale societies [e.g. Broesch & Bryant, 2018; Cristia et al., 2019; Hilton et al., 2022]), the way we speak to children may have undergone changes in recent history and beyond. This casts further doubt on claims about the universality of CDS prosody (e.g. Schick et al., 2022). Moreover, the observed temporal discontinuity, marked by a sudden drop in CD articulation rate after German reunification, suggests that historical change may not always be gradual but can instead reflect socio-cultural shifts triggered by major historical events.

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