Every provides an implicit comparison class when *each* does not

Tyler Knowlton and Florian Schwarz*

1 Introduction

It's long been observed that *each* and *every*, while both distributive universal quantifiers, differ in subtle ways. One recent proposal, outlined in Knowlton (2021), seeks to explain these differences by positing a semantic distinction: the mental representation that serves as the meaning of *every* has a semantic constituent that calls for grouping the things quantified over as a plurality; the representation that serves as the meaning of *each* lacks any such piece.

A natural prediction of this view is that *every NP* should implicitly make available a plurality corresponding to "the NPs" in a way that *each NP* does not. We test this prediction in two forced choice judgment experiments, both involving sentence-internal elements that require anaphora to a plurality. As predicted, *every NP* is better able to provide the necessary plural comparison class to predicates involving *same*, and to serve as the antecedent of plural *they*.

2 Background

The English quantifiers *each* and *every* are obviously similar. For one thing, both express universal content, as opposed to being existential or proportional. For another, both are distributive universals, and as such are often contrasted with *all* in examples like (1).

(1) a. *Each/?Every frog gathered by the pond.
b. All the frogs gathered by the pond.

These sorts of examples are meant to illustrate that neither *each* nor *every* seem particularly fond of combining with collective predicates like *gather* or *surround*, which fundamentally predicate something of entire groups. It's often noted that *every* might be slightly less degraded than *each* when combined with collective predicates – hence the '?' – but even so, both *each* and *every* are commonly discussed in the literature as being distributive universal quantifiers (e.g., Beghelli and Stowell 1997, Tunstall 1998, Bumford 2015).

Despite both being distributive universal quantifiers, though, it's been acknowledged since at least Vendler (1962) that *each* is in some sense "more individualistic" (or "more distributive") than *every*. After asking readers to imagine a basket of apples, Vendler notes that while it's fine to say (2a) on its own, it sounds incomplete to say (2b) without further elaboration (e.g., *...and examine it for worms*).

(2) a. Take every one of them.
b. Take each one of them... and examine it for worms.

And since Vendler's initial exploration into this difference between these universal quantifiers, there have been various data points discovered (marshalled in support of various theoretical positions) that support his intuition. For example, in line with *every* being slightly friendlier to collective predicates, Landman (2003) notes that the *every*-variant of sentences like (3) is preferable to the *each*-variant; *every person* seems to be a better potential referent for the collective noun *the press*.

(3) The press is every/#each person who writes about the news.

Perhaps relatedly, *each* resists generic readings of sentences even when *every* permits them, as seen in (4), from Beghelli and Stowell (1997), and (5), from Knowlton et al. (2023b).

*For helpful discussions, we thank Zoe Ovans, Anna Papafragou, John Trueswell, Paul Pietroski, Jeff Lidz, and audiences at PLC 47 and HSP 2023. We also thank MindCORE at the University of Pennsylvania for funding this project.

(4) After devoting the last three decades to a study of lexical semantics, George made a startling discovery: Every/#Each language has over twenty color words.

(5) a. Every martini needs an olive. ≈ *a claim about martinis in general*
b. Each martini needs an olive. ≈ *some particular cocktails are missing garnishes*

Similarly, *each* more readily allows pair-list readings in cases where *every* resists them, or at least prominently allows for another reading, as seen in (6), modified from Beghelli (1997), and (7), from Surányi (2003).

(6) a. Which book did you loan to each student?
A: I loaned *Frankenstein* to Frank, *Persuasion* to Paula, and *Dune* to Dani.
b. Which book did you loan to every student?
A: There's no one book I loaned to every student; I loaned a different book to each.

(7) a. Determine whether each number in this list is odd: $\langle 1,3,4\rangle$.
A: 1: yes; 3: yes; 4: no
b. Determine whether every number in this list is odd: $\langle 1,3,4\rangle$.
A: No, it's not the case that every number is odd.

Though subtle, these contrasts illustrate the general sense in which *each* is more individualistic than *every*. This presents something of a puzzle: how can both quantifiers be distributive but nonetheless differ with respect to how individualistic they are? Put another way, how can this subtle, non-categorical difference between *each* and *every* be explained without losing sight of the obvious fact that they are both distributive universal quantifiers?

