Speech Prosody 2024
2-5 July 2024, Leiden, The Netherlands

Understanding individual differences in audiovisual child-directed language: The role of empathy and personality traits

Yanran Zhang[1], *Yan Gu*[2, 3]

[1]Department of Communication and Cognition, Tilburg University, Netherlands
[2]Department of Psychology, University of Essex, UK
[3]Experimental Psychology, UCL, UK
Y.zhang@tilburguniversity.edu, yan.gu@essex.ac.uk

Abstract

This study explores individual differences in broadcasters' use of child-directed prosody and gesture, focusing on the role of empathy and the Big Five personality traits. Forty-two female future broadcasters simulated live broadcasts for both adults (ADB) and children (CDB) programmes. Prosodic and gestural analyses showed several key findings. First, openness negatively predicted speaking rate, while empathy positively predicted the rate of representational gestures. Mean intensity was positively predicted by empathy but negatively by agreeableness in CDB. Additionally, the saliency of pointing gestures was positively influenced by empathy and conscientiousness. Furthermore, participants varied in adjustments between programmes. Compared to ADB, in CDB, prosodically, higher empathy and neuroticism but lower extraversion predicted faster speech; higher empathy, extraversion and lower openness predicted higher pitch; and higher empathy and extraversion, along with lower openness and agreeableness, predicted higher intensity. Gesturally, higher-empathetic participants produced more salient pointing and beats, while more extroverted participants made more salient representational gestures in CDB. Notably, the frequency of child-directed representational gestures negatively correlated with neuroticism. The findings highlight the role of individual differences in tailoring audiovisual child-directed communication, with implications for broadcaster training.
Index Terms: child-directed language, individual differences; prosody; gesture; big-five personality traits; empathy

1. Introduction

Speakers alter their language when addressing children (child-directed language, CDL) as opposed to adults (adult-directed language, ADL). Child-directed language is characterized by distinctive prosodic and gestural features, such as a higher pitch, a slower speaking rate and more representational gestures [1], [2], [3], and is observed across cultures [4]. CDL not only conveys positive emotions [5], but also aids children's speech comprehension [3], [6], [7] and facilitates word learning [8], [9]. However, it remains unknown whether individuals uniformly adapt their language for children and how this adaptation is affected by speakers' empathy and personality traits.

Empathy, defined as the ability to recognize and understand other people's thoughts and feelings, plays a crucial role in fostering mutual understanding and sensitivity in interpersonal relationships [10]. For instance, maternal sensitivity to infant distress has been found to influence children's behaviour [11]. Similarly, infants of sensitive mothers who spoke with more prototypical CDL prosody tend to exhibit better emotional regulation abilities [12]. Like sensitivity, more empathetic individuals may be more motivated to communicate clearly with their interlocutors. The only study investigating empathy level and ADL/CDL showed that empathy positively correlates with adult-directed pitch, but no such correlation exists when addressing infants. However, that lab experiment only focused on the prosodic analysis of six given sentences [13], questioning its generalizability. Regarding gestures, a previous study found a positive correlation between the saliency of gestures and empathy levels [14]. Nevertheless, the impact of empathy on child-directed gestures remains unclear.

Another important measurement of individual differences is the Big Five personality traits [15]. The model proposes five major dimensions of personality traits (extraversion, neuroticism, conscientiousness, agreeableness, and openness) that are known to exaplain most individual differences. Furthermore, personality traits have been shown to influence specific aspects of interpersonal communication, including intonation and gestures [16], [17]. For example, the frequency of representational gestures has been positively correlated with levels of extraversion and neuroticism among speakers [16], while higher extroversion has been linked to higher pitch variability [18]. However, so far, no research has investigated the influence of the Big Five personality traits on CDL.

If language production varies across by contexts, such as interactions with adults versus children, and if personality affects speech and gesture production, the role of individual differences in shaping child-directed communication is entirely unknown. For example, it is unclear whether the effects of personality traits remain stable across ADL and CDL, or if they interact with contexts to impact the degree of adjustment. Thus, the main goal of the present study is to offer deeper insights into individual differences in audiovisual child-directed language.

