Adapting to children: information redundancy in language production

Background. During conversations, speakers make decisions both about what they want to convey and how to communicate that with language. Previous research established that speakers are biased toward efficient communication: being sufficiently informative for listeners, while minimizing their own production effort (Grice, 1975; Jaeger & Buz, 2018; Zipf, 1949). Hence, efficient speakers expend less effort producing redundant elements (i.e., those typical of the situation and predictable with real-life knowledge). For example, Westerbeek et al. (2015) found more mentions of the colour blue over red when referring to tomatoes, thereby reducing redundancy since tomatoes are stereotypically red. This creates an interesting situation when speaking to children. Unlike adult interlocutors, who have already acquired sufficient real-world knowledge, children are still learning what is typical in the world. Therefore, what is redundant for an adult may not be such for a child. Consequently, when talking to children, the pressure for efficiency may be outweighed by the need to use language informatively to explain how the world is, thereby leading speakers to produce signals that would be considered to be redundant for adults in order to maximize the informativity for a child. Tal et al. (2021a, 2021b) showed that speakers used longer references like full noun phrases for highly predictable targets when talking to younger compared to older children, and this redundancy declined as children aged.

Most research on informativity considers the linguistic forms that speakers employ rather than the content itself. Thus, it is unclear (1) how informativity may be reflected in the overall propositional meaning speakers choose to convey and (2) how the needs of different interlocutors interact with this choice. The current study explored *whether speakers select content with different levels of informativity when they are communicating with different listeners (adult vs. children)*. We predicted that similar to the findings on linguistic expressions, messages directed to children would also be more redundant than those directed to adults.

Stage 1. Elicit production data. We collected production data from 12 adults who saw 40 paintings, presented with a photo of either an adult or a child, and wrote down what they'd say about the painting to their interlocutor. We examined the sentence length (number of words per sentence, Dickinson & Porche, 2011) and sentence type (declaratives vs. questions vs. fragments, Dong et al., 2021). Additionally, since people with higher empathy are better at predicting and responding to others' actions (Newman-Norlund et al., 2009; Saxe & Baron-Cohen, 2006), we measured participants' empathy levels via the Empathy Quotient (Baron-Cohen & Wheelwright, 2004).

Results. We obtained 480 descriptions segmented into 1471 sentences (adult: 687, child: 784). The data were analysed using mixed effects models for sentence length (linear) and each of the sentence types (logistic) with condition (adult vs. child), empathy score, and their interaction as fixed effects, with maximal random effects.[1] We controlled for item order when looking at sentence length and used a Bonferroni-corrected p-value of .17 for significance. Consistent with features of child-directed speech (Soderstrom, 2007), our results revealed that child-directed descriptions (1) were shorter in sentence length (β=-1.91, *SE*=0.69, *p*=.020), (2)

---

[1] Sentence_length ~1+ Condition*EQ+Order+(Condition|ID)+(Condition+Order|Picture)
  Declarative ~1+Condition*EQ+(Condition|ID)+(Condition+Order|Picture)
  Question ~1+Condition*EQ+(Condition|ID)+(Condition+Order|Picture)
  Fragment ~1+Condition*EQ+(Condition|ID)+(Condition+Order|Picture)

contained fewer declaratives (β=-1.11, *SE*=0.40, *p*=.006), and (3) tended to have more questions (β=1.90, *SE*=0.94, *p*=.04). If declaratives convey more (propositional) content than other forms, child-directed descriptions appear to contain less content. In addition, speakers with higher empathy shortened their sentences to a greater extend (β = -0.15, *SE*= 0.06, *p* = .029), produced more questions (β=0.12, *SE*=0.04, *p*=.003), and tended to use fewer declaratives (β = -0.09, *SE*= 0.03, *p* = .006) in child-directed descriptions. The findings support the idea that more empathetic speakers may be more sensitive to the listener during communication (Rowe, 2008). The speakers appeared to engage in audience design in a manner comparable to real-life interactions even when they were only informed about the general identity of a listener.

Stage 2. **Collect Informativity ratings.** An independent group of adults evaluated the informativity of the content of collected descriptions. Since the paintings were visually available to the speakers and their imaginary addressees in Stage 1, we speculated that content of observable information from the painting would be predictable and redundant, whilst content that could not be ascertained simply by looking at the painting would be newsworthy and informative. 102 participants rated description newsworthiness based on 'How far does the speaker go beyond the artwork?' from 1 (the lowest) to 10 (the highest), resulting in 24,480 ratings for 240 descriptions (see figure 1, lower ratings indicate more redundancy, i.e., the speaker did not go beyond the artwork).
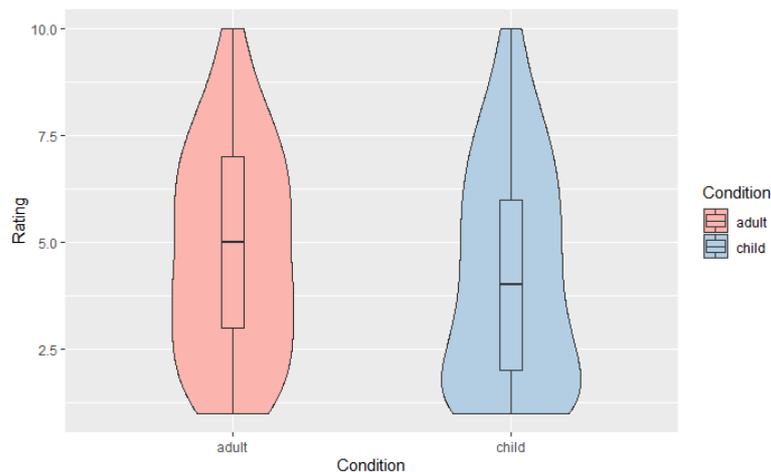

