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Genericity Signals the Difference between *each* and *every* in Child-Directed Speech

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1. Overview

The universal quantifiers *each* and *every* can both be used to label the same situations in the world. Even so, they differ semantically in subtle ways (§2). In particular, they differ at least with respect to (i) whether they allow pair-list answers in response to questions, (ii) their compatibility with certain "generic" interpretations, and (iii) the extent to which they encourage treating the domain of quantification as independent individuals or as members of a larger group.

This raises an acquisition question (§3): what evidence do learners use to infer the meanings of *each* and *every*? Here, we report on a corpus analysis of child-ambient speech suggesting that parents use *each* to talk about a local domain and use *every* to make broad generalizations that project beyond the local domain. These differences in use come with lower-level concomitants, like quantifying over individuals versus times, or being the argument of a verb as opposed to a topic-setting adjunct (§4). Since these surface-level footprints are available in learners' input, they might, in principle, be used by learners to infer the relevant difference in meaning.

We also sketch a proposal of a learning story (§5) to be investigated in future work. We assume that the usage difference stems from a representational difference: *each* has a fully first-order meaning that implicates individuals and their properties, whereas *every* has a second-order meaning that implicates a single group. These distinct mental representations are supported by two different cognitive systems for representing objects: object-files for *each* and ensemble representations for *every*. We propose that only the latter is compatible with "generic" thoughts of the sort that *every* gets used to express. Learners can then make the inference from the lower-level differences in parents' speech and parents' intended message-level meaning to the appropriate pairing of quantifiers and concepts (a first-order universal concept grounded in object-files for *each*; a second-order universal concept grounded in ensemble representations for *every*).

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2. Subtle differences between *each* and *every*

On the surface, *each* and *every* are very similar. Beyond being universal quantifiers, both are generally reported to be bad with collective predicates, as in (1a-b). In this respect, they both stand in contrast with *all*, which can easily appear with collective predicates, as seen in (1c) (e.g., Vendler 1962; Dowty 1987; Gil 1995; Beghelli & Stowell 1997; Tunstall 1998; Winter 2002; Champollion 2017).

(1) a. *each student {gathered/surrounded the teacher/is similar}.
b. *every student {gathered/surrounded the teacher/is similar}.
c. all students {gathered/surrounded the teacher/is similar}.

Still, there are subtle differences between *each* and *every*. One, potentially related to distributivity, is their ability to give rise to pair-list readings (Williams 1986; Beghelli 1997; Szabolcsi 2010). For example, if asked the question in (2a), an interlocutor could felicitously respond with (2b), which refers to the whole group, or (2c), which pairs individual students with the books they received.

(2) a. Which book did you give to each student?
b. I gave *Aspects* to each student.
c. I gave *Aspects* to Anne; *Syntactic Structures* to Sara; and *SPE* to Scott.

But if asked the *every*-variant in (3a), only (3b) is an available response.

(3) a. Which book did you give to every student?
b. I gave *Aspects* to every student.
c. #I gave *Aspects* to Anne; *Syntactic Structures* to Sara; and *SPE* to Scott.

These pair-list responses are likewise available with *each* given a sentence with a whether-island, as in (4). But, as seen in (5), the same pair-list answer is not available given *every*.

(4) a. Determine whether each student has a copy of *Aspects*.
b. No, only one of them does.
c. Anne does, but Sara doesn't and neither does Scott.

(5) a. Determine whether every student has a copy of *Aspects*.
b. No, only one of them does.
c. #Anne does, but Sara doesn't and neither does Scott.

A second difference between *each* and *every* is their compatibility with certain "generic" interpretations. In particular, sentences with *every* are naturally understood as claims that project beyond the local domain, whereas sentences with *each* are more naturally understood as being about some particular, locally-

present individuals. For example, while (6a) sounds off, (6b) is naturally read as a cross-linguistic claim (Beghelli & Stowell 1997).

(6) After a lifetime of investigation, Suzie came to a striking discovery:
a. #Each language has over 20 color words.
b. Every language has over 20 color words.

Likewise, while (7a) is felicitous, (7b) gives the feeling of having generalized too far based on data from only four new languages.

(7) Suzie just discovered four new languages and interestingly,
a. each language has over 20 color words.
b. #every language has over 20 color words.

In being amenable to projecting beyond the local domain, *every* can be used to state generalizations that suggest a deeper explanation or license a prediction. In contrast, *each* is more amenable to expressing accidental facts and doesn't as easily license predictions about future situations. For example, compare the *every* and *each* variants of (8). Using *each* in (8a) suggests that it might have been the case that gravity acts on only *most* objects. And using *each* in (8b) suggests that there could have been spiders without eight legs.

