Early language experience in a Papuan village

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Abstract

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13 **Introduction**

14 In their first five years of life, children hear an extraordinary amount of language in a
15 wide variety of interactional contexts. Tracking the distribution and characteristics of this
16 linguistic input over the day, across age, and between children is a difficult task. Until
17 recently, developmental language science has relied on short video recordings of
18 caregiver-child interaction, at home or in the lab, to get a grasp on what kinds of language
19 children typically hear. This has been a fruitful approach in teasing out individual and
20 group-based differences in interactional style (REFS). However, short recordings are limited
21 in their insight because they represent only a small slice of the child's language abilities and
22 experiences (REFS).

23 Improved recording hardware and advances in speech technology have recently allowed
24 us to use daylong recordings to get a peek into children's broader language landscapes.
25 Daylong recordings are made with a device, usually positioned on the target child's chest,
26 while that child freely navigates their social environment for most of a waking day (REFS).
27 This style of audio recording has allowed researchers to track children's verbal language use
28 across a range of activity and interlocutor contexts, yielding more representative and
29 generalizable measures of their language environments (REFS). While daylong recording
30 collections are typically too large for comprehensive transcription and annotation, a
31 combination of automated tools, (REFS) sampling techniques (REFS), and standardized
32 annotation approaches (REFS) can lead to rich, but efficiently-gained glimpses into the
33 at-home language environment. However, properly collecting, processing, and archiving
34 daylong data is not easily achieved and may not be well suited for a range of research
35 questions (REFS). At time of writing, there are few options for capturing visual information
36 across the day (but see REFS), limiting this method primarily to acoustic phenomena

37 (REFS).

38   Daylong recording methods are still relatively new, and their reliability and predictive

39 value for language development have not yet been fully established. For example, one

40 collection of recordings made in the US Northwest suggests that there is so much variability

41 across activities and days in basic talk characteristics (e.g., how much speech comes from

42 what types of speakers) that researchers need several days of recordings before they can

43 expect their input estimates to stabilize (Anderson & Fausey, in prep). Even if one can

44 achieve a reliable estimate of a language environment measure (e.g., overhearable adult

45 words per hour), how and why that estimate relates to deeper factors shaping the learning

46 situation, including caregiving ideologies and language outcomes, is often indirect at best.

47 Relatedly, meaningful differences between individual children may be minimized when

48 averaging across the entirety of the day's high and low moments; it may well be that a few

49 key interactions throughout the day provide sharper resolution on individual and

50 group-based differences compared to whole-day averages.

51   Recent studies have directly investigated the effect of recording duration on caregiver

52 speech, finding that short recordings display much denser, and somewhat different input than

53 longer recordings (Bergelson, Amatuni, Dailey, Koorathota, & Tor, 2019; Tamis-LeMonda,

54 Kuchirko, Luo, Escobar, & Bornstein, 2017). Bergelson and colleagues (Bergelson et al.,

55 2019) analyzed the contexts of noun use encountered by 44 6- and 7-month-old children in

56 the US in both hour-long at-home videos and comparable sub-samples of daylong recordings.

57 They found that, while the videos tended to have very dense noun-related input and

58 significantly more nouns embedded in questions, daylong samples contained more nearby

59 speakers and more noun types (see (Bergelson et al., 2019) for the full range of differences).

60 Frequently heard nouns were more consistent across families in the daylong data compared

61 to the video data, suggesting that daylong data may more more robustly capture stable,

62 group-level similarities in child-proximal speech. Interestingly, children heard more dense

63 noun input during their "peak" hour for the day compared to the video, which also highlights

64 peak interactions from daylong recordings as a promising compromise between ecological

65 validity and concentrated measures of language environment and development. Importantly,

66 a child's relative rank across a range of speech environment measures may be stable across

67 recording contexts, at least for US children (Tamis-LeMonda et al., 2017). Based on these

68 findings, one could infer that at-home short recordings are influenced by some (but not all)

69 of the same underlying factors that drive language patterns during daylong recordings (e.g.,

70 caregiver ideologies about child development, child responsiveness, household composition).

