A psycho-semantic explanation of “each” and “every” quantifier use

“Each” and “every” can be used to express the same truth-conditions but differ in their contexts of use. A long-standing observation is that “each” is somehow more individualistic than “every” [A]. On standard (truth-conditional) approaches, capturing this difference requires additional machinery [B]. We adopt an alternative, mentalistic semantics for the two quantifiers and show that it correctly predicts a host of known and newly-observed constraints on how “each” and “every” are pragmatically used.

On this alternative [C,D], quantifier meanings are mental representations with different properties. In particular, “each” treats its first argument as independent individuals, whereas “every” groups its first argument. So despite shared truth-conditions, processing sentences with “each” or “every” leads to the assembly of distinct mental representations: “each” implicates the cognitive system for parallel-individuation [E]; “every” implicates the system for ensemble representation [F]. We propose that this meaning difference predicts a host of usage differences (all consistent with the long-held intuition that “each” is more individualistic [A]).

First, since parallel-individuation is subject to more stringent working memory constraints than ensemble representation [G], “every” should be preferred when the domain of quantification is larger as opposed to smaller. Second, since parallel-individuation treats individuals independently whereas ensemble representations describe many individuals with summary statistics (e.g., their average size) [H], “every” should be preferred when the speaker intends to license a global generalization as opposed to a statement about the locally-established domain. Third, though both quantifiers are ‘distributive universals’ [B,I], “every” groups the domain, and thus should be better suited to collective predicates, which apply to groups. In a series of experiments, we show that people’s preferences for “each” vs. “every” confirm these predictions.

In three forced-choice judgment experiments conducted on Prolific, participants chose between “each” and “every” for 12 sentences in minimally-different pragmatic contexts, manipulated within-subjects. They were asked to “pick which sentence best continues the story”. In Exp1 ($n=100$), the context either established a small or large domain (“three” vs. “three thousand martinis”; see example in (1)). Participants were more likely to pick “every” for the large compared to the small domain ($p<.001$; Fig1). Exp2 ($n=100$) established a small domain (see example (2)) and the quantificational phrase either referred back to that domain or explicitly went beyond it. Participants were more likely to pick “every” when quantification projected beyond the locally-established domain ($p<.001$; Fig2). Exp3 ($n=100$) sentences either contained collective predicates, which apply to groups as a whole (“gathered in the hall”) or distributive predicates, which apply to individuals (“went to their locker”; see example (3)). Participants were more likely to pick “every” given a collective predicate ($p<.001$; Fig3).

Finally, Exp4 ($n=198$) confirmed the domain size differences more directly: participants were asked how many martinis someone had in mind after they said “each/every martini needs an olive”. Participants were more likely to provide an answer ≤3 in the “each” than the “every” condition ($\chi^2=11.97$, $p<.001$; Table2).

The current results demonstrate that fine-grained differences in semantic representations affect canonical patterns of use in predictable ways, thereby offering natural links between the psycho-semantics and pragmatics of quantifiers. By treating the output of semantics as mental representations that are more finely articulated than propositions (/truth-conditions), we can explain these otherwise puzzling patterns.

(1) a. The bartender at the local tavern has made three martinis. (SMALL DOMAIN)
He said that {**each**/every} martini he made had an olive.
b. The bartender at the local tavern has made three thousand martinis. (LARGE DOMAIN)
He said that {each/**every**} martini he made had an olive.

(2) a. The bartender at the local tavern made a few martinis.
He said that {**each**/every} martini that he made has an olive. (LOCAL DOMAIN)
b. The bartender at the local tavern made a few martinis.
He said that {each/**every**} martini that's worth drinking has an olive. (GLOBAL DOMAIN)

(3) a. Math class at the local middle school lasts a full hour.
After class, {**each**/every} student went to their locker. (DISTRIBUTIVE PREDICATE)
b. Math class at the local middle school lasts a full hour.
After class, {each/**every**} student gathered in the hall. (COLLECTIVE PREDICATE)

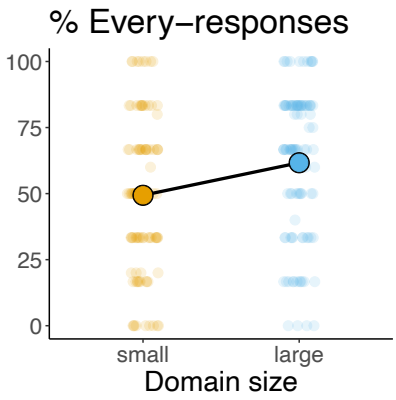

Figure 1 - Exp1

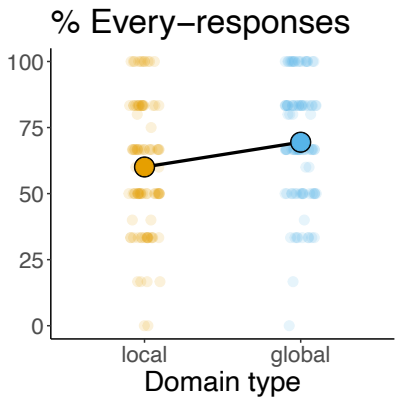

Figure 2 - Exp2

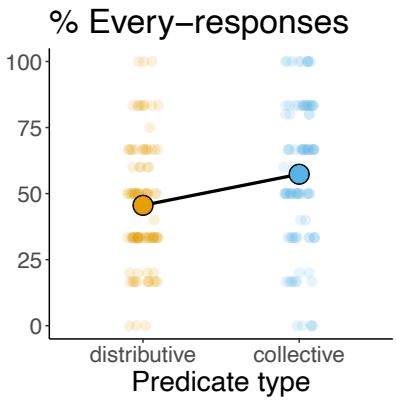

Figure 3 - Exp3

Table 1: Results of mixed-effects binomial regression with effects coding

Experiment	Estimate	SE	z value	P(z)
1: Domain size	0.6995	.132	5.30	<.001 ***
2: Domain type	0.5707	.132	4.31	<.001 ***
3: Predicate type	0.58906	.129	4.56	<.001 ***

Table 2: Responses to the Exp4 question:
If someone said: {*each*/*every*} *martini needs an olive,*
how many martinis would you guess they have in mind?

Quantifier	**≤3**	4-5	≥6	Infinitely many	Exhaustive (e.g., "all of them")
Each	**62**	10	12	0	9
Every	**29**	13	21	5	30

References

[A] Vendler (1962) *Each* and *every*, *any* and *all* **[B] Beghelli & Stowell (1997)** Distributivity and negation: the syntax of *each* and *every*. **[C] Knowlton, Pietroski, Halberda & Lidz (2021)** The mental representation of universal quantifiers. **[D] Knowlton (2021)** The psycho-logic of universal quantifiers. **[E] Kahneman, Treisman & Gibbs (1992)** The reviewing of object files: Object-specific integration of information. **[F] Whitney & Yamanashi Leib (2018)** Ensemble perception. **[G] Feigenson & Carey (2005)** On the limits of infants' quantification of small object arrays. **[H] Haberman & Whitney (2012)** Ensemble perception: Summarizing the scene and broadening the limits of visual processing. **[I] Dowty (1987)** Collective predicates, distributive predicates, and *all*.