Furthermore, there is a growing interest in exploring CDL in the context of children's exposure to media, such as children's television programmes. While children benefit from CDL in the daily interactions with caregivers and teachers, they also encounter this language style in television programmes. Broadcasters play a crucial role in structuring language to effectively engage young audiences. Their distinct speaking style, marked by higher and more emphatic intonation and a faster speaking rate, is easily recognizable and preferred by listeners [19]. These prosodic cues are essential in establishing rapport and credibility with the audience; for example, listeners demonstrate more accuracy in identifying advertising texts narrated by professionals compared to non-professional voiceovers [20]. Moreover, TV broadcasts are multimodal, with broadcasters adjusting their prosody, facial expressions and hand gestures when hosting child-directed programmes

10.21437/SpeechProsody.2024-43

[21], [22]. However, we have limited knowledge about how individual differences influence broadcasters' audiovisual prosody in children's broadcasting programmes.

Existing studies have primarily focused on listeners' perception of prosody and gestures [23], [24], neglecting the impact of broadcasters' intrinsic qualities, such as empathy and personality traits, on their language strategies. Our study aims to investigate the influences of these individual characteristics on audiovisual child-directed language in the context of TV broadcasting. Specifically, we examined whether empathy level and Big Five personality traits predict: 1. Prosodic and gestural production in both child-directed and adult-directed broadcasting; 2. The degree to which one adjusts audio-visually between child-directed and adult-directed broadcasting.

2. Method

2.1. Participants

Forty-one broadcasting majors participated (Mean age=19.7 years, SD=0.91). To avoid gender differences [25], participants were all female. They were informed of the camera's presence and gave their written consent to use the data. Five participants were excluded due to missing data on personality traits.

2.2. Stimuli

Participants imagined themselves live broadcasting and explain four easily understood pictures for both regular TV (adult-directed) and children's (child-directed) programmes.

2.3. Procedure

Sequences and pictures were counterbalanced in order. Half of participants started with adult-directed broadcasting, then child-directed. A lunch break separated the two parts. Voice was recorded using Audacity (44.1 kHz, 16-bit) via a wireless clip-on, while video was captured by a mobile phone (2772*1344) resolution. Participants finished the Empathy Quotient questionnaire (EQ) [26] and Chinese Big Five Personality Inventory Brief Version (CBF-PI-B) [27] post experiment.

2.4. Coding and measure

2.4.1. Empathy and Big Five personality traits

Empathy level was assessed via EQ [26] (60 questions, total score 80; M=43.39, SD=9.68). Big Five personality traits were measured with CBF-PI-B [27] (40 questions): Extraversion (M=26.21, SD=5.63), Neuroticism (M=25.1, SD=7.7), Openness (M=36.95, SD=6.07), Agreeableness (M=24.24, SD=5.66), Conscientiousness (M=31.93, SD=5.47).

2.4.2. Prosody

Boundaries of utterances were annotated in Praat [28]. We measured: (1) *Speaking rate* (log-transformed): the mean number of words per sec excluding pauses over 200ms [29]; (2) *Mean pitch* (semitone, ST); (3) *Mean intensity* (dB).

2.4.3. Gesture

Gestures were coded through Elan [30]. In total, there were 9564 gestures. We measured gesture saliency (size of gestures), and gesture rate (per sec) for the following gestures:

(1) *Representational gestures*: metaphorical or iconic gestures illustrating the concept by drawing its outline, shape or representation [31]. (2) *Pointing*: a finger extends in a direction or points without any visible target, such as time or location [32]. (3) *Beat*: motoric movements produced along with speech rhythm (e.g., index finger moves up and down) [33].

2.5. Data analysis

Linear mixed-effects models were used to analyse prosody and gestures, considering programmes, empathy, big-five and their interactions with programmes as independent variables. Participants served as a grouping variable with a random intercept, and the four pictures were added as control variables.

3. Results

Compared to adult-directed broadcasting (ADB), broadcasters tended to adjust more in child-directed broadcasting (CDB) in both prosody and gestures (details in [22]). The current study focuses on individual differences in audiovisual adjustments.