71   Studies of children growing up in two indigenous Mayan communities of Southern

72 Mexico (Tseltal and Yucatec Mayan) suggest that short and long recordings may yield

73 substantial differences in how the speech environment is characterized (REFS). Previous

74 studies on these communities have tended to use ethnographic and microanalytic analyses of

75 short interactions to examine the character of children's speech environments. They have

76 found that caregivers shape infants' and young children's worlds such that the children learn

77 to attend to what is going on around them rather than expecting to be the center of

78 attention (REFS). Consistent with this goal, direct talk to infants, particularly from adults,

79 is rare until children themselves begin to elicit responses from others (REFS). Because young

80 children are often cared for by older siblings and cousins, a substantial portion of talk to

81 young children was also expected to come from other children (REFS). Similar observations

82 have been reported for multiple other distinct (but ethnolinguistically related) communities

83 in the region (REFS). Following up on this ethnographic work, Shneidman (REFS) used

84 short videos of interaction to conduct a quantitative, longitudinal study of the speech young

85 Yucatec children heard. She found that interactional patterns aligned well with observations

86 in previous work in that community: infants were rarely spoken to at first, but their

87 language input increased enormously with age, mostly due to an influx of speech from other

88 children (REFS). However, when Casillas and colleagues (REFS) used daylong recordings

89 with a Tseltal Mayan community, where a similar caregiver interactional style has been

⁹⁰ described previously on the basis of short videos, the pattern of findings diverged from

⁹¹ expectations. In brief, they found that infants and young children were indeed spoken to

⁹² rarely, but that there was no increase in speech input with age and the majority of speech

⁹³ came from adult women, even when children were old enough to independently follow their

⁹⁴ older siblings and cousins around the house. These divergent results betweeh daylong and

⁹⁵ short video recordings don't imply that the latter is wrong, only that it is not representative

⁹⁶ with respect to the child's language experience over an entire day.

⁹⁷   These findings do raise an important issue faced by developmental psychology as it

⁹⁸ continues to expand the study of child language to more diverse speech communities: when

⁹⁹ researchers are not members of the community they are studying, it is difficult to know a

¹⁰⁰ priori what is typical, representative, or meaningful in children's language experience. By

¹⁰¹ observing as much speech as possible in a context as ecologically valid as possible and by

¹⁰² sampling, annotating, and analyzing the data on the basis of the most established

¹⁰³ development measures we have, researchers using daylong recordings might hope to approach

¹⁰⁴ this issue without first needing to conduct deep ethnographic studies in the community on

¹⁰⁵ caregiving practices and ideologies around language use and language development (REFS).

¹⁰⁶ When studying members of our own cultural group, we can bridge between simple, observable

¹⁰⁷ behaviors and rich interpretations of, thereby expanding our explanatory model beyond the

¹⁰⁸ measures directly analyzed (e.g., why child-directed talk might relate to faster vocabulary

¹⁰⁹ development). We cannot hope to gain such enriched understandings cross-culturally

¹¹⁰ without ethnographic work; and in the absence of such work we must accept that there may

¹¹¹ be a dissociation between how we have traditionally understood an operationalized language

¹¹² behavior (e.g., child-directed speech) and what drives the use and form of that behavior in a

¹¹³ given community or interactional context (e.g., pedagogical concerns, entertainment of the

¹¹⁴ caregiver, getting the child to assist). Until there are trained researchers working on this

¹¹⁵ topic who were born and raised as members of these communities (what we should be trying

¹¹⁶ to cultivate for the longer term) this is a quandary we will continue to face.

117   Pairing ethnographic work with broader-scope studies of children's language

118 environments may be the most fruitful way to ensure that their speech environments and

119 speech development are captured well enough to propose and test meaningful theories

120 cross-culturally. These two methods have complementary roles to play in exploring the

121 landscape of at-home language, and neither should be taken to reflect the "true" language

122 input for a given child; after all, in the example of Tseltal above, many interactions with

123 infants during the daylong recordings came during moments where visitors using a video

124 camera, or even other community members, would not typically be invited (e.g., after the

125 parent was roused by the child, who was waking from an afternoon sleep). If we want to

126 encourage more work on small-scale and/or understudied language learning contexts, it will

127 be important to continue establishing how different methods of measuring the input impact

128 the conclusions that are likely to be made.