Figure 1: the mean and distribution of the ratings across conditions

Results. We analysed the ratings using a maximal linear mixed effects model with the identity of the original addressee (adult vs. children) as a fixed effect, controlling for sentence length and the number of sentences in the description.[2] Child-directed descriptions received significantly lower ratings than adult-directed descriptions (β=-0.37, *SE*=0.18, *p*=.048), suggesting that the speakers were judged as conveying less informative content when talking to children.

Discussion and conclusion. Our findings align with previous research on communicative efficiency, which demonstrated that speakers increased redundancy to avoid potential

---

[2]Rating~Condition+SentenceLength+SentenceNum+(Condition+SentenceNum+SentenceLength| Participant)+(Condition+SentenceNum+SentenceLength|Painting)+(Condition+SentenceNum+ SentenceLength|Speaker)

communication failure (Buz et al., 2016; Tal et al., 2021). Although speakers may have a general preference to be informative, they still choose to convey redundant content when their listener, a child, may have difficulties in understanding complex ideas and knowledge. We suggest that redundant content may be newsworthy from the perspective of the children because they have not established adult-like world knowledge yet. Thus, speakers may choose the content that is within children's knowledge, or use questions, which do not provide much information at all. Our study is the first to show that the identity of the audience not only affects speakers' choice on how to formulate their messages, but also their decision on what messages to communicate.

References

Baron-Cohen, S., & Wheelwright, S. (2004). The Empathy Quotient: An Investigation of Adults with Asperger Syndrome or High Functioning Autism, and Normal Sex Differences. *Journal of Autism and Developmental Disorders*, *34*(2), 163–175. https://doi.org/10.1023/B:JADD.0000022607.19833.00

Buz, E., Tanenhaus, M. K., & Jaeger, T. F. (2016). Dynamically adapted context-specific hyper-articulation: Feedback from interlocutors affects speakers' subsequent pronunciations. *Journal of Memory and Language*, *89*, 68–86.

Dickinson, D. K., & Porche, M. V. (2011). Relation Between Language Experiences in Preschool Classrooms and Children's Kindergarten and Fourth-Grade Language and Reading Abilities: Preschool Language Experiences and Later Language and Reading. *Child Development*, *82*(3), 870–886. https://doi.org/10.1111/j.1467-8624.2011.01576.x

Dong, S., Gu, Y., & Vigliocco, G. (2021). The impact of child-directed language on children's lexical development. *Proceedings of the Annual Meeting of the Cognitive Science Society*.

Grice, H. P. (1975). Logic and conversation. In *Speech acts* (pp. 41–58). Brill.

Jaeger, T. F., & Buz, E. (2018). Signal reduction and linguistic encoding. In *The handbook of psycholinguistics* (pp. 38–81). Wiley Blackwell.

Newman-Norlund, S. E., Noordzij, M. L., Newman-Norlund, R. D., Volman, I. A. C., Ruiter, J. P. de, Hagoort, P., & Toni, I. (2009). Recipient design in tacit communication. *Cognition*, *111*(1), 46–54. https://doi.org/10.1016/j.cognition.2008.12.004

Rowe, M. L. (2008). Child-directed speech: Relation to socioeconomic status, knowledge of child development and child vocabulary skill. *Journal of Child Language*, *35*(1), 185–205.

Saxe, R., & Baron-Cohen, S. (2006). Editorial: The neuroscience of theory of mind. *Social Neuroscience*, *1*(3–4), 1–9. https://doi.org/10.1080/17470910601117463

Soderstrom, M. (2007). Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review*, *27*(4), 501–532. https://doi.org/10.1016/j.dr.2007.06.002

Tal, S., Grossman, E., & Arnon, I. (2021a). *Infant-directed speech becomes less redundant as infants grow: Implications for language learning* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/bgtzd

Tal, S., Grossman, E., Rohde, H., & Arnon, I. (2021b). *Speakers use more redundant referents with language learners: Evidence for communicatively-efficient referential choice* [Preprint].

PsyArXiv. https://doi.org/10.31234/osf.io/cw2be

Westerbeek, H., Koolen, R., & Maes, A. (2015). Stored object knowledge and the production of referring expressions: The case of color typicality. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00935

Zipf, G. K. (1949). *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology*. Cambridge: Addison-Wesley Press.