3 Proposed meaning difference

There are various sorts of explanations that have been given for the facts presented in the above section. This includes positing that the two expressions are synonymous but are associated with distinct syntactic features (e.g., Kroch 1974; Beghelli and Stowell 1997). But such strict grammatical approaches face issues with over- and under-generation of possible meanings for given sentences (see e.g., Surányi 2003; Brendel 2019). And, intuitively, the contrasts presented above seem more deserving of '#'s than '*'s. As such, we adopt a semantic approach, in particular, the one initially outlined in Knowlton (2021).

The idea is that while both expressions are universal quantifiers, *each* has a purely first-order meaning and directly combines with its restriction/internal argument ('$[\mathbf{I}(x)]$'), as in (8a). *Every* differs in that its meaning first groups the satisfiers of its internal argument with a second-order variable ('$\iota X\ldots$'), as in (8b), where **I** and **E** represent the quantifier's internal and external arguments.

(8) a. $\forall x[\mathbf{I}(x)][\mathbf{E}(x)]$ *each* ***I*** *is* ***E***
≈ *any thing*$_x$ *that satisfies* ***I*** *is such that it*$_x$ *satisfies* ***E***
b. $\iota X[\forall x[x \in X \equiv \mathbf{I}(x)]][\forall y[y \in X][\mathbf{E}(y)]]$ *every* ***I*** *is* ***E***
≈ *the things*$_X$ *that satisfy* ***I*** *are such that any thing*$_y$ *that's one of them*$_X$ *satisfies* ***E***

Essentially, the proposal is that both expressions support universally applying a predicate (the condition supplied by **E**) to some restricted domain (the things that meet the condition supplied by **I**). The difference is in how the domain is treated: as a series of independent individuals or as a group of some sort.[1] So both *each* and *every* are distributive because in both (8a) and (8b), the predicate is applied to the individuals in the domain 'distributively' ('$\forall x\ldots$'). But *every* is nonetheless friendlier

[1]The exact nature of this grouping depends on ancillary hypotheses about how to interpret second-order variables. On some views, first- and second-order variables range over distinct domains (e.g., individuals versus sets of individuals); on others, both sorts of variables range over the same domain but allow different kinds of assignments of values to variables (e.g., one individual at a time versus more than one individuals at a time). For discussion of this distinction see e.g., Boolos (1984, 1998), Schein (1993), Pietroski (2003, 2018).

to groups in the various ways noted above because only (8b) involves a representation of grouping the domain ('ιX...').

Put another way, the difference between *each* and *every* is that only *every*'s meaning has a piece corresponding to a grouping of its internal argument. The meaning of *every frog is green*, on this view, might be paraphrased as "the frogs are such that each one of them is green", whereas the meaning of *each frog is green* includes no constituent corresponding to the plurality "the frogs".

To be sure, the proposed meanings in (8) do not yet provide compositional details (which remains an important task for future work). They are, however, supported by a host of novel psycholinguistic predictions concerning which groups do and do not get mentally represented in the course of understanding sentences with *each* and *every*. The backbone of this psycholinguistic work relies on the notion of a psychological ensemble: the mind's way of aggregating individuals and representing them as a single collection (see Whitney and Yamanashi Leib 2018 for review). A symptom of engaging in ensemble representation is that participants recall "group properties" of the individuals encoded as an ensemble. These properties include the cardinality, center of mass, and average hue of a series of visually presented objects, as well as the average frequency of a series of auditorily presented tones. Leveraging work on this mental system from cognitive and developmental psychology, a spate of recent psycholinguistic work has found that speakers deploy ensemble representation in response to understanding sentences with *every* to a greater degree than in response to understanding sentences with *each*.

For example, Knowlton et al. (2022) found that when asked to verify sentences like *every big circle is blue*, participants accurately recalled the cardinality of the big circles, but their ability to recall this group property suffered when they were shown the same images but instead asked to verify sentences like *each big circle is blue*. Building on this result, Knowlton et al. (2023a) found that sentences with *every* only lead to accurate recall of group properties for the internal argument: participants were far less accurate when asked about the group defined by the external argument (e.g., the blue things) or by the conjunction of the internal and external arguments (e.g., the big blue circles). Similar results have been found for other group properties besides cardinality, like center of mass of a visual group (Knowlton 2021) and average tone of an auditory group (Ongchoco et al. 2023). In general, sentences in which some things are quantified over with *every* lead participants to mentally group those things to a greater degree than otherwise equivalent sentences in which universal quantification is indicated with *each*.