129   In this study we present analyses of daylong recordings from a small-scale indigenous

130 group, on Rossel Island, Papua New Guinea (PNG), in which prior ethnographic work has

131 painted a clear picture of early caregiver-child interaction: child-centric, face-to-face

132 interaction from the first days of infancy. Based on the prior ethnographic work, detailed

133 below, we made four predictions about children's speech environments. First, we predicted

134 that children on Rossel Island would hear frequent child-directed speech from a wide variety

135 of caregiver types throughout the day. Second, given how frequently they are passed between

136 caregivers, we expected to see weaker effects of the subsistence farming schedule on Rossel

137 children's input than has been found in other societies (Casillas et al., forthcoming). Third,

138 as children get older, we expected to see a large increase in the proportion of child-directed

139 speech coming from other children (see also Shneidman REFS). Fourth, we expected a large

140 quantity of other-directed speech around them, given the large number of family numbers

141 typically present. Based on prior work with daylong recordings with both Western and

142 non-Western small-scale populations, we additionally expected (a) no age-related increase in

143 child-directed speech (Scaff, Casillas, Bergelson, REFS), (b) an age-related decrease in

other-directed speech (Casillas, Bergelson, REFS), and (c) that children's input would be non-uniformly distributed over the day (Abney, Smith, & Yu, 2017; Blasi, Schikowski, Moran, Pfeiler, & Stoll, in preparation) such that interactional peaks present a much denser view of their input (Casillas et al., forthcoming), similar to that observed in short videos.

In what follows we will review the ethnographic work done with this community previously, describe our methods for following up on these findings with daylong recordings, present the current findings, and discuss the differences that arose. This study was completed as part of a larger comparative project focusing on children's speech environments and linguistic development at two sites: the Tseltal Mayan community mentioned above (Casillas et al., forthcoming) and this Rossel Island community. Therefore all methods for annotation and analysis in this study parallel those reported elsewhere for Tseltal Mayan children's speech environments (Casillas, Brown, & Levinson, forthcoming).

Method

Corpus

The participants in this study live in a collection of small hamlets on north-eastern Rossel Island, approximately 250 nautical miles off the southern tip of mainland Papua New Guinea. The traditional language of Rossel Island is Yélî Dnye, a presumed Papuan isolate, which features a phonological inventory and set of grammatical features that are unlike any other in the (predominantly Austronesian) languages of the region. Rosselers are skilled farmers, cultivating taro, sweet potato, manioc, yam, coconut, and more for their daily subsistence, with protein coming from fishing and (occasionally) slaughtering pigs or local animals. Most children on Rossel Island grow up speaking Yélî Dnye monolingually at home, beginning to learn English as a second language once they begin school around age 7 or 8. Children grow up in patrilocal household clusters (i.e., their family and their father's brothers

families), usually arranged such that there is some shared open space between households.

During their waking hours, infants are typically carried in a caregiver's arms as they go about daily activities. Infants, even very young ones, are frequently passed between different family members (male and female, young and elderly) throughout the day, returning to the mother to suckle when hungry. The arc of a typical day for an infant might include waking, being dressed and fed, then a mix of (a) spending time with nearby adults or older children as they walk around socializing and completing tasks with others and (b) more feeding, perhaps followed by short bouts of sleep in the late morning and afternoon, usually with the mother. Afternoon meals are cooked from around 15:00 onward, with another meal time and more socializing at home before resting for the night. Starting around age two or three, children also begin to spend a lot of their time in large, independent child playgroups involving up to 10 or more cousins at a time who freely travel near and around the village searching for nuts and fruits, bathing in nearby rivers, and engaging in group games (e.g., tag, pretend play, etc.).

Interaction with infants and young children on Rossel Island is initiated by women, men, girls, and boys alike in a face-to-face, contingency-seeking, and affect-laden style (Brown REFS). Children are considered a shared responsibility, but also a source of joy and entertainment for the wider network of caregivers in their community. In her prior ethnographic work, Brown details some ways in which interactants make bids for joint attention and act as if the infant can understand what is being said (REFS). Infants pick up on this pattern of caregiving, intiating interactions with others twice as frequently as Tseltal children, who are encouraged instead to be observers of the interactions going on around them (Brown 2011 REFS). At the same time, Brown (REFS) documents how Rossel caregivers encourage early independence in their children, observing their autonomy in choosing what to do, wear, eat, and say while finding other ways to promote pro-social behavior (e.g., praise; REFS). Overall, Rossel Island could be characterized as a

child-centered language environment (Ochs & Schieffelin 1984; REFS but see Brown & Casillas REFS), in which children, even very young ones, are considered interactional and conversational partners whose interests are allowed to shape the topic and direction of conversation.