(8) a. Gravity acts on {every/#each} object
b. {Every/#Each} species of spider has eight legs.

So, while *every* is compatible with generalizations that project beyond the local domain in a way that licenses future predictions, *each* does not seem to be compatible with these kinds of "generic" thoughts.

A third difference between these two universal quantifiers is their propensity for triggering group-representations (e.g., Knowlton, Pietroski, Halberda, & Lidz *under review*). In particular, adults and children have been shown to have better memory for fundamentally group properties – like cardinality and center of mass – after evaluating statements like *every circle is green* compared to statements like *each circle is green*. For example, if shown a picture of circles and asked to evaluate *each/every circle is green* and then subsequently asked to remember how many circles there were, participants given the *every* sentence remember the cardinality as well as their visual system will allow, but those given the same exact picture and the *each* sentence show performance closer to that of guessing.

The takeaway from this result (and others in the same vicinity) is that *each* and *every* bias participants to treat the domain of quantification differently. While sentences with *each* cause them to focus on the individuals being quantified over as such, sentences with *every* drive participants to encode those individuals as members of a larger group.

To summarize the differences: pair-list responses are often acceptable given *each* but not *every*; certain kinds of "generic" interpretations (i.e., those that

express generalizations that project beyond the local domain) are often possible given *every* but not *each*; and group-representations are triggered by sentences with *every* but not *each*. Learners thus need to acquire two similar terms that differ semantically in subtle ways.

3. How could learners notice the difference in principle?

What evidence could lead learners to conclude that these similar words differ in exactly the relevant way? While theorists have tools for uncovering the subtle differences discussed above, learners do not necessarily have access to the same information. Take the pair-list facts reviewed in §2, for instance. For facts like (2) and (3) to be useful for learning *each* and *every*, learners would need to hear not only the question, but the corresponding answer. Perhaps if they heard enough pair-list responses to *each*-questions while never hearing pair-list responses to *every*-questions, this difference could serve as a signal to the underlying semantic distinction between *each* and *every*.

In the North American English portion of CHILDES (MacWhinney 2000) that we examined (see the Appendix for details and citations), we found only 11 instances of *each* co-occurring with a WH-question (out of over 1.7 million utterances). Of these, only a single utterance, given in (9), was a question for which one could plausibly give a pair-list response. For example, one could imagine answering "the tiger is about to hunt, the zebra is about to run, and the monkey is about to have a banana."

(9) Father: What do you think each animal is about to do?
Child: Clean up that mess. Nathaniel, 3;04

Likewise, there were only 19 instances of *every* co- occurring with a WH-question. And of those, only one utterance, given in (10), could have been answered with a pair-list response (save for the fact that *every* was used).

(10) Mother: What did you play every day while you were there?
Child: …the water game. Son, 4;11

This makes it unlikely that learners could use information about the availability of pair-list responses (e.g., facts like (2) and (3) from §2) to infer anything about the semantics of *each* and *every* (though it remains to be seen whether other cues to the relative scope position of these quantifiers are present).

Similarly, the input will likely not contain details about whether parents are mentally representing the domain as a group or as individuals. For example, if a parent says *every circle is green* while looking at a scene, they will, by hypothesis, be treating the circles as a group, meaning they will have mentally extracted group properties like center of mass, cardinality, and average size. But short of being able to read their parents' minds, learners will not have access to this difference.

The "genericity" asymmetry, on the other hand, might drive large-scale differences in how parents use *each* and *every*. In particular, parents might use *every* but not *each* when they intend to convey broad generalizations that project beyond the local domain, like those in (8) or (11), which is found in the Peters/Wilson corpus (Wilson & Peters 1988).

(11) Every time I give you one [a cookie], you throw it. (spoken to Seth, 1;05)

In uttering (11), Seth's father is presumably not intending to highlight each past cookie-giving event and remember its properties in detail. Instead, he seems to be making a bigger claim about what happens, in general, when he gives his son a cookie. This generalization projects beyond the local domain in two respects. First, it quantifies over things (events, in this case) that are not co-present with the utterance. Second, and more importantly, it licenses a prediction: if given another cookie, Seth will throw it. Indeed, (11) was uttered in a context of trying to decide whether to give Seth a cookie, where the generalization that he's a cookie-thrower and the associated prediction is immediately relevant.