That said, the bulk of this evidence in favor of the proposed meanings in (8) comes from one kind of paradigm (sentence verification tasks). Given this fact, along with the subtlety of the contrasts initially motivating (8), broadening the empirical landscape is crucial.

4 A novel prediction of the proposed meanings

Here, we seek to test a novel prediction of the proposed distinction in (8). Namely, if the meaning of a sentence like *every frog is green*, but not that of *each frog is green*, decomposes in part into "the frogs...", as in (8b), we expect *every frog* to make a plural antecedent available in ways that *each frog* does not. That is, if *every frog* implicitly introduces the group of frogs, then perhaps other linguistic items that require antecedents can pick up on this plural object. And if *each frog* doesn't likewise introduce such a plurality, then we might expect *every frog* to be better than *each frog* at providing a plural antecedent.

Of course, this is not to suggest that the presence of a group in the meaning representation is the sole way for that group to be the target of anaphora, nor is it to suggest that that the presence of a group in the meaning representation is sufficient for establishing anaphora. That is, this novel prediction is not meant to suggest that having or not having a group representation in a meaning like those in (8) in any way supplants extant theories of anaphora (e.g., Moxey and Sanford 1993, Sanford et al. 1996,Kibble 1997, Patterson et al. 1998, Hendriks and de Hoop 2001, Nouwen 2003). The idea is merely that a plurality introduced by a meaning representation is more easily accessible than a plurality that isn't. And if the pragmatic influences on the availability of that plurality for anaphora are held constant (by keeping the context and the rest of the sentence identical), then perhaps a

difference owing to whether a group representation is present in the meaning can be detected.

In what follows, we test this prediction in two experiments. The first experiment asks whether *every* is better able to provide a plural comparison class for sentence-internal *same*. The second asks whether *every* is better able to provide a plural antecedent to sentence-internal *they*. In both experiments, we make the same general prediction: In otherwise identical contexts, *every NP* should be better able to serve as a plural antecedent than *each NP*.

4.1 Experiment 1: Sentence-internal *same*

One potential testing ground for this prediction is sentences with predicates involving *same*. Such predicates, like *be the same color*, require a comparison class (i.e., same as what?) (see e.g., Kuhn 2015). For this reason, out of the blue, a sentence like (9a) is fine, but a sentence like (9b) is not.

(9) a. The frogs are the same color.
b. #Kermit is the same color.

In the former case, the comparison class is clear (the frogs are the same color as each other), whereas the latter case requires some extra contextual support (e.g., pointing to some other frogs, or to some shade of green). So if *every frog* covertly introduces the plurality "the frogs", then it should behave more like (9a). And if *each frog* provides no such plural comparison class, and instead invokes the notion of applying the predicate (*be the same color*) to each frog individually, it should behave more like (9b). This is not absolute; it may well be possible to access the necessary comparison class through some form of pragmatic accommodation. Our key prediction is just that *every* should make accessing that comparison class easier than *each*.

Intuitively, this prediction seems to be borne out. Holding fixed the size of the domain and other potentially-relevant contextual details, a sentence like (10a) seems degraded compared to the corresponding *every*-variant in (10b). And this contrast seems to disappear when given another way of making salient the comparison class, like mentioning other frogs, as in (10c) and (10d).

(10) a. #Each frog is the same color.
b. Every frog is the same color.
c. Each frog is the same color as the others.
d. Every frog is the same color as the others.

To test this prediction more systematically, we recruited 120 English-speaking adults online to participate in a forced choice judgment experiment in which participants were instructed to "select a word to fill in the blank". Each trial consisted of a sentence, with a dropdown menu labeled "(select a word)" obscuring part of the text. Upon clicking this menu, participants were allowed to choose a word; in the critical trials, they were faced with a choice between *each* or *every*. See Figure 1 for a schematic depiction.

Figure 1: Schematic depiction of participants' experience in Experiment 1.

The experiment itself was built using PCIbex (Zehr and Schwarz 2018). All participants gave informed consent and were compensated for their time. The task consisted of 28 items in total, 16 of which were unrelated filler items. These fillers asked participants to choose between *both of them* and *the two of them*, which we selected given that they are also near-synonyms which may differ in degree of distributivity. The remaining 12 items were the experimental targets, and each had the structure of (11).