We were interested to investigate the language environment of children acquiring Yélî Dnye because prior ethnographic work had suggested that child-directed speech is highly frequent in this community, from mothers and other adult caregivers, but also from other children. Therefore we were interested in understanding how children's input environment influenced their acquisition of this language with all its rare structures.

The data presented here come from Rossel Island subset of the Casillas HomeBank Corpus (Casillas, Brown, & Levinson, 2017), a collection of raw daylong recordings and more from over 100 children under age four growing up on Rossel Island and in the Tseltal Mayan community described elsewhere (Casillas et al. forthcoming). The Rossel Island subcorpus was collected in 2016 and includes daylong audio recordings and experimental data from 57 children born to XX mothers. On average, the target children in these recordings had X–X younger siblings (mean = X; median = X) and X–X older siblings (mean = X; median = X); most participating parents were on the younger end of parents in the community (mothers: mean = XX years; median = XX; range = XX–XX and fathers: mean = XX; median = XX; range = XX—XX). Based on our demographic data we estimate that mothers are typically XX years old when they give birth to their first child (median = XX; range = XX–XX) with an average inter-child interval of X years (median = X; range = X–X). Notably, however, we received several reports, including from nursing staff at the local health clinic, that mothers now are having children younger and closer together than in generations past. Household size, defined here as the number of people sharing kitchen and sleeping areas on a daily basis, ranged between X and XX (mean = X; meadian = X). Households are clustered into small hamlets which form a wider group of communal caregivers and playmates. The hamlets

themselves are clustered together into broader patches of patrilocal residents. The average hamlet in our corpus comprises X households (median = X; range = X–X); assuming an average of X children under age seven (i.e., not schooling) and X adults per household, we estimate that there are between XX and XX children and between XX and XX adults present throughout the day, not including visitors, visits to neighboring hamlets or other nearby resident areas. Therefore, while XX% of the target children in our corpus are first born to their mothers, they are immediately incorporated into a much larger pool of young children whose care is divided among numerous caregivers. Among our participating families, most mothers had finished primary school (XX%; X years of education) or secondary school (XX%; X years of education), with a few having completed preparatory school (XX%; X years of education) or beyond (XX%; X years of education). Only XX% of mothers had less than a primary school education. Similarly, most fathers had finished primary school (XX%; X years of education) or secondary school (XX%; X years of education), with a few having completed preparatory school (XX%; X years of education) or beyond (XX%; X years of education), with only XX% having less than a primary school education. To our knowledge at the time of recording, all but two children were typically developing; one showed signs of significant language delay and one showed signs of multiple developmental delay (motor, language, intellectual), both children's delays were consistently observed in follow-up trips in 2018 and 2019.

Dates of birth for children were initially gotten from parent report. We were able to verify the vast majority of birth dates using the records at the island health clinic. Because not all mothers give birth at the clinic and because dates are written by hand, some births are not recorded, are inaccurately recorded, or otherwise significantly diverge from what the parents report. In these cases we gathered information from as many sources as possible and followed up with the families, often using the dates of neighboring children born around the same time to home in on the correct date.

246 The data we present come from 7–9-hour recordings of a waking day at home for the

247 child. Children wore the recording device, which was an elastic vest containing a small stereo

248 audio recorder (Olympus WS-832 or WS-853) and a miniature camera that captured photos

249 of the child's frontal view at a fixed interval (every 15 seconds; Narrative Clip 1). The

250 camera was outfitted with a fisheye lens that, while distorting the images, allowed us to

251 capture 180 degrees of children's frontal view. This technique allows us to use daylong

252 recordings while also partially getting around the traditional sacrifice of no visual context,

253 thereby increasing ease and reliability of our transcrition and annotation. However, because

254 the camera and recorder are separate devices, we had to synchronize them manually after

255 the recordings were made. To do this, we used an external wristwatch to record the current

256 time at start of recording on each device individually, with accuracy down to the second

257 (photographed by the camera and spoken into the recorder). The camera timestamps each

258 photo such that we can calculate the number of seconds that have elapsed between each one.