3.1. Prosody

Speaking rate: openness negatively predicted speaking rate in both programmes (β=-.02, p=.04). In addition, empathy tended to predict speaking rate in CDB (β=.0008, p=.08), while extraversion marginally predicted speaking rate in ADB (β=.002, p=.08). Significant two-way interactions emerged between condition and empathy (β=.007, p=.007), neuroticism (β=.008, p=.01) and extraversion (β=-.01, p=.03). This indicated participants of higher empathy, lower extraversion and higher neuroticism spoke faster in CDB compared to ADB, whereas their counterparts had opposite adjustments (e.g., empathy scores 66 vs. 22: β_{66}=-.01, p=.004 vs. β_{22}=.01, p=.02; extroversion: β_{10}=-.01, p=.02 vs. β_{36}=.007, p=.08; neuroticism: β_{39}=-.01, p=.01 vs. β_{10}=.009, p=.03, Figure 1).

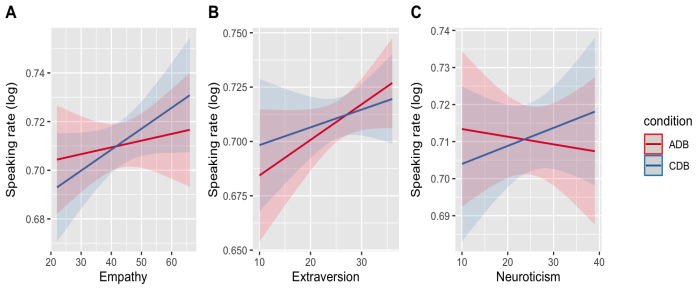

Figure 1: *Predicted speaking rate as a function of (A-C) empathy, extraversion and neuroticism in ADB and CDB.*

Mean pitch: empathy or personality traits did not predict mean pitch, but significant interactions emerged between programmes and empathy (β=.02, p<.001), extraversion (β=.03, p =.007) and openness (β=-.05, p<.001). This indicated that participants with higher empathy (β_{66}=-1.4, p<.0001), higher extraversion (β_{36}=-1.1, p<.0001) and lower openness (β_{25}=-1.4, p<.0001) adjusted more between programmes than those with lower empathy (β_{22}=-.3, p=.035), lower extraversion (β_{10}=-.3, p=.13) and higher openness (β_{48}=-.18, p=.16, Figure 2).

Intensity: child-directed intensity was marginally positively predicted by empathy (β=.099, p=.057) but negatively predicted by agreeableness (β=-.21, p=.087). Significant interactions occurred between conditions and empathy (β=.06, p<.001), extraversion (β=.05, p=.009), openness (β=-.04, p=.02) and

agreeableness (β=-.07, p=.003). This showed that higher empathetic (β_{66}=-1.5, p<.0001), more extroverted (β_{36}=-.7, p=.001), less open (β_{25}=-.7, p=.003) and less agreeable (β_{15}=-.8, p=.0004) participants talked louder in CDB than ADB, while lower empathetic (β_{22}=1.1, p<.0001), less extroverted (β_{10}=.06, p=.058), more open (β_{48}=.3, p=.25) and more agreeable (β_{30}=.24, p=.18) individuals did not (Figure 3).

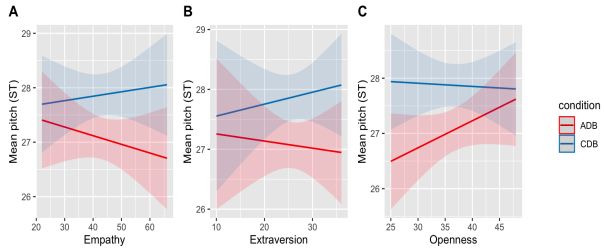

Figure 2: *Predicted mean pitch as a function of empathy (A), extraversion (B) and openness (C) in ADB and CDB.*