(11) Friday was a great day to practice tennis at the park.
Interestingly, {each/every} player had the same skill level (as their teammates).

Each item involved a short context sentence followed by a quantificational phrase paired with a predicate involving *same*. The presence of a linguistically explicit comparison class, by way of an *as*-phrase containing a plural NP (the parenthetical material in (11)), was manipulated between subjects (see Figure 1). That is, half of the participants received the linguistically explicit material in parentheses, whereas for the other half of the participants, the comparison class was left implicit (i.e., they saw examples like (11) but without the parenthetical material). The full list of experimental items is reported in the Appendix.

This "linguistically explicit comparison class" condition functions as a kind of baseline, allowing us to determine the acceptability of the sentences with *each* and *every*. Any residual preference for *every* can thus be attributed to its being better able to provide the necessary plural comparison class. Our dependent measure, then, is the degree to which participants prefer *every* over *each*. By hypothesis, the choice between quantifier should matter less in cases where the comparison class is explicitly introduced, but without the *as*-phrase, participants should prefer *every*.

These predictions were borne out. As seen in Figure 2, participants favored *every* in the absence of another source of the comparison class for *same* (one sample $t_{707} = 5.58, p < .001$). But this preference disappeared when the comparison class was made linguistically explicit through the presence of the *as*-phrase (main effect of *as*-phrase on rate of picking *every*: $\beta = -.15$ [95% CI: $-.19$ to $-.12$], $t = -4.61$, $p < .001$). In other words, it appears that *every NP* is better able to provide a plural comparison class for predicates involving *same* than *each NP*, as expected given the proposed meanings in (8).

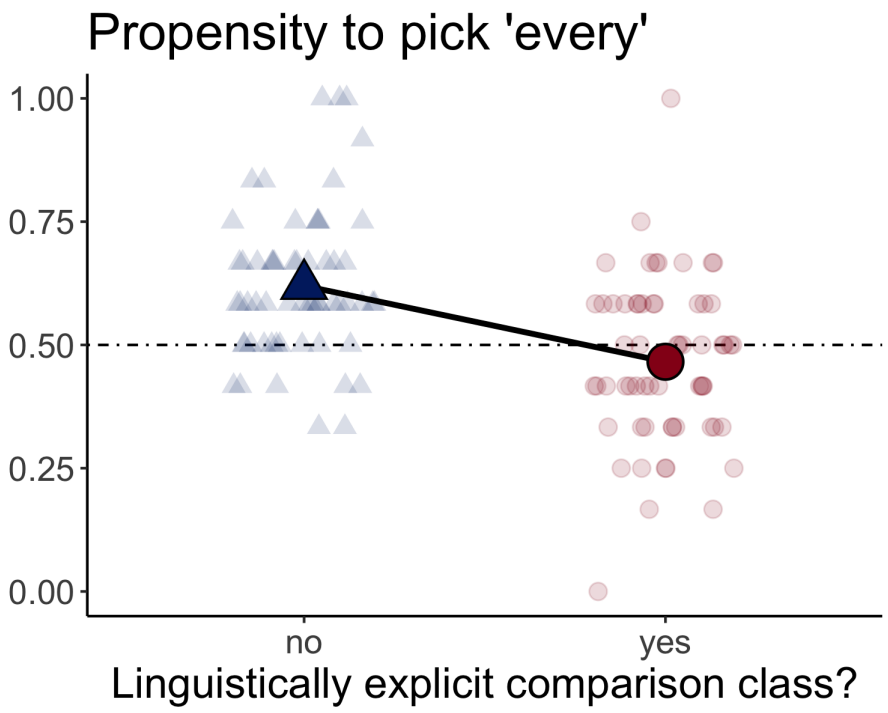

Figure 2: Participants' propensity to select *every* over *each* in Experiment 1 given the presence or absence of a linguistically explicit comparison class (e.g., *as their teammates*). Translucent points represent individual performance.

4.2 Experiment 2: Sentence-internal *they*

Another, potentially more straightforward, testing ground for our prediction is sentence-internal *they*, which requires an antecedent. In some cases, this required antecedent moreover needs to be plural. For example, consider (12).

(12) Before asking for donations for the race, {each/every} runner was promised that they would jointly decide on a charity to support.