If parents use *every* – but not *each* – to express thoughts like the one expressed in (11), this difference in use could serve as a strong signal for acquiring the *each*/*every* difference. And given work arguing that preschoolers "default" to generic thinking (e.g., Leslie & Gelman 2012), there is some reason to think that learners may be able to pick up on their parents' intentions in this respect. Even so, low-level cues that correlate with genericity may also be helpful for noticing the distinction. In §4, we report on four such low-level footprints that plausibly reflect a quantificational determiner being used to convey a "generic" thought:

(12) a. Quantifying over times/situations/events
b. Having the domain explicitly restricted
c. Occurring in a clause in present tense
d. Appearing as a topic-setting adjunct

For each low-level difference in (12), we present the results from an analysis of child-directed speech and describe the potential link to the proposed difference in speaker meaning.

4. Parents' use of *each* and *every*

4.1. What is being quantified over?

First, we asked what types of things parents quantify over: times (e.g., *every year*), events (e.g., *every move you make*), measures (*every last bit*), locations (e.g., *every place*), or individuals (e.g., *every raven*). As seen in Figure 1, most of parents' *each* utterances quantify over individuals (e.g., *you need to eat each piece of broccoli if you want dessert*) whereas the vast majority of their *every* utterances quantify over times (e.g., *every time we have broccoli, you leave leftovers!*). Statistically, *every* is more likely to be used to quantify over times than *each*

(χ^2=260.95, p<.001) and *each* is more likely to be used to quantify over individuals than *every* (χ^2=145.65, p<.001).

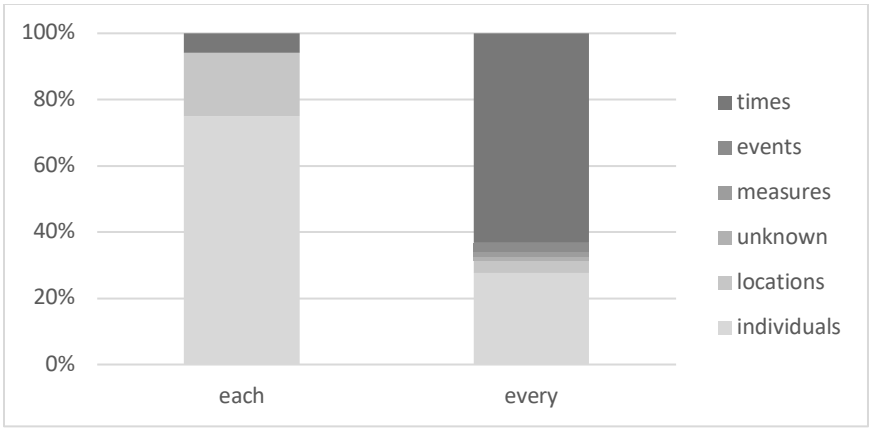

Figure 1: What gets quantified over by *each* or *every* in parents' speech.

If parents do use *each* to talk about local domains, it is perhaps unsurprising that they mostly use *each* to quantify over individuals. The individual toys, teacups, and pieces of food generalized over are more likely to be in the local domain than, for example, all the events of dinner-eating generalized over. For the same reason, it would likewise be unsurprising to find that the individuals quantified over by *each* are often co-present at the time of the parents' utterance whereas individuals quantified over by *every* are not (we hope to explore this possibility in future work). The idea of *each* more often quantifying over individual objects also makes sense given the findings, discussed in §2, that speakers treat the domain of quantification in an individualistic way for *each*.

In contrast, while *every* is sometimes used to quantify over individuals in a way that projects beyond the local domain (e.g., *every raven is black*), parents may be more likely to make projectable generalizations about situations and events, as these seem to be more useful.

4.2. Is the domain explicitly restricted?

Next, we asked whether the NP being quantified over was explicitly modified with a relative clause (e.g., *you turn into a wild man every time that we go out*). As seen in Figure 2, parents are more likely to use a relative clause to explicitly restrict the domain of quantification in *every*-utterances than in *each*-utterances (χ^2=81.7, p<.001).