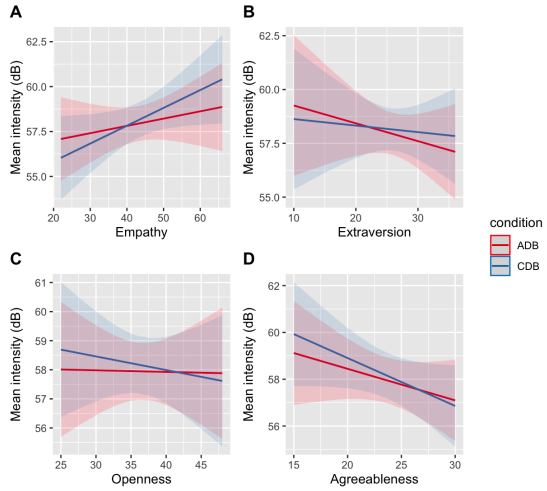

Figure 3: *Predicted intensity as a function of A-D: empathy, extraversion, openness and agreeableness in ADB and CDB.*

3.2 Gestures

Representational gesture: empathy predicted the frequency of representational gestures (β=1.3, p=.049), irrespective of programmes. Moreover, for representational gesture rate, there was a significant interaction between neuroticism and condition (β=-2.1, p=.002, Figure 4), indicating minimal differences in high neuroticism between programmes (β_{39}=.004, p=.73), while low neuroticism adjusted significantly (β_{10}=-.06, p<.0001). Regarding gesture saliency, a significant interaction was found between extraversion and condition (β=.09, p=.046), revealing that highly extroverted participants (β_{36}=-1.6, p=.002) used more *salient* representational gestures in CDB than in ADB, while less extroverted participants had an opposite pattern, though not significant (β_{10}=.7, p=.34).

Pointing gesture: saliency of pointing gestures in CDB was positively predicted by empathy (β=.09, p=.01) and conscientiousness (β=.13, p=.04). Programmes interacted with empathy (β=.06, p=.007) and extraversion (β=.09, p=.018) for pointing saliency, indicating more empathetic or highly extroverted participants had more salient pointing gestures in CDB than ADB, while less empathetic or extroverted participants showed a reverse trend. Moreover, variation between programmes diminished at higher levels of empathy (β_{22}=1.7, p=.001; β_{66}=-1.1, p=.06) and extraversion (β_{10}=1.9, p=.005; β_{36}=-.06, p=.19).

Beat gesture: empathy or personality traits did not predict the frequency of beats. For beat saliency, there was a significant interaction between empathy and programmes (β=.04, p=.02). Higher-empathetic participants (β_{66}=-.9, p=.01) used more salient beats in CDB than ADB, but the lower-empathetic participants showed the opposite (β_{22}=.8, p=.03).

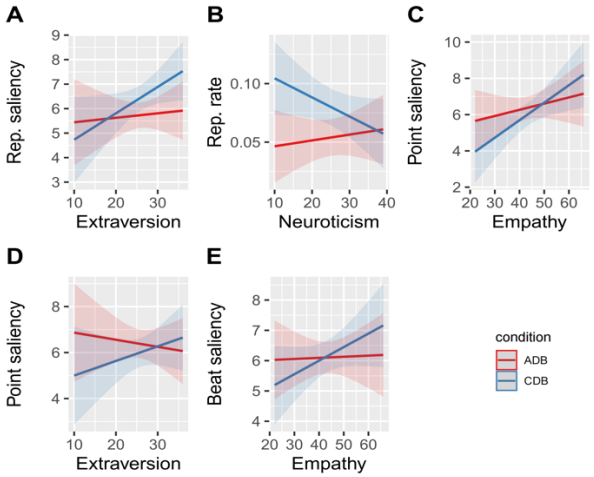

Figure 4: *Predicted representational gesture saliency and rate, pointing saliency, beat saliency as a function of individual differences (A-E) in ADB and CDB.*

4. Discussion

We explore individual differences in audiovisual adjustments in child-directed versus adult-directed language, revealing the impact of empathy levels and personality traits on language production, and the degree of adjustments in CDB.

4.1. Speaking rate

Openness predicted speaking rate in both programmes, while empathy and neuroticism only predicted speaking rate in CDB, and extraversion predicted only ADB. Openness, characterized by curiosity and a desire for variety [34], may lead individuals to favor novel challenges and cope effectively with interpersonal events. Research suggests that more open individuals experience less stress when facing new challenges [35]. Moreover, those high in openness often have a rich fantasy life and are imaginative [36], thus when doing new live broadcastings, they were more talkative from their imagination and consequently higher speaking rates within time constrains.