Here, the collective predicate *jointly decide on a charity to support* ensures that *they* requires a plural antecedent (without a collective predicate, it could easily be understood as an instance of singular *they*, for which *each runner* could serve as a perfectly fine antecedent). Our intuition is that *every* is preferred over *each*, because *every runner* makes more salient the desired plural antecedent of *they*, namely, "the runners".

To test this prediction more systematically, we again recruited 120 English-speaking adults online to participate in a forced choice judgment experiment. As in Experiment 1, participants' task was to "select a word to fill in the blank" and each trial consisted of a sentence with a dropdown menu obscuring part of the text. As before, all participants gave informed consent and were compensated for their time. Experiment 2 also consisted of 16 filler and 12 target items, each of which mirrored the structure of the example in Figure 3 (the full list of experimental items is reported in the Appendix).

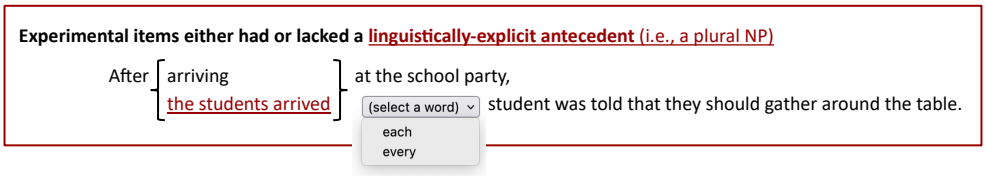

Figure 3: Schematic depiction of participants' experience in Experiment 2.

That is, each item involved a short preamble (the content before the comma) followed by a quantificational phrase paired with a collective predicate involving *they*. For half of the participants, the plural antecedent was made linguistically explicit. This was accomplished by replacing the gerund in the preamble with an explicit subject and a past tense verb (e.g., *After arriving...* became *After the students arrived...*). As in Experiment 1, this "linguistically explicit antecedent" condition functions as a kind of baseline, allowing us to determine the acceptability of the sentences with *each* and *every* independently. By hypothesis, without the explicit antecedent, participants should prefer *every* over *each* (at least relative to their baseline preference for either).

These predictions were borne out. As seen in Figure 4, participants showed an overall *each*-bias. But importantly for our purposes, participants were more likely to select *every* when the linguistically explicit antecedent was absent (main effect of explicit antecedent on rate of picking *every*: $\beta = -.11$ [95% CI: $-.16$ to $-.06$], $t = -2.40$, $p < .05$). Whatever the source of the general *each*-bias, then, this baseline preference can be ameliorated by removing an easy source of the necessary plural antecedent for *they*. In other words, it again seems that *every NP* is better able to provide a plural antecedent than *each NP*, as expected given the proposed meanings in (8).

5 Discussion

The above experiments suggest that *every NP* is better able to supply a plural comparison class for sentence-internal *same* and a plural antecedent for sentence-internal *they*. This pattern of results is well-explained given the proposed difference between *each* and *every* in (8). That is, the present results support the idea that *every NP* introduces the plurality "the NPs" in a way that other linguistic elements can pick up on, and in a way that *each NP* does not, even in otherwise identical contexts.