259 These timestamps can be used with the cross-device time synchronization cue to create

260 photo-linked audio files of each recording, which we then format as video files (see

261 https://github.com/marisacasillas/Weave for post-processing scripts and more information).

262 The informed consent process used with participants, as well as data collection and storage,

263 were conducted in accordance with ethical guidelines approved by the Radboud University

264 Social Sciences Ethics Committee.

265 **Data selection and annotation**

266 From the daylong recordings of XX Rossel children, we selected 10 representative

267 children between ages 0;0 and 3;0 for transcription and analysis in the current study. The 10

268 children were selected to be spread between the target age range (0;0–3;0) while also

269 representing a range of typical maternal education levels found in the community and being

270 evenly split between male and female children (see also ACLEW REFS). For each child we

then selected a series of non-overalapping sub-clips from the day for transription in the following order: nine randomly-selected 2.5-minute clips, five manually-selected "peak" turn-taking activity 1-minute clips, five manually-selected "peak" vocal activity 1-minute clips, and one manually-selected 5-minute expansion of the best one-minute clip, for a total of 37.5 minutes of transcribed audio for each child (6.25 audio hours in total). The criteria for manual clip selection are identical to those described for the parallel study on Tseltal by Casillas and colleagues (forthcoming).

We were limited to selecting sub-clips from 10 children for analysis because of the time-intensive nature of transcribing these naturalistic data; 1 minute of audio typically took us approximately 60–70 minutes to be segmented into utterances, transcribed, annotated, and loosely translated into English (~400 hours total). Given that Yélî Dnye is nearly exclusively spoken on Rossel Island, where there is no electricity and unreliable access to mobile data, transcription could only be completed over the course of three 4–6 week visits by our research group to the island in 2016, 2018, and 2019.

We used the ACLEW Annotation Scheme (REFS) in ELAN (ELAN REFS) to transcribe and annotate all hearable speech—both near and distant—in the clips. We first segmented out the utterances and ascribed them to individual speakers (e.g., older brother, mother, aunt, etc.). We then annotated the vocal maturity of each utterance produced by the target child (non-canonical babble/canonical babble/single word/multi-word/unsure) and annotated the addressee of all speech from other speakers (addressed to the target child/one or more other children/one or more adults/a mix of adults and children/any animal/other/unsure). Transcription and annotation was done together by the first author and one of three community members (all native speakers of Yélî Dnye). The community-based research assistants personally knew all the families in the recordings, and were able to use their own experience, the discourse context, and information from the accompanying photos in reporting what was said and to whom speech was addressed for each

utterance. Detailed manuals and self-guided training materials, including a "gold standard test" for this annotation scheme can be found at URL (REFS).

In what follows we first analyze the nine randomly selected 2.5-minute clips from each child to establish a baseline view of their speech environment, focusing on the effects of child age, time of day, household size, and number of speakers on the rate of child-directed and overhearable speech present. Next, we repeat these analyses, focusing instead only on the turn-taking clips to gain a view of the speech environment as it appears during the peak interactions for the day. This latter set of analyses may more closely mirror results from prior ethnographic work. To demonstrate typical development in this context we briefly present one measure of language development: a coarse trajectory mapping children's use of babble, first words, and multi-word utterances. Finally, we wrap up by integrating the divergent perspectives on Yélî children's speech environment across methods and relating these findings to the larger literature on child-directed speech and its role in language development.

Statistical models

We conducted all analyses in R, using the glmmTMB package to run generalized linear mixed-effects regressions on our dependent measures (Brooks et al., 2017; R Core Team, 2018). We used ggplot2 to generate all plots (Wickham, 2009). The dataset and scripts used to generate this manuscript and analyses can be found at https://github.com/marisacasillas/Yeli-CLE. As explained in previous work (REFS Casillas et al. forthcoming, Bunce et al, in prep), child-directed and overhearable speech minutes per hour are naturally restricted to non-negative (0–infinity) values, causing the distributional variance of those measures to become non-gaussian (positively skewed). We therefore use negative binomial regressions, which can better fit non-negative, overdispersed data (Brooks et al., 2017; Smithson & Merkle, 2013). In cases when there were extra zeroes in the data (e.g., no hearable speech because the child was alone), we added a zero-inflation model to the

Table 1

Demographic overview of the 10 children whose recordings are sampled in the current study, including from left to right: child's age (years;months.days); child's sex (M/F); mother's age (years); level of maternal education (none/primary/secondary/preparatory/university); and the number of people living in the child's household.