CDL usually has a slower speaking rate [3], but individual differences observed here challenge this notion. Compared to ADB, participants with higher empathy, neuroticism and lower extraversion talked faster in CDB. Broadcasters aim for facial expressions that match their more expressive verbal content when addressing children [21], possibly leading to increased speaking rate in CDB. Alternatively, a faster speaking pace in CDB may convey happiness to children, as fast speech is associated with joy [37]. In contrast, highly extroverted participants increased their speaking rates more in ADB. Faster

speakers are perceived as more animated and extroverted [38], but past research has not compared adult-directed and child-directed contexts. Participants may feel more inclined to talk when addressing adults, given their shared knowledge. Moreover, those high in neuroticism are emotionally less stable and experience more anxiety [39], leading to a faster speaking rate [23]. For them speaking to children audience can provoke more emotional changes (speaking faster) compared to adults.

4.2. Mean pitch and mean intensity

Empathy or personality traits did not directly predict mean pitch, but in CDB mean intensity was positively predicted by empathy and negatively by agreeableness. Higher empathetic, extroversion or lower openness correlated with higher mean pitch and intensity, while less agreeable participants had a lower mean intensity in CDB than ADB. Moreover, higher openness led to less variation between programmes, unlike the other two traits. Individuals high in openness are often seen as creative and innovative, while low openness is more conventional [40]. This hints at how more open broadcasters may adopt diverse prosodic patterns to create a unique image compared to traditional approaches.

Higher empathy led to greater adjustments in mean pitch and intensity for children, while agreeableness caused a sharper decrease in CDB compared to ADB. Agreeable individuals are typically seen as trusting, caring, and cooperative [41], whereas those low on agreeableness may exhibit manipulative or self-centered traits [42]. Speakers perceived as less agreeable often have higher formants [17], potentially influencing broadcasters to modulate their loudness, especially when addressing children, to foster a trusting and kind atmosphere.

4.3. Representational gestures

Speakers' empathy predicted their representational gesture rate positively regardless of conditions. While participants with high extraversion produced more salient representational gestures for children, participants with high neuroticism exhibited a reverse pattern. Moreover, high neuroticism groups performed hardly any differences between programmes.

Highly extroverted speakers are often perceived more outgoing and energetic, and they tend to use more expressive and salient gestures to fully engage their audiences [43]. While previous research found that speakers' extraversion and neuroticism are positively correlated with their representational gesture rates [16], our findings diverge. One possible explanation lies in the features of neuroticism, which is correlated psychological disorders, especially anxiety [44]. Individuals high in neuroticism are characterized by excessive rumination, low self-esteem, and shifting self-concepts. Despite the potential of representational gestures to enhance communication by directly conveying semantic content [45], highly neurotic participants in our study did not adapt their gestures for the child programme. Moreover, as the neuroticism levels increased, the difference in representational gesture rates between programmes became smaller, suggesting that highly neurotic speakers made no adjustments for different audiences. Additionally, our analysis methods, which considered the joint impact of multiple personality traits together in different contexts may have contributed to these differing results from previous studies that examined each personality separately.

Unlike Chu and colleagues [14], who found no link between empathy and representational gesture rate, our study revealed a positive association. It appears that higher levels of empathy may drive speakers to use more representational gestures to enhance communicate effectively.

4.4. Pointing gestures

The saliency of pointing was predicted by both empathy and conscientiousness in CDB, and there were interactions between conditions and empathy and extraversion for pointing saliency. Adults' pointing is helpful for children's comprehension and vocabulary acquisition [46]. More empathetic speakers may prioritize audience understanding, thus making more salient pointings. Similarly, highly extroverted individuals produce more salient pointings to capture audiences' interest and attention immediately. Additionally, conscientious individuals, known for plan ahead [47], use pointing (but see discursive gestures/discourse markers in [48]) more saliently to connect speech to visual aids, which assists themselves and their audience in comprehension.

4.5. Beat gestures

Although empathy or personality traits did not directly predict beat gesture frequency, a notable interaction emerged between empathy and programmes for beat saliency. Higher-empathetic participants used more salient beats in CDB. Despite beat gestures lacking semantic content, they can improve children's word recall [49]. This suggests that empathetic participants are more motivated to emphasize key parts of their speech to children, given their limited attention spans during broadcasts.

