Supplementary Material

This supplemental material contains a data link and additional information on the following: instructions to the parent; how we coded parents' referential speech; the statistical models we used, along with their R code and a few notes about those models; and two supplementary tables containing sample transcripts of parent speech.

Data link: The data reported in this paper (utterance onsets, offsets, and reference coding for both studies; learning scores for study 2) are available on the OSF [https://osf.io/dzru7/?view_only=e6b44a6f86a14ec2a5b74cf75e687967].

Instructions to parents (Study 2): The parent was given two laminated cards, each containing the pictures and novel names of one set of three objects. The experimenter pronounced the names of each of the objects and the parents repeated the names back, with feedback if needed to correct their pronunciation. The novel names were those used in Pereira et al. (2014) and were pronounced as follows (IPA), all with stress on the first syllable: habble (/ˈhæbl̩/), mapoo (/ˈmæpu/), wawa (/ˈwɑwɑ/), zeebee (/ˈzibi/), tema (/ˈtimə/), and dodi (/ˈdodi/). Parents were instructed to use these names when talking about the objects, but were not told that the purpose of the study was for them to teach their toddler these names.

Coding referential speech: All coders were first trained in how to code verbal references to objects from sample videos and transcripts of parent-child interactions. This included the use of contextual cues from the videos and audio recordings. As part of this process, new coders' coding was compared with that of an experienced coder and disagreements between the coders were discussed as part of the training process. Trained coders then coded the data presented in this manuscript by reviewing the transcript utterance by utterance as they watched the video recording of the interaction and listened to the audio recording of parent speech. Any utterance in the transcript that contained one or more nouns or pronouns that could refer to one or more of the objects was coded with the ID numbers of any objects referenced, in the order that they were referenced, or was coded as "NA" if no object was referenced (see the supplementary material for an example). A second coder independently coded 25% of the recordings in order to calculate inter-rater reliability, but these secondary codings were not used to amend the primary coding.

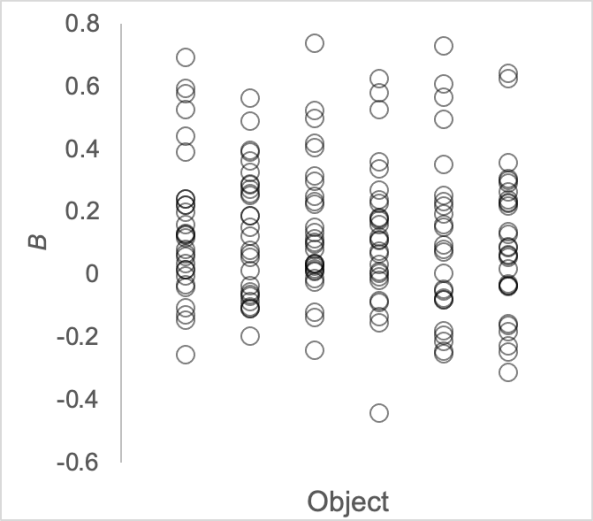
Statistical models (Study 2): Statistical models were conducted using the lmer and glmer functions of the R package lme4 (Doran, Bates, Bliese, & Dowling, 2007) in RStudio Version 1.4.1717 and took the general form: lmer(dependentVariable ~ fixedEffect1 + …fixedEffectN + randomEffect1 + … randomEffectN, data=dataFile). Below are the formulas for the four models reported in the manuscript:

> **Linear mixed effects null model:**
> lmer(propNamesLearned ~ meanNumberOfIOIs + childAge + (1 | subject), data = data_perSubject, REML = FALSE)
>
> **Linear mixed effects alternate model:**
> lmer(propNamesLearned ~ meanNumberOfIOIs + childAge + B_category + (1 | subject), data = data_perSubject, REML = FALSE)

Generalized linear mixed effects null model:
glmer(binaryLearningOutcome ~ numberOfIOIs + childAge + (1 | subject), family=binomial, data = data_perObject)

Generalized linear mixed effects alternate model:
glmer(binaryLearningOutcome ~ numberOfIOIs + childAge + B_value + (1 | subject), family=binomial, data = data_perObject)

Modeling notes:
1. We began with GLM null model with the most complex (maximal) random effect structure permitted by the design: glmer(binaryLearningOutcome ~ numberOfIOIs + childAge + (1 + B_value | subject) + (1 + B_value | object), family=binomial, data = data_perObject); however, by-subject random slopes and by-object random intercepts and slopes were removed to allow a non-singular fit (Barr et al., 2013). We did check for potential systematic variability across items in terms of both burstiness and learnability, and found none. For visual reference, burstiness (*B*) values are shown in the figure below by object, with each circle representing *B* for one parents' talk about the object, for all 6 objects. In terms of learnability, the best learned object name (9 out of the 30 children learned the name) and the worst learned object name (5 out of the 30 children learned the name) did not significantly differ in their learning rates (one-tailed Fisher's exact test: p=0.18).



2. The manuscript describes a possible interaction between burstiness and age as a direction for future research. We were not able to explore this possibility directly because adding this interaction term into the model resulted in the model failing to converge. Moreover, our relatively small sample size -- Study 2 contained 30 participants that spanned the age range of 15 months to 26 months -- likely provided insufficient power to detect an interaction between age and burstiness, even if it did exist.