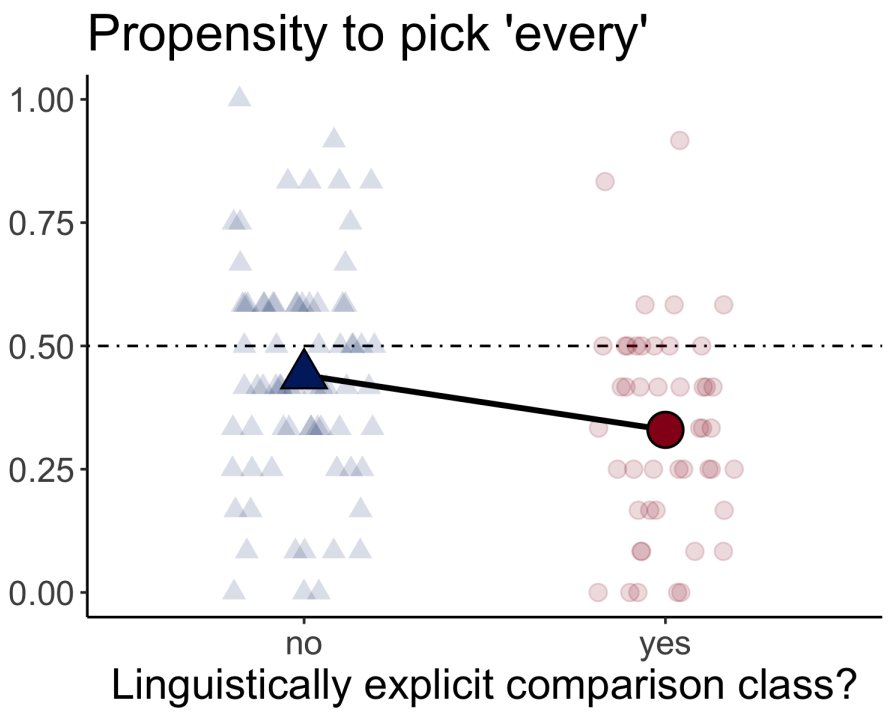

Figure 4: Participants' propensity to select *every* over *each* in Experiment 2 given the presence or absence of a linguistically explicit antecedent (e.g., *the students arrived*). Translucent points represent individual performance.

As always, it is worth asking whether alternative views might be able to account for our results. There have been, as noted above, a number of proposals about what differs between *each* and *every*. We touch on two of the better-known proposals here.

First, consider the idea that *each* and *every* have the same meaning but differ in syntactic features/position. This sort of approach is perhaps most thoroughly articulated in Beghelli and Stowell (1997). Very roughly, the gist is that *each* scopes higher than *every*, due to having a "strong distributivity" feature that requires checking in the specifier of a functional projection situated relatively high in the sytactic structure. This functional projection, DistP, is proposed to house the distributivity operator, which is taken to be responsible for enforcing distributive readings of sentences. The idea is that, as a consequence of always moving to Spec,DistP, *each* always gives rise to distributive readings. *Every*, in contrast, is said to have a "weak distributivity" feature, which only sometimes triggers movement to Spec,DistP. As a consequence, *every* sometimes avoids distributive readings (e.g., when other material intervenes to block movement). Moreover, if one assumes that a genericity operator is responsible for generic readings of sentences, and that this operator lives at a lower functional projection, then this sort of view can also capture the observation that *every* is friendlier to genericity than *each* (i.e., *each* never associates with the genericity operator because *each* always moves away from it to associate with the distributivity operator).

In our view, this sort of cartographic approach is better suited to handling categorical contrasts. A lot of the data at issue with respect to *each* versus *every* strike us as non-categorical. They seem not to be matters of ungrammaticality, but subtle differences in compatibility of either quantifier with expressing a certain kind of thought. This isn't to say there aren't syntactic differences between *each* and *every*, just that the sorts of differences at issue here – those pertaining to *each* being more individualistic – are more fruitfully thought of as genuine semantic differences. For instance, we see no obvious way of deriving the antecedent availability effect tested in our two experiments from scope differences. To reiterate, the effect under investigation here isn't in any sense incompatible with there being syntactic differences between *each* and *every*; but it's not clear to us that this effect

could rightly be claimed as a prediction of the syntactic view.

Turning to another well-known proposal, Tunstall (1998) takes a more semantic tack. The basic idea is that different universal quantifiers have the same core meaning but impose different conditions on the events they get used to describe. *Each* is said to impose the strict condition wherein each object quantified over has to be part of a separate event. In *Kermit lifted each basket*, for example, the liftings must, in some sense, be done independently of each other. So this sentence would be a good description of a case where, for example, he lifted one basket in his left hand, one in his right hand, and another with his mouth. Or it might describe a case in which he lifted one basket with both hands, put it down, lifted the next, put it down, and so on. In contrast, *every* is said to impose a weaker requirement that there be some differentiation. So *Kermit lifted every basket*, on this view, can describe a situation in which Kermit lifted two baskets together, put them down, then lifted a third (unlike *each*), but not a situation in which he lifted them in one fell swoop (unlike, for example, *all*, which is said to impose no such differentiation condition).