There was no correlation between openness, agreeableness and gestures in programmes. The findings imply that openness is not crucial in gesturing behavior [50], [41]. Agreeableness is associated with trustworthiness, highly agreeable individuals may struggle with assertiveness [38], potentially affecting their ability to present programmes attractively. Participants with high agreeableness may lack creativity in gesture production. Overall, the study suggests these personality traits may not strongly influence gesturing behavior in the examined context.

5. Conclusions

This study comprehensively analyzes how empathy and the Big Five personality traits affect the audiovisual modulation of CDB and ADB, with implications for multimodal child-directed language. On the one hand, our study reflects the importance of considering individual differences in crafting effective child-directed communication. Our results better understand the significant variations in caregivers' CDL [8], [51]. On the other hand, for broadcasters, who tailor their language and nonverbal communication to audience needs, can enhance programme value, especially for children. Understanding individual differences can guide target training for broadcasters, improving the quality of children programmes.

6. Acknowledgements

We thank all participants in this study. The work was supported by Chinese Scholarship Council (CSC), and The National Social Science Fund of China (20BYY179).

7. References

[1] E. Campisi and A. Özyürek, "Iconicity as a communicative strategy: Recipient design in multimodal demonstrations for adults and children," *Journal of Pragmatics*, vol. 47, no. 1, pp. 14-27, Feb. 2013.

[2] A. Cristia, "Input to language: The phonetics and perception of infant-directed speech," *Language and Linguistics Compass*, vol. 7, no. 3, pp. 157-170, Mar. 2013.

[3] M. Han, N. H. De Jong, and R. Kager, "Prosodic input and children's word learning in infant- and adult-directed speech," *Infant Behavior and Development*, vol. 68, 101728, Aug. 2022.

[4] C. Cox, C. Bergmann, E. Fowler, T. Keren-Portnoy, A. Roepstorff, G. Bryant, and R. Fusaroli, "A systematic review and Bayesian meta-analysis of the acoustic features of infant-directed speech," *Nature Human Behaviour*, vol. 7, pp. 114-133, Oct. 2022.

[5] M. Kalashnikova, V. Peter, G. M. Di Liberto, E. C. Lalor, and D. Burnham, "Infant-directed speech facilitates seven-month-old infants' cortical tracking of speech," *Scientific Reports*, vol. 8, no. 1, pp. 1-8, Sep. 2018.

[6] N. Dimitrova and Ş. Özçalışkan, "How gesture input provides a helping hand to language development," *Seminars in Speech and Language*, vol. 34, no. 04, pp. 227-236, Dec. 2013.

[7] A. Fernald, "Speech to infants as hyperspeech: Knowledge-driven processes in early word recognition," *Phonetica*, vol. 57, no. 2-4, pp. 242-254, Aug. 2000.

[8] J. Shi, Y. Gu, and G. Vigliocco, "Prosodic modulations in child-directed language and their impact on word learning," *Developmental Science*, vol. 25, no. 1, e13357, Dec. 2023.

[9] S. Dong, Y. Gu, and G. Vigliocco, "The impact of child-directed language on children's lexical development," *Pro. of the Annual Meeting of the Cognitive Science Society*, vol. 43, pp. 43, 2021.

[10] P. C. Britton and J. M. Fuendeling, "The relations among varieties of adult attachment and the components of empathy," *The Journal of Social Psychology*, vol. 145, no. 5, pp. 519-530, Aug. 2005.

[11] E. M. Leerkes, A. N. Blankson, and M. O'Brien, "Differential effects of maternal sensitivity to infant distress and nondistress on social-emotional functioning," *Child Development*, vol. 80, pp. 762-775, May. 2009.

[12] M. Spinelli and J. Mesman, "The regulation of infant negative emotions: The role of maternal sensitivity and infant-directed speech prosody," *Infancy*, vol. 23, no. 4, pp. 502-518, Mar. 2018.

[13] V. Kempe, "Child-directed speech prosody in adolescents: Relationship to 2D:4D, empathy, and attitudes towards children," *Per. and Ind. Differences*, vol. 47, no. 6, pp. 610-615, Oct. 2009.