Supplementary tables: Supplementary tables provide transcripts and referential coding of the sample utterance sequences that are visually portrayed in Figure 2D-E. Details of the referential coding process are provided below. Table S1 provides one parent's bursty utterance sequence (*B*

= .48; see Figure 2D) and Table S2 provides a different parent's non-bursty utterance sequence (B = -.16; see Figure 2D). Tables include all utterances that intervened between the parent's first and last utterances to the target object – the helmet (object 1) in Table S1 and the turtle (object 9) in Table S2. Calculation of the inter-onset-intervals (IOIs) of utterances about the target object begins at the second utterance about the target object, by subtracting the onset time of the previous utterance about the target object (see final column). Parent speech occasionally included syllables that were not words (e.g., "lalala", "mwah"), which were coded as langplayx, or sounds that were not clearly language syllables (e.g., whistling, humming), which were coded as vocplayx.

Table S1

Timing, Transcription, Referential Coding, and Inter-Onset-Interval (IOI) Coding of a Sample Utterance Sequence Containing Bursty Speech About the Helmet (Object 1) from Parent A.

Utterance Onset (s)	Utterance Offset (s)	Utterance Transcript	First Object Referenced	Referential Term(s)	IOI (s) for Object 1
442.7	443.3	you want this one	1	this one	
443.7	445.6	this is red too look red	1	this	1.03
446.1	447.6	red and	NA		
449.1	450.2	red	NA		
450.8	454.7	that is a red ladybug and that is a red ladybug do they look the same look	11	that; ladybug; they	
455.3	455.5	look	NA		
456.1	458.1	red ladybug red ladybug	11	ladybug	
459.4	461.0	except one is a bug toy	NA		
461.5	462.1	that is squeaky	11	that	
462.9	464.6	and one a little drum toy	NA		
468.7	470.8	this is a helmet it goes on your head	1	helmet	24.94
471.5	473.0	should we put it on our doll head	1	it	2.87
473.8	474.5	hi babyname	NA		
475.1	476.3	how are you doing today	NA		
477.4	479.5	should we put the helmet on her head she going to play football	1	helmet	5.89

480.3	481.4	can you put her head in the helmet	15	her	
482.4	483.3	or the helmet on her head	1	helmet	5.00
486.2	487.2	oh almost	NA		
488.7	489.0	vocplayx	NA		
490.4	492.4	langplayx oh she has got poofy hair	15	she	
493.0	495.8	she has got pigtails like you do see if we cannot get her in there	15	she; her	
496.3	498.2	oh her pigtail want to stick out	15	her	
500.7	507.7	langplayx	NA		
510.5	510.8	oh	NA		
511.4	512.9	she has got a helmet on her head	15	she; her	
513.4	514.1	does she not	15	she	
515.2	517.9	say blue forty one blue forty two hut hut	NA		
518.6	519.4	keep play football	NA		
520.1	521.4	alright let us see what else we have	NA		
524.2	525.7	she looks funny in there does she not	15	she	
526.4	527.8	she looks silly in there	15	she	
530.4	532.2	is she tired should we put her to bed	15	she; her	
532.7	533.9	do you see a bed anywhere	23	bed	
535.2	536.0	hmm	NA		
536.5	537.3	where is her bed	23	bed	
538.3	538.7	oh	NA		
539.3	540.8	way over here	NA		

541.9	542.7	is that her bed	15	her	
543.1	544.6	can you put the baby doll in her bed	15	baby doll; her	
546.0	546.8	can you put her in her bed	15	her	
547.7	550.0	we got lots of car over here let us move some of those	20	car	
551.0	551.3	langplayx	NA		
553.6	554.6	want to put her in her bed	15	her	
558.0	558.4	yes	NA		
560.1	561.6	oh she has got to take the helmet off right	15	she	
562.5	563.3	oh can you get it	1	it	80.05
563.9	564.6	pull	NA		
565.5	566.5	pull	NA		
570.1	571.7	can you get it say i got it	1	it	7.58
572.9	573.3	yes	NA		
574.3	574.9	help please	NA		
577.3	577.8	there you go	NA		
579.2	580.9	it pop it is off oh	1	it	9.12

Table S2

Timing, Transcription, Referential Coding, and Inter-Onset-Interval (IOI) Coding of a Sample Utterance Sequence Containing Non-Bursty Speech About the Turtle (Object 9) from Parent B.

Utterance Onset (s)	Utterance Offset (s)	Utterance Transcript	First Object Referenced	Referential Term(s)	IOI (s) for Object 1
540.32	545.09	oh hi babyname will you play with me today i am just coming out of my house	9	me; i	NA
546.36	547.55	will you play with me	9	me	6.04
549.41	549.69	huh	NA		
550.10	551.20	i will climb up here	9	i	3.74
551.74	553.30	langplayx vocplayx	NA		
554.90	556.40	uh oh did he fall	9	he	4.80
557.28	557.95	langplayx	NA		
559.35	560.53	i will help you	5	i	
561.00	561.93	langplayx	NA		
563.56	564.32	he fell off	9	he	8.66
565.48	566.68	mister elephant	5	elephant	
567.17	568.23	that did not help me	9	me	3.61
569.57	570.46	can you help me	5	you	
571.36	572.83	i need help getting down	9	i	4.18
573.55	575.20	okay grab my trunk	NA		
575.60	576.06	oh	NA		
576.49	577.31	langplayx	NA		
578.57	580.19	thank you mister elephant	5	elephant	
582.59	583.73	langplayx	NA		
585.99	587.28	yeah it is a turtle	9	it; turtle	14.63
589.01	589.93	yeah you want to pet him	9	him	3.02
590.64	591.86	oh good turtle	9	turtle	1.63
593.65	594.57	is that a good turtle	9	that; turtle	3.01