Again, this view might well be right, but it doesn't seem to us that it readily explains or predicts the effects observed here pertaining to antecedent availability. Importantly, this event differentiation view does not maintain that *every NP* groups the NPs; if anything it suggests that there isn't a full grouping corresponding to "the NPs", as there has to be some amount of separation of the things named by the NP being quantified over. And the link between mere partial differentiation (as opposed to full differentiation) and antecedent availability is not an obvious one. That said, maybe *every NP* is simply a better option than *each NP* because the former requires less differentiation. Perhaps one could pursue the idea that *all NP*, which requires no differentiation, would be an even better way to provide a plurality than *every NP*. Such a finding might be taken to support the idea that event differentiation is at issue when it comes to antecedent availability, though there is a tricky confound given that *all* requires plural agreement (which presumably itself may help make the plural antecedent more easily available). As with the syntactic view, though, this event-based approach need not be incompatible with the proposed meanings in (8). Our claim here is just that the proposed semantic difference in (8) more clearly predicts and explains the results we observe.

In sum, we think this kind of finding adds grist for the mill of saying that the difference – or at least a main difference – between *each* and *every* is that the latter's meaning has a piece that corresponds to a grouping of its first argument, whereas the former's meaning has no such piece.

6 Appendix

Experimental items from Experiment 1. Participants chose between *each* and *every*. Participants in the "explicit comparison class" condition saw the parenthetical content; other participants saw no *as*-phrase.

(13) Anna and John decided to throw a school Halloween party.
Surprisingly, {each/every} student showed up in the same costume (as their classmates).

(14) The university president asked for nominations for commencement speakers.
Unfortunately, {each/every} professor came up with the same suggestion (as their colleagues).

(15) Friday was a great day to practice tennis at the park.
Interestingly, {each/every} player had the same skill level (as their teammates).

(16) A regional bank hosted a charity run.
Amazingly, {each/every} employee raised the same amount of money (as their coworkers).

(17) An Italian restaurant downtown was the venue for a theater troupe meeting.
Surprisingly, {each/every} actor ordered the same entrée as their colleagues.

(18) The family cookout last week was a lot of fun.
Astonishingly, {each/every} guy ate the same amount of meat (as his brothers).

(19) A popular sorority invited new recruits last week.
Coincidentally, {each/every} girl wore the same dress (as her sorority sisters).

(20) A Coast Guard endurance training exercise was happening near a popular beach.
Coincidentally, {each/every} sailor swam the same distance (as their shipmates).

(21) The resident director suspected his housework survey would spark discussions about equal sharing of responsibilities around the dorm.
Remarkably, {each/every} undergrad spent the same amount of time on chores (as their dormmates).
(22) A bunch of cousins went to a family style Sunday brunch to catch up.
Naturally, {each/every} family member paid the same amount (as their relatives).
(23) Selecting the village resident with the best holiday decorations this year was tough.
Amusingly, {each/every} villager got the same number of points (as their neighbors).
(24) The mayor asked a local art commune to paint a mural on an old building.
Shockingly, {each/every} artist used the same amount of paint (as their collaborators).

Experimental items from Experiment 2. Participants chose between *each* and *every*. Participants in the "explicit NP" condition saw the parenthetical content; other participants saw a gerund (e.g., *after arriving*) in place of "the NPs Ved" (e.g., *the students arrived*).

(25) After the students arrived at the school party,
{each/every} student was told that they should gather around the table.
(26) After the professors decided on the job candidate list,
{each/every} professor was informed that they had to unanimously agree on a winner.
(27) After the players arrived at the baseball field,
{each/every} player was told that they needed to form a stretching circle.
(28) Before the runners asked for donations for the race,
{each/every} runner was promised that they would jointly decide on a charity to support.
(29) Before the lawyers placed dinner orders,
{each/every} lawyer was reminded that they should huddle around the table to discuss business.
(30) Before the fraternity brothers prepared for the cookout,
{each/every} fraternity brother was told that they would team up to cook one meal as a group.
(31) After the sorority sisters learned of a movie star visiting campus,
{each/every} sorority sister was told that they should not surround their special guest.
(32) When the sailors jumped into the water to swim,
{each/every} sailor was promised that they would congregate on the shore after the race.
(33) Before the residents kept track of chores for a week,
{each/every} resident was warned that they would gather to discuss responsibilities soon.
(34) After the relatives sat down to an expensive meal,
{each/every} relative was informed that they are not allowed to split the check evenly.
(35) When the neighbors voted for the best decorated house,
{each/every} neighbor was told that they should assemble in the town hall to hear the results.
(36) Before the artists submitted a proposal for a new mural,
{each/every} artist was told that they would jointly paint the winning degisn.

References

Beghelli, Filippo. 1997. The syntax of distributivity and pair-list readings. In *Ways of Scope Taking*, ed. Anna Szabolcsi, 349–408.