[14] M. Chu, A. Meyer, L. Foulkes, and S. Kita, "Individual differences in frequency and saliency of speech-accompanying gestures: The role of cognitive abilities and empathy," *Journal of Experimental Psychology: General*, vol. 143, no. 2, pp. 694-709, Apr. 2014.

[15] R. R. McCrae and P. Costa, "Personality trait structure as a human universal," *American Psychologist*, vol. 52, no. 5, pp. 509-516, May. 1997.

[16] A. B. Hostetter and A. L. Potthoff, "Effects of personality and social situation on representational gesture production," *Gesture*, vol. 12, no. 1, pp. 62-83, Jan. 2012.

[17] G. Mohammadi and A. Vinciarelli, "Automatic personality perception: Prediction of trait attribution based on prosodic features," *IEEE Transactions on Affective Computing*, vol. 3, no. 3, pp. 273–284, Apr. 2012.

[18] G. B. Ray, "Vocally cued personality prototypes: An implicit personality theory approach," *Communication Monographs*, vol. 53, no.3, pp. 266–276, 1986.

[19] E. Gasser, B. Ahn, D. J. Napoli, and Z. L. Zhou, "Production, perception, and communicative goals of American newscaster speech," *Lan. in Society*, vol. 48, no. 2, pp. 233-259, Feb. 2019.

[20] R. Medrado, L. P. Ferreira, and M. Behlau, "Voice-over: Perceptual and acoustic analysis of vocal features," *Journal of Voice*, vol. 19, no. 3, pp. 340-349, Sep. 2005.

[21] M. Swerts and E. Krahmer, "Visual prosody of newsreaders: Effects of information structure, emotional content and intended audience on facial expressions," *Journal of Phonetics*, vol. 38, no. 2, pp. 197-206, Apr. 2010.

[22] Y. Zhang and Y. Gu, "A recipient design in multimodal language on TV: A comparison of child-directed and adult-directed broadcasting," *Proceedings of the Annual Meeting of the Cognitive Science Society*, vol. 45, pp. 45, 2023.

[23] W. Apple, L. A. Streeter, and R. M. Krauss, "Effects of pitch and speech rate on personal attributions," *Journal of Personality and Social Psychology*, vol. 37, no. 5, pp. 715-727, ,May. 1979.

[24] M. Zuckerman and K. Miyake, "The attractive voice: What makes it so?" *Jou. of Non. Beh.*, vol. 17, no. 2, pp. 119-135, Jun. 1993.

[25] S. M. Kennison and J. Byrd-Craven, "Gender differences in beliefs about infant-directed speech: The role of family dynamics," *Child Development Research*, 2015, 871759, Oct. 2015.

[26] S. Baron-Cohen and S. Wheelwright, "The empathy quotient: An investigation of adults with asperger syndrome or high functioning autism, and normal sex differences," *Jou. of Autism and Dev. Disorders*, vol. 34, no. 2, pp. 163-175, Apr. 2004.

[27] M. Wang, X. Dai, and S. Yao, "Development of Chinese Big Five Personality Inventory (CBF-PI): theoretical framework and reliability analysis," *Chinese Journal of Clinical Psychology*, vol. 18, no. 5, pp. 545-548, 2010.

[28] P. Boersma and D. Weenink, "Praat: Doing phonetics by computer," Version 6.1.08, 2019. http://www.praat.org/

[29] M. Han, *The role of prosodic input in word learning: A cross-linguistic investigation of Dutch and Mandarin Chinese infant-directed speech*. LOT Publisher: Amsterdam, 2019.

[30] P. Wittenburg, H. Brugman, A. Russel, A. Klassmann and H. Sloetjes, "ELAN: A professional framework for multimodality research," *Proc. Int. Conf. Lang. Res. Eval*., pp. 1556-1559, 2006.

[31] D. McNeill, *Hand and mind: What gestures reveal about thought*. Chicago: The University of Chicago Press, 1992.

[32] D. McNeill, "Speech and gesture integration," *New Direction in Child Development*, no.79, pp. 11-27, 1998.