Age	Sex	Mother's age	Level of maternal education	People in household
00;01.09	F	31	secondary	8
00;03.19	M	37	primary	9
00;04.13	M	24	preparatory	5
00;07.18	M	24	secondary	5
00;09.03	F	29	secondary	5
01;00.29	F	30	primary	9
01;05.02	M	25	secondary	6
01;08.03	F	33	primary	9
02;01.22	F	21	secondary	4
02;11.29	M	41	primary	8

regression. This method creates two models: (a) a binary model to evaluate the likelihood of the variable's presence (e.g., no vs. some directed speech) and (b) a count model of the variable (e.g., "3" vs. "5" minutes of directed speech), with an extra parameter indicating data dispersion. More conventional, gaussian linear mixed-effects regressions with logged dependent variables are available in the Supplementary Materials. The results of those alternative models are qualitatively similar to what we report here.
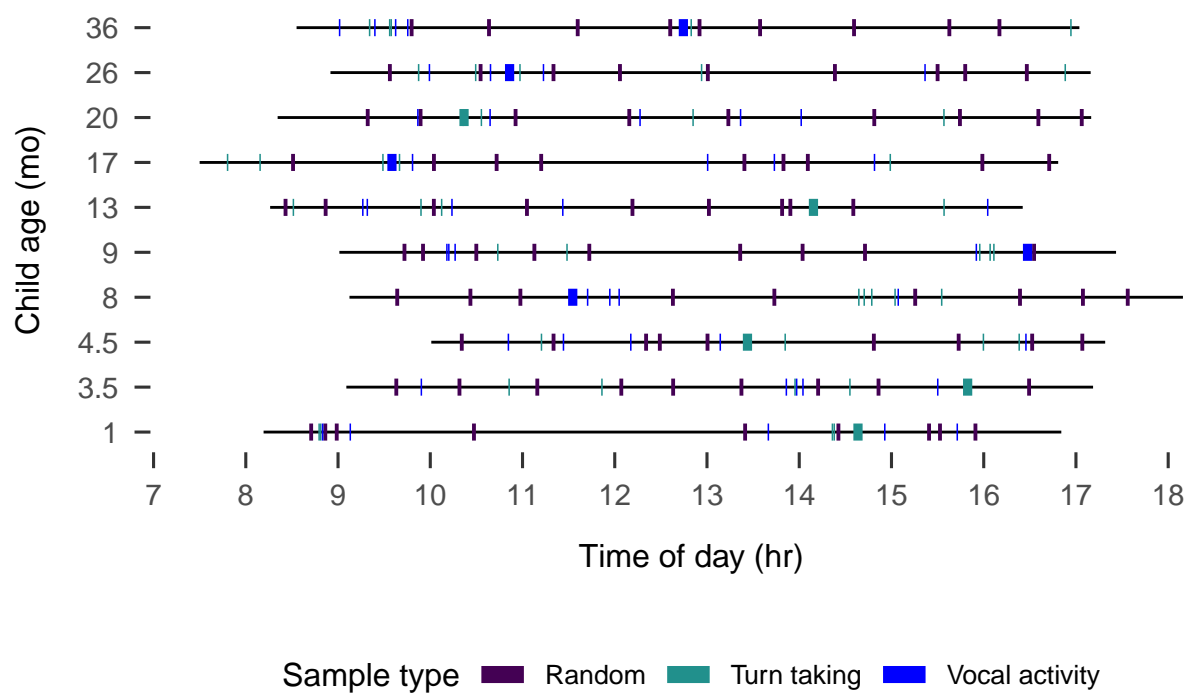
Figure 1. Recording duration (black line) and sampled clips (colored boxes) for each of the 10 recordings analyzed, sorted by child age in months.