Beghelli, Filippo, and Tim Stowell. 1997. Distributivity and negation: The syntax of each and every. In *Ways of Scope Taking*, ed. Anna Szabolcsi, 71–107.

Boolos, George. 1984. To be is to be a value of a variable (or to be some values of some variables). *The Journal of Philosophy* 81:430–449.

Boolos, George. 1998. *Logic, Logic, and Logic*. Harvard University Press.

Brendel, C. I. 2019. An investigation of numeral quantifiers in english. *Glossa: A Journal of General Linguistics* 4.

Bumford, Dylan. 2015. Incremental quantification and the dynamics of pair-list phenomena. *Semantics and Pragmatics* 9:1–70.

Hendriks, Petra, and Helen de Hoop. 2001. Optimality theoretic semantics. *Linguistics and Philosophy* 24:1–32.

Kibble, Rodger. 1997. Complement anaphora and dynamic binding. *Semantics and Linguistic Theory* 7:258–275.

Knowlton, Tyler. 2021. The Psycho-logic of Universal Quantifiers. Doctoral dissertation, University of Maryland.

Knowlton, Tyler, Paul Pietroski, Justin Halberda, and Jeffrey Lidz. 2022. The mental representation of universal quantifiers. *Linguistics and Philosophy* 45:911–941.

Knowlton, Tyler, Paul Pietroski, Alexander Williams, Justin Halberda, and Jeffrey Lidz. 2023a. Psycholinguistic evidence for restricted quantification. *Natural Language Semantics* 31:219–251.

Knowlton, Tyler, John Trueswell, and Anna Papafragou. 2023b. Keeping quantifier meaning in mind: Connecting semantics, cognition, and pragmatics. *Cognitive Psychology* 144:101584.

Kroch, Anthony. 1974. The semantics of scope in English. Doctoral dissertation, Massachusetts Institute of Technology.

Kuhn, Jeremy. 2015. Cross-categorial Singular and Plural Reference in Sign Language. Doctoral dissertation, New York University.

Landman, Fred. 2003. Predicate-argument mismatches and the adjectival theory of indefinites. In *From NP to DP*, ed. M Coene and Y D'hulst, 211–237.

Moxey, Linda M., and Anthony J. Sanford. 1993. *Communicating quantities: a psychological perspective*. Lawrence Erlbaum Associates.

Nouwen, Rick. 2003. Complement anaphora and interpretation. *Journal of Semantics* 20:73–113.

Ongchoco, Julia, Tyler Knowlton, and Anna Papafragou. 2023. Language shifts the representation of sounds in time: From auditory individuals to auditory ensembles. In *Proceedings of the Annual Meeting of the Cognitive Science Society*, ed. M Goldwater, F. K. Anggoro, B. K. Hayes, and D. C. Ong.

Patterson, Kevin B., Anthony J. Sanford, Linda M. Moxey, and Eugene Dawydiak. 1998. Quantifier polarity and referential focus during reading. *Journal of Memory and Language* 39:290–306.

Pietroski, Paul M. 2003. Quantification and second-order monadicity. *Philosophical Perspectives* 17:259–298.

Pietroski, Paul M. 2018. *Conjoining Meanings: Semantics Without Truth Values*. Oxford University Press.

Sanford, Anthony J., Linda M. Moxey, and Kevin B. Paterson. 1996. Attentional focusing with quantifiers in production and comprehension. *Memory and Cognition* 24:144–155.

Schein, Barry. 1993. *Plurals and Events*. MIT Press.

Surányi, László Balázs. 2003. Multiple Operator Movements in Hungarian. Doctoral dissertation, Utrecht University.

Tunstall, Susanne. 1998. The Interpretation of Quantifiers: Semantics and Processing. Doctoral dissertation, University of Massachusetts Amherst.

Vendler, Zeno. 1962. Each and every, any and all. *Mind* 71:145–160.

Whitney, David, and Allison Yamanashi Leib. 2018. Ensemble perception. *Annual review of psychology* 69:105–129.

Zehr, Jeremy, and Florian Schwarz. 2018. Penncontroller for internet based experiments (ibex).

Department of Linguistics & MindCORE
University of Pennsylvania
3401 Walnut St.
Philadelphia, PA 19104
tzknowlt@upenn.edu
florians@upenn.edu