[33] W. C. So, C. Sim, and W. S. Low, "Mnemonic effect of iconic gesture and beat gesture in adults and children: Is meaning in gesture important for memory recall?," *Language and Cognitive Processes*, vol. 27, no. 5, pp. 665-681, Jun. 2012.

[34] B. S. Connelly, D. S. Ones, S. E. Davies, and A. Birkland, "Opening up openness: A theoretical sort following critical incidents methodology and a meta-analytic investigation of the trait family measures," *Journal of Personality Assessment*, vol. 96, no. 1, pp. 17-28, Jul. 2013.

[35] C. R. Jonassaint, S. H. Boyle, C. M. Kuhn, I. C. Siegler, W. E. Copeland, and R. Williams, "Personality and Inflammation: The Protective Effect of Openness to Experience," *Ethnicity & Disease*, vol. 20, no. 1, pp. 11-14, Jan, 2010.

[36] P. Costa, and R. R. McCrae, *NEO PI–R: Revised NEO Personality Inventory.* Odessa: Psychological Assessment Resources, 1992.

[37] M. D. Pell, "Influence of emotion and focus location on prosody in matched statements and questions", *Journal of the Acoustical Society of America*, vol. 109, pp. 1668-1680, Apr. 2001.

[38] D. W. Addington, "The relationship of selected vocal characteristics to personality perception," *Speech Monographs*, vol. 35, no. 4, pp. 492-503, 1968.

[39] D. Nettle, *Personality: What Makes You the Way You Are*. New York: Oxford University Press. 2007.

[40] H. Zhao and S. E. Seibert, "The Big Five personality dimensions and entrepreneurial status: A meta-analytical review," *Journal of Applied Psychology*, vol. 91, no. 2, pp. 259-271, Mar. 2006.

[41] G. Toegel and J. L. Barsoux, "How to become a better leader," *MIT Sloan Management Review*, vol. 53, no. 3, pp. 51-60, 2012.

[42] P. T. Costa and R. R. McCrae, "Normal personality assessment in clinical practice: The NEO personality inventory," *Psychological Assessment*, vol. 4, no. 1, pp. 5-13, Mar. 1992.

[43] P. Borkenau and A. Liebler, "Trait inferences: Sources of validity at zero acquaintance," *Journal of Personality and Social Psychology*, vol. 62, no. 4, pp. 645-657, 1992.

[44] D. Watson, W. Gamez, and L. J. Simms, "Basic dimensions of temperament and their relation to anxiety and depression: A symptom-based perspective," *Journal of Research in Personality*, vol. 39, no. 1, pp. 46-66, Feb. 2005.

[45] P. L. Rohrer, J. Florit-Pons, I. Vilà-Giménez, and P. Prieto, "Children use non-referential gestures in narrative speech to mark discourse elements which update common ground," *Frontiers in Psychology*, vol. 12, Jan. 2022.

[46] K. K. McGregor, "Gesture supports children's word learning," *Internat. Jour. of Spe-Lang Path*, vol. 10, no. 3, pp. 112-117, 2008.

[47] O. P. John and S. Srivastava, "The Big Five trait taxonomy: History, measurement, and theoretical perspectives," *in Handbook of personality: Theory and research, L. A. Pervin & O. P. John, Eds. New York: Guilford*, pp. 102-138, 1999.

[48] R. Lopez-Ozieblo, "Is personality reflected in hand gestures co-occurring with speech?," *Proceedings of the 8th Workshop on Gesture and Speech in Interaction*, 2023.

[49] A. Igualada, N. Esteve-Gibert, and P. Prieto, "Beat gestures improve word recall in 3- to 5-year-old children," Journal of Experimental Child Psychology, vol. 156, pp. 99-112, Apr. 2017.

[50] C. Schut, K. Reinisch, A. Classen, S. Andres, U. Gieler, and J. Kupfer, "Agreeableness as predictor of induced scratching in patients with atopic dermatitis: A replication study," *Acta Dermato-Venereologica*, vol. 98, no. 1, pp. 32-37, Jan. 2018.

[51] M. Han, & Y. Gu, "Faster and smoother: Fluency in Chinese child-directed speech", *Speech Prosody 2024*.