Results

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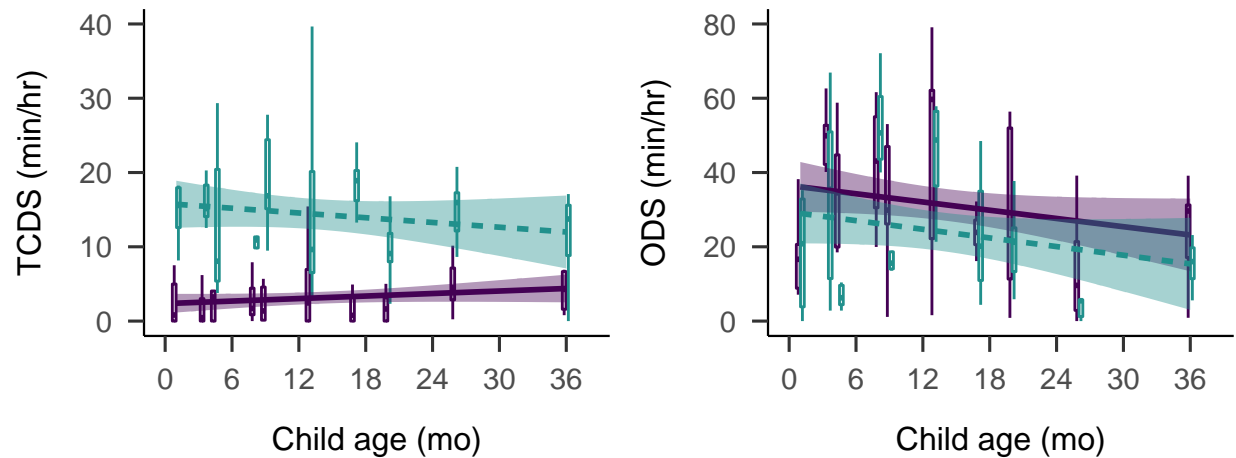
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Figure 2. Estimates of TCDS min/hr (left) and ODS min/hr (right) across the sampled age range. Each box plot summarizes the data for one child from the randomly sampled clips (purple; solid) or the turn taking clips (green; dashed). Bands on the linear trends show 95% confidence intervals.

Vocal maturity

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Acknowledgements

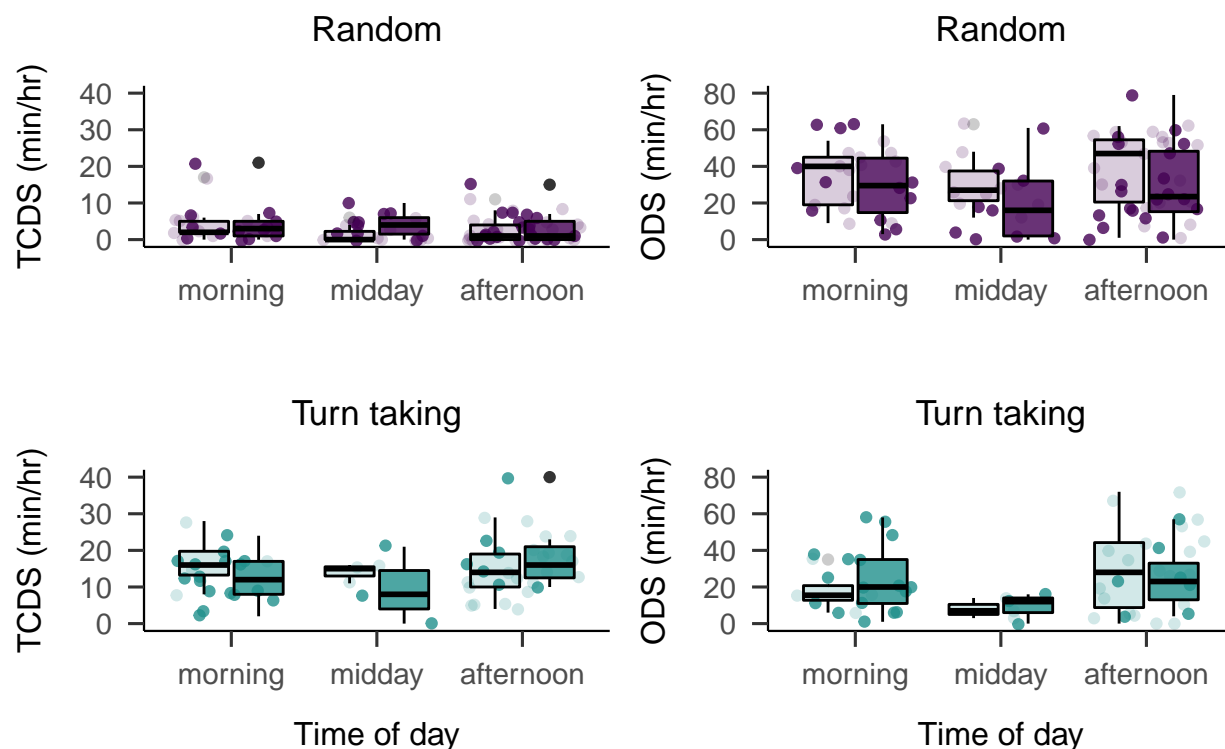This paper was written using the papaja library in RStudio (Aust & Barth, 2018).