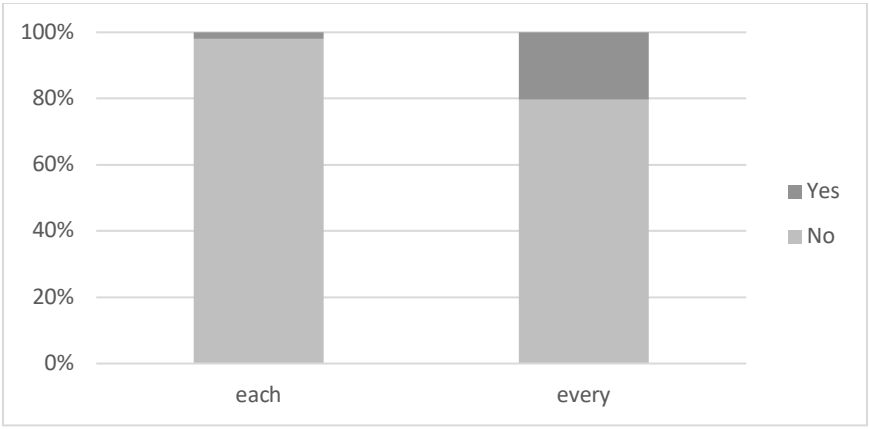

Figure 2: Percentage of times parents use a relative clause to modify the quantifier phrase, explicitly restricting the domain of quantification.

This difference may reflect the fact that parents are more likely to quantify over times with *every*: Generalizing over days, years, or times without qualification is likely less useful than generalizing over a specific subset of times (e.g., in the above example, the times that they go out). However, the statistical difference holds when considering just cases in which *each* or *every* are being used to quantify over individuals (χ^2=43.79 p<.001).

Why might this difference arise? One possibility is that in cases where parents use *each* the domain is contextually salient, making explicit restriction with a relative clause unnecessary. If a parent uttered something like *each toy needs to be put away*, the domain of quantification is likely understood to be the toys in the room, not all toys in the universe. It would be somewhat redundant to linguistically highlight the restricted domain, as in *each toy that is in this room needs to be put in the basket*. For this reason, we might expect fewer *each*-utterances to have the need for relative clause modification.

4.3. What is the tense of the quantifier phrase's clause

Next, we looked at the tense of the clause in which the quantifier appeared. Most utterances with either *each* or *every* are in present tense. But for *each*, there is a higher rate of past tense than for *every* (χ^2=8.49, p<.05; Figure 3), as well as a higher rate of "tenseless" utterances (χ^2=50.71, p<.001). Included in this category – labeled "no" in Figure 3 – are future-oriented imperatives like *put sugar in each coffee*.

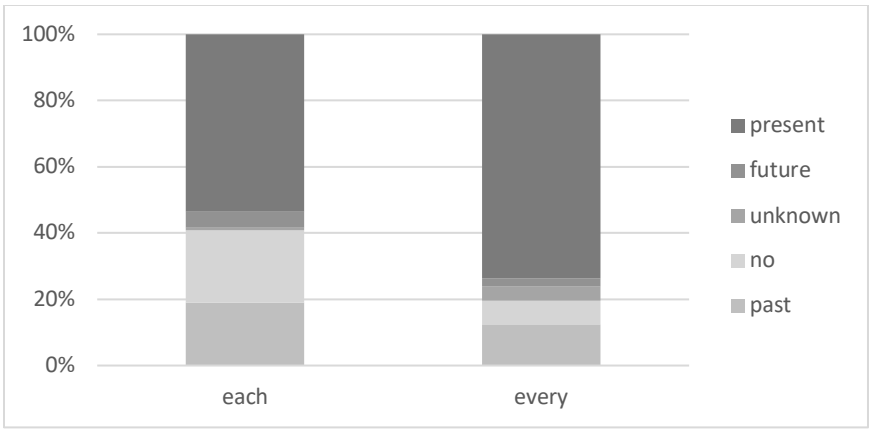

Figure 3: Tense of the clause in which the quantifier phrase appears.

To the extent that parents use *every* to express "generic" generalizations, it makes sense that *every* does not occur in clauses in past tense. This is because past tense is often incompatible with such interpretations. For example, (13a) is not naturally understood to have a generic interpretation, whereas (13b) is.

(13) a. Every dog barked.
b. Every dog barks.

Likewise, imparities in speech to children are often instructions to change something about a very local domain (e.g., *pour milk into each cup*), not to project beyond it. This may explain why parents are more likely to use *each* over *every* in such utterances.

4.4. What is the syntactic position of the quantifier phrase?

Lastly, we considered syntactic position. As seen in Figure 4, almost all of the utterances with *each* have the quantifier phrase in argument position, whereas in the majority of the utterances with *every*, the quantifier phrase is an adjunct. Statistically, *every* is more likely to show up as an adjunct than *each* (χ^2=258.34, p<.001). This may reflect the fact that parents use *each* to quantify over individuals in a local domain and thus want to predicate properties of those individuals. In contrast, since *every* seems to more often be used to make broad generalizations, it makes sense that quantifier phrases headed by *every* more often appear as topic-setting adjuncts (e.g., *every time I ask you a question, you say you don't know!*). However, this distinction may also reflect the propensity of *every* to be used for quantifying over times.

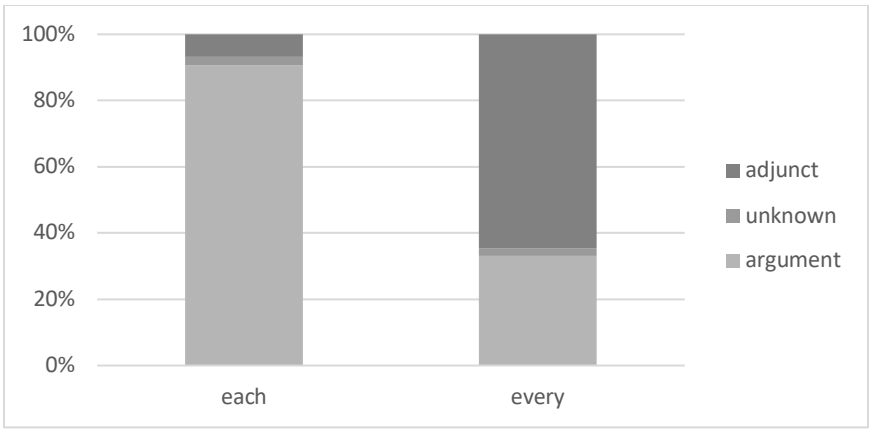

Figure 4: Syntactic position of the quantifier phrase in parents' speech.

5. Sketching the proposed learning story

In sum, there are low-level differences present in speech to children that plausibly stem from a difference in how parents use *each* and *every*. In particular, they seem to use *every* for expressing broad generalizations that are "generic" in the sense that they project beyond the local domain. In contrast, they seem to use *each* for talking about local domains. This difference in use may help children acquire the semantic difference between *each* and *every*. We now turn to the question of what that difference is: what are the targets of learning that this "genericity" asymmetry might highlight?

To be sure, there are a range of theories about the meanings of *each* and *every* that aim to account for the differences between them. Perhaps the most popular is that the linguistic differences discussed in §2 arise from a difference in the relative scope position of both quantifiers and a generic operator (e.g., Beghelli & Stowell 1997; Beghelli 1997). In other work we propose a representational distinction: *each* has completely first-order a meaning that involves no device for grouping satisfiers of a predicate, whereas *every* has a second-order meaning in which the first argument is treated as a group (e.g., Knowlton, Pietroski, Halberda, & Lidz *under review*). We will assume this proposal for the remainder of the paper, and leave a direct comparison between the two approaches for future work.

On the representational view, the first-order meaning of *each* is grounded in our psychological system for object-files (see e.g., Feigenson, Dehaene, & Spelke 2004). This system for representing multiple distinct entities simultaneously can be thought of as generating representations that are pointers to individual objects to which properties are bound. These properties though, are largely treated as incidental: what makes an object an object is not its color or shape or size etc. As such, representations created by this system do not, on their own, support generalizations. That two object files share some properties is an accident as far as the object-file system is concerned.

In contrast, on this view, the second-order meaning of *every* is grounded in psychological systems for representing ensembles (see e.g., Ariely 2001; Whitney & Leib 2018). Ensemble representations are pointers to multiple similar objects at once, where the whole collection is encoded in terms of summary statistics (e.g., average size, center of mass, cardinality). Moreover, they are initiated based on homogeneity (e.g., a bowl of lemons can trigger an ensemble representation, but a collection of random objects may be too heterogenous to trigger an ensemble representation). These representations have properties that make them appear to be compatible with "generic" thoughts of the sort at issue here. Most importantly, to be a member of an ensemble is to contribute to its summary statistics. This allows for a prediction not unlike the projection beyond the local domain seen in *every*-utterances: if a new object or event is a member of the ensemble, it will be similar to the current members.

To put the claim succinctly: *every*'s second-order meaning is grounded in ensemble representations, which are compatible with the sort of "generic" thoughts discussed here. To be sure, this claim will require further theoretical development and empirical defense. But, if right, then the proposed representational difference between *each* and *every* can explain why the two words get used in different ways. In particular, parents use *each* to make claims about local individuals because the cognitive system underlying *each*'s meaning is a system for representing individuals and their properties. They use *every* to express broad generalizations that project beyond the local domain because the cognitive system underlying *every*'s meaning allows for projection. The difference in use in turn leaves low-level footprints, like whether individuals or times are more often quantified over.

For learners, the inference runs in the opposite direction. They can use the low-level cues – perhaps in conjunction with an understanding of their parents' intended messages – to pair the quantifier used with the meaning that is linked to a cognitive system that supports the desired understanding. For example, they can use the detectable differences to pair *every* with a second-order meaning grounded in ensemble representations that supports a "generic" understanding. The elements of this learning story and the links between them are given in Figure 5.

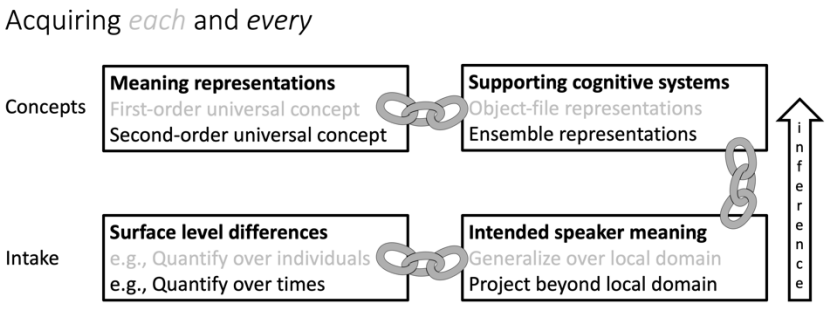

Figure 5: A sketch of the proposed learning story.

In this paper, we have offered evidence about what kinds of low-level linguistic data are available to learners (i.e., the box labeled "Surface level differences" in Figure 5). Future theoretical work will further explore the relationship between ensemble representations and "generic" thoughts, and how the representational difference between *each* and *every* leads to the apparent difference in intended speaker meanings. Future empirical work will take aim at the learning question: Are learners are actually sensitive to these lower-level cues and do they use these cues to make the sort of inference described here? Moreover, the question of cross-linguistic generalizability looms large: Are these low-level cues in English also found in other languages? We expect that while the precise low-level cues will vary from language to language, if a language has a second-order universal (e.g., a quantificational determiner most accurately translated as *every*), then it will be used for expressing "generic" thoughts.

Appendix

We analyzed utterances with *each* and *every* from corpora in the North American English portion of CHILDES (MacWhinney 2000). We focused on corpora that had typically-developing children under 8-years-old (Bates, Bretherton, & Snyder 1991; Bernstein 1982; Bliss 1988; Bloom, Hood, & Lightbown 1974; Bloom 1973; Bohannon & Marquis 1977; Braunwald 1971; Brent & Siskind 2001; Brown 1973; Clark 1978; Demetras 1989; Heilmann, Weismer, Evans, & Hollar 2005; Feldman 1998; Garvey & Hogan 1973; Gathercole 1980; Gelman, Coley, Rosengren, Hartman, & Pappas 1998; Gleason 1980; Haggerty 1929; Hall & Tirre 1979; Higginson 1985; Dickinson & Tabors 2001; Kuczaj 1977; MacWhinney 1991; McCune 1995; Morisset, Barnard, Greenberg, & Spieker 1990; Nelson 1989; Nino, Snow, Pan, & Rollins 1994; Newman, Rowe, & Bernstein Ratner 2016; Nicholas & Geers 1997; Peters 1987; Berl et al. 2005; Demetras, Post, & Snow 1986; Rollins 2003; Rondal 1978; Sachs 1983; Sawyer 1997; MacWhinney & Snow 1990; Soderstrom, Blossom, Foygel, & Morgan 2008; Suppes 1974; Valian 1991; Can Houten 1986; Warren-Leubecker 1982; Weist & Zevenbergen 2008).

In total, this sample contained over 1.7 million child-ambient utterances. Of these, there were only 538 utterances with *each* and 728 utterances with *every* (we only analyzed cases where *each* and *every* were transcribed as standalone quantificational determiners; lexicalized quantifiers like *everybody* or *everyone* were not included). For comparison, there were 20,558 utterances with *all*. Assuming that children hear between 900,000 and 2.5 million utterances each year (Hart & Risley 1995; 2003), we estimate that they likely hear *each* used in between 284 and 788 utterances and *every* used in between 384 and 1,067 utterances each year. For comparison, they likely hear between 10,843 and 30,119 instances of *all* in the same timeframe.

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