Figure 3. Estimates of TCDS min/hr (left panels) and ODS min/hr (right panels) across the recorded day in the random clips (top panels) and turn-taking (bottom panels) clips. Each box plot summarizes the data for children age 1;0 and younger (light) or age 1;0 and older (dark) at the given time of day.

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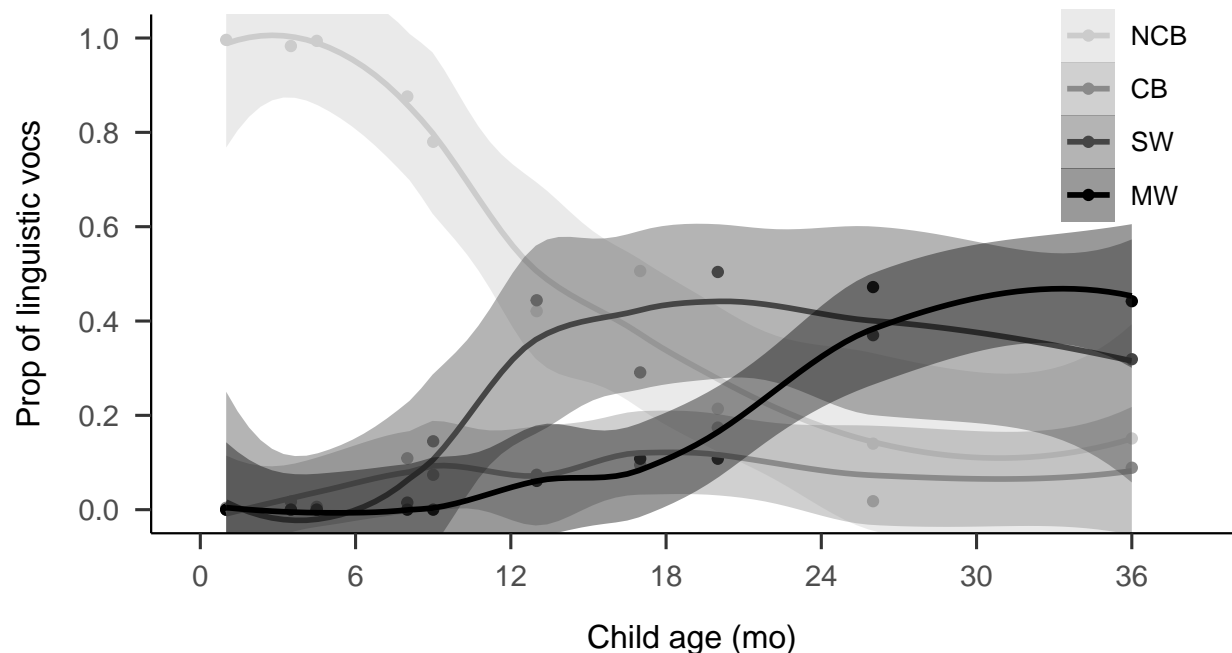353 Bergelson, E., Amatuni, A., Dailey, S., Koorathota, S., & Tor, S. (2019). Day by day, hour

Figure 4. Proportion of vocalization types used by children across age (NCB = Non-canonical babble, CB = Canonical babble, SW = single word utterance, MW = multi-word